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Draft B

Expedited Response Action Proposal (EE/CA & EA) for 200 West Area Carbon Tetrachloride Plume

United States
Department of Energy
Richland, Washington

Approved for Public Release

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1.0 INTRODUCTION

The report contains the proposal for an expedited response action (ERA) for the remediation of carbon tetrachloride contamination in the unsaturated soils beneath the 200 West Area of the Hanford Site (Figure 1). It provides the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) with information regarding the need for the ERA and an evaluation of alternatives to reduce the mobility, toxicity, and/or volume of the carbon tetrachloride in the unsaturated soils. This report is intended to aid the EPA and Ecology in selecting a preferred alternative for implementing the ERA. This proposal does not address remediation of carbon tetrachloride in the ground water underlying the 200 West Area; nor is the radioactive waste mixed with the carbon tetrachloride in the disposal site the subject of this ERA. This report has also been prepared to address the requirements for an environmental assessment (EA) (see Section 1.4).

1.1 PURPOSE

The purpose of this ERA is to prevent, or at least minimize, further migration of carbon tetrachloride contamination from the unsaturated soils to uncontaminated areas. This action is needed to ensure that the environment and public health are adequately protected and to reduce the threat of further groundwater contamination. Information on the origin, nature, and extent of carbon tetrachloride (and co-contaminants), and other site characteristics used as a basis for evaluating remedial alternatives is presented in Chapter 2.0.

1.2 GENERAL SELECTION PROCESS

Selection of the preferred method to perform the ERA follows the general sequence specified in 40 CFR 300.430(e) and as required by EPA, with concurrence by Ecology (December 20 letter, see Appendix A). Potential remedial alternatives are identified as a preliminary screening; a more detailed examination is conducted of applicable technologies retained after the screening. Preferred technology(ies) are then selected as part of the formal engineering evaluation/cost analysis (EE/CA). The EE/CA is a rapid, focused, feasibility study that uses specific screening factors and selection criteria to assess the feasibility, appropriateness, and costs of available technologies for the removal of the carbon tetrachloride.

1.3 ERA BACKGROUND

On December 20, 1990, the EPA and Ecology requested the U.S. Department of Energy-Richland Field Office (DOE-RL) to assess contamination and evaluate alternatives for an ERA for carbon tetrachloride contamination located in the unsaturated soils beneath certain disposal sites in the 200 West Area of the Hanford Site. The request was made based on concerns that the carbon tetrachloride residing in the soils is continuing to spread to the ground water.

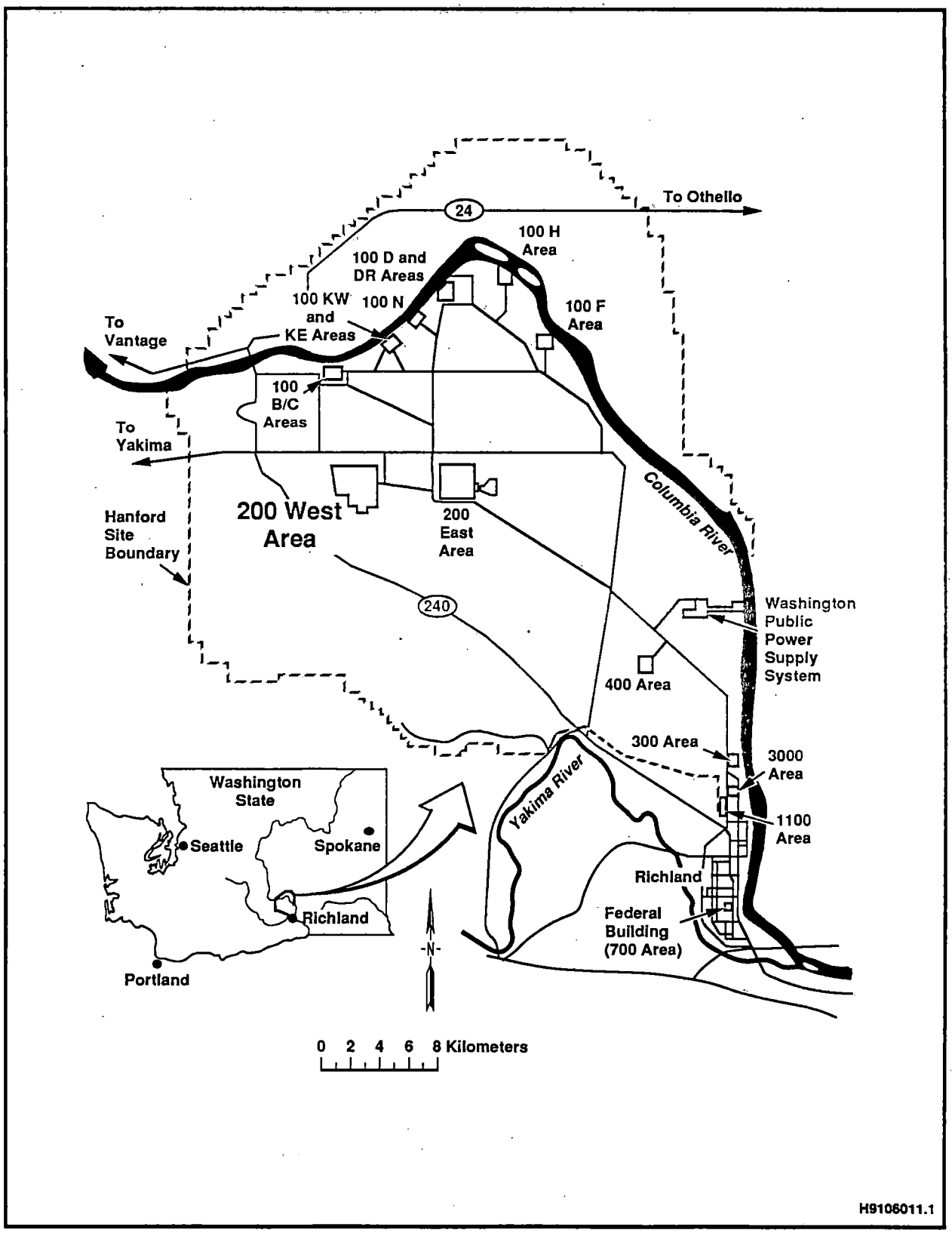

Figure 1. Map of the Hanford Site, Washington.

An ERA, also known as an interim response action, is a provision included in the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) *of 1980*, as amended, that allows for expedited responses to be taken at waste sites where early remediation will abate potential threats or prevent significantly-increased degradation that might occur if action were delayed until completion of the remedial investigation/feasibility study (RI/FS) and the record of decision (ROD). The ERA is implemented according to the requirements outlined in the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1989, Part 3, Article XIII, Section 38), and in accordance with 40 CFR 300, Subpart E.

The ERA activities described herein are conducted in support of, and before completion of, the CERCLA RI/FS of the 200-ZP-1 and 200-ZP-2 operable units where the carbon tetrachloride disposal sites are located. The RI/FS work plans for these operable units will not be completed until 1992, and plans for cleanup of the operable units are not anticipated to be completed before 1997. Implementation of this ERA does not represent a final solution to the carbon tetrachloride problem, but it may make that final solution attainable in the cleanup of the operable units.

This ERA proposal will be submitted to the EPA, Ecology, and the public for review. The EPA, as the lead regulatory agency, will review the proposal and issue an Action Memorandum, which directs the action to be taken regarding the carbon tetrachloride contamination.

1.4 NATIONAL ENVIRONMENTAL POLICY ACT

This proposal has been prepared to address the requirements for an environmental assessment as defined in the regulations for implementing the procedural requirements of the National Environmental Policy Act (NEPA) and U.S. Department of Energy (DOE) orders. These regulations and orders require an environmental assessment to provide brief discussions of the need for the proposal, of alternatives considered, of the environmental impacts associated with each alternative, and a listing of agencies and persons contacted. The need for the proposed action is provided in Section 1.1. The affected environment is described in Chapter 2.0. Alternatives are described in Chapters 3.0, 4.0, and 5.0, and evaluated for potential environmental impacts in Section 5.1.2. Agencies and persons contacted are as follows:

- Hanford Cultural Resources Laboratory
  Hal Gard, Cultural Resources Specialist
  J. C. Chatters, PhD, Manager Cultural Resource Project

- Environmental Protection Agency, Region 10
  Hanford Project Office
  Doug Sherwood
  712 Swift Blvd., Suite 5
  Richland, Washington 99352

- Washington State Department of Ecology
  Hanford Facility Project Office
  David Nylander
  7601 W. Clearwater, Suite 102
  Kennewick, Washington 99336

The DOE will use this document to determine whether the potential environmental impacts are significant enough to warrant the preparation of an environmental impact statement. A Finding of No Significant Impact (FONSI) will be prepared and published by the DOE if it is determined that the potential environmental impacts are not significant.

2.0 SITE EVALUATION

2.1 INTRODUCTION

This section summarizes the information about the site operations, site characteristics, the extent of contamination, and conceptual models of the behavior and distribution of contaminants in the subsurface. A detailed discussion is provided in Appendix B.

The carbon tetrachloride disposal sites are located in the 200 West Area where chemical processing plants have been operating since 1944. The 200 West Area is approximately 11 km (7 mi) east of the western boundary of the Hanford Site and approximately 8 km (5 mi) south of the Columbia River (see Figure 1).

2.2 WASTE DISPOSAL

The carbon tetrachloride disposal sites include the 216-Z-1A Tile Field, 216-Z-9 Trench, and 216-Z-18 Crib (Figure 2). These facilities received liquid waste from the Z Plant facility operations. The 216-Z-1A Tile Field received overflow liquid waste between 1949 and 1959. From 1964 to 1969, aqueous and organic waste from the Plutonium Reclamation Facility (PRF) were disposed of in the 216-Z-1A Tile Field. The 216-Z-9 Trench operated from 1955 to 1962 to receive all solvent and aqueous waste from the Recuplex facility. The 216-Z-18 Crib operated from 1969 to 1973 and received aqueous and organic wastes from PRF.

It is estimated that 363,000 to 580,000 L (96,000 to 153,000 gal) of carbon tetrachloride were discharged to the soil column at the carbon tetrachloride disposal sites between 1955 and 1973. From 83,000 to 300,000 L (22,900 to 79,300 gal) of carbon tetrachloride are estimated to have been discharged to the 216-Z-9 Trench, 170,000 L (44,900 gal) are estimated to have been discharged to 216-Z-1A Tile Field, and 110,000 L (29,100 gal) are estimated to have been discharged to 216-A-18 Crib. The total amount of carbon tetrachloride disposed to the soils represents less than 1/10 of the total liquid (mostly aqueous) disposed to the sites.

2.3 CHARACTERISTICS OF THE SITE

The topography of the Hanford Site is relatively flat with elevations ranging from 120 m (400 ft) above mean sea level along the Columbia River to greater than 1,000 m (3,300 ft) at Rattlesnake Mountain. The 200 West Area is also relatively flat with elevations ranging from 200 to 225 m (650 to 735 ft) above mean sea level.

The climate at the Hanford Site includes summers that are warm and dry and winters that are cool with occasional precipitation. The mean annual precipitation at the Hanford Meteorology Station (adjacent to the 200 West Area) is 16 cm (6 in). The average wind direction is from the west-northwest with an average wind speed of 4.8 km/h (3 mi/h).

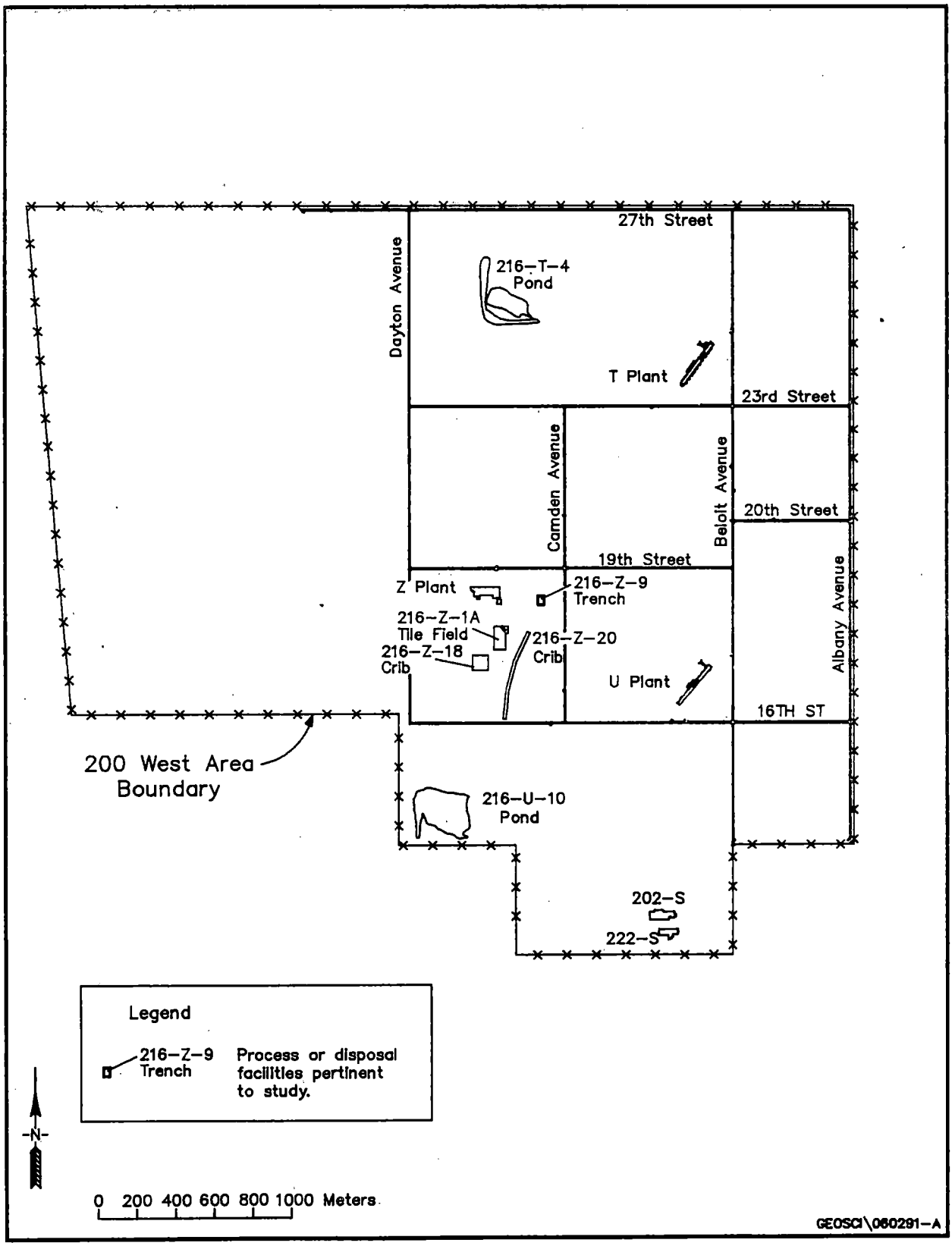

Figure 2. Site Map of the 200 West Area.

The natural vegetation of the 200 West Area consists of a sparse covering of desert shrubs and drought-resistant grasses. State and federal endangered and threatened species are known to visit the Hanford Site or live along the Columbia River and in Benton County. No plant or animal species registered as rare, threatened, or endangered are known to depend on the habitats in the immediate vicinity of the carbon tetrachloride disposal sites.

Cultural resources at the Hanford Site consist of Native American archeological sites. These sites are located along the Columbia River and near Gable Mountain. No archeological sites have been found in the 200 West Area. A cultural resources review of the proposed project area was conducted in January 1991 by the Hanford Cultural Resource Laboratory (HCRL) (HRCL #91-200-002). The review concluded that there are no cultural or historic properties in the area.

The Hanford Site is drained by the Columbia and Yakima rivers. No natural surface drainage channels exist within the 200 West Area. Existing surface water features at the 200 West Area are the 216-Z-21 seepage basin and 200 West Area powerhouse ponds.

The geology of the 200 West Area consists primarily of basalts overlain by fluvial and glaciofluvial sediments. The sediments are, from oldest to youngest:

- Ringold Formation - a series of alluvial sands and gravels, and overbank and lacustrine deposits of late Miocene to Pliocene age
- Plio-Pleistocene unit - basaltic detritus and a carbonate-rich paleosol - often referred to as the caliche layer
- Early Palouse Soil - eolian silt and fine-grained sand
- Hanford formation - glaciofluvial gravels, sands, and silts deposited by middle to late Pleistocene cataclysmic flood waters.

Local structural features in the vicinity of the 200 West Area include the Cold Creek syncline and the Gable Butte-Gable Mountain extension of the Umtanum Ridge anticline. The 200 West Area is located on the northern flank of the Cold Creek syncline, which dips at about 5% to the south. No faults have been identified beneath the 200 West Area.

The uppermost aquifer in the 200 West Area is unconfined and located within the Ringold Formation. The depth to the water table ranges from 58 to 82 m (190 to 269 ft). Beneath the carbon tetrachloride disposal sites, the depth to ground water ranges from 60 to 66 m (197 to 216 ft). The saturated thickness of the uppermost aquifer ranges from 67 to 113 m (219 to 371 ft). Ground water velocities are estimated to range from <0.1 to about 47 m/d (<.3 to 154 ft/d). Ground water flow directions are generally radial outward from the southwest portion of the 200 West Area primarily because of the continuing influence of the residual ground water mound underlying the decommissioned 216-U Pond. Recharge to the aquifer is primarily artificial recharge from waste disposal activities. The ground water in the 200 West Area is only used for monitoring; drinking, emergency, and process water come from the Columbia River.

The unsaturated zone consists of sediments of the Ringold Formation, Plio-Pleistocene unit, early Palouse soil and Hanford formation. The unsaturated zone ranges in thickness from 58 to 82 m (190 to 269 ft). Within the unsaturated zone, the Plio-Pleistocene unit (caliche layer) is less permeable and may result in slower travel times through this unit or perched ground water or vapor. The vapor extraction tests indicate that the air permeability of the Hanford formation is 2×10^{-8} to 5.6×10^{-8} cm^2 (3.1×10^{-9} to 8.7×10^{-9} in^2).

2.4 EXTENT OF CONTAMINATION

Carbon tetrachloride has been identified in downhole and wellhead vapor sampling in the vicinity of the disposal sites. Carbon tetrachloride vapor has been detected at depths ranging from 24 to 63 m (79 to 207 ft) below ground surface.

During the soil vapor characterization tests, carbon tetrachloride vapor was detected at depths of 35 to 42 m (115 to 138 ft) below the ground surface in the 216-Z-1A Tile Field. During the long-term vapor extraction test, concentrations of up to 915 p/m vol were observed with a flowrate of 300 to 310 cubic feet per minute (cfm) (8,500 to 8,780 L) and a well vacuum of 35 to 40 in. water gage (w.g.) (89 to 101.6 cm). During these tests, it is estimated that 300 lb of carbon tetrachloride were removed from the system over an 80-h period. These tests also indicate that carbon tetrachloride vapor has migrated laterally at least 24 m (79 ft) outside the tile field. During these tests, vapor samples were collected and analyzed for volatile organic compounds (VOC). Chloroform was detected, in trace amounts; 2-butanone was also detected at concentrations up to 148 p/m vol, but this may be a reflection of the analytical method. No other volatile organics were detected in the 216-Z-1A Tile Field and other volatile organics have not been analyzed for at 216-Z-9 Trench and 216-Z-18 Crib.

Plutonium and americium have been detected in the soils at the 216-Z-1A Tile Field and naturally occurring radon was detected in the vapors at the tile field. Plutonium and americium were also present in the soil at 216-Z-9 Trench (prior to excavation). The 216-Z-18 Crib has not been sampled for radionuclides, although based on the disposal history, it is likely that radionuclides are present.

Carbon tetrachloride has also been detected in the 200 West Area away from the disposal sites. During drilling in this area, carbon tetrachloride vapor has been detected in borings both above and below the Plio-Pleistocene unit. Soil samples from these wells indicate the presence of carbon tetrachloride in the unsaturated zone north and west of the disposal sites. Other volatile organic compounds have also been found in these soils as discussed in Appendix B.

Ground water in the 200 West Area is contaminated with carbon tetrachloride, with concentrations of 7,340 p/b having been observed. The carbon tetrachloride plume appears to be emanating from the area of the disposal sites and extends primarily to the north. Carbon tetrachloride has been detected at the water table and to depths of 116 m (380 ft). It is estimated that the ground water plume (as defined by the 5 p/b contour) covers

an area of 11 km^2 (6.8 mi^2) and contains only a small percentage of the carbon tetrachloride thought to have been disposed of in the three disposal sites. Other contaminants that have been detected in the ground water are discussed in Appendix B.

2.5 CONCEPTUAL MODELS

There are two basic conceptual models that describe the observed contamination in the ground water and unsaturated zone. The first conceptual model is that a significant amount of the carbon tetrachloride disposed to the ground in the 200 West Area is still present within the unsaturated zone. In this model, carbon tetrachloride vapor moves downward and laterally away from the disposal sites, providing a continuous source of contamination to the ground water.

The second conceptual model is that most of the carbon tetrachloride discharged as a dense nonaqueous phase liquid (DNAPL) has reached the uppermost aquifer in a liquid phase. The DNAPL has settled in the aquifer and provides a continuous source of contamination.

In both models, aqueous phases containing dissolved carbon tetrachloride migrate to and contaminate the ground water. Carbon tetrachloride vapors in the unsaturated zone that equilibrate with perched water and/or waste water from other sources may then be transported to the water table in dissolved form. The discharges of aqueous phase containing dissolved carbon tetrachloride may also have reached and contaminated the ground water.

The observed distribution of carbon tetrachloride in the subsurface suggests a combination of both models. These models are discussed in more detail in Appendix B.

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3.0 IDENTIFICATION AND SCREENING OF REMEDIAL ALTERNATIVES

Preliminary screening of remedial alternatives is guided by whether each alternative will provide overall public health and/or environmental protection and will meet regulatory or policy requirements. Preliminary screening also eliminates conceptual and emerging technologies that require further development and presently do not have a proven record for the application under consideration. Engineering judgement is used in this evaluation. Two of the major considerations in the evaluation are: (1) the large volume of soils contaminated by the carbon tetrachloride, and (2) the presence of carbon tetrachloride in radiologically-contaminated soils. The general response actions considered for the ERA (Table 1) are:

- No action
- Institutional controls
- Source control.

3.1 NO ACTION

The no-action alternative would slightly reduce the organic wastes due to natural biodegradation and by limited loss of carbon tetrachloride through volatilization to the atmosphere. Though the no-action alternative does not satisfy the underlying need presented in this document, it supplies a projection of future trends by providing an environmental baseline against which the site impacts of the active alternatives can be compared. The no-action alternative is not acceptable because it would not quickly mitigate the releases of hazardous substances that are the subject of this proposal. Failure to prevent or limit the continuing migration of carbon tetrachloride would not meet the ERA objective and would violate the intent and specific requirements of the Resource, Conservation, and Recovery Act (RCRA), CERCLA, Tri-Party Agreement, and the Agreement in Principle between the DOE, EPA, and Ecology dated October 18, 1990 (Hagood and Rohay 1991, Appendix A).

3.2 INSTITUTIONAL CONTROLS

This alternative would include preventing or limiting access to the contaminated soil areas and contaminated ground water. In addition, other institutional controls to be considered include cessation of any disposal of aqueous effluent to the soils in the vicinity of the carbon tetrachloride contamination and remediation of existing wells.

Limiting access to contaminated soils and ground water would protect public health; however, this approach would allow continuing carbon tetrachloride migration, resulting in expansion of the soil and ground water contamination.

Table 1. Identification of Contaminated Soil Remediation Alternatives.

Remedial action objectives	General response action	Remedial technology type	Process options
Human health:	No action/institutional actions:	No action/institutional options:	
Prevent direct contact and ingestion of soil, vapor, or ground water resulting in a 10^{-4} to 10^{-7} excess cancer risk from carbon tetrachloride	No action	Fencing	
	Access restrictions	Deed restrictions	
		Seal well annuli	
Environmental protection:		Drilling constraints	
Prevent migration of contaminants that would result in ground water contamination in excess of 5 p/b carbon tetrachloride.		Cease effluent disposal to ground in vicinity of source	
	Source control:	Containment technologies:	
	Containment actions - Containment	Barriers	Ground freezing, slurry wall
		Well remediation	Seal well annuli
	Excavation/treatment actions: Excavation/treatment/disposal - In situ treatment - Excavation and disposal	Collection technologies: Excavation	Soil excavation
		Extraction - Liquid extraction	Soil wash/flush, product extraction
		- Vapor extraction	Extraction wells, injection wells
		Treatment technologies:	
		Biological treatment	Cultured microorganisms
		Physical treatment	Stabilization, solidification, vitrification
		Extracted vapor treatment: - Physical treatment	Carbon adsorption
		- Thermal treatment	Incineration
		- Chemical treatment	Catalytic oxidation
		- No treatment	Vent to atmosphere

Drilling and well completion through soils in both the unsaturated and saturated zones may cause further contamination of the ground water. Carbon tetrachloride in either liquid or vapor form could potentially migrate along the well/formation interface due to its density. Drilling could be prohibited, limited, or restricted. These actions would compete with the need to acquire site characterization information through drilling and testing and the emplacement of any injection/extraction wells in support of a remedial technology, such as vapor extraction.

Drilling and well completion through contaminated soils is also a health and safety concern, as onsite workers may be exposed to carbon tetrachloride vapors and radiological contamination. Prohibiting drilling for this reason competes with the need to acquire data and implement certain cleanup activities. In addition, safety concerns for onsite workers can be mitigated with proper safety equipment and practices.

Discharges of aqueous waste water to the soil column, where carbon tetrachloride (or other contaminants) reside, could potentially contribute to the further migration of the contaminant. Current information is inadequate to assess this possibility.

Existing wells in the vicinity of the carbon tetrachloride contamination may be poorly sealed, potentially allowing migration of liquid or vapor carbon tetrachloride to deeper strata and ground water. Well remediation could prevent further or future spread of the carbon tetrachloride by sealing and/or resealing certain wells. Further evaluation would be necessary to assess this potential problem.

Preventing access to contaminated soils or ground water would protect public health by limiting access to areas affected by hazardous substances. This approach does not meet the immediate ERA objectives of reducing the mobility, toxicity, and/or volume of the existing carbon tetrachloride. These actions are rejected from further consideration in the EE/CA. In addition, current information is inadequate to assess whether drilling and well completion practices, discharges to the soil column, and existing wells would cause further migration of carbon tetrachloride contamination. These actions are not considered further in the EE/CA, but should be further evaluated as part of future site characterization activities (see Section 6.1.1).

3.3 SOURCE CONTROL

Source control could involve many different types of containment, collection, or treatment. 'Source' is defined for the purposes of this study as the soil mass containing carbon tetrachloride between the ground surface and the water table. The source zone contaminant(s) can migrate outward and downward to contaminate additional soil and ground water.

Assuming that the bulk of residual carbon tetrachloride contamination lies directly beneath each of the three disposal sites, the contaminated area of concern would be approximately 200 m by 300 m (650 by 985 ft) and extend approximately 58 m (190 ft) to the ground water. The actual distribution of carbon tetrachloride throughout this volume of soil is not fully known. The extent of contamination may be much larger. The following sections provide brief descriptions of technologies considered for containment, collection, and treatment.

3.3.1 Containment

For the purpose of comparative evaluation of alternatives, the containment barriers are assumed to be installed around each of the disposal sites. This would result in a cumulative area containment zone of approximately 200 m by 300 m (650 by 985 ft).

3.3.1.1 Ground Freezing. Ground freezing could be used to build vapor barriers (vertical ice walls) around the source zone. Circulation of liquid nitrogen or other coolant in boreholes, while injecting water into the cooled zones, would produce ice walls and reduce or eliminate vapor migration; however, this process would not remove, destroy, or permanently stabilize the contaminant(s) and would be expensive to install and maintain. This technique has not been demonstrated to provide acceptable long-term containment. Upon cessation of maintenance, the ice would melt and could contribute to further contamination of ground water. In addition, the dilation that would result from the freeze-thaw cycle would likely increase the permeability, providing conduits for further migration of contaminants. These reasons support a determination that this alternative is not applicable to the 200 West Area.

3.3.1.2 Slurry Trench/Wall. A slurry wall could also provide a vapor barrier to prevent lateral movement of vapor in the unsaturated zone. Extension of the trench down to the underlying basalt could also halt migration of contaminated ground water; however, trench collapse is likely at the extreme depths required. Massive quantities of bentonite and costly additives would be needed to construct such a wall around the source zone. This alternative would not remove or destroy trapped contaminants, and the degree of containment achieved would be questionable and difficult to verify. These factors support a decision that this alternative is not applicable to the 200 West Area.

The extent of contamination is probably too great for either containment options to be practical.

3.3.2 Collection Technologies

The collection technologies considered include excavation and extraction processes. The approach assumed for all collection technologies is to focus on removal of the highest concentrations of carbon tetrachloride.

3.3.2.1 Excavation and Removal. Standard earthmoving equipment and methods could be used to excavate and remove contaminated soil; however, this method is not feasible due to radiologically-contaminated soils below the three disposal locations. Excavation would also allow rapid escape of carbon tetrachloride vapor to the atmosphere. In addition, the extreme depth and large volume of excavation required to remove the soil that contains only carbon tetrachloride make this method inapplicable.

3.3.2.2 Soil Flushing. Soil flushing is in-situ extraction of organic compounds from soil. It is accomplished by passing extractant solvent through the soil using injection and extraction wells. These solvents may include air, steam, water, surfactant, chelating agents, or oxidizing agents.

Flushing with liquid is not applicable for the high radiation zones in the near-surface soil below the three disposal locations. Flushing in these zones would remove some radionuclides while causing others to migrate farther. Severe solvent treatment problems and unnecessary personnel radiation exposures would occur. In addition, the extreme volume of solvent required to contact the widely spread carbon tetrachloride outside the radiologically-contaminated soils and lack of control of the liquid in the permeable unsaturated zone make flushing with liquid solvents not applicable. Flushing with air or steam is considered further in the following sections.

3.3.2.3 Vapor Extraction. Vapor extraction is the removal of gaseous carbon tetrachloride or other soluble organics from the source zone soil. Two methods of removal include stand-alone extraction wells and stand-alone extraction wells combined with injection wells.

Extraction alone involves the removal of soil gas by vacuum pumping. The wells serve two purposes; (1) they provide a negative pressure that draws the surrounding carbon tetrachloride vapors out of the soil, and (2) since carbon tetrachloride is volatile, the negative pressure and air flow in the zone of influence of an extraction well drive liquid carbon tetrachloride into the vapor phase. Thus, any liquid carbon tetrachloride mixed with man-made radioactive contaminants will separate and exit through the wells as a vapor (Section 4.1.1). Extraction may require treatment of removed vapor to meet applicable emission concentration limits.

The injection well process involves flushing contaminated soil with injected air or steam. This method would be used in conjunction with nearby extraction wells. It would work similarly to extraction alone, but would require additional equipment to provide compressed air or steam.

These techniques have been well proven at many hydrocarbon (gasoline and diesel fuel) release location sites across the United States. The applicability of vapor extraction to the source zone at the 200 West Area is discussed in Section 3.4. Both forms of vapor extraction are considered potentially effective and applicable, and are retained for further evaluation. Vapor extraction is considered in greater detail in Chapters 4.0 and 5.0. Treatment alternatives for extracted vapor are discussed in Section 4.3. A soil vapor extraction pilot test was conducted onsite April 1991, and is discussed in Section 4.5.

3.3.2.4 Liquid Product Extraction. Liquid product extraction can be used when the contaminant is in the form of pools of liquid entrapped in the soil. This method involves the use of underground pumps strategically placed in areas where pools of liquid contaminants have settled. The most likely locations of such pooled or perched liquid are directly above the "caliche zone" 35 to 45 m (115 to 150 ft) below the surface (see Chapter 2.0 and Appendix B), directly beneath the three release locations. A method of locating the pools would be required, as well as treatment and disposal of the extracted liquid.

This method does not address contaminant vapors trapped in the soil, nor does it address the presence of radioactive elements (dissolved or as particulates) that may require further treatment. Accordingly, this technology is not considered applicable to the source zone for the ERA, but may be considered in the final remedial action for the site.

3.3.3 Treatment

Treatment technologies that could be used to immobilize or destroy carbon tetrachloride without separating it from the soil matrix are screened in this section. The candidate processes cover a wide range of possibilities. The list of processes discussed is not intended to be exhaustive, but representative. Various modifications of each type of process are possible, but only the most attractive types of treatment are examined in detail.

3.3.3.1 Biological Treatment. Bacteria and fungi that have the ability to metabolize carbon tetrachloride could be injected into the 200 West Area source zone. Both naturally occurring and imported organisms could perform this function if adequate nutrients and transport mechanisms were provided.

However, the optimum organisms, nutrient solutions and injection/transport methods would have to be determined through site-specific research. Hazardous degradation products such as methylene chloride and chloroform should be minimized by proper choice of organisms and growth conditions. Large quantities of the cultured organisms and nutrient solutions would be required to remediate the large volume of the source zone. The highest concentration portions of the source zone may be toxic even to efficient carbon tetrachloride-eating organisms. Finally, the highest concentrations of carbon tetrachloride and other organics are combined with high radiation zones that may be lethal to microorganisms.

Due to the long research and development time frame, combined with high costs and uncertainty of the performance of this process in the varied conditions that will be encountered in the unsaturated soils, the biological treatment approach is not applicable.

3.3.3.2 Physical Treatment. Physical treatment technologies considered in developing this proposal are limited to in-situ stabilization or solidification, and vitrification. Excavation of source zone soil was rejected in Section 3.3.2.1; therefore, no surface processing of contaminated soil was considered.

In-situ stabilization and/or solidification involves fixation of contaminants in the unsaturated (or saturated) soils to reduce or eliminate further migration. This may be accomplished by injecting cement or other reagents that chemically bond or physically encapsulate contaminants. The process will be more effective if physical mixing of the reagent and contaminated soil is also performed. The process has been applied to numerous sites where shallow soil contamination exists.

Large volumes of reagents would be required to fix the carbon tetrachloride in the source zone. The extreme depth of much of the heavily contaminated zone would make efficient mixing difficult or impossible. In

addition, fixation of carbon tetrachloride by commonly used reagents is unproven. These difficulties and uncertainties indicate that stabilization/solidification is not applicable to this situation.

In-situ vitrification is accomplished by applying a high-density electrical current to melt soil minerals, resulting in a congealed glass-like solid mass that encapsulates contaminants. This process may be most applicable to high radiation zones in the soil. The heat produced from the melt zone may actually drive nearby organic contaminants away rather than encapsulating or destroying them. Only limited volumes and depths of soil can be treated in a given time period, allowing surrounding organic contaminants to rapidly migrate away. This process has not been used to treat contaminated soil more than 6 to 10 m (20 to 33 ft) below ground surface. Although this technology may be considered for remediation of the limited volumes and depths directly below the three release locations, it is not applicable to the large volume of the source zone.

3.4 RETAINED REMEDIAL ALTERNATIVES

The unsaturated soils have characteristics favorable to the implementation of vapor extraction. Breckenridge et al. (1991) identify six process-limiting characteristics and the associated site data required for the remedial technology evaluation of vapor extraction. These criteria, along with the typical site data for the source zone, are shown in Table 2. All six process-limiting characteristics are met or exceeded in the 200 West Area unsaturated soils.

Based on the preliminary screening, vapor extraction (with associated treatment processes) is the only alternative retained for further evaluation. This section is consistent with the informal preliminary screening conducted by Hagood and Rohay (1991) in the project plan and with EPA and Ecology guidance (see December 20, 1990, letter from EPA, Appendix A).

Table 2. Vapor Extraction System: Process Limiting Characteristics, Site Data Required and Typical Site Data.

Process limiting characteristics[a]	Site data required[a]	Typical site data
Applicable only to volatile organics with significant vapor pressure (>1 mm mercury [7.04 in])	Contaminants present	Carbon tetrachloride: Vapor pressure at 50°F is about 35 mm 1.38 in) mercury
Low soil permeability inhibits air movement	Soil permeability	2E-8 to 5.6E-8 cm^2 (3.1E-9 to 8.7E-9 in^2) (high permeability)
Soil hydraulic conductivity (>1E-8 cm/s [4E-10 in/s] required)	Hydraulic conductivity	1.3E-4 to 3.7E-4 cm/s (5.1E-5 to 1.46E-4 in/s)
Depth to ground water (>20 ft [6 m])	Depth to ground water	About 190 ft (58 m)
High moisture content inhibits air movement	Soil moisture content	Low soil moisture content
High organic matter content inhibits contaminant removal	Organic matter content	Low soil organic matter content

[a] Obtained from Breckenridge et al (1991), Table 4.

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4.0 REMEDIAL ALTERNATIVE DESCRIPTION - VAPOR EXTRACTION AND TREATMENT

Vapor extraction and treatment, the technology retained from the preliminary screening (Chapter 3.0), is further profiled in this chapter. The vapor extraction technology proposed for this ERA would be implemented as two vapor extraction systems (VES). Each VES would be similar in design and function. One VES would operate on two of the carbon tetrachloride disposal sites (216-Z-1A Tile Field and 216-Z-18 Crib) and the other VES would operate on the third carbon tetrachloride disposal site (216-Z-9 Trench). The two-system approach is necessary due to the relatively large flowrates required (up to 1,400 cfm per system) and because of the physical distance between the sites.

4.1 VAPOR EXTRACTION

Vapor extraction is widely used to remove a variety of VOCs from soils contaminated by leaking underground storage tanks and other sources. The specific terms used to describe such systems in EPA RODs vary somewhat (e.g., vapor extraction, vacuum extraction, in situ volatilization) but these all indicate systems similar to those under consideration for the ERA. In addition to hundreds of gasoline and diesel fuel leak sites, this technology is the most frequently used "innovative treatment technology" at Superfund sites in the United States (EPA 1991). According to EPA, vapor extraction is in use and has been approved for use at 31 sites (through 1989).

4.1.1 Vapor Extraction Theory

Carbon tetrachloride in the source zone may exist as a DNAPL, as organics in perched water or pore water, material adsorbed to the soil, and free vapor. When air is drawn through the soil during the vapor extraction process, contaminants vaporize from one or more of the condensed phases, replacing the vapors that were carried away in the air stream. The ability of an element (or compound) to enter into the vapor phase, or to volatilize, is dependent on the vapor pressure. The vapor pressure is a characteristic property of a given liquid or solid, and varies with the strength to the intermolecular forces. To obtain a vapor pressure of 760 mm (30 in.) mercury a temperature of 76.7°C (170°F) is required for carbon tetrachloride, compared to 100°C (212°F) needed for water. Materials with higher vapor pressures than water will evaporate quicker or vaporize more readily. Carbon tetrachloride is characteristic of a liquid with a much higher vapor pressure than water.

Carbon tetrachloride can be readily separated from the plutonium or americium in the soils beneath the disposal sites. Since plutonium and americium are metals, they require extremely high temperatures to volatilize. Under the site conditions, volatilization of these metals will not occur (WHC 1991, pp 92-96). In addition, plutonium and americium attach to host soil particles and are not likely to be moved with a vacuum due to their affinity for certain size particles (WHC 1991, pp 92-96). However, as a precaution, filtration and moisture control will be required for systems placed within radiologically-zoned areas. The soil vapor and air extracted

from the source zone may entrain small particles of radiologically-contaminated particulates that must be removed prior to treatment. High-efficiency particulate air (HEPA) filters and coarse prefilters will be provided for filtering the soil vapor stream.

4.1.2 Vapor Extraction Process

For the vapor extraction process, vapor extraction wells or vents are installed in the contaminated zone. As soil vapor is removed from the subsurface by blowers pulling a vacuum on the wells, ambient air is drawn into the subsurface or is injected at various locations around the site. When ambient air passes through the soil, carbon tetrachloride is volatilized and may then be removed by the VES.

After the soil vapor is pulled from the extraction well(s), the vapor is conveyed via pipes and/or hosing to the mechanical equipment. The equipment treats the vapor by filtration and other mechanisms and then forces the effluent out the exhaust stack.

A generic VES consists of (1) one or more vapor extraction wells, (2) an air handling system (including vacuum pumps or air blowers), and (3) vapor treatment (see Section 4.3). Often a VES will include one or more air inlet or injection wells and monitoring wells. Instrumentation is also a typical part of a VES to provide operational control and indicate system effectiveness.

4.2 WELLFIELD DESIGN OPTIONS

Two major options are associated with the design of the VES wellfield. These options are (1) the locations of the wells and the placement of screened intervals within those wells and, (2) the well types, which include extraction, monitoring, and injection. These types of wells can be placed vertically or angled (e.g, horizontal).

4.2.1 Well Locations

The wellfield design approach has two phases. The first phase will use some of the 46 existing vertical wells in and around the three carbon tetrachloride disposal sites. The available existing wells are listed in Table 3 and shown graphically in Figure 3. All of the existing wells are vertical wells and those chosen for extraction, monitoring, or injection will be perforated in specific intervals based on historic borehole logs describing the site stratigraphy.

During the first phase, the operational parameters will be varied to develop an understanding of the areas of influence, achievable flows and vacuums, and the concentrations of carbon tetrachloride in the source zone for the second phase. This information will be used in the design of the wellfield.

Table 3. Existing Wells In and Around the Three Tile Fields.

Well	Coordinates EW	Coordinates NS	Casing elevation (ft)	Ground elevation (ft)	Casing diameter (in.)	Drilled depth (ft)	Date drilling completed	Total depth[a] (ft)	Depth to (ft)[a]	Perf/scrn interval (ft)
216-Z-9 Trench										
W15-6	75765	40005	661.50	658.57	6	410	05/24/59	361.1	189.5	175-408
W15-8	75910	39740	667.79	665.69	4	206	11/23/66	201.6	196.9	N/A
W15-9	75890	39930	662.30	660.58	4	195	12/14/66	190.8	190.4	186-189
W15-82	75810	39860	660.09	659.57	8	101	10/04/54	99.1	N/A	N/A
W15-84	76000	39860	669.82	668.35	8	110	10/10/54	106.3	N/A	N/A
W15-85	75910	39970	664.11	662.67	8	106	10/12/54	103.7	N/A	N/A
W15-86	75958	39790	661.22	658.16	4	144	08/14/57	140.8	N/A	N/A
W15-95	75925	39930	660.00	657.35	8	100	01/21/59	99.3	N/A	N/A
216-Z-1A Tile Field										
W18-6	76706	39212	678.47	675.91	6	300	01/15/64	201.0	N/A	190-298
W18-7	76491	39204	678.99	676.49	6	300	01/13/64	203.3	N/A	190-298
W18-76	76610	39318	669.00	668.16	6	19	03/28/67	18.8	N/A	N/A
W18-78	76600	39308	669.00	668.48	6	17	03/30/67	14.0	N/A	N/A
W18-81	76605	39283	669.00	665.80	6	41	04/03/67	37.7	N/A	N/A
W18-85	76717	38989	679.75	676.83	6	150	08/05/69	150.0	N/A	N/A
W18-86	76742	39106	683.49	681.48	6	150	08/21/69	149.1	N/A	N/A
W18-87	76604	38980	677.23	674.86	6	150	09/05/69	149.2	N/A	N/A
W18-88	76432	39298	679.76	677.01	6	150	09/19/69	146.7	N/A	N/A
W18-89	76752	35360	681.32	678.50	6	150	10/21/69	141.7	N/A	N/A
W18-149	76602	39329	672.56	670.56	6	100	04/12/74	24.7	N/A	N/A
W18-150	76601	39075	671.81	668.85	6	128	07/21/77	115.9	N/A	N/A
W18-158	76650	39266	672.61	669.97	6	131	09/08/77	125.6	N/A	N/A
W18-159	76602	39228	670.77	669.63	6	130	01/11/78	120.9	N/A	N/A
W18-163	76552	39284	670.00	667.50	8	135	02/16/77	130.3	N/A	N/A
W18-164	76602	39040	678.75	675.68	6	153	02/01/77	143.4	N/A	N/A
W18-165	76650	39180	672.09	668.99	6	135	03/29/77	125.4	N/A	N/A
W18-166	76650	39108	671.11	668.36	6	137	04/14/77	129.4	N/A	N/A
W18-167	76552	39214	669.00	665.68	8	134	05/17/77	126.2	N/A	N/A
W18-168	76552	39043	669.00	665.70	8	131	06/16/77	124.1	N/A	N/A
W18-169	76552	39073	669.00	665.94	8	132	09/05/77	125.7	N/A	N/A
W18-170	76602	39154	672.32	668.59	6	30	09/21/77	28.0	N/A	N/A
W18-171	76604	39010	677.65	675.14	8	136	08/09/77	128.7	N/A	N/A
W18-173	76574	39307	673.31	670.02	8	51	10/14/77	44.6	N/A	N/A
W18-174	76565	39296	673.21	669.85	8	51	10/11/77	46.4	N/A	N/A
W18-175	76600	39117	670.00	667.07	6	130	12/07/77	118.4	N/A	N/A
216-Z-18 Crib										
W18-9	76846	38852	682.47	679.56	6	220	12/13/68	217.6	210.7	180-218
W18-10	76803	38847	682.63	679.51	6	220	12/11/68	ND	ND	180-218
W18-11	76955	38735	683.00	679.66	6	220	01/04/69	188.6	N/A	180-220
W18-12	76955	38850	683.00	680.52	6	220	ND	212.6	N/A	190-218
W18-82	77101	38570	680.00	677.58	6	146	ND	148.3	N/A	N/A
W18-93	76905	38744	665.00	662.00	6	140	02/08/72	139.7	N/A	N/A
W18-94	76880	38662	665.00	661.77	6	80	02/10/72	84.4	N/A	N/A
W18-95	76970	38665	665.00	661.88	6	80	02/15/72	78.1	N/A	N/A
W18-96	76790	38825	665.00	662.02	6	80	02/18/72	78.2	N/A	N/A
W18-97	76790	38745	665.00	662.00	6	85	02/24/72	83.2	N/A	N/A
W18-98	76880	38940	665.00	662.03	6	80	02/29/72	76.3	N/A	N/A
W18-99	76768	38949	665.00	662.13	3	135	03/08/72	131.4	N/A	N/A

[a]Measured in January and February 1991.
ND = Not Determined.
N/A = Not Applicable.

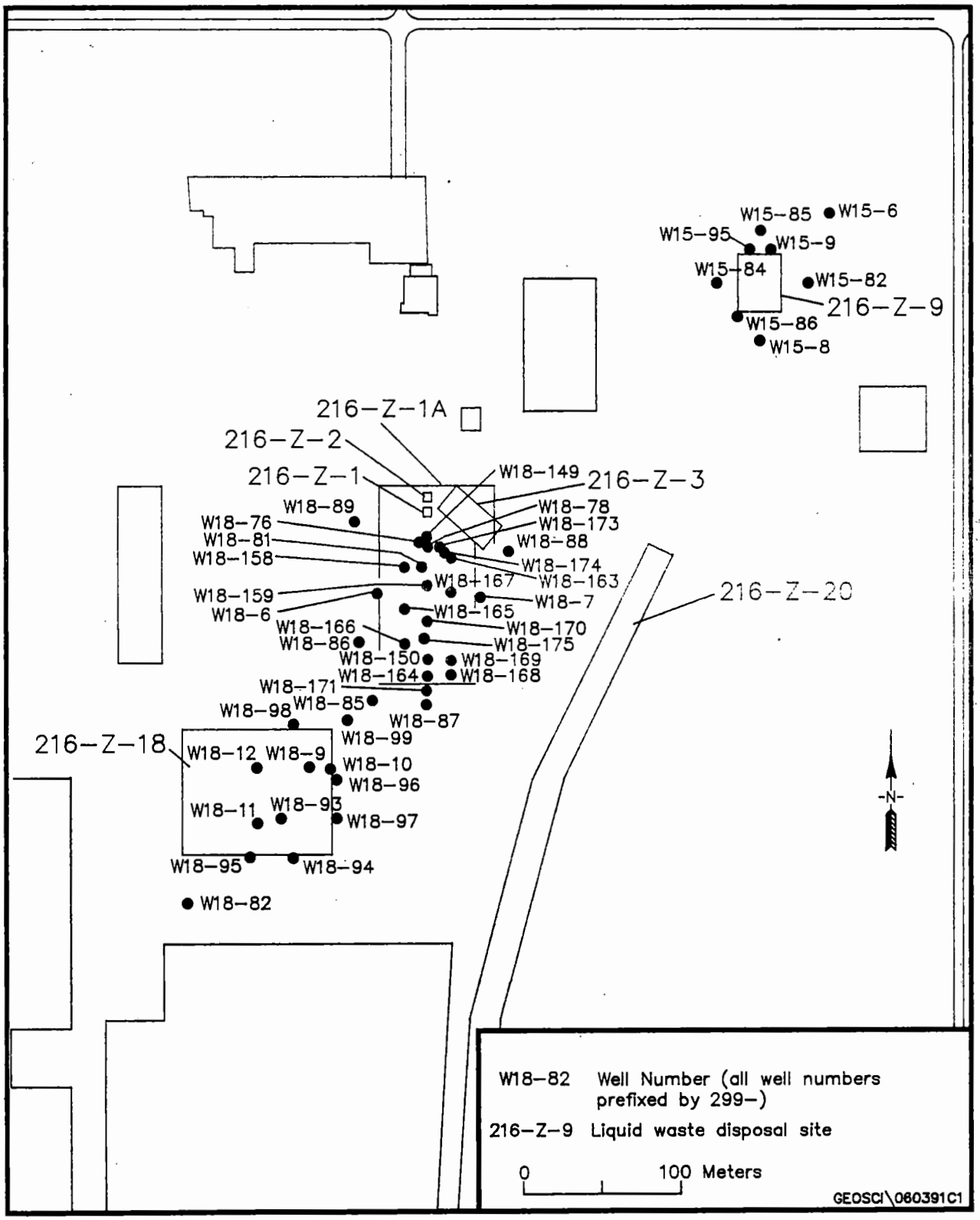

Figure 3. Available Existing Wells Around the Three Disposal Sites.

The second phase will utilize existing wells and new wells drilled specifically for the VES. The new wells will include vertical wells and may include horizontal wells.

4.2.2 Well Types

The well types vary in function and form. The functions include extraction, monitoring, and injection. The forms include vertical and horizontal.

4.2.2.1 Extraction Wells. The primary wells of the VES are the extraction wells, which provide the conduit for the removal of the carbon tetrachloride from the subsurface. Several extraction wells will be connected to the VES at each of the disposal sites, though not all the extraction wells will necessarily be operating at the same time.

For the first phase, all of the extraction wells will be existing vertical wells. Also, during the first phase, horizontal wells will be evaluated for possible use during the second phase.

4.2.2.2 Monitoring Wells. The VES monitoring wells provide a means of observing the effect the flow through the extraction wells is having on the subsurface. Specifically, each monitoring well shows the vacuum in the subsurface at its location and this provides information concerning the relative zone of influence of the operating system.

Extraction wells will function as monitoring wells during those times when they are not being used to extract vapor.

4.2.2.3 Injection Wells. Carbon tetrachloride vapor removal from the source zone may be enhanced by injecting air or steam to increase the movement of contaminants toward an adjacent extraction well. Existing vertical wells could be used for injection purposes. These techniques will be assessed for later use in the remediation effort.

Steam may be needed to provide efficient removal in relatively low permeability soil zones (e.g., caliche layer), or highly permeable zones where heat addition is required to desorb contaminants from soil particles. Higher air flowrates and heating may be needed where the clay content in the target strata is relatively high. However, steam injection could be counter-productive in the vicinity of radiologically-contaminated soils in the disposal sites and could cause migration of radiological contaminants to the ground water; this option requires further assessment.

An option to steam injection would be to open inlet wells or vents to passively allow air to be drawn into the ground and used in conjunction with extraction wells. Existing wells could be used for this purpose.

4.2.2.4 Vertical Wells. Vapor extraction wells (or injection wells) are typically designed to penetrate the source zone. Vertical wells are more ideally suited for use with greater thicknesses and depths of contaminated soils in the source zone, such as the soils found beneath the three carbon tetrachloride disposal sites (see Chapter 2.0). Additionally, most of the

soils underlying the disposal sites are highly permeable and this will allow a significant area (radius of influence) of the source zone to be affected by vapor extraction, as supported in the pilot test (see Section 4.5).

As described, 46 existing vertical wells with carbon-steel casing are located in the vicinity of the carbon tetrachloride disposal sites, and could be used as VES wells. Existing wells can be modified by perforating the carbon-steel casing at appropriate depth intervals. Four existing wells were perforated and used as extraction wells during the pilot test (see Section 4.4).

4.2.2.5 Horizontal Wells. Horizontal extraction/injection wells (or angle-drilled wells) could provide a method to reach carbon tetrachloride contaminated zones beneath radiologically-contaminated soils in the carbon tetrachloride disposal sites or enhance efficiency by targeting certain flat-lying strata (i.e., caliche layer). A horizontal well system would normally be classified as an experimental, "emerging" technology, and therefore inapplicable for an ERA. However, horizontal drilling has been tested at the Savannah River Site as part of a VES removing VOCs in both the vadose and the ground water.

The Savannah River Site test is sponsored by DOE and several other organizations as part of the DOE Integrated Demonstration Program. This program is specifically intended to encourage rapid development of technologies that can be used in DOE remedial action projects throughout the country. The horizontal well technology is sufficiently successful to qualify for a United States patent. Several differences exist between the Savannah River Site and the Hanford Site that may preclude the implementation of horizontal drilling as a "developed technology" during the ERA: (1) soil texture differences, (2) configuration of contaminant plume, (3) regulatory constraints on drilling fluid losses, (4) associated costs, and (5) time requirements. The use of horizontal wells will be further investigated for later phases of the ERA.

4.3 EXTRACTED VAPOR TREATMENT PROCESSES

Vapors extracted by a VES are typically treated using carbon adsorption or thermal destruction (catalytic oxidation or thermal oxidation). The type of treatment chosen depends on the composition and concentration of contaminants. Methods that destroy or recover contaminant vapors onsite are preferable because they do not require offsite shipment or burial of hazardous constituents.

The extracted vapor treatment processes described in this section include only those technologies that are considered to be proven through extensive previous use in industrial applications and which appear applicable to this project.

Though it is not essential that the VES operate without downtime, each of the treatment processes described allows the VES to operate with minimal interruption.

4.3.1 No Treatment

Direct discharge of extracted vapor with no treatment would not follow the general requirements of the CERCLA. In addition, carbon tetrachloride is an ozone-depleting chemical that will come under direct regulation pursuant to the 1990 Clean Air Act. The EPA is expected to issue monitoring and reporting rules in August 1991. Washington State regulations limiting toxic air pollutant discharges will also be implemented in the near future and will be applicable to emissions from the VES.

4.3.2 Carbon Adsorption

Carbon adsorption is a process in which activated carbon is employed as an adsorbent and where contaminant vapor molecules are attracted and held on the surface of the carbon. Carbon adsorption is the most commonly employed vapor treatment process and is adaptable to a wide range of VOC concentrations and flowrates. The treatment process using skid-mounted, offsite-regenerated, carbon canisters is generally employed for low soil vapor flow volumes and the treatment process using beds regenerated onsite is typically used for high soil vapor flow volumes and cleanup of extended duration. Carbon adsorption can be used alone or with other methods. The "spent" carbon would require treatment or disposal by thermal desorption and destruction of vaporized carbon tetrachloride.

4.3.2.1 Carbon Adsorption with Offsite Regeneration. This treatment alternative would use carbon canisters as a means of capturing the carbon tetrachloride from the soil vapor stream. Each canister, when it reaches sorptive capacity, would be taken out of the process train and shipped offsite for regeneration at a vendor's facility. A previously-regenerated canister would immediately replace the canister that was removed.

4.3.2.2 Carbon Adsorption with Onsite Regeneration and Offsite Treatment of the Condensate. This treatment alternative would also use the carbon canisters to capture the carbon tetrachloride from the soil vapor stream, but the regeneration of the carbon would be performed onsite. The resultant carbon tetrachloride condensate from the regeneration process would be transported offsite where it would be treated in a vendor's RCRA-permitted incinerator.

4.3.2.3 Carbon Adsorption with Onsite Regeneration and Conversion of the Carbon Tetrachloride. This treatment alternative would also use the carbon canisters to capture the carbon tetrachloride from the soil vapor stream and the carbon would be regenerated onsite. However, rather than producing a condensate, ultraviolet light and ozone would be used to convert the carbon tetrachloride to mostly carbon dioxide and hydrochloric acid.

4.3.2.4 Carbon Adsorption with Onsite Regeneration and Conversion of the Carbon Tetrachloride with Acid Scrubbing. This treatment alternative is the same as just described using the ultraviolet light and ozone, with the addition of a process step. Acid scrubbing would be utilized to reduce the effluent of hydrochloric acid produced during the conversion of the carbon tetrachloride.

4.3.3 Catalytic Oxidation

Catalytic oxidation is a chemical treatment process that oxidizes VOCs over a catalyst. The oxidation of carbon tetrachloride would produce mostly carbon dioxide, hydrochloric acid, and water vapor. Similar to the other onsite carbon tetrachloride conversion processes, the hydrochloric acid in the exhaust may need treatment prior to discharge.

4.3.3.1 High-Efficiency Catalytic Oxidation. This treatment alternative would use a standard catalytic oxidation unit with a specialized catalyst to convert the carbon tetrachloride in the soil vapor stream as it passed through the unit.

4.3.3.2 High-Efficiency Catalytic Oxidation with Acid Scrubbing. This treatment alternative is the same as just described using the standard catalytic oxidation unit, with an additional process step. Acid scrubbing would be utilized to reduce the effluent of hydrochloric acid produced during the conversion of the carbon tetrachloride.

4.3.3.3 Ultra-High-Efficiency Catalytic Oxidation. This treatment alternative would use an advanced catalytic oxidation unit to achieve a greater carbon tetrachloride conversion efficiency than the standard unit previously discussed.

4.3.3.4 Ultra-High-Efficiency Catalytic Oxidation With Acid Scrubbing. This treatment alternative is the same as just described using an advanced catalytic oxidation unit, with an additional process step. Acid scrubbing would be utilized to reduce the effluent of hydrochloric acid produced during the conversion of the carbon tetrachloride.

4.3.4 Incineration

This process applies heat to thermally destroy hazardous organic compounds. As with catalytic oxidation, this process would convert the carbon tetrachloride into mostly carbon dioxide, hydrochloric acid, and water vapor. Similar to the other onsite carbon tetrachloride conversion processes, the hydrochloric acid in the incinerator exhaust may need treatment prior to discharge.

4.3.4.1 High-Efficiency Thermal Oxidation. This treatment alternative would use a standard thermal oxidation unit to convert the carbon tetrachloride in the soil vapor stream as it passed through the unit.

4.3.4.2 High-Efficiency Thermal Oxidation with Acid Scrubbing. This treatment alternative is the same as just described using the standard thermal oxidation unit, with an additional process step. Acid scrubbing would be utilized to reduce the effluent of hydrochloric acid produced during the conversion of the carbon tetrachloride.

4.3.4.3 Ultra-High-Efficiency Thermal Oxidation. This treatment alternative would use an advanced thermal oxidation unit to achieve a greater carbon tetrachloride conversion efficiency than the standard unit previously discussed.

4.3.4.4 Ultra-High-Efficiency Thermal Oxidation with Acid Scrubbing. This treatment alternative is the same as just described using the advanced thermal oxidation unit, with an additional process step. Acid scrubbing would be utilized to reduce the effluent of hydrochloric acid produced during the conversion of the carbon tetrachloride.

4.4 HYDROCHLORIC ACID TREATMENT PROCESSES

The carbon tetrachloride treatment processes that convert the carbon tetrachloride onsite produce hydrochloric acid. The installation of a scrubber system to reduce the hydrochloric acid emissions may be required. Both wet and dry scrubber systems are readily available for this purpose. The wet scrubber effluent (dilute aqueous acid solution) would require additional treatment and disposal. The dry scrubber effluent (calcium chloride) may require additional treatment and would require disposal.

4.4.1 Wet Scrubber Alternatives

Three wet scrubber alternatives are considered. Each alternative would use a standard wet scrubber to remove the hydrochloric acid from the effluent and each would deal with the resultant wastewater in a different way.

4.4.1.1 Wet Scrubber with Evaporation Ponds. This treatment alternative would direct the wastewater from the scrubbing operation to ponds where it would be neutralized and volume reduced by solar evaporation. The salt cake left behind by the evaporation process might need further treatment and would require disposal.

4.4.1.2 Wet Scrubber with Discharge to 282WA Reservoir. This treatment alternative would direct the wastewater from the scrubbing operation to the 282WA Raw Water Reservoir of the power plant. The water would be treated with all of the other raw water by systems that are already in place and operating. No salt cake or other secondary waste would require treatment or disposal.

4.4.1.3 Wet Scrubber with Mechanical Evaporator. This treatment alternative would direct the wastewater from the scrubbing operation to a mechanical evaporator where it would be neutralized and volume reduced by mechanical processes and heat. The salt cake left behind by the evaporation process might require further treatment and would require disposal.

4.4.2 Dry Scrubber Alternative

This treatment alternative would use a dry scrubber with a neutralizing chemical to remove the hydrochloric acid from the effluent. In contrast to the wet scrubber alternatives, this alternative would use no water. The calcium chloride formed during the acid scrubbing operation might require further treatment and would require disposal.

4.5 VAPOR EXTRACTION AND TREATMENT PILOT TEST

During April 1991, a VES pilot test was conducted in the 216-Z-1A Tile Field to determine the feasibility of conducting vapor extraction for the full-scale ERA cleanup. Specifically, the test was designed to determine: (1) the suitability of using existing wells for extraction, (2) if subsurface conditions are adequate for vapor extraction, (3) if sufficient quantities of carbon tetrachloride are present for remediation using vapor extraction, (4) if there are any co-contaminants present, (5) the technical feasibility of extracting carbon tetrachloride vapor from radiologically-contaminated soils, (6) if there are any safety concerns related to using this technology in a radiologically-contaminated area, and (7) engineering input parameters for the full-scale VES to be potentially implemented in the ERA. Test design, methodology, operations, results, and full-scale design are discussed in detail in the test report (Appendix F2).

4.5.1 Test System Design

The test system consisted of using a VES that included carbon adsorption canisters for collection of the carbon tetrachloride. The system was connected to extraction wells in the 216-Z-1A Tile Field of the 200 West Area. The VES was designed to vent a maximum of 500 cfm of soil vapor at a venting vacuum of 150 in. w.g. (381 cm). Major system components consisted of a water separator, an electric preheater, carbon canisters, a vacuum pump (50 to 500 cfm [1,416 to 14,160 L/min] flowrate capability), and a 20-ft (6-m) exhaust stack. The VES was modified to include both radiological and organic detection and warning systems that would automatically shut down the system if thresholds were exceeded. The system was also equipped with prefilters and a HEPA filter to contain potential radiological particulates.

Existing wells within and outside the 216-Z-1A Tile Field were successfully used as extraction wells. The carbon-steel well casings were perforated in four vadose wells at up to three intervals. The intervals were isolated with straddle packers for the testing. Existing wells were used rather than installing new wells, due to the time, cost, and safety concerns involved with installation of new wells in radiologically-contaminated soils. Wells used for extraction did not penetrate the caliche layer (Chapter 2.0 and Appendix B) and therefore the test is not indicative of conditions in and below this layer.

4.5.2 Operations

Testing was conducted at various wells, well depth intervals, and durations to measure concentrations of VOCs and the properties of the subsurface. Vapor samples were taken from inlet piping for laboratory analyses. The VOC and radiological concentrations, vacuum, barometric pressure, temperature, and flowrates were all monitored in real time and recorded on a computerized data acquisition system.

Radiation and VOCs were monitored in and around the system with hand-held instrumentation as a redundant safeguard for onsite personnel. Field precautions were implemented at each wellhead hose connection by using

double-sleeved bags to contain potential radiological contaminants while accessing the wellbore. Samples from constant air monitoring, regulatory compliance filters, and carbon canisters were analyzed for radiological particulates.

Radiological control and exclusion zones were set around the VES, and each well used for extraction and monitoring. Site workers were required to have hazardous and radiological training and medical examinations before entering the exclusion zone and were surveyed for radiological contamination upon exiting the exclusion zones. Work at the site required personal protective equipment ranging from level D to level C and provisions for level B, depending on atmospheric conditions and the task required. The personal protective equipment was compatible for both chemical and radiological protection.

4.5.3 Nature and Extent of Carbon Tetrachloride and Co-contaminants

Vapors extracted during testing consisted principally of carbon tetrachloride. Trace amounts of chloroform and 2-butanone were also detected; however, 2-butanone may result from laboratory contamination. Analyses for semivolatiles have been delayed due to malfunction of laboratory equipment and are not available for this report. Naturally-occurring radon gas and associated daughter products were extracted from the wells also.

During a venting test at a well near the center of the tile field at about 60 cfm (1,700 L/min) for 24 h, carbon tetrachloride vapor concentrations quickly stabilized at about 200 p/m vol, and about 8 lb (3.6 kg) of carbon tetrachloride were removed during the test. A second test was performed by venting a well at the outer edge of the tile field at about 300 cfm (8,500 L/min) for about 80 h. The carbon tetrachloride vapor concentration increased steadily to about 600-700 p/m vol with a peak concentration of 915 p/m vol. About 300 lb (1136 kg) of carbon tetrachloride were removed during the 80-h test.

4.5.4 Permeability

Air permeability of a silty-sand layer about 18 m (60 ft) below ground surface ranged from 2×10^{-8} to 3.7×10^{-4} cm/s (7.9×10^{-9} to 1.5×10^{-4} in/s). The lateral radius of influence extended at least 18 m (60 ft) away at 8.6 m^3/min (304 cfm). A vacuum of about 1.5 in. w.g. (3.8 cm) was observed 17 m (56 ft) above the vented interval 18 m (60 ft) away, indicating significant vertical influence. Subsurface soils in the area are sufficiently permeable for using the VES.

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5.0 ENGINEERING EVALUATION AND COST ANALYSIS

The EE/CA involves a two-step process that focuses on each of the categories of alternatives described in Chapter 4.0 of this proposal. Alternatives that were eliminated in the Preliminary Screening (Chapter 3.0) are not included in the EE/CA. The first step is the application of screening factors to the action/alternatives. The two screening factors are (1) compliance with applicable or relevant and appropriate requirements (ARARs) and (2) protection of the environment and public health. The alternatives that satisfy the threshold screening factors are then subjected to selection criteria in the second process step. The alternative that passes the screening factors and ranks highest among the selection criteria becomes the preferred remedial alternative. A summary of the VES treatment alternatives is presented in Table 4. A summary of the hydrochloric acid treatment alternatives is presented in Table 5. The preferred alternative is discussed in Section 5.3.

5.1 SCREENING FACTOR EVALUATION

Protection of public health and the environment screening is based on an evaluation of overall effectiveness, i.e., reducing or eliminating current or possible future exposure of the public or wildlife to hazardous substances. The ARARs screening is based on the *National Oil and Hazardous Substances Pollution Contingency Plan* (EPA 1990) requirement to eliminate alternatives or justify waivers for alternatives that do not meet ARARs.

The alternatives for vapor extraction wells and extracted vapor treatment were evaluated for the threshold screening factors. The evaluation is summarized in Table 6 and discussed in the following sections.

5.1.1 ARARs

Though this ERA is an interim action and the ARARs are only guidelines, the interim action will be consistent with the final action and, as such, adherence will be made to the ARARs.

The most directly applicable requirements that a VES may have to meet are those regarding discharges to the atmosphere. The draft Washington Toxic Air Pollutant regulations (WAC 173-460) are anticipated to restrict carbon tetrachloride and hydrochloric acid concentrations (emitted from a vapor treatment system) at the Hanford Site boundary to limits of 0.067 and 23.3 $\mu g/m^3$ (1×10^{-5} and 1.5×10^{-2} p/m vol). Actual limits and emission control technology must be negotiated to satisfy a general requirement for best available control technology.

Table 4. Vapor Extraction System Treatment Alternatives.

Treatment alternative	CCl_4 removal efficiency (%)	CCl_4 in effluent (lb/d)	CCl_4 destruct offsite	HCl created onsite	HCl in effluent (lb/h)	Secondary waste amount and type	Secondary waste disposal	Ability to meet ARARs	Time until start (mo)	Costs for start-up	DOE exemption required	Costs for annual operation	Costs for secondary waste	Total costs for first year	Total costs for first three years
No treatment	0	1,000	No	No	0	N/A	N/A	A: N/A D: Yes B: Yes E: No C: No F: Yes	4	$960,000	No	$270,000	N/A	$1,230,000	$1,770,000
GAC with offsite regeneration	99	10	Yes	No	0	1,600 lb/d GAC (powder)	Offsite incinerator	A: N/A D: Yes B: Yes E: Yes C: Yes F: Yes	4	$1,153,000	No	$512,000	$312,000	$1,977,000	$3,625,000
GAC regenerated onsite with offsite treatment of condensate	99	10	Yes	No	0	80 gal/d CCl_4 (liquid)	Offsite incinerator	A: N/A D: Yes B: Yes E: Yes C: Yes F: Yes	8	$1,960,000	No	$274,000	$136,000	$2,370,000	$3,190,000
GAC regenerated onsite by UVOX	98	20	No	Yes	42	N/A	N/A	A: N/A D: Yes B: Yes E: No C: Yes F: Yes	11	$1,484,000	No	$298,000	N/A	$1,782,000	$2,378,000
GAC regenerated onsite by UVOX with acid scrub	98	20	No	Yes	<4	1,900 lb/d $CaCl_2$ (powder)	Non-rad. hazardous landfill	A: N/A D: Yes B: Yes E: No C: Yes F: Yes	11	$1,974,000	Yes	$330,000	$70,000	$2,374,000	$3,174,000
High-efficiency CATOX	98	20	No	Yes	42	N/A	N/A	A: No D: Yes B: No E: No C: Yes F: Yes	10	$1,430,000	No	$330,000	N/A	$1,760,000	$2,420,000
High-efficiency CATOX with acid scrub	98	20	No	Yes	<4	1,900 lb/d $CaCl_2$ (powder)	Non-rad. hazardous landfill	A: No D: Yes B: Yes E: No C: Yes F: Yes	10	$1,920,000	Yes	$362,000	$70,000	$2,352,000	$3,216,000
Ultra-high-efficiency CATOX	99	10	No	Yes	42	N/A	N/A	A: No D: Yes B: No E: Yes C: Yes F: Yes	10	$1,450,000	No	$330,000	N/A	$1,780,000	$2,440,000
Ultra-high-efficiency CATOX with acid scrub	99	10	No	Yes	<4	1,900 lb/d $CaCl_2$ (powder)	Non-rad. hazardous landfill	A: No D: Yes B: Yes E: Yes C: Yes F: Yes	10	$1,940,000	Yes	$362,000	$70,000	$2,372,000	$3,236,000
High-efficiency THERMOX	98	20	No	Yes	42	N/A	N/A	A: No D: Yes B: No E: No C: Yes F: Yes	8	$1,246,000	No	$1,264,000	N/A	$2,510,000	$5,038,000
High-efficiency THERMOX with acid scrub	98	20	No	Yes	<4	1,900 lb/d $CaCl_2$ (powder)	Non-rad. hazardous landfill	A: No D: Yes B: Yes E: No C: Yes F: Yes	8	$1,736,000	Yes	$1,296,000	$70,000	$3,102,000	$5,634,000
Ultra-high-efficiency THERMOX	99	10	No	Yes	42	N/A	N/A	A: No D: Yes B: No E: Yes C: Yes F: Yes	8	$1,286,000	No	$1,465,000	N/A	$2,751,000	$5,681,000
Ultra-high-efficiency THERMOX with acid scrub	99	10	No	Yes	<4	1,900 lb/d $CaCl_2$ (powder)	Non-rad. hazardous landfill	A: No D: Yes B: Yes E: Yes C: Yes F: Yes	8	$1,776,000	Yes	$1,497,000	$70,000	$3,343,000	$6,477,000

NOTES: All values are approximate and may be changed as further information is acquired.

For the purposes of this table, it is assumed that two identical systems are operating simultaneously, each with a flow rate of 1,400 acfm and a CCl_4 loading of 500 lb/d. The numbers shown represent the combined flows of the two systems.

ARARs:
A: 99.99% CCl_4 Conversion Efficiency
B: <4 lbs/hr HCl in Effluent
C: ASIL for CCl_4 (0.067 $\mu g/m^3$)
D: ASIL for HCl (23.3 $\mu g/m^3$)
E: Reportable Quantity for CCl_4 (10 lb/d)
F: Reportable Quantity for HCl (5,000 lb/d)

Key:
GAC: Granular Activated Carbon
UVOX: Ultraviolet Light - Ozone
CATOX: Catalytic Oxidation
THERMOX: Thermal Oxidation
CCl_4: Carbon Tetrachloride
HCl: Hydrochloric Acid
ASIL: Acceptable Source Impact Level

Table 5. Hydrochloric Acid Treatment Alternatives.

HCl treatment alternative	Costs of equipment	Costs of installing utilities	Costs of annual operations and feedstocks (yr)	Secondary waste type	Secondary waste amount	Secondary waste handling and disposal costs	Time until start	Total costs for start-up	Total costs of annual operations and waste (yr)
No treatment	$0	$0	$0	None	None	$0	0 d	$0	$0
Wet scrubber with evaporation ponds	$67,000	$19,100,000	$64,000	Salt Cake	290 tons/yr	$58,000	4-5 yr	$19,167,000	$122,000
Wet scrubber with discharge to 282WA Reservoir	$67,000	$260,000	$62,000	Dilute Brine Solution	18,400,000 gal/yr	$0	1.3 yr	$327,000	$62,000
Wet scrubber with mechanical evaporator	$1,067,000	$100,000	$130,000	Salt Cake	290 tons/yr	$58,000	1.3 yr	$1,167,000	$188,000
Dry scrubber	$490,000	$0	$32;000	$CaCl_2$	350 tons/yr	$70,000	7 mo	$490,000	$102,000

NOTES: All values are approximate and may be changed as further information is acquired.

For the purposes of this table, it is assumed that two identical systems are operating simultaneously, each with a flow rate of 1400 acfm and a CCl_4 loading of 500 lbs/day. The CCl_4 is converted and the subsequent HCl loading is 500 lbs/day/system. The numbers shown represent the combined flows of the two systems.

Table 6. Evaluation of Remedial Technologies for EE/CA Screening Factors.

Alternative	ARAR	Screening factors		Retained for evaluation
		Protect public health	Protect environment	
Extraction/injection wells				
Horizontal and angle wells Vertical wells	State Well Construction Permit required	Public health risks associated with waste are reduced	Source of contamination reduced. Potential contaminant migration is reduced. (Assuming treatment of extracted vapor)	Yes
Extracted vapor treatment				
No treatment	May violate Clean Air Act, Washington Model Toxics Control Act, and other statutes	Public health risk not reduced or eliminated	Potential contaminant migration offsite is uncontrolled. Environmental risk is not reduced or eliminated.	No
Carbon adsorption, Catalytic oxidation, Incineration	Can comply with air emissions and other ARARs if enough equipment is used	Public health risks associated with waste reduced	Source of contamination reduced. Potential contaminant migration is reduced.	Yes

Recently adopted federal RCRA regulations for control of organic chemical waste emissions to the atmosphere in 40 CFR 264, Subparts AA and BB may be applicable to other remedial alternatives that involve condensation and follow-up treatment of liquid carbon tetrachloride. These regulations impose specific monitoring and control measures on distillation and other processes, and leak detection and repair requirements for valves, vents, pumps, and other equipment.

Another common type of regulated waste that may be generated by two or more alternative systems is spent or loaded activated carbon. As with contaminated water condensate, it would have to be managed according to applicable dangerous waste, RCRA, and U.S. Department of Transportation (DOT) regulations. Onsite burial is prohibited.

The fourth type of regulated waste is radioactive material. Limited amounts of natural radioactive elements (e.g., radon) are expected to be extracted from the soil. State regulations for notification of actions involving potential releases of radionuclides and federal rules for limiting potential exposure of the public apply to the proposed action. However, no man-made radionuclides will be intentionally removed from the disposal sites. Incidental removal of fission products from the soil can be entirely avoided or limited to extremely low levels, according to the results of the pilot test conducted at the 216-Z-1A Tile Field.

Accumulation of radioactive particulates in the inlet HEPA filter would result in unnecessary personnel exposures when the filters are removed for disposal. If such accumulations occur at initial extraction locations, the accumulations of radionuclide particulates cannot be avoided, and the entire project may be closed down. In any case, radiation emissions will be minimized or avoided entirely.

The regulations that are considered potentially applicable are listed in Table 7.

Table 7. Summary of Environmental Regulations Applicable to the 200 West Area Carbon Tetrachloride ERA.

Regulation	Applicable	Comments
WAC 246-247 (formerly WAC 402-80) (RAEP)	Yes	If radionuclides are extracted during the test, pre-operational notification to DOH is required.
40 CFR 61 (NESHAPs)	No	Applicable only if extracted radionuclides result in a dose of 0.1 mrem or greater, using 40 CFR 61, Appendix D methodology.
WAC 173-400 (PSD)	No	Unless emitting large quantities of carbon tetrachloride (more than 40 tons/yr).
40 CFR 264-265, Subpart AA and BB (RCRA Organic Air)	Possible	CERCLA actions of this type are specifically excluded from permitting, but compliance may be required.
40 CFR 264, Subpart O Incinerators	Yes	99.99% conversion efficiency of carbon tetrachloride in thermal units <4 lb/h HCl in emissions.
State TAP Regulations WAC 173-460	Yes	ASIL for carbon tetrachloride is 0.067 $\mu g/m^3$ (annual average) ASIL for HCl is 23.3 $\mu g/m^3$ (24-h average)
CERCLA Reportable Quantities (40 CFR 302)	Yes	Reportable quantities are over 4.5 kg carbon tetrachloride/day/disposal site and 2,270 kg HCl/day/disposal site.
WAC 173-160	Yes	Well construction standards.

ASIL = Acceptable Source Impact Level
CCl_4 = Carbon Tetrachloride
DOH = Washington Department of Health.
HCl = Hydrochloric Acid
NESHAPs = National Emissions Standards for Hazardous Air Pollutants
PSD = Prevention of Significant Deterioration
RAEP = Radiological Airborne Emission Program
TAP = Toxic Air Pollutants
T-BACT = Best Available Control Technology for Toxics

In addition, certain DOE orders and Westinghouse Hanford procedures apply to the proposed action. As part of the standard procedures for planning and implementing any DOE/Westinghouse Hanford environmental remediation activity, the requirements to limit personnel radiation exposure to as low as reasonable achievable (ALARA) are especially applicable to the proposed action. Several primary DOE orders, Westinghouse Hanford procedures, American National Standards Institute (ANSI), and Nuclear Regulatory Commission regulations that may apply to this ERA are listed in Table 8.

Table 8. Regulations and Procedures That May Apply to the 200 West Area ERA.

Regulations and Procedures	Title
ANSI N13.6	Practice for Occupational Radiation Exposure Records Systems
ANSI N42.18-1980	Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents
ANSI N323-1978	Radiation Protection Instrumentation Testing and Calibration
DOE Memorandum	W.A. Vaughn, August 5, 1985, Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities
DOE Order 5400.1	Guide Environmental Protection Program
DOE Order 5400.5	Radiation Protection of the Public and the Environment
Draft DOE Order 5400.xx	Radiation Protection of the Public and Environment
Draft DOE Order 5400.xy	Radiological Effluent Monitoring and Environmental Surveillance
DOE Order 5480.10	Contractor Industrial Hygiene Program
DOE Order 5480.4	Environmental Protection, Safety, and Health Protection Standards
DOE Order 5480.11	Radiation Protection for Occupational Workers
DOE Order 5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
DOE Order 5820.2A	Radioactive Waste Management
DOE Order 6430.1	General Design Criteria
DOE/EP - 0096	A Guide for Effluent Radiological Measurements at DOE Installations
DOE-RL, March 1987	Plan and Schedule to Discontinue Disposal of Contaminated Liquids into the Soil Column at the Hanford Site
DOE-RL	Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management, August 1985
DOE-RL-89-18	Environmental Protection Implementation Plan
DOE-RL Order 5480.11A	Requirements for Radiation Protection
DOE-RL Order 5484.1	Effluent and Environmental Monitoring Program Requirements, Chapter III
NRC	Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation
WHC-CM-1-1 (WHC 1987b)	Management Policies
WHC-CM-1-3 (WHC 1988f)	Management Requirements and Procedures Manual
WHC-CM-2-1 (WHC 1988i)	Procurement Manual
WHC-CM-2-14 (WHC 1988d)	Hazardous Material Packaging and Shipping
WHC-CM-4-1 (WHC 1988l)	WHC Emergency Plan
WHC-CM-4-3 (WHC 1987a)	Industrial Safety Manual, Volumes 1 and 4
WHC-CM-4-11 (WHC 1988a)	ALARA Program
WHC-CM-5-10 (WHC 1988j)	Radiation Protection
WHC-CM-5-16 (WHC 1988e)	Hazardous Waste Management
WHC-CM-7-4 (WHC 1988g)	Operational Environmental Monitoring
WHC-CM-7-5 (WHC 1988c)	Environmental Compliance
WHC-CM-7-6 (WHC 1991a)	Environmental Compliance Verification Manual
WHC-CM-8-6 (WHC 1988k)	Site Support
WHC-CM-8-7 (WHC 1988h)	Operations Support Services
WHC-EP-0137 (WHC 1988b)	Best Available Technology (BAT) Guidance document for the Hanford Site

5.1.2 Protection of Public Health and the Environment

Operation of the vapor extraction and treatment equipment will not have a significant adverse impact on public health or the environment. Implementation of the preferred alternative is expected to minimize the potential for further plume migration. The greatest hazard associated with normal operation of the VES is the release of hydrochloric acid vapor and a small concentration of carbon tetrachloride vapor.

During the test phase, sample results indicated that there were only three chemical contaminants detected. The vapors extracted during testing consisted primarily of carbon tetrachloride. Trace amounts of chloroform and 2-butanone were also detected. The quantities of these contaminants are much smaller than the quantities of carbon tetrachloride and the toxicity of both chloroform and 2-butanone are less than carbon tetrachloride. The test assessment identified these contaminants as chemicals that were expected to be vaporized and removed during the overall remediation phase. During the test phase, concentrations of volatile organic compounds (VOC) were not detected outside the VES.

Protection of the occupational worker will involve monitoring the VES unit in areas where fittings, hose connections, carbon canisters, and positive pressure points are located. Also in-line monitors, calibrated to detect concentrations below the time weighted average (TWA) exposure limits, and interlocks to shutdown the process, in the event concentrations exceed these limits, should be provided. This is required to minimize the potential exposure to the occupational worker to concentrations of carbon tetrachloride that may exceed the TWA limits identified in the National Institute for Occupational Safety and Health (NIOSH) guidelines.

Detection capability will involve the use of instrumentation (i.e., gas chromatograph) calibrated to measure concentrations of carbon tetrachloride or other VOCs. Concentrations that may be detected around the VES unit exceeding the toxicity limit values will require maximum protection that ensures occupational exposures from carcinogens be limited to the lowest feasible concentrations.

Each active carbon tetrachloride treatment alternative would provide increased protection and decrease future risks to public health and the environment by removing carbon tetrachloride from the effluent.

Each of the remedial alternatives could be implemented within 1 yr or less. This time period is short in comparison with the carbon tetrachloride vapor travel time from Z Plant to the 200 West Area boundary.

No impacts to site workers, the public, or the environment are expected due to the presence of man-made radionuclides in the subsurface soils at the ERA site. Plutonium and americium are not expected to be extracted during operations (WHC 1991). Sampling associated with vapor extraction tests and follow-up sampling of the system components resulted in no detection of americium or plutonium. However, several precautions will be taken in the event that plutonium and americium are extracted from the soil. The vapor extraction system will require alpha and beta CAMs and a set of two high-efficiency particulate air filters. If granular activated carbon (GAC) is used to collect the carbon tetrachloride, a routine survey program will also be needed to monitor the GAC canisters for excessive external gamma exposure. The system will be shutdown if the measurable activity exceeds 6,000 cpm.

Sampling associated with vapor extraction tests conducted at the ERA site resulted in the detection of low concentrations of naturally-occurring radon daughter products (Appendix F2). If GACs are used for the collection of carbon tetrachloride, the GACs may become saturated by radon. A gamma exposure problem could occur if the radon buildup in the GAC were to reach an

activity of 6,000 cpm on the outside of a GAC canister. If this occurs, the system would be shutdown. A beta CAM, placed upstream of the GAC canisters, would alarm if enough radon is pulled to saturate the GAC canisters. A routing survey program will also be needed to monitor the GAC canisters for excessive external gamma exposure. The system will be shutdown if the measurable activity exceeds 6,000.

Potential impacts, of the extraction and treatment of carbon tetrachloride, to the public were assessed in two separate modeling efforts. The EPA-approved SCREEN model was used in one effort and the EPA-approved Industrial Source Code Short Term (ISCST) and COMPLEX1 models were used in the other effort. The summary of the SCREEN modeling results are shown in Table 9 and the summary of the ISCST and COMPLEX1 modeling results are shown in Table 10. Effluent parameters used in the modeling are shown in Table 11.

5.1.2.1 Air Dispersion Modeling - SCREEN. The SCREEN model provides an easy-to-use, comparatively conservative, method of obtaining pollutant concentration estimates. It requires the user to input various emission data (e.g., emission rate and velocity, stack height and diameter, exit and ambient temperatures, receptor distance, etc.) and the results are expressed as estimated maximum 1-h concentrations that can be converted to 24-h or annual average concentrations. Impacts were assessed for an individual assumed to be residing near the Hanford Site boundary about 12.4 km (7.7 mi) from the ERA site. Worst-case meteorological conditions were also considered.

The SCREEN model was run for the proposed two-VES design discussed in Chapter 4.0. The results of the SCREEN model indicate the concentration of carbon tetrachloride at the Hanford Site boundary would be greater than the allowable 0.067 $\mu g/m^3$ for all of the vapor treatment alternatives. Similarly, the concentration of hydrochloric acid at the Hanford site boundary for these alternatives producing the acid and not scrubbing would be greater than the allowable 23.3 $\mu g/m^3$. Those alternatives that scrub the acid and those not producing the acid would have Hanford Site boundary concentrations of hydrochloric acid below the allowable limit.

5.1.2.2 Air Dispersion Modeling - COMPLEX1 and ISCST. Emissions from the proposed two-VES design were modeled using EPA dispersion models and onsite meteorology. Ambient concentrations of carbon tetrachloride and hydrochloric acid were calculated for the Hanford boundary, the Federal Building in the city of Richland, and for the area immediately surrounding the VES exhaust stacks. Maximum 24-h and annual average concentrations were calculated at the Hanford boundary and Federal building. Maximum 8-h, 24-h, and annual average concentrations were determined for the area immediately surrounding the VES exhaust stacks. Isopleth maps of dispersion coefficients for the area surrounding the VES were produced (Appendix H).

Onsite meteorologic data were used in the analysis. The data were collected at the Hanford meteorological tower, located between the 200 East and 200 West Areas. Data used in the analysis included wind speed, wind direction, ambient temperature, mixing height and stability class. The data were processed into files compatible with the dispersion programs.

Table 9. Results of SCREEN Modeling.

Distance (meters)	25	100	200	4,500	10,461	12,400
No treatment						
Carbon tetrachloride (μg/m^3)	0	1354	691	34.2	12.0	9.67
Hydrochloric acid (μg/m^3)	0	0	0	0	0	0
Carbon with Offsite Regeneration						
Carbon tetrachloride (μg/m^3)	0	13.5	6.91	0.34	0.12	0.097
Hydrochloric acid (μg/m^3)	0	0	0	0	0	0
Carbon Regenerated Onsite with Offsite Treatment of Condensate						
Carbon tetrachloride (μg/m^3)	0	27.1	13.8	0.68	0.24	0.19
Hydrochloric acid (μg/m^3)	0	0	0	0	0	0
Carbon Regenerated Onsite by Ultraviolet Light - Ozone						
Carbon tetrachloride (μg/m^3)	0	27.1	13.8	0.68	0.24	0.19
Hydrochloric acid (μg/m^3)	0	5459	2786	138	48.3	39.0
Carbon Regenerated Onsite by Ultraviolet Light - Ozone with Acid Scrub						
Carbon tetrachloride (μg/m^3)	0	27.1	13.8	0.68	0.24	0.19
Hydrochloric acid (μg/m^3)	0	1040	531	26.3	9.20	7.42
High-Efficiency Catalytic Oxidation						
Carbon tetrachloride (μg/m^3)	0	30.3	17.9	0.67	0.24	0.19
Hydrochloric acid (μg/m^3)	0	6110	3605	135	47.6	38.4
High-Efficiency Catalytic Oxidation with Acid Scrub						
Carbon tetrachloride (μg/m^3)	0	30.3	17.9	0.67	0.24	0.19
Hydrochloric acid (μg/m^3)	0	1164	687	25.8	9.06	7.32
Ultra-High-Efficiency Catalytic Oxidation						
Carbon tetrachloride (μg/m^3)	0	15.2	8.94	0.34	0.12	0.095
Hydrochloric acid (μg/m^3)	0	6110	3605	135	47.6	38.4
Ultra-High-Efficiency Catalytic Oxidation with Acid Scrub						
Carbon tetrachloride (μg/m^3)	0	15.2	8.94	0.34	0.12	0.095
Hydrochloric acid (μg/m^3)	0	1164	687	25.8	9.06	7.32
High-Efficiency Thermal Oxidation						
Carbon tetrachloride (μg/m^3)	0	30.3	17.9	0.67	0.24	0.19
Hydrochloric acid (μg/m^3)	0	6110	3605	135	47.6	38.4
High-Efficiency Thermal Oxidation with Acid Scrub						
Carbon tetrachloride (μg/m^3)	0	30.3	17.9	0.67	0.24	0.19
Hydrochloric acid (μg/m^3)	0	1164	687	25.8	9.06	7.32
Ultra-High-Efficiency Thermal Oxidation						
Carbon tetrachloride (μg/m^3)	0	15.2	8.94	0.34	0.12	0.095
Hydrochloric acid (μg/m^3)	0	6110	3605	135	47.6	38.4
Ultra-High-Efficiency Thermal Oxidation with Acid Scrub						
Carbon tetrachloride μg/m^3)	0	15.2	8.94	0.34	0.12	0.095
Hydrochloric acid (μg/m^3)	0	1164	687	25.8	9.06	7.32

Table 10. Results of ISCST and COMPLEX1 Modeling. (sheet 2 of 2)

Maximum concentrations near VES

Treatment alternatives	CCl_4 Concentrations ($\mu g/m^3$)			HCl Concentrations ($\mu g/m^3$)		
	8 hr	24 hr	Annual	8 hr	24 hr	Annual
No treatment	2300	1700	140	-	-	-
GAC with offsite regeneration	23	17	1.4	-	-	-
GAC regeneration onsite with offsite treatment of condensate	23	17	1.4	-	-	-
GAC regenerated onsite by UVOX	47	33	2.9	98	70	6.1
GAC regenerated onsite by UVOX with acid scrub	47	33	2.9	19	13	1.2
High-efficiency CATOX	23	15	1.4	48	31	3.0
High-efficiency CATOX with acid scrub	23	15	1.4	9.1	5.9	0.56
Ultra-high-efficiency CATOX	11	7.3	0.70	48	31	3.0
Ultra-high-efficiency CATOX with acid scrub	11	7.3	0.70	9.1	5.9	0.56
High-efficiency THERMOX	23	15	1.4	48	31	3.0
High-efficiency THERMOX with acid scrub	23	15	1.4	9.1	5.9	0.56
Ultra-high-efficiency THERMOX	11	7.3	0.70	48	31	3.0
Ultra-high-efficiency THERMOX with acid scrub	11	7.3	0.70	9.1	5.9	0.56

MAXIMUM CONCENTRATIONS AT HANFORD RESERVATION BOUNDARY

Treatment alternatives	CCl_4 Concentrations ($\mu g/m^3$)		HCl Concentrations ($\mu g/m^3$)	
	24 hr	Annual	24 hr	Annual
No treatment	9.7	0.48	-	-
GAC with offsite regeneration	0.097	0.048	-	-
GAC regeneration onsite with offsite treatment of condensate	0.097	0.048	-	-
GAC regenerated onsite by UVOX	0.19	0.0097	0.41	0.020
GAC regenerated onsite by UVOX with acid scrub	0.19	0.0097	0.077	0.0039
High-efficiency CATOX	0.20	0.0091	0.41	0.019
High-efficiency CATOX with acid scrub	0.20	0.0091	<0.079	0.0036
Ultra-high-efficiency CATOX	0.098	0.0045	0.41	0.019
Ultra-high-efficiency CATOX with acid scrub	0.098	0.0045	<0.079	0.0036
High-efficiency THERMOX	0.20	0.0091	0.41	0.019
High-efficiency THERMOX with acid scrub	0.20	0.0091	<0.079	0.0036
Ultra-high-efficiency THERMOX	0.098	0.0045	0.41	0.019
Ultra-high-efficiency THERMOX with acid scrub	0.098	0.0045	<0.079	0.0036

Table 10. Results of ISCST and COMPLEXI Modeling. (sheet 2 of 2)

MAXIMUM CONCENTRATIONS AT FEDERAL BUILDING IN RICHLAND, WASHINGTON

Treatment alternatives	CCl_4 Concentrations ($\mu g/m^3$)		HCl Concentrations ($\mu g/m^3$)	
	24 hr	Annual	24 hr	Annual
No treatment	1.5	0.12	-	-
GAC with offsite regeneration	0.015	0.0012	-	-
GAC regeneration onsite with offsite treatment of condensate	0.015	0.0012	-	-
GAC regenerated onsite by UVOX	0.029	0.0023	0.062	0.0049
GAC regenerated onsite by UVOX with acid scrub	0.029	0.0023	0.012	0.00093
High-efficiency CATOX	0.029	0.0021	0.061	0.0043
High-efficiency CATOX with acid scrub	0.029	0.0021	0.012	0.00083
Ultra-high-efficiency CATOX	0.015	0.0010	0.061	0.0043
Ultra-high-efficiency CATOX with acid scrub	0.015	0.0010	0.012	0.00083
High-efficiency THERMOX	0.029	0.0021	0.061	0.0093
High-efficiency THERMOX with acid scrub	0.029	0.0021	0.021	0.00083
Ultra-high-efficiency THERMOX	0.015	0.0010	0.061	0.0043
Ultra-high-efficiency THERMOX with acid scrub	0.015	0.0010	0.021	0.00083

The modeling assumed that two identical systems are operating simultaneously, each with a flow rate of 1400 acfm and a CCL_4 loading of 500 lb/d. The numbers shown are the results of the modeling for the given locations.

GAC = Granular Activated Carbon
UVOX = Ultraviolet Light - Ozone
CATOX = Catalytic Oxidation
THERMOX = Thermal Oxidation
CCL_4 = Carbon Tetrachloride
HCL = Hydrochloric Acid

Table 11. Effluent Parameters for Treatment Alternatives for One Vapor Extraction System.

Treatment alternative	Flow (acfm)	Amount of CCl_4 (lb/d)	Amount of HCl (lb/h)	Temperature (°F)	Stack Height (ft)	Stack Diameter (in.)	Exit Velocity (fps)
No treatment	1,400	500	0	100	15	8	67
GAC with offsite regeneration	1,400	5	0	100	15	8	67
GAC regenerated onsite with offsite treatment of condensate	1,400	5	0	100	15	8	67
GAC regenerated onsite by UVOX	1,400	10	21	100	15	8	67
GAC regenerated onsite by UVOX with acid scrub	1,400	10	<4	100	15	8	67
High-efficiency CATOX	2,300	10	21	350	15	8	110
High-efficiency CATOX with acid scrub	2,300	10	<4	350	15	8	110
Ultra-high-efficiency CATOX	2,300	5	21	350	15	8	110
Ultra-high-efficiency CATOX with acid scrub	2,300	5	<4	350	15	8	110
High-efficiency THERMOX	2,300	10	21	350	15	8	110
High-efficiency THERMOX with acid scrub	2,300	10	<4	350	15	8	110
Ultra-high-efficiency THERMOX	2,300	5	21	350	15	8	110
Ultra-high-efficiency THERMOX with acid scrub	2,300	5	<4	350	15	8	110

NOTE: All values are approximate and may be changed as further information is acquired.

GAC = Granular Activated Carbon
UVOX = Ultraviolet Light - Ozone
CATOX = Catalytic Oxidation
THERMOX = Thermal Oxidation
CCl_4 = Carbon Tetrachloride
HCl = Hydrochloric Acid

The EPA modeling guidance includes procedures for determining stability class. The meteorological data provided by Battelle Northwest include stability class data. The EPA recommends that stability class data be derived from the standard deviation of the wind direction, or from night-time vertical temperature difference and day-time solar radiation measurements, adjusted wind speed classes, or from solar radiative indices determined from cloud cover and ceiling heights. Stability class data for this modeling effort were derived from vertical temperature differences. During data processing for this study, the stability class was not allowed to change by more than one stability class per hour.

Maximum offsite concentrations resulting from emissions from the VES were determined. Ambient concentrations of carbon tetrachloride and hydrochloric acid were calculated at a series of receptors spaced approximately every 2 km (1.2 mi) along the Hanford Site boundary. An additional receptor was included to represent the Federal Building in the city of Richland. A total of 77 receptors was included in this aspect of the modeling. This grid system included terrain elevations. Because the Hanford boundary crosses Rattlesnake Mountain and goes part way up the Wahluke Slope, many of the receptors are at elevations higher than the top of the VES exhaust stacks. The elevated terrain, the noncollocated sources, and the rural environment indicate that use of the COMPLEX1 model is appropriate for determining the maximum offsite concentrations resulting from the VES emissions.

Maximum carbon tetrachloride and hydrochloric acid concentrations were also determined for the area immediately surrounding the VES. The area surrounding the VES is relatively level. Therefore, the ISCST Model is appropriate for this application. The model was allowed to generate a polar coordinate receptor field centered on the VES exhaust stack of the system operating near the 216-Z-1A Tile Field. The grid system consisted of 36 radials and 32 downwind directions. The downwind distances were spaced at 100-m (62-mi) intervals out to 1 km (0.6 mi), 200-m (660-ft) intervals out to 4 km (2.5 mi), and 500-m (1,640-ft) intervals out to 7.5 km (4.7 mi).

Five years of Hanford meteorology were processed and used as input to the COMPLEX1 and ISCST models. The various treatment alternatives investigated have different emission rates. However, only two different combinations of exit temperatures and flowrates are expected (100°F [38°C] and 67 ft/s [20 m/s], 350°F [177°C] and 110 ft/s [34 m/s]). Therefore, only two cases were actually modeled. Each case was modeled for all 5 yr of meteorology, for the boundary receptors and for the receptors near the VES. For each case and receptor field, the maximum annual, 24-h and 8-h concentration were tabulated.

The maximum offsite concentration is located 26.1 km (16.2 mi) directly east of the VES, at a ground elevation of 200 m (660 ft). The location of the maximum 4-h offsite concentration is 13.1 km (8.1 mi) west of the VES at an elevation of 300 m (980 ft).

The results of the modeling indicate that the allowable concentration of carbon tetrachloride at the Hanford Site boundary would not be exceeded by any of the treatment alternatives except "No Treatment". The "No Treatment" alternative is excluded from further consideration as a potential treatment,

but is included in the discussions for comparative purposes. The concentration of hydrochloric acid at the Hanford Site boundary for all the alternatives, both with acid scrubbing and without, would not exceed the allowable limit.

The abilities of the vapor treatment alternatives to meet the six ARARs are shown in the following subsections. The abilities to meet the ARARs are based on the two-system design with both systems operating. The ability to meet the Acceptable Source Impact Level (ASIL) is based on the results of the COMPLEX1 modeling for expected concentrations at the Hanford Site boundary.

5.1.2.2.1 No Treatment.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	N/A
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	No
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.2 Carbon with Offsite Regeneration.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	N/A
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.3 Carbon Regenerated Onsite with Offsite Treatment of Condensate.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	N/A
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.4 Carbon Regenerated Onsite by Ultraviolet-Ozone

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	N/A
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.5 Carbon Regenerated Onsite by Ultraviolet-Ozone with Acid Scrub.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	N/A
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.6 High-Efficiency Catalytic Oxidation.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.7 High-Efficiency Catalytic Oxidation with Acid Scrub.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.8 Ultra-High-Efficiency Catalytic Oxidation.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.9 Ultra-High-Efficiency Catalytic Oxidation with Acid Scrub.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.10 High-Efficiency Thermal Oxidation.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.11 High-Efficiency Thermal Oxidation with Acid Scrub.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	No
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.12 Ultra-High-Efficiency Thermal Oxidation.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

5.1.2.2.13 Ultra-High-Efficiency Thermal Oxidation with Acid Scrub.

Ability to Meet ARARs

99.99% Carbon Tetrachloride Conversion Efficiency	No
<4 lb/h (1.8 kg/h) Hydrochloric Acid in Effluent	Yes
ASIL for Carbon Tetrachloride	Yes
ASIL for Hydrochloric Acid	Yes
Reportable Quantity for Carbon Tetrachloride	Yes
Reportable Quantity for Hydrochloric Acid	Yes

The SCREEN model was also used to estimate potential exposure concentrations to workers near the ERA site (i.e., at Z Plant). Exposure concentrations were estimated for each active alternative at locations 25 m (82 ft), 100 m (330 ft) and 200 m (660 ft) from Z Plant, the nearest site building. These distances represent potential proximities of the VES facility to workers on a routine basis. During normal operation of the VES system, exposure to site workers at or adjacent to the treatment system location is essentially nonexistent due to the height of the plume and dispersion of effluent away from the stacks. All concentrations of carbon tetrachloride and hydrochloric acid vapors predicted for onsite locations would not only be well below levels considered to be Immediately Dangerous to Life and Health (IDLH) but also below permissible exposure levels.

The effects to onsite workers from an abnormal situation involving failure of piping or other containment at one of the VES units and thus allowing a carbon tetrachloride-contaminated influent pool to form on the ground was also analyzed using the SCREEN model. The emission rate of unreacted carbon tetrachloride was assumed to be 2.625 g/s (0.0058 lb/s). Impacts to workers due to these failures possibly could exceed the permissible exposure limits for carbon tetrachloride but would be below levels that are IDLH. Concentrations of hydrochloric acid due to failure of one of the VES units are not predicted because hydrochloric acid is only formed as a byproduct of treatment of extracted vapor. Occurrences of these types are considered to be highly unlikely because the vapor extraction and treatment system will be equipped with automatic shut-off monitors and alarms and designed to preclude such occurrences.

Construction and operation of the vapor extraction and treatment system(s) (i.e., well installation and equipment placement) will result only in relatively minor short-term impacts. The vapor extraction and treatment system(s) will be located in previously disturbed areas of the 200 West Area, which is a highly industrial area. These areas are not known to contain any sensitive areas including wetlands, sole source aquifers, or critical habitats. Similarly, no archeological, historical, or native American religious sites have been identified in the immediate vicinity of these activities. No species of plant or animal listed as threatened or endangered are known to occur in the immediate area.

Placement of the equipment at the site and the transport of workers to and from the site may result in small particulate releases to the atmosphere in the form of dust. Water will be applied to the site and access roads as needed to suppress dust generation. Some equipment sites may require extension of utilities (i.e., electrical power). Operations to extend utilities may also result in minor land disturbances and dust generation.

Small amounts of nonrenewable fuel and resources will be consumed during the ERA. The amount of resources consumed will not be significant when compared to the overall consumption of resources on the Hanford Site.

Implementation of the vapor extraction and treatment system(s) will reduce the contamination of the unsaturated zone soils, and will ultimately reduce the future risk associated with contaminants migrating to the underlying aquifer.

5.2 SELECTION CRITERIA EVALUATION

The three extraction well alternatives, twelve of the vapor treatment alternatives, and the four acid scrubbing alternatives met the screening evaluation criteria and were retained for selection criteria evaluation. In this section, the alternatives are evaluated for: (1) effectiveness, (2) implementability, and (3) cost. The "No Treatment" alternative is included for comparative purposes. Each of the alternatives will be compatible with the final cleanup alternatives.

The selection criteria evaluations are more conceptual and less detailed than might be expected in a comprehensive RI/FS report. This is appropriate because the proposed removal action is not a complete remedy and will eventually be superseded by comprehensive RI/FS work and RODs for each operable unit in the area.

5.2.1 Effectiveness

The criterion of effectiveness includes the factors of short- and long-term effectiveness, and reduction of toxicity, mobility, or volume. These factors were applied to each of the remedial alternatives and are discussed below.

5.2.1.1 Wells.

5.2.1.1.1 Horizontal and Angle Wells. Horizontal and angle wells offer the potential advantages of a greater area of (vacuum) influence and/or access to contaminated zones not accessible via vertical wells. However, the three main carbon tetrachloride release sites in the 200 West Area are accessible from the surface via existing (or new) vertical wells. Although the possible advantage of a wider zone of influence (from a single surface access point) seems obvious, the increase in area of vacuum influence from a horizontal or angled well is uncertain. Determination of advantages of such wells would require installation and testing to provide comparison data and/or performance monitoring.

5.2.1.1.2 Vertical Wells. The high permeability to air and vapor exhibited by the source zone soil in the 200 West Area indicates that vertical wells will be sufficiently effective in providing access to the source zone. The radius influence from a vertical well in the 216-A-1A Tile Field source zone was determined to be approximately 18 m (59 ft) during site characterization work in early 1991. Existing vertical wells with perforated casings were proven effective for removing soil vapor.

5.2.1.1.3 Injection Wells. Injection of air or steam in conjunction with extraction wells would likely increase the rate of removal and the total volume of carbon tetrachloride removed from the source zone. However, injection would also add complexity to the extraction system. Unexpected preferential migration pathways (e.g., highly permeable gravel) could result in the opposite effect. Some vapor could be forced to move rapidly away from an extraction well. In view of the lack of comparison data, and the apparent effectiveness of removal without injection, this alternative is not attractive during the initial stages of extraction.

5.2.1.2 Extracted Vapor Treatment. Emissions from each of the treatment systems considered would be subject to limitations based on the Federal Clean Air Act of 1990 and Washington State Toxic Air Pollutant regulations. The EPA is expected to issue rules that begin implementation controls on ozone-depleting chemicals including carbon tetrachloride.

The system will not be required to obtain a permit, since the CERCLA exclusion applies to this project. However, the system may have to meet a 5 p/m vol carbon tetrachloride exhaust concentration limit. Approval of this ERA may be contingent on the ability of the preferred treatment system to meet this standard, as discussed in Section 5.1.1.

The carbon tetrachloride removal effectiveness of each of the treatment alternatives is shown in Table 12. The listed effectiveness represents the expected long-term (1 yr) effectiveness of carbon tetrachloride removal based on vendor input, field experience, and best engineering judgement. The amount of carbon tetrachloride shown in the effluent is based on the assumption that two identical systems will be operating simultaneously, each with a flowrate of 1,400 actual cfm (39,600 L/min) and a carbon tetrachloride loading of 500 lb/d (230 kg/d). The numbers shown represent the combined flows of the two systems.

5.2.1.3 Hydrochloric Acid Treatment. The wet scrubber and dry scrubber alternatives all operate at a greater than 95% removal effectiveness for hydrochloric acid. This reduces the estimated 42 lb/h (19 kg/h) hydrochloric acid to much less than the potentially-required 4 lb/h (1.8 kg/h).

5.2.2 Implementability

Implementability includes technical feasibility, administrative feasibility, and availability of services and materials. These factors were applied to each alternative and are discussed below.

5.2.2.1 Wells. The distinguishing features of the three types of wells used in the VES are the forms and functions of the wells installed in the source zone. The first phase will utilize existing vertical wells for extraction, injection, and monitoring. A sufficient number of wells already exist that can be used in Phase I (see Section 4.2). The second phase will incorporate existing wells and newly-drilled wells.

5.2.2.1.1 Vertical Extraction Wells. As discussed previously in Section 4.2.1, 46 vertical wells exist in or near the tile fields. Many of these wells are located in prime areas for extraction, monitoring, and injection. Some of these wells can be modified to perform as extraction wells such as was done during the 1991 vapor extraction test (see Appendix F2). Steel casings in existing wells at the 216-Z-1A Tile Field were perforated at various horizons, so that these wells could be used as extraction wells. These wells functioned acceptably. The use of existing wells has the advantages of: (1) not having to drill through radiologically-contaminated soils, (2) being time efficient, (3) not being labor intensive, and (4) being more cost effective.

Table 12. Carbon Tetrachloride Removal Effectiveness.

Treatment alternatives	Carbon tetrachloride removal effectiveness (%)	Carbon tetrachloride in effluent (lb/d)	Carbon tetrachloride destruct offsite
No treatment	0	1,000	No
GAC with offsite regeneration	99	10	Yes
GAC regenerated onsite with offsite treatment of condensate	99	10	Yes
GAC regenerated onsite by UVOX	98	20	No
GAC regenerated onsite by UVOX with acid scrub	98	20	No
High-efficiency CATOX	98	20	No
High-efficiency CATOX with acid scrub	98	20	No
Ultra-high-efficiency CATOX	99	10	No
Ultra-high-efficiency CATOX with acid scrub	99	10	No
High-efficiency THERMOX	98	20	No
High-efficiency THERMOX with acid scrub	98	20	No
Ultra-high-efficiency THERMOX	99	10	No
Ultra-high-efficiency THERMOX with acid scrub	99	10	No

Removal effectiveness is expected long-term (one year) effectiveness of carbon tetrachloride removal based on vendor input, field experience, and best engineering judgement.

For the purposes of this table, it is assumed that two identical systems are operating simultaneously, each with a flow rate of 1400 acfm and a carbon tetrachloride loading of 500 lbs/day. The numbers shown represent the combined flows of the two systems.

GAC = Granular Activated Carbon
UVOX = Ultraviolet Light - Ozone
CATOX = Catalytic Oxidation
THERMOX = Thermal Oxidation

Emplacement of new vertical extraction wells in and around the three carbon tetrachloride disposal sites would be a costly and time-consuming effort that would impact the schedule for initiation of cleanup. Standard drilling and well completion activities at the Hanford Site are conducted with cable tool rigs. Drilling and completion of wells within radiologically-contaminated soils (i.e., within the disposal sites) is more time-consuming. Drilling new wells in or near the disposal sites would be further complicated by the requirement to avoid creating new migration pathways that could cause rapid movement of contaminants. Installation of new vertical wells will be assessed for Phase II remediation.

5.2.2.1.2 Horizontal Wells. Presently, the successful implementation of horizontal drilling at the Hanford Site in a Phase I ERA time frame is doubtful. Installation of these wells requires highly specialized drilling equipment and operator training. In addition, the basic equipment is a mud-rotary drill rig. Mud rotary drilling will be difficult to conduct due to the geology beneath the 200 West Area, causing severe stress on rotary drill bits and rapid abrasion of the drill string. In addition, drilling fluids will migrate through the permeable soils, possibly limiting the vapor extraction effectiveness, causing a mud waste problem, and potentially remobilizing contaminants by mixing with the carbon tetrachloride and the radioactive particulates.

Horizontal drilling should be considered an "emerging" technology at the site, even though it is presently being demonstrated elsewhere, such as the Savannah River Site. Even at the Savannah River Site, where geologic conditions are more favorable, several drilling and well completion problems were encountered, causing redrilling efforts (four borings abandoned), and a lost drill string. This method will be further evaluated for future use in the ERA.

5.2.2.1.3 Injection Wells. Injection of air or steam into the source zone to enhance movement of soil vapor toward adjacent extraction wells is a proven technique at sites where only organic chemical contamination exists. The equipment needed to perform this function is limited to a cased and screened (or perforated casing) well, hoses and connection to the well casing, and an air compressor or steam generator.

No applications of injection in radiologically-contaminated soils are known, and adverse results are possible, as discussed in Section 4.2. The potential problem with steam injection is condensation of water in the well and soil, leading to limited zones of saturation and uncontrolled infiltration toward groundwater.

This equipment is readily available, reliable, easily installed and requires minimal training and maintenance to operate.

5.2.2.2 Extracted Vapor Treatment Alternatives. All of the vapor treatment systems will utilize off-the-shelf equipment for the baseline system, including:

- Heaters
- HEPA trailer
- Blower trailer
- Piping
- Valves
- Instrumentation
- Stack.

Most of these components are readily available, with standardized connections. They are well proven in similar industrial and hazardous waste or hydrocarbon release site cleanup applications. Use of these components in the 200 West Area Carbon Tetrachloride ERA will not subject them to unique

stresses or loading conditions. Installation, maintenance, and replacement do not require highly specialized training, except those services required to work in a potential radiation zone.

All of the extracted vapor treatment alternatives require only off-the-shelf equipment. No specialized training would be necessary to operate the equipment other than standard initial training.

For the purposes of determining the volumes associated with the treatment alternatives, it is assumed that the proposed two-system design is operating. As previously described, the two-system design incorporates two identical vapor extraction systems operating simultaneously, each with a flowrate of 1,400 cfm (39,600 L/min) and a carbon tetrachloride loading of 500 lb/d (230 kg/d). The volumes shown represent the combined flows of the two systems.

For the purposes of determining secondary waste volumes for those alternatives incorporating acid scrubbing, the dry scrubber alternative is used. A summary of the extracted vapor treatment alternatives' secondary waste types, volumes, and disposal is shown in Table 13.

5.2.2.2.1 No Treatment (Baseline System). This alternative represents the operation of the system without treating the carbon tetrachloride in the soil vapor. As such, this is "no treatment" and not "no action". With no treatment of the carbon tetrachloride in the soil vapor, this alternative is functionally the baseline system, which is described in the following headings.

Process Description--The baseline system process begins with the blower on the blower trailer creating a vacuum on the system back to the extraction wells. The vacuum pulls soil vapor (containing carbon tetrachloride) from the surrounding subsurface soils into the extraction wells. The soil vapor proceeds through the extraction wells and into the conveyance hoses where heaters control the soil temperature to prevent condensation of moisture from the soil vapor. The soil vapor proceeds to the HEPA trailer where it passes through a HEPA filtration unit to remove particulate contaminants. The soil vapor then travels through the system blower where it is expelled through the stack to atmosphere. Throughout the system, various valves provide control of the flow and instruments provide documentation of various operational parameters.

With this baseline treatment alternative, there is no treatment of the carbon tetrachloride in the soil vapor. The other treatment alternatives require the placement of the carbon tetrachloride treatment components between the system blower and the stack.

Operations--The baseline system is fully automated and does not require constant attention by personnel. The instrumentation of the system is connected via modem to several offsite personnel to allow updated operational information and to signal when an upset condition occurs. Because it is not critical that the system operates without interruption, the system controls shut down the system during any upset conditions.

Table 13. Extracted Vapor Treatment Alternatives: Secondary Waste Types, Volume, and Disposal.

Treatment alternative	Type of secondary waste produced	Volume of secondary waste produced (lb/d)	Secondary waste disposal
No treatment	None	None	N/A
GAC with offsite regeneration	Used granular activated carbon	1,600	Offsite incinerator
GAC regenerated onsite with offsite treatment of condensate	Concentrated, aqueous carbon tetrachloride	80 (gal/d)	Offsite incinerator
GAC regenerated onsite by UVOX	None	None	N/A
GAC regenerated onsite by UVOX with acid scrub	Calcium chloride	1,900	Nonradioactive, hazardous landfill
High-efficiency CATOX	None	None	N/A
High-efficiency CATOX with acid scrub	Calcium chloride	1,900	Nonradioactive, hazardous landfill
Ultra-high-efficiency with CATOX	None	None	N/A
Ultra-high-efficiency CATOX with acid scrub	Calcium chloride	1,900	Nonradioactive, hazardous landfill
High-efficiency THERMOX	None	None	N/A
High-efficiency THERMOX with acid scrub	Calcium chloride	1,900	Nonradioactive, hazardous landfill
Ultra-high-efficiency THERMOX	None	None	N/A
Ultra-high-efficiency THERMOX with acid scrub	Calcium chloride	1,900	Nonradioactive, hazardous landfill

It is assumed that the secondary wastes generated by the treatment alternatives do not require further treatment prior to handling, transportation, and disposal.

GAC = Granular Activated Carbon
UVOX = Ultraviolet Light - Ozone
CATOX = Catalytic Oxidation
THERMOX = Thermal Oxidation

A technician performs a daily walk-through of the system to observe the functioning of the equipment. Based on the desired operation of the system, the technician may adjust certain operational parameters.

With this baseline treatment alternative, there is no treatment of the carbon tetrachloride in the soil vapor, so no treatment components require the attention of the technician. The other treatment alternatives described in this report have components that require the checking by the technician during the daily walk-through.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is not converted with this treatment option, so no hydrochloric acid is produced.

Secondary Waste--There is no treatment of the carbon tetrachloride in the soil vapor, so there is no generation of liquid or solid secondary waste.

Time Until Start--The systems can be operating approximately 4 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.2 Carbon with Offsite Regeneration. This alternative uses carbon to capture the carbon tetrachloride from the soil vapor for offsite conversion of the carbon tetrachloride and regeneration of the carbon.

Process Description--This treatment alternative functions by passing the soil vapor through canisters containing carbon. The carbon tetrachloride vapor molecules migrate from the soil vapor to the surface of the solid carbon where they are held by physical attraction. When a carbon canister has nearly reached its full sorptive capacity, it is taken offline and stored in a holding area where, on a weekly basis, the used canisters are picked up and regenerated canisters are dropped off by a carbon vendor. The used canisters are taken to the vendor's facility, where the carbon is regenerated by removing the carbon tetrachloride, which is subsequently converted in a RCRA-permitted incinerator.

Each operating system has canisters placed in parallel and in series to allow continuous operation of the system and to improve carbon tetrachloride removal efficiency. When a primary canister reaches its sorptive capacity, it is replaced by the canister after it in the series. This secondary canister, which has been functioning as a polishing step, becomes the new primary canister and a new secondary canister is placed after it.

In addition to the baseline instrumentation, this treatment alternative includes four additional radon detectors per system. These detectors are used to facilitate the release of the canisters as nonradioactive waste and are useful for radon research studies.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is the connecting and disconnecting of the carbon canisters.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is not converted onsite with this treatment option, so no hydrochloric acid is produced.

Secondary Waste--Secondary waste is produced with this treatment process due to the adsorption of the carbon tetrachloride by the carbon. It is assumed that the 1,600 lb (730 kg) of secondary waste produced each day are classified as nonradioactive, hazardous waste that may be transported without further treatment for regeneration of the carbon and conversion of the carbon tetrachloride at an offsite RCRA-permitted incinerator.

Time Until Start--The systems can be operating approximately 4 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.3 Carbon Regenerated Onsite with Offsite Treatment of Condensate. This alternative uses carbon to capture the carbon tetrachloride from the soil vapor and subsequent condensation and offsite conversion of the carbon tetrachloride. The carbon is regenerated onsite.

Process Description--This treatment alternative also uses carbon to adsorb the carbon tetrachloride from the soil vapor, but the carbon is not sent offsite. Rather, the carbon is regenerated by an automatic process that takes a saturated portion of the fixed carbon bed and passes it through a desorption column. The desorbed carbon is then placed back at the top of the fixed carbon bed for renewed adsorptive service.

The desorption process is achieved by electric induction that quickly heats the carbon to desorption temperature. The off-gas from the desorption is directed to a condenser and from the condenser to the inlet side of the system. The condensed carbon tetrachloride is directed to a storage tank where it is held as concentrated carbon tetrachloride liquid. This condensate is collected from the storage tank every other month and is shipped by a truck to a RCRA-permitted incinerator for conversion.

Each operating system has fixed carbon beds placed in parallel to allow continuous operation of the systems. The automatic processing of the system takes a bed offline to enable it to be regenerated and then automatically places it back on line when completed.

It should be noted that this treatment alternative does not require water or steam for stripping the carbon tetrachloride from the carbon as is commonly employed with carbon regeneration systems. For this specific project, providing water and a boiler or steam and dealing with the water as a secondary waste make steam stripping expensive.

It should be further noted that direct condensation of the carbon tetrachloride from the soil vapor was investigated, but because of the relatively high soil vapor flowrate and low carbon tetrachloride concentration, this technique proved to be not feasible.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is the transfer of the condensate from the holding tanks to DOT-approved containers for transporting carbon tetrachloride offsite.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is not converted onsite with this treatment option, so no hydrochloric acid is produced.

Secondary Waste--Liquid secondary waste is produced with this treatment process due to the condensation of the carbon tetrachloride to a concentrated liquid. It is assumed that the 80 gal (300 L) of concentrated liquid carbon tetrachloride produced each day may be transported without further treatment at Hanford for conversion at an offsite RCRA-permitted incinerator. It is also assumed that the carbon tetrachloride is a nonradioactive, hazardous liquid waste.

Time Until Start--The systems can be operating approximately 8 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.4 Carbon Regenerated Onsite by Ultraviolet-Ozone. This alternative also regenerates the carbon onsite, but rather than condensing the carbon tetrachloride, the carbon tetrachloride is converted by oxidants during the self-regeneration, multistage process.

Process Description--This treatment alternative functions by passing the soil vapor through a photolytic reactor where the carbon tetrachloride is exposed to tuned-frequency ultraviolet (UV) light that excites the molecules and initiates the conversion process. The soil vapor then passes through a mist air dispersion unit, which wets the carbon tetrachloride molecule prior to its entry into an aqua reactor. Highly oxidized process water is added to the aqua reactor in a counter flow, thus providing continuous air scrubbing in the aqua reactor, where oxidants and ozone are injected as needed to enhance carbon tetrachloride conversion.

The soil vapor then passes from the aqua reactor to carbon canisters arranged in parallel. The carbon canisters are used as a polishing step because most of the of the carbon tetrachloride removal and conversion of the carbon tetrachloride takes place in the aqua reactor. The carbon canisters are regenerated by directing the oxidant air stream to one of the carbon canisters while the other canister remains online for carbon tetrachloride collection from the process. The effluent from a carbon canister during its regeneration is to the influent side of the system.

The aqua reactor and the carbon canisters receive the oxidant air stream from the activated oxygen generators. These generators produce ozone in combination with other oxygen species. The highly reactive and oxidative field, along with the selected-frequency, UV-light photolysis, enhances the overall oxidation rate of the carbon tetrachloride and allows for essentially complete oxidation of the carbon tetrachloride.

The final effluent from this treatment alternative includes air, carbon dioxide, and hydrochloric acid.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is the daily walk-through.

The system requires electricity and water. The water is used at a rate of 12 gal/h, which makes up for the evaporative losses from the system. No water is released from this system as a liquid secondary waste.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced in the off-gas at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]).

Secondary Waste--No liquid or solid secondary waste is produced by the operation of this treatment alternative.

Time Until Start--The systems can be operating approximately 11 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.5 Carbon Regenerated Onsite by Ultraviolet-Ozone with Acid Scrub. This treatment alternative is the same as the one just described, with the addition of acid scrubbing.

Process Description--The process description for this treatment alternative is the same as that of the Carbon Regenerated Onsite by Ultraviolet-Ozone alternative with the addition of acid scrubbing using the dry scrubber.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is with the hydrochloric acid scrubbers. This involves overseeing the transfer of hydrated lime into the storage silos and the transfer of waste calcium chloride out of the holding tanks.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]). The acid scrubbing reduces the hydrochloric acid in the effluent to less than 4 lb/h (1.8 kg/h).

Secondary Waste--Solid secondary waste is produced with this treatment process due to the acid scrubbing and results in an estimated 1,900 lb/d (860 kg/d) of calcium chloride, which it is assumed may be transported without further treatment for disposal at a landfill as nonradioactive, hazardous waste.

Time Until Start--The systems can be operating approximately 11 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.6 High-Efficiency Catalytic Oxidation. This treatment alternative uses thermal energy and catalyst beds to convert the carbon tetrachloride.

Process Description--This treatment alternative functions by passing the soil vapor through the tube side of a heat exchanger and then into a burner section, which is fueled by Liquid Propane Gas (LPG). The heat exchanger and burner preheat the soil vapor to the catalyzing temperature of about 650°F (343°C). The soil vapor then passes through the catalyst beds where an exothermic reaction takes place and the carbon tetrachloride is converted. The hot soil vapor then passes on the shell side of the heat exchanger where it is used to preheat the influent soil vapor. The treated soil vapor then passes through a stack to the atmosphere.

Due to the chemical stability of carbon tetrachloride, a specialized precious metal catalyst is required in the Catalytic oxidation unit.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. Each system requires only a daily walk-through by a technician.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]).

Secondary Waste--No liquid or solid secondary waste is produced by the operation of this treatment alternative.

Time Until Start--The systems can be operating approximately 10 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.7 High-Efficiency Catalytic Oxidation with Acid Scrub. This treatment alternative is the same as the one just described, with the addition of acid scrubbing.

Process Description--The process description for this treatment alternative is the same as that of the High-Efficiency Catalytic Oxidation system with the addition of acid scrubbing by a dry scrubber.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is with the hydrochloric acid scrubbers. This involves overseeing the transfer of hydrated lime into the storage silos and the transfer of waste calcium chloride out of the holding tanks.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]). The acid scrubbing reduces the hydrochloric acid in the effluent to less than 4 lb/h (1.8 kg/h).

Secondary Waste--Solid secondary waste is produced with this treatment process due to the acid scrubbing and results in an estimated 1,900 lb/d (860 kg/d) of calcium chloride, which it is assumed may be transported without further treatment for disposal at a landfill as nonradioactive, hazardous waste.

Time Until Start--The systems can be operating approximately 10 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.8 Ultra-High-Efficiency Catalytic Oxidation. This treatment alternative is similar to the High-Efficiency Catalytic Oxidation, with increased carbon tetrachloride conversion efficiency.

Process Description--The process description for this treatment alternative is the same as that of the High-Efficiency Catalytic Oxidation system with the addition of another catalyst bed to increase the residence time of the soil vapor in the catalyst bed and, thereby, the efficiency of the carbon tetrachloride conversion.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. Each system requires only a daily walk-through by a technician.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]).

Secondary Waste--No liquid or solid secondary waste is produced by the operation of this treatment alternative.

Time Until Start--The systems can be operating approximately 10 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.9 Ultra-High-Efficiency Catalytic Oxidation with Acid Scrub. This treatment alternative is the same as the one just described, with the addition of acid scrubbing.

Process Description--The process description for this treatment alternative is the same as that of the Ultra-High-Efficiency Catalytic Oxidation system with the addition of acid scrubbing by a dry scrubber.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is with the hydrochloric acid scrubbers. This involves overseeing the transfer of hydrated lime into the storage silos and the transfer of waste calcium chloride out of the holding tanks.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]). The acid scrubbing reduces the hydrochloric acid in the effluent to less than 4 lb/h (1.8 kg/h).

Secondary Waste--Solid secondary waste is produced with this treatment process due to the acid scrubbing and results in an estimated 1,900 lb/d (860 kg/d) of calcium chloride, which it is assumed may be transported without further treatment for disposal at a landfill as nonradioactive, hazardous waste.

Time Until Start--The systems can be operating approximately 10 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.10 High-Efficiency Thermal Oxidation. This treatment alternative is a thermal process similar to the catalytic oxidation system alternatives, but utilizes higher temperatures and no catalyst beds.

Process Description--This treatment alternative functions by passing the soil vapor through the tube side of a heat exchanger. The soil vapor is then passed into the burner section, which is fueled by LPG. The soil vapor is heated to the temperature (about 1,800°F [1,000°C]) where a reaction takes place and the carbon tetrachloride is converted. The hot soil vapor then passes through the shell side of the heat exchanger and on through a stack to the atmosphere.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. Each system requires only a daily walk-through by a technician.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]).

Secondary Waste--No liquid or solid secondary waste is produced by the operation of this treatment alternative.

Time Until Start--The systems can be operating approximately 8 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.11 High-Efficiency Thermal Oxidation with Acid Scrub. This treatment alternative is the same as the one just described, with the addition of acid scrubbing.

Process Description--The process description for this treatment alternative is the same as that of the High-Efficiency Thermal Oxidation system with the addition of acid scrubbing by a dry scrubber.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is with the hydrochloric acid scrubbers. This involves overseeing the transfer of hydrated lime into the storage silos and the transfer of waste calcium chloride out of the holding tanks.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]). The acid scrubbing reduces the hydrochloric acid in the effluent to less than 4 lb/h (1.8 kg/h).

Secondary Waste--Solid secondary waste is produced with this treatment process due to the acid scrubbing and results in an estimated 1,900 lb/d (860 kg/d) of calcium chloride, which it is assumed may be transported without further treatment for disposal at a landfill as nonradioactive, hazardous waste.

Time Until Start--The systems can be operating approximately 8 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.12 Ultra-High-Efficiency Thermal Oxidation. This treatment alternative is similar to the High-Efficiency Thermal Oxidation, with increased carbon tetrachloride conversion efficiency.

Process Description--The process description for this treatment alternative is the same as that of the High-Efficiency Thermal Oxidation system, but utilizes a longer residence time and an elevated temperature (about 2,000°F) to achieve improved carbon tetrachloride conversion efficiency.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. There is no significant involvement by a technician with either of the systems.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]).

Secondary Waste--No liquid or solid secondary waste is produced by the operation of this treatment alternative.

Time Until Start--The systems can be operating approximately 8 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.2.13 Ultra-High-Efficiency Thermal Oxidation with Acid Scrub. This treatment alternative is the same as the one just described, with the addition of acid scrubbing.

Process Description--The process description for this treatment alternative is the same as that of the Ultra-High-Efficiency Thermal Oxidation system with the addition of acid scrubbing by a dry scrubber.

Operations--Each operating system is fully automated and includes appropriate system responses and shutdowns. The only significant involvement that a technician has with each system is with the hydrochloric acid scrubbers. This involves overseeing the transfer of hydrated lime into the

storage silos and the transfer of waste calcium chloride out of the holding tanks.

This treatment alternative uses LPG, which requires scheduled deliveries.

Hydrochloric Acid Generation and Amount--The carbon tetrachloride is largely converted with this treatment option to hydrochloric acid, which is produced at the rate of about 1,000 lb/d (450 kg/d) (42 lb/h [19 kg/h]). The acid scrubbing reduces the hydrochloric acid in the effluent to less than 4 lb/h (1.8 kg/h).

Secondary Waste--Solid secondary waste is produced with this treatment process due to the acid scrubbing and results in an estimated 1,900 lb/d (860 kg/d) of calcium chloride, which it is assumed may be transported without further treatment for disposal at a landfill as nonradioactive, hazardous waste.

Time Until Start--The systems can be operating approximately 8 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.3 Hydrochloric Acid Treatment Alternatives. All of the hydrochloric acid treatment systems will require off-the-shelf scrubber systems. No specialized training would be required to operate the systems other than standard initial training.

The wet scrubber alternatives utilize water with a commercially-available wet scrubber to remove the hydrochloric acid from the system effluent. The counter-current flow of water (at 35 gal/min [130 L/min] per system) and air allows contact between the water and the hydrochloric acid in the air, capturing the hydrochloric acid in the water.

5.2.2.3.1 Wet Scrubber with Evaporation Ponds. This treatment alternative uses a wet scrubber to remove the hydrochloric acid from the effluent gas of the operating systems and then directs the scrubber water to ponds for solar evaporation.

Process Description--A wet scrubber is utilized to remove the hydrochloric acid from the effluent gas of the operating systems. The water from the scrubbing operation is constantly neutralized and pumped to 15 acres (60,700 m^2) of evaporation ponds located outside the fenceline of the 200 West Area. The ponds use solar evaporation to drive off the water. At periodic intervals, each of the ponds is cleaned of the salt cake that is left behind by the evaporation process.

Operations--The evaporation ponds require operation and maintenance similar to other water treatment systems of similar size. The wet scrubber requires electric and water utilities. The neutralization system requires bulk chemical delivery and handling.

Secondary Waste--This treatment alternative produces 290 tons/yr (260,000 kg/yr) of salt cake that is assumed to be a nonradioactive, hazardous waste that may be transported to a landfill for disposal without further treatment.

Time Until Start--The systems can be operating approximately 4 to 5 yr from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.3.2 Wet Scrubber with Discharge to 282WA Reservoir. This treatment alternative uses a wet scrubber to remove the hydrochloric acid from the effluent gas of the operating systems and then directs the scrubber water to the 282WA Reservoir for treatment with the other raw water influent.

Process Description--The wet scrubber is utilized to remove the hydrochloric acid from the effluent gas of the operating systems. The water from the scrubbing operation is constantly neutralized and pumped to the 282WA Reservoir located near the 200 West Area power plant. The water joins the other raw water flowing into the reservoir, all of which is treated by the treatment system already in operation there.

This treatment alternative requires that the "Source Water Quality Standards" are met and State of Washington approval is granted.

Operations--The wet scrubber requires electric and water utilities. The neutralization system requires bulk chemical delivery and handling.

Secondary Waste--This treatment alternative produces 18,400,000 gal/yr (69,600,000 L/yr) of dilute brine solution which it is assumed may be pumped to the 282WA reservoir for handling with the other raw influent water to that system.

Time Until Start--The systems can be operating approximately 1 yr and 3 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.3.3 Wet Scrubber with Mechanical Evaporator. This treatment alternative uses a wet scrubber to remove the hydrochloric acid from the effluent gas of the operating systems and then directs the scrubber water to a mechanical evaporator.

Process Description--The wet scrubber is utilized to remove the hydrochloric acid from the effluent gas of the operating systems. The water from the scrubbing operation is constantly neutralized and pumped to a mechanical evaporator. The evaporator uses heat to drive off the water.

At periodic intervals, the mechanical evaporator is cleaned of the salt cake that is left behind by the evaporation process.

Operations--The mechanical evaporator requires a daily walk-through by a technician. The mechanical evaporator requires electricity.

The wet scrubber requires electric and water utilities. The neutralization system requires bulk chemical delivery and handling.

Secondary Waste--This treatment alternative produces 290 tons/yr (260,000 kg/yr) of salt cake that is assumed to be a nonradioactive, hazardous waste that may be transported to a landfill for disposal without further treatment.

Time Until Start--The systems can be operating approximately 1 yr and 3 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.2.3.4 Dry Scrubber. This treatment alternative uses a dry scrubber to remove the hydrochloric acid from the effluent gas of the operating systems, providing a means of acid scrubbing without dealing with water.

Process Description--The soil vapor enters the dry scrubber where, if necessary, it is mixed with dilution air to lower the temperature. The soil vapor passes through parallel baghouses containing many bags. The hydrochloric acid in the soil vapor contacts hydrated lime that is fed into the baghouses, resulting in the creation of calcium chloride. This calcium chloride falls to the base of the dry scrubber where it is augured out to a storage tank. The soil vapor continues its flow out to a stack and then to the atmosphere.

The parallel baghouses allow continuous operation of the dry scrubber during maintenance of one of the baghouses. The hydrated lime is stored in a silo for supply to the baghouses.

Operations--The dry scrubber requires a daily walk-through by a technician. The dry scrubber uses electricity and hydrated lime. A technician is required to oversee the transfer of hydrated lime into the storage silos and the transfer of calcium carbonate out of the holding tanks.

Secondary Waste--The hydrated lime reacts with the hydrochloric acid to produce calcium chloride at the rate of 1,920 lb/d (870 kg/d). It is assumed that this material is a nonradioactive, hazardous waste that may be transported to a landfill for disposal without further treatment.

Time Until Start--The systems can be operating approximately 7 mo from the time the procurement process of obtaining the VES equipment is begun.

5.2.3 Costs

Well installation costs are not included in this section because all well alternatives, except existing vertical wells, were eliminated in preceding sections on grounds other than comparative costs, although relative costs were noted.

The costs of each alternative shown below do not include engineering or administrative expenditures incurred before implementation of an alternative. This evaluation is done for comparison of the different systems, and the cost of labor and engineering/management are assumed to be equal in each case. Thus, these values are not included.

The following costs are informal estimates from equipment vendors or based on limited information from the pilot testing of the VES at the 216-Z-1A Tile Field and additional assumptions concerning seasonal variation in humidity, transportation costs, etc. They should not be relied on for budgeting, but they are useful for comparing the treatment systems. Final cost estimates will reflect more definitive design criteria for the preferred alternative.

For the purposes of determining relative costs for the treatment alternatives, several assumptions were made and are presented in Table 14.

5.2.3.1 Costs for Vapor Extraction Alternatives. For the purposes of determining secondary waste costs for those alternatives incorporating acid scrubbing, the dry scrubber alternative is used. A summary of the costing information is shown in Table 15.

5.2.3.1.1 No Treatment (Baseline System).

Costs for Start-Up	$960,000
Costs for Annual Operation	$270,000
Costs for Secondary Waste	$0
Total Costs for First Year	$1,230,000
Total Costs for First Three Years	$1,770,000

5.2.3.1.2 Carbon with Offsite Regeneration.

Costs for Start-Up	$1,153,000
Costs for Annual Operation	$512,000
Costs for Secondary Waste	$312,000
Total Costs for First Year	$1,977,000
Total Costs for First Three Years	$3,625,000

5.2.3.1.3 Carbon Regenerated Onsite with Offsite Treatment of Condensate.

Costs for Start-Up	$1,960,000
Costs for Annual Operation	$274,000
Costs for Secondary Waste	$136,000
Total Costs for First Year	$2,370,000
Total Costs for First Three Years	$3,190,000

5.2.3.1.4 Carbon Regenerated Onsite by Ultraviolet-Ozone.

Costs for Start-Up	$1,484,000
Costs for Annual Operation	$298,000
Costs for Secondary Waste	$0
Total Costs for First Year	$1,782,000
Total Costs for First Three Years	$2,378,000

Table 14. Assumptions Made for Costing Purposes.

Two identical systems are operating simultaneously, each with a flowrate of 1,400 acfm and a carbon tetrachloride concentration of 500 lb/d. These flow characteristics are constant over the first 3 yr of operation.

All costs remain constant over the first 3 yr.

All costing is in 1991 dollars and does not include provisions for the time value of money. Furthermore, elements that could significantly affect costing, such as inflation and taxes, were not factored in.

It will require 4 mo from the time the procurement process of obtaining the VES equipment begins before bid awards are made to the vendors.

The cost for installing water supply lines for both systems is $100,000.

Water usage cost is an "assessment" done annually, based on operating cost divided by total water production (in some standard unit) times customer estimated usage. For costing purposes, this cost was estimated to be $20,000 annually for both sites for those treatment alternatives requiring water.

The liquid and solid secondary waste produced by the treatment alternatives for offsite treatment or disposal will be released offsite by the appropriate groups and agencies.

The secondary waste salt cake and $CaCl_2$ from the HCl scrubbing alternatives are considered nonradioactive, hazardous wastes and do not require further processing prior to transportation and disposal. The cost for transporting and disposing these wastes at an offsite landfill is $200/ton.

The soil gas has a 50% relative humidity.

The soil gas is 50°F coming out of the wells and is 100°F after passing through the system blower.

For onsite conversion of carbon tetrachloride, every pound of carbon tetrachloride that enters the system produces 1 lb of HCl.

The LPG usage for the High-Efficiency Catalytic Oxidation and Ultra-High-Efficiency Catalytic Oxidation treatment alternatives is 90 gal/d/system.

The LPG usage for the High-Efficiency Thermal Oxidation treatment alternatives is 66.5 gal/h/system.

The LPG usage for the Ultra-High-Efficiency Thermal Oxidation treatment alternatives is 80 gal/h/system.

The cost of LPG is $0.85/gal.

The cost of electricity is $0.06/kWh.

The carbon canisters that have reached its sorptive capacity is a nonradioactive, hazardous waste that does not require further treatment prior to transportation. It will be approved for offsite release by the appropriate groups and agencies.

Carbon canisters adsorb carbon tetrachloride at 60% efficiency (e.g., 100 lb of carbon canisters will adsorb 60 lb of carbon tetrachloride).

For the dry scrubber alternative, about 1.9 lb of $CaCl_2$ are produced for every 1 lb of HCl scrubbed from the effluent air. The cost of hydrated lime is $80/ton delivered. The dry scrubber uses hydrated lime at the rate of 40 lb/h/system.

The carbon tetrachloride condensate is a nonradioactive, hazardous waste that does not require further treatment prior to offsite transportation. It will be approved for offsite release by the appropriate groups and agencies. It will be converted offsite.

The cost of carbon tetrachloride condensate transportation is $3.25/loaded mile for the 2,150 mi trip from Richland, Washington, to Houston, Texas. A truck can hold 4,500 gal. The cost of carbon tetrachloride conversion at a RCRA-permitted incinerator is $0.25/lb.

The heat exchanger of the Catalytic Oxidation alternatives is able to raise the 100°F soil gas influent to 350°F and lower the effluent from 650°F to 350°F.

The heat exchanger of the High-Efficiency Thermal Oxidation alternatives is able to raise the 100°F soil gas influent to 350°F and lower the effluent from 1,800°F to 350°F.

The heat exchanger of the Ultra-High-Efficiency Thermal Oxidation alternatives is able to raise the 100°F soil gas influent to 350°F and lower the effluent from 2,000°F to 350°F.

Table 15. Extracted Vapor Treatment Alternatives: Summary of Cost Data.

Treatment alternative	Costs for start-up	DOE exemption required	Costs for annual operation	Costs for secondary waste	Total costs for first year	Total costs for first three years
No treatment	960,000	No	270,000	N/A	1,230,000	1,770,000
GAC with offsite regeneration	1,153,000	No	512,000	N/A	1,977,000	3,625,000
GAC regenerated onsite with offsite treatment of condensate	1,960,000	No	274,000	136,000	2,370,000	3,190,000
GAC regenerated onsite by UVOX	1,484,000	No	298,000	N/A	1,782,000	2,378,000
GAC regenerated onsite by UVOX with acid scrub	1,974,000	Yes	330,000	70,000	2,374,000	3,174,000
High-efficiency CATOX	1,430,000	No	330,000	N/A	1,760,000	2,420,000
High-efficiency CATOX with acid scrub	1,920,000	Yes	362,000	70,000	2,352,000	3,216,000
Ultra-high- efficiency CATOX	1,450,000	No	330,000	N/A	1,780,000	2,440,000
Ultra-high- efficiency CATOX with acid scrub	1,940,000	Yes	362,000	70,000	2,372,000	3,236,000
High-efficiency THERMOX	1,246,000	No	1,264,000	N/A	2,510,000	5,038,000
High-efficiency THERMOX with acid scrub	1,736,000	Yes	1,296,000	70,000	3,102,000	5,834,000
Ultra-high- efficiency THERMOX	1,286,000	No	1,465,000	N/A	2,751,000	5,681,000
Ultra-high- efficiency THERMOX with acid scrub	1,776,000	Yes	1,497,000	70,000	3,343,000	6,477,000

GAC = granular activated carbon
UVOX = ultraviolet light - ozone
CATOX = catalytic oxidation
THERMOX = thermal oxidation

5.2.3.1.5 Carbon Regenerated Onsite by Ultraviolet-Ozone with Acid Scrub.

Costs for Start-Up	$1,974,000
Costs for Annual Operation	$330,000
Costs for Secondary Waste	$70,000
Total Costs for First Year	$2,374,000
Total Costs for First Three Years	$3,174,000

5.2.3.1.6 High-Efficiency Catalytic Oxidation.

Costs for Start-Up	$1,430,000
Costs for Annual Operation	$330,000
Costs for Secondary Waste	$0
Total Costs for First Year	$1,760,000
Total Costs for First Three Years	$2,420,000

5.2.3.1.7 High-Efficiency Catalytic Oxidation with Acid Scrub.

Costs for Start-Up	$1,920,000
Costs for Annual Operation	$362,000
Costs for Secondary Waste	$70,000
Total Costs for First Year	$2,352,000
Total Costs for First Three Years	$3,216,000

5.2.3.1.8 Ultra-High-Efficiency Catalytic Oxidation.

Costs for Start-Up	$1,450,000
Costs for Annual Operation	$330,000
Costs for Secondary Waste	$0
Total Costs for First Year	$1,780,000
Total Costs for First Three Years	$2,440,000

5.2.3.1.9 Ultra-High-Efficiency Catalytic Oxidation with Acid Scrub.

Costs for Start-Up	$1,940,000
Costs for Annual Operation	$362,000
Costs for Secondary Waste	$70,000
Total Costs for First Year	$2,372,000
Total Costs for First Three Years	$3,236,000

5.2.3.1.10 High-Efficiency Thermal Oxidation.

Costs for Start-Up	$1,246,000
Costs for Annual Operation	$1,264,000
Costs for Secondary Waste	$0
Total Costs for First Year	$2,510,000
Total Costs for First Three Years	$5,038,000

5.2.3.1.11 High-Efficiency Thermal Oxidation with Acid Scrub.

Costs for Start-Up	$1,736,000
Costs for Annual Operation	$1,296,000
Costs for Secondary Waste	$70,000
Total Costs for First Year	$3,102,000
Total Costs for First Three Years	$5,834,000

5.2.3.1.12 Ultra-High-Efficiency Thermal Oxidation.

Costs for Start-Up	$1,286,000
Costs for Annual Operation	$1,465,000
Costs for Secondary Waste	$0
Total Costs for First Year	$2,751,000
Total Costs for First Three Years	$5,681,000

5.2.3.1.13 Ultra-High-Efficiency Thermal Oxidation with Acid Scrub.

Costs for Start-Up	$1,776,000
Costs for Annual Operation	$1,497,000
Costs for Secondary Waste	$70,000
Total Costs for First Year	$3,343,000
Total Costs for First Three Years	$6,477,000

5.2.3.2 Costs for Hydrochloric Acid Treatment Alternatives.

5.2.3.2.1 Wet Scrubber with Evaporation Ponds.

Costs of Equipment	$67,000
Costs of Installing Utilities	$19,100,000
Total Costs for Start-Up	$19,167,000
Costs of Annual Operations and Feedstocks	$64,000
Secondary Waste Handling & Disposal Costs	$58,000
Total Costs of Annual Operations & Wastes	$122,000

5.2.3.2.2 Wet Scrubber with Discharge to 282WA Reservoir.

Costs of Equipment	$67,000
Costs of Installing Utilities	$260,000
Total Costs for Start-Up	$327,000
Costs of Annual Operations and Feedstocks	$62,000
Secondary Waste Handling & Disposal Costs	$0
Total Costs of Annual Operations & Wastes	$62,000

5.2.3.2.3 Wet Scrubber with Mechanical Evaporator.

Costs of Equipment	$1,067,000
Costs of Installing Utilities	$100,000
Total Costs for Start-Up	$1,167,000
Costs of Annual Operations and Feedstocks	$130,000
Secondary Waste Handling & Disposal Costs	$58,000
Total Costs of Annual Operations & Wastes	$188,000

5.2.3.2.4 Dry Scrubber.

Costs of Equipment	$490,000
Costs of Installing Utilities	$0
Total Costs for Start-Up	$490,000
Costs of Annual Operations and Feedstocks	$32,000
Secondary Waste Handling & Disposal Costs	$70,000
Total Costs of Annual Operations & Wastes	$102,000

5.3 PREFERRED REMEDIAL ALTERNATIVE

Based on the preliminary technology screening, screening factors, and selection criteria of the EE/CA, the preferred alternative for Phase I of the 200 West Area carbon tetrachloride ERA is vapor extraction utilizing existing vertical wells and carbon canisters with offsite regeneration. One VES will be used at the 216-Z-1A Tile Field and the 216-Z-18 Crib and the other VES will be used at the 216-Z-9 Trench.

Vapor extraction technology was the only retained remedial alternative from the screening process of Section 3. The characteristics of the source zone are favorable to the implementation of vapor extraction (see Section 3.4 and Table 2) and the pilot testing of a VES demonstrated the ability to remove large amounts (several tens of thousands of kg) of carbon tetrachloride in a reasonable amount of time (several months to a few years) from above the caliche layer (see Section 4.5).

The categories of remedial technologies associated with the vapor extraction system are (1) well type and (2) extracted vapor treatment process. The selection of each specific remedial technology was based on the ability to satisfy the threshold screening factors and the ranking by the selection criteria. The technology in each category that passed the screening factors and ranked highest among the selection criteria became the chosen remedial technology of the vapor extraction system.

The threshold screening factors are (1) compliance with ARARs and (2) protection of the environment and public health. Section 5.1 discusses these factors and includes a discussion of the air dispersion modeling performed for each of the extracted vapor treatment processes and their ability to meet the ARARs. Carbon canisters with offsite regeneration was one of only two extracted vapor treatment processes that meet all of the ARARs. The interim action of Phase I, like the final action of Phase II, is expected to fully comply with the ARARs.

As shown in Table 6, all the well types and all the extracted vapor treatment processes except the "No Treatment" alternative were retained by the threshold screening factors for further evaluation by the selection criteria.

In the selection criteria evaluation of Section 5.2, the well types and extracted vapor treatment processes were evaluated for (1) effectiveness, (2) implementability, and (3) cost.

Existing vertical wells were chosen because of their demonstrated effectiveness during the pilot testing of the VES, implementability and availability, and low cost to modify for the purpose as compared to the installation of new wells. It is planned that at each disposal site several existing vertical wells will be used for extracting the soil vapors and that several others will be used for monitoring the vacuum in the subsurface.

The results of the evaluation criteria of the extracted vapor treatment processes are summarized in Table 4. The effectiveness of carbon canisters with offsite regeneration is shown by the 99% long-term removal efficiency of carbon tetrachloride from the soil vapor stream and its ability to meet all of the ARARs. This alternative is implementable is 4 mo, which is the shortest time of any of the retained alternatives and will allow a VES to be operating quicker than any of the other alternatives. Though it is not the least costly of the alternatives, the total purchase and operation costs for the first year for this alternative are not unreasonable compared to the other alternatives. The ranking of carbon canisters with offsite regeneration is the highest of the extracted vapor treatment process alternatives considered for Phase I.

In addition to the factors noted above, the overall design of the remedial alternative will allow operation of the system through the wide range of conditions expected during the interim Phase I. This adaptability will be required because of the dynamic nature of the carbon tetrachloride removal from the source zone. This adaptability will also be necessary during Phase I because of the planned demonstration testing of various well types and carbon tetrachloride treatment alternatives. This demonstration testing, along with the operational information and further evaluation and costing of the various alternatives, will aid in selection of the preferred remedial alternative for the planned long-term operation of Phase II of the 200 West Area carbon tetrachloride ERA.

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6.0 IMPLEMENTATION

Implementation of this proposal is contingent on approval by the EPA as the lead agency. Careful consideration must be accorded to additional ARARs and public comments that are brought out during review prior to implementation.

The schedule for implementation is presented in Figure 4. This schedule assumes issuance of an EPA Action Memorandum Authorizing implementation by December 16, 1991. An Action Memorandum received beyond that date will require adjustment of the schedule.

6.1 PHASE I

The Phase I operations will begin the production-scale removal of carbon tetrachloride from the source zone. One VES will operate on the section of the source zone underlying the 216-Z-1A Tile Field and the 216-Z-18 Crib and a second VES will operate on the section of the source zone underlying the 216-Z-9 Trench. Specific removal rates, as well as other operational parameters, will be established during the start-up stage of the systems.

The initial VES mechanical equipment located near the 216-Z-1A Tile Field will be an upgrade of the equipment used during the pilot test and will utilize carbon canisters as the carbon tetrachloride treatment process. The carbon canisters will be regenerated offsite. The mechanical equipment will be replaced with larger volume equipment when procured and carbon canisters will continue to be utilized through Phase I.

The VES mechanical equipment for the 216-Z-9 Trench will be the identical larger volume equipment used in the other VES and will also utilize carbon canisters with offsite regeneration.

Carbon canisters will be used in Phase I because of their availability and demonstrated effectiveness. The use of carbon canisters will provide an opportunity for the treatment alternatives presented in this proposal to be investigated in more detail and demonstration testing can be performed (Section 6.2.1). This will provide information for the decision regarding the treatment system for the Phase II operations.

Existing wells, perforated in several intervals, will be used for extraction and monitoring during the Phase I operations. Well configurations and placement will be varied with time as a means of obtaining information concerning the subsurface and providing additional site characterization.

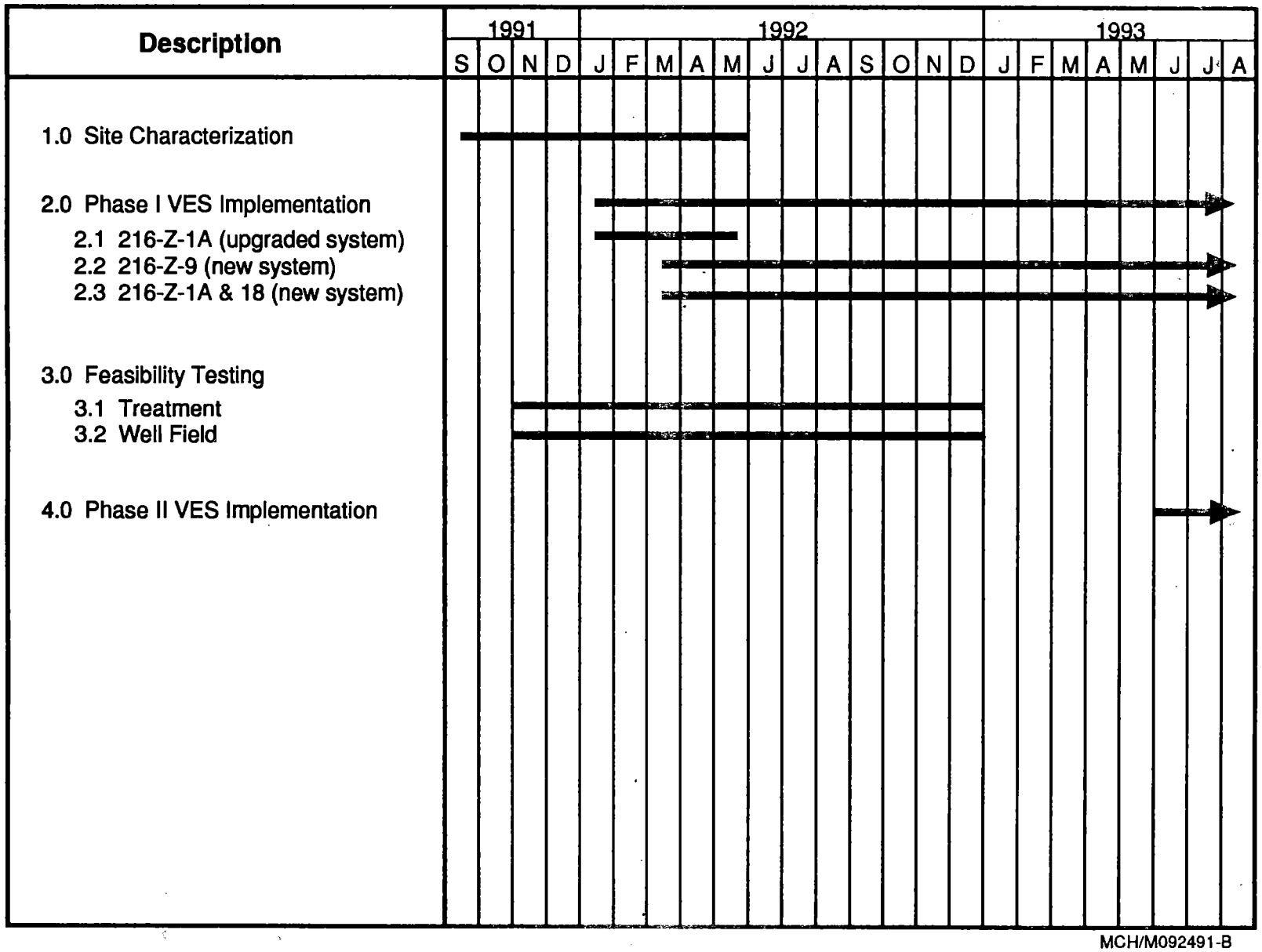

Figure 4. 200 West Area Carbon Tetrachloride ERA Schedule.

6.1.1 Additional Site Characterization

Additional site characterization is planned to establish baseline monitoring networks, provide data to improve design efficiency of each VES, and address health and safety concerns. The work will continue to focus on the nature, quantity, and lateral and vertical distribution of carbon tetrachloride, with particular emphasis on the unsaturated zone. Examples of additional field activities being considered include drilling and sampling new boreholes, improving and evaluating soil gas sampling, and collecting field data to support the modeling process. In addition, upon EPA direction, further investigation of drilling and well completion practices, well integrity, and liquid effluent disposal practices in the vicinity of the carbon tetrachloride contamination will be evaluated (see Section 3.2). As in the initial site characterization, work in radioactively-contaminated areas and generation of radioactive and hazardous wastes will be minimized. A work plan will be provided detailing the specific tasks and schedule.

6.1.2 Project Assessment and Reports

Operation of each VES will be guided by ongoing assessment of vapor concentrations, radiation and zone of influence data, and experience in mechanical subsystems and instrument performance. Routine reports will identify the active extraction wells, incremental and cumulative amounts of carbon tetrachloride extracted, changes in equipment configuration and extraction locations, general performance of the system, and problems encountered. An overall evaluation of the system will be prepared after sufficient data and operating experience are accumulated to support a request for approval of Phase II expansion plans.

6.2 FEASIBILITY STUDY

During the Phase I operations, two feasibility studies will be undertaken. These studies will include both a review of available information and demonstration testing at the site.

6.2.1 Onsite Treatment

The onsite treatment feasibility study will attempt to identify the most favorable alternative for the onsite treatment of the carbon tetrachloride in the soil vapor extracted from the source zone for potential implementation in Phase II remediation. Onsite treatment of the carbon tetrachloride is preferable because it would not require offsite shipment or burial of hazardous constituents.

The treatment alternatives evaluated may include some of those presented in this proposal as well as others not previously discussed. The demonstration testing will utilize a sidestream of soil vapor from a VES to scrutinize the effectiveness and operational capabilities of various pilot and full-scale treatment systems.

6.2.2 Wellfield Design

The feasibility study investigating the wellfield design will attempt to delineate the optimum design of the existing wells and placement and type of new wells. Due to the limited information concerning the variable concentrations of carbon tetrachloride in the source zone and the unclearly-defined stratigraphic characteristics of the subsurface, the optimum design of the wellfield will be an evolutionary process as operational information is gathered during Phase I. Variables such as flowrates, vacuums, extraction intervals, and extraction rates will be used to develop an understanding of the subsurface. Injection and the use of horizontal wells will also be assessed. Additionally, various drilling techniques may be tested at the site to test their applicability to the project.

6.3 PHASE II

Phase II of the carbon tetrachloride extraction project is planned to be the long-term production-mode removal of carbon tetrachloride from the source zone. It is expected to consist of additional extraction systems or major increases in the capacity of the original equipment, installation of new extraction wells or moving the system to additional release locations, and implementation of long-term VESs. The conclusions from the feasibility studies will provide input for the selection of the carbon tetrachloride treatment equipment and the wellfield design.

An overall assessment of the performance of the Phase I systems and proposal for Phase II operations will be forwarded to the EPA and Ecology for review. Phase II implementation will not be initiated without concurrence by the agencies.

7.0 REFERENCES

Breckenridge, R. P., J. R. Williams, and J. F. Keck, 1991, *Characterizing Soils for Hazardous Waste Site Assessments*, In "Ground-Water Issue", EPA/540/4-91/003, March 1991.

Hagood, M. C., and V. J. Rohay, 1991, *200 West Area Carbon Tetrachloride Expedited Response Action Project Plan*, WHC-EP-EN-AP-046, Rev. 0. Westinghouse Hanford Company, Richland, Washington.

WHC, 1987a, *Industrial Safety Manual*, WHC-CM-4-3, Vols 1 and 4, Westinghouse Hanford Company, Richland, Washington.

WHC, 1987b, *Management Policies*, WHC-CM-1-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988a, *ALARA Program*, WHC-CM-4-11, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Best Available Technology (BAT) Guidance Document for the Hanford Site*, WHC-EP-0137, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, *Environmental Compliance*, WHC-CM-7-5, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988d, *Hazardous Material Packaging and Shipping*, WHC-CM-2-14, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988e, *Hazardous Waste Management*, WHC-CM-5-16, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988f, *Management Requirements and Procedures Manual*, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988g, *Operational Environmental Monitoring*, WHC-CM-7-4, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988h, *Operations Support Services*, WHC-CM-8-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988i, *Procurement Manual*, WHC-CM-2-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988j, *Radiation Protection*, WHC-CM-5-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988k, *Site Support*, WHC-CM-8-6, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988l, *WHC Emergency Plan*, WHC-CM-4-1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Environmental Compliance Verification Manual*, WHC-CM-7-6, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Safety Assessment for Task #7 of the 200 West Area Carbon Tetrachloride Expedited Response Action*, WHC-SD-ER-HC-001, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

SUPPORTING DOCUMENTATION

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Atlantic Richfield Hanford Company DOE/RL-91-32
Draft B

RE 5.1.1.2

Date: April 17, 1974

To: R. E. Olson

From: D. T. Crawley D. T. Crawley

Subject: PLUTONIUM RECLAMATION FACILITY ORGANIC CONSUMPTION

On January 11, 1973, Process Test PRF-72-14, "Optimization of CX Column," was initiated to improve the efficiency of the CX column, to maintain the process organic quality and reduce organic usage. Three weeks of operating the CX column with a top interface and increased volume velocity showed greatly improved dibutyl phosphate (DBP) removal efficiency. The new operating conditions were incorporated into the standards and procedures.

On May 15, 1973, all intentional organic discards were discontinued. Contaminated discards to ground were terminated and contaminated aqueous streams were discarded to the 242-T Waste Evaporator.

This document reports the organic charges to the Plutonium Reclamation Facility in 1973 and comparisons with earlier organic charges. Table I lists the organic chemical charges to Z Plant. The table lists the charges by calendar year since the startup of the Plutonium Reclamation Facility (PRF) in May 19~~7~~4, and 1964
Waste Treatment Facility (WT) in September 19~~7~~4. The 1964
average monthly volume is listed with the total charges.

After Process Test PRF-72-14 was initiated in January 1973, and the change in organic cleanup was adopted, some organic discards were still made to the 216-Z-18 crib until May 15, 1973. On May 15, 1973, (as mentioned) intentional discards of organic were discontinued as a matter of policy and all aqueous discards were routed to the 242-T Evaporator via the D-5 tank. No intentional discards have subsequently been made.

The CAX makeup procedure was revised at the end of October 1972, because it was believed that organic was being decanted to the chemical sewer during the preparatory washes. The revision was made to minimize the organic discards during decanting. However, heavy organic was noted in the outfall to the 216-Z-19 ditch as late as July 1973.

R. E. Olson
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The organic charges for 1973 are one half of that for 1972. The decrease is not as great as was anticipated. The charges through May 1973, were more than half of the total 1973 charges. However, there was no operation for about 2 months during the year following the month of May due to an inability to discard waste to the 242-T Evaporator. The decrease may be as great as to one quarter of the 1972 rate but a longer period of operation and observation are needed to make a better comparison.

The "Handbook of Chemistry and Physics" lists the solubility of carbon tetrachloride (CCl_4) in water as .08 grams per 100 ml. Calculations using the volume of aqueous waste discards to the D-5 tank indicate that approximately 2 to 3 percent of the CCl_4 would be discarded as dissolved CCl_4. The TBP and DBBP solubilities are equally small or smaller.

The new organic makeups (20% TBP and 30% DBBP) account for about 63% of the CCl_4 charged to Z Plant. The difference between makeups and charges (37%) is assumed to be due to evaporation. This averaged about 640 liters per month for 1973. For 1972 it was about 1300 liters per month.

The organic liquid volume not lost to evaporation or solubility is assumed to be lost by entrainment with the aqueous waste discards to D-5. This averaged about 1400 liters per month during 1973. The aqueous waste volume discarded from PRF and WT for June through December 1973, averaged about 80,000 liters per month. The organic lost due to assumed entrainment with the aqueous waste is about 2% of the discards to the D-5 tank (aqueous having been in contact with organic in the above facilities; tanks 39, 40, W-3, W-4 and W-5). This organic loss rate is 3-4 liters per hour.

Earlier estimates of probable organic loss were about 1 liter per hour compared with the 1973 experience of 3-4 liters per hour.

No direct data is available on losses of organic due to degradation but it certainly enters into the losses. Organic on the hood floor must certainly contribute to degradation losses but cannot be entirely avoided.

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Nearly a year of operation has not shown a need for intentional discard of organic. The indications are that it might not be necessary in the future either.

DTC:rzh

cc: MH Curtis
DA Danch
DA Dodd
PC Doto
DG Harlow
JR Irish
GA Nicholson
CM Peabody
DA Turner

54-600C-031 (10-68)

PLUTONIUM RECLAMATION FACILITY
ORGANIC CONSUMPTION

Year	Carbon Tetrachloride, drums	Dibutylbutyl Phosphonate, pounds	Tributyl Phosphate, pounds	Comments
1964	67 1680 1/mo.	1720 206 1/mo.	2920 170 1/mo.	Startups - 236-Z: May 1964 242-Z: Sept. 1964
1965	162 2700 1/mo.	10,583 423 1/mo.	11,724 455 1/mo.	3 shift
1966	347 6010 1/mo.	15,352 613 1/mo.	21,936 851 1/mo.	to 4 shift in March, 1 1/2 mo. strike
1967	240 4000 1/mo.	12,165 486 1/mo.	8800 341 1/mo.	to 3 shift in June
1968	215 3580 1/mo.	7838 313 1/mo.	14,060 545 1/mo.	3 shift
1969	144 2400 1/mo.	6431 257 1/mo.	7480 290 1/mo.	3 shift 242-Z down 3 mos.
1970	166 2767 1/mo.	5655 226 1/mo.	11,440 443 1/mo.	3 shift
1971	178 2970 1/mo.	4875 195 1/mo.	10,560 410 1/mo.	3 shift
1972	215 3580 1/mo.	4350 174 1/mo.	11,440 443 1/mo.	3 shift
1973	104 1730 1/mo.	2175 87 1/mo.	5720 222 1/mo.	3 shift (6 day week July and Aug.) 236-Z down 1 1/2 mos. Tank Farm leaks, 242-T unable to receive aqueous waste. Organic discards discontinued in May.

CALCULATIONS

CCl_4 Consumption

1973

CAX 222 l TBP/mo. from table X 4 = 888 liters CCl_4/mo.

CAX 20% TBP

E1X 87 l DBBP/mo. from table X 2.3 = 200 liters CCl_4/mo.

E1X 30% DBBP

Total CCl_4 for makeups 1088 liters/mo.

CCl_4 loss due to evaporation = 1730 l CCl_4/mo. from table -1088

$\cong$ 640 l/mo.

$$\frac{1088}{1730} \times 100 = 62.9\% \text{ of } CCl_4 \text{ for makeups}$$

100 - 63 = 37% of CCl_4 to evaporation

1972

All the figures for above calculations are twice those for 1973, hence 1300 liters/mo. for CCl_4 evaporation.

Organic Entrainment

CAX 222 l TBP/mo. from table X 5 = 1110 liters/mo.

E1X 87 l DBBP/mo. from table X 3.33 = 290 liters/mo.

Total makeup volumes 1400 liters/mo.

$$\frac{1400}{80{,}000 \text{ l/mo. waste}} \times 100 = 1.75\% \cong 2\%$$

Organic Loss Rates

52 weeks per year 52 X 5 days/week = 260 working days/year

Holidays per year -9

Working days/year available 251

$$\frac{251}{12} = 20.92 \text{ working days per mo. available}$$

21 X .8 (mechanical efficiency) = 16.8 days/mo. operating time

16.8 X 24 = 403 hrs./mo. operating time

$$\frac{1400 \text{ liters/mo. organic makeups}}{403 \text{ hrs./mo.}} = 3.47 \text{ liters/hr. instantaneous loss rate}$$

United States
Environmental Protection
Agency

Region 10
Hanford Project Office
712 Swift Boulevard, Suite 5
Richland WA 99352

EPA

December 20, 1990

Steven H. Wisness
Hanford Project Manager
U.S. Department of Energy
P.O. Box 550, A6-95
Richland, Washington 99352

Ref: 200 West Area Carbon Tetrachloride Interim Response Action

Dear Mr. Wisness:

The United States Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) have reviewed the Interim Response Action (IRA) proposal for the 200 West Area Carbon Tetrachloride IRA enclosed with your December 6, 1990 letter. Based on the information provided, we believe that early action could successfully limit the further spread of carbon tetrachloride vapors in the unsaturated zone beneath the 200 West Area and intercept much of that material prior to entering the groundwater. We encourage you to proceed with detailed planning, including non-intrusive field work that is required to implement this action. Since the 200 West Area carbon tetrachloride plume emanates from the 200-ZP-1 Operable Unit and EPA is the lead regulatory agency for that unit, EPA will be the lead agency for this IRA and Ecology will be the support agency.

A final proposal for this action is required and must include sufficient information for us to develop an Action Memorandum. The Action Memorandum will be the mechanism for approving the start of IRA field work.

EPA and Ecology believe the current proposal schedule, as presented, could be shortened by implementing the removal action in a phased approach. It appears that existing structures, principally vadose zone monitoring wells, could be modified to extract vapors or inject air to enchance carbon tetrachloride recovery. This action could be initiated at one of the primary sources to evaluate recovery efficiency, air injection and withdrawal rates as well as other process design data. This information would provide valuable data to increase removal efficiency and locate additional vapor extraction and recovery wells, and will allow for flexibility in final design of the IRA project.

An Engineering Evaluation/Cost Assessment (EE/CA) for this project is required. Of particular concern, is the treatment of the vapors extracted and the treatment or recovery alternatives to be evaluated in the EE/CA. Implementation of this IRA does not represent a final solution to the carbon tetrachloride problem, but it may, in fact, make that final solution attainable. In other words, we consider this IRA to be consistent with the likely-preferred alternative(s) for carbon tetrachloride remediation at this point in time.

It is important that we develop a meaningful public involvement process for this action that would begin in the near future. As part of this effort, we suggest that a fact sheet be prepared for this IRA to be used at the next Tri-Party quarterly meeting schedule for mid-January. Additionally, we are requesting a project description to be submitted on the IRA no later than January 9, 1991.

According to the October 18, 1990 Agreement in Principle, the funding for this project is in addition to that identified to meet previously identified activities required by the Tri-Party Agreement.

If you have any questions on the above, please do not hestitate to contact either one of us. Additionally, we intend to maintain regular staff interaction, allowing for early identification of issues or concerns.

Sincerely,

Douglas R. Sherwood for
Paul T. Day
Hanford Project Manager
U.S. Environmental Protection Agency

L. Gelston for
Timothy L. Nord
Hanford Project Manager
Washington State Department of Ecology

cc: Willis Bixby, DOE
Roger Stanley, Ecology

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APPENDIX B

SITE EVALUATION

V. J. Rohay and V. G. Johnson
Geosciences Group
Westinghouse Hanford Company

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B.1 INTRODUCTION

This section provides a discussion of the results of current and previous investigations of the carbon tetrachloride disposal sites at Hanford, Washington. Information is presented about site operations, site physical characteristics, and the extent of contamination. To satisfy the requirements of NEPA, general descriptions of the Hanford Site ecology and cultural resources are included. A conceptual model of the behavior and distribution of contaminants in the subsurface is then provided.

The proposed ERA would take place in the 200 West Area on the Hanford Site. The Hanford Site is a restricted access area of approximately 1,450 km^2 in semiarid southeastern Washington. The 200 West Area is located near the middle of the Hanford Site, approximately 11 km east of the western boundary of the Hanford Site and approximately 8 km south of the Columbia River (Figure B-1); it is not located in the Columbia River floodplain. There are no wetlands in the vicinity of the 200 West Area carbon tetrachloride disposal sites.

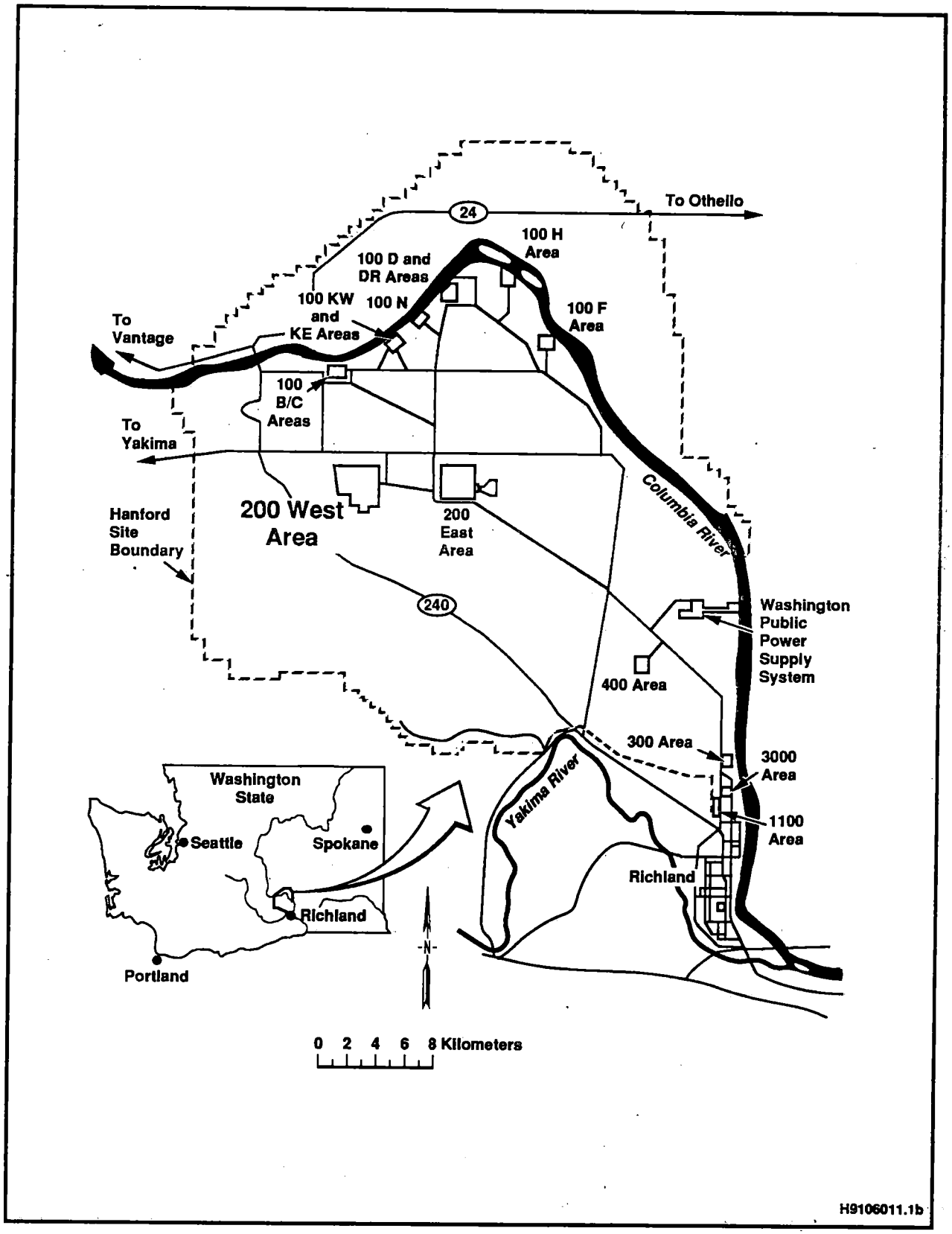
The 200 West Area is located approximately 29 km northwest of the city of Richland. Richland lies within the Columbia Basin, which includes Pasco, Kennewick, and surrounding agricultural communities. In 1990, the estimated population of the three cities was 85,980 (PNL 1990).

B.1.1 Site Evaluation Investigations

The first geologic investigations of southeastern Washington were made around the turn of the century in an effort to evaluate the area's ground water resources. Operation of the Hanford facilities from 1944 to the present has resulted in the discharge of large volumes of radioactive liquid waste to the ground on the Hanford Site and has prompted extensive investigations into the geologic and hydrologic characteristics of the sediments underlying the Hanford Site. These numerous previous studies, particularly of the 200 West Area, were used in part to compile the conceptual hydrogeologic model presented below.

Since the 1950s, samples of ground water underlying the 200 West Area have been analyzed for radiological constituents characteristic of the liquid waste discharged to the soils. Since the mid 1980s, ground water samples have been analyzed for hazardous chemical constituents also. These data have been used to compile ground water plume maps for the 200 West Area. Although some data have been published on the distribution of radiological contaminants in the unsaturated zone underlying specific cribs in the 200 West Area, virtually no such studies have been conducted on distribution of hazardous chemical contaminants.

Figure B-1. Hanford Site Map and Location of the 200 West Area.



A program to collect site-specific data during Phase I site evaluation was outlined in the 200 West Area Carbon Tetrachloride Project Plan (Hagood and Rohay 1991). The purpose of the data collection program was to:

- better define geologic and hydrogeologic characteristics of the site
- better define lateral and vertical distribution of carbon tetrachloride and co-contaminants
- provide data necessary for design and implemention of the remedial action.

Data were also collected to verify and revise the preliminary conceptual model that most of the carbon tetrachloride discharged to the ground in the 200 West Area is still present in the unsaturated zone.

Phase I site evaluation was conducted from January through April 1991. Phase I tasks included compiling existing data and conducting field activities to collect new data.

B.1.2 Approach

The Phase I site evaluation was designed to supplement previous studies with data specific to the nature and distribution of carbon tetrachloride and its co-contaminants, with special emphasis on the unsaturated zone underlying the disposal sites. These data were identified as necessary to determine whether interim remedial action is justified, to provide input for design and implementation of the remediation, and to verify and refine the initial site conceptual model.

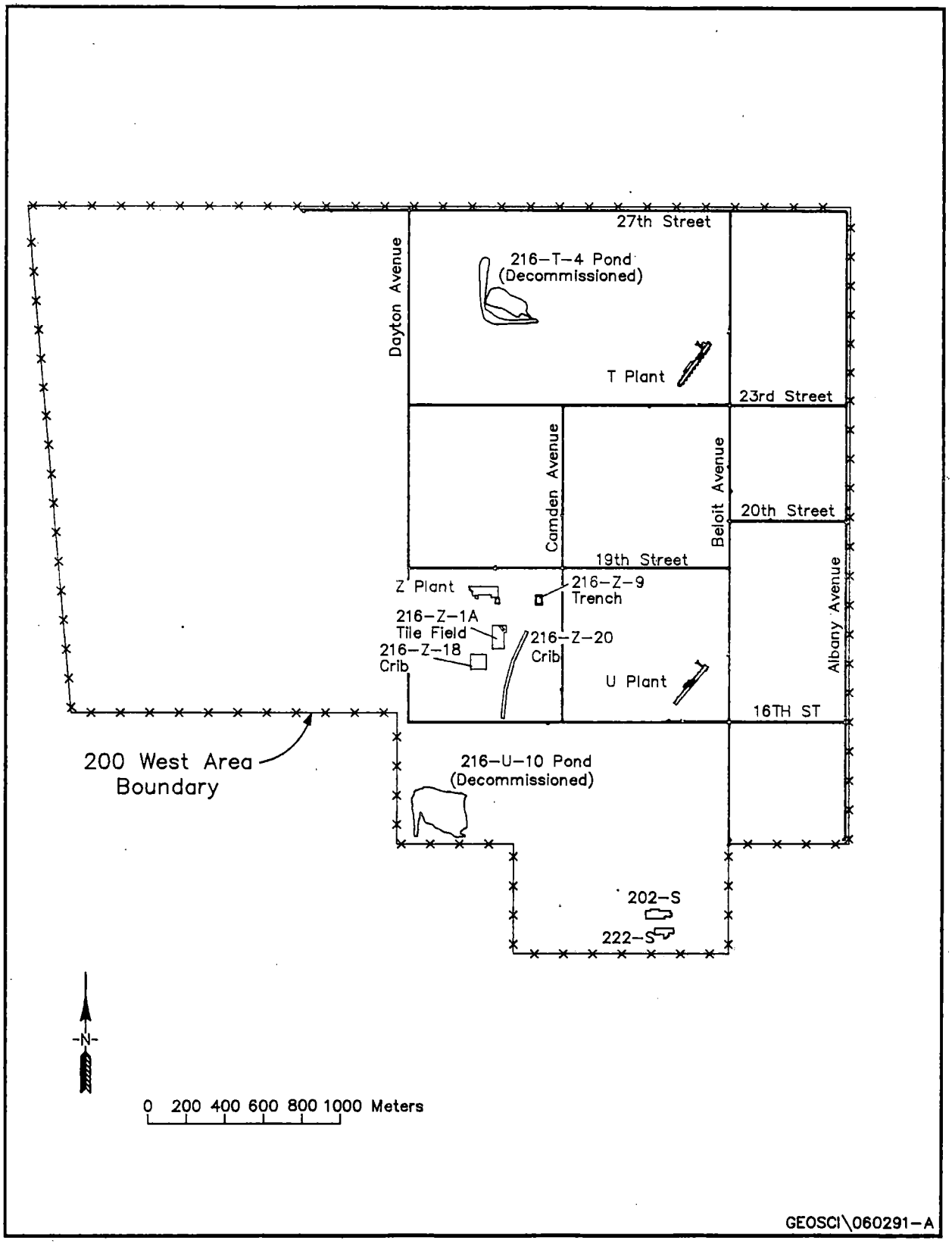
To complete the ERA, the site investigation relied on a phased approach and was designed to optimize use of screening level data. Field activities for the first phase were limited primarily to nonintrusive activities to avoid delays and costs related to drilling in and around radioactively contaminated soils. In addition to maximizing the use of existing data, data collection tasks were designed to minimize both work in radiologically contaminated areas and the generation of radioactive and hazardous wastes.

B.2 SITE OPERATIONS

This section describes site carbon tetrachloride usage and disposal at and near the 200 West Area Z Plant (Figure B-2). No other plant in the 200 West Area is known to have used carbon tetrachloride.

Z Plant (currently called the Plutonium Finishing Plant [PFP]) is a complex of chemical processing facilities designed to process Hanford-generated plutonium to a final product form. Uranium-bearing fuel rods were irradiated in one of the several Hanford production reactors; a process which creates plutonium from uranium. The irradiated rods were processed through one of Hanford's chemical separation facilities where the plutonium was extracted and transferred as plutonium nitrate to Z Plant.

Figure B-2. Site Map of the 200 West Area.



Z Plant then processed the plutonium nitrate to a final form on one of three process lines. Each of these process lines generated side streams which contained recoverable quantities of plutonium.

Recuplex and the Plutonium Reclamation Facility (PRF) were established to recover plutonium from these streams and were the primary contributors of carbon tetrachloride to Z Plant soils. The Waste Treatment and Americium Recovery Facility that was added to PRF also contributed carbon tetrachloride waste.

B.2.1 Processes Using Carbon Tetrachloride

Historically, carbon tetrachloride was used, in mixtures with other organics, to recover plutonium from aqueous streams containing plutonium nitrate. Solvent extraction processes using pulse columns were used in PRF and its pilot facility, Recuplex, to recover the plutonium.

The extraction process involved an aqueous feed containing impurities and plutonium entering the bottom of the column, while the dense organic stream entered the top. As the aqueous stream moved upward and the organic stream moved downward in the column, the organic extracted the plutonium from the aqueous stream. The plutonium then left the bottom of the column with the organic, and most of the impurities left the top of the column with the aqueous waste. The plutonium-rich organic then entered another extraction column, where the organic stream was stripped of its plutonium by another aqueous stream. Although the solvent was routinely recycled, it was periodically purged and discharged as waste to the soil column.

The organic stream in the process consisted of a mixture of carbon tetrachloride and tributyl phosphate (TBP). The TBP forms several complexes with the plutonium in the organic phase, thus extracting the plutonium from the aqueous phase. The carbon tetrachloride was added as a diluent (meaning that the TBP was diluted with carbon tetrachloride) for several reasons:

1. To increase the density of the organic stream. (TBP alone has a density nearly equal to that of the aqueous stream; the extraction processes require that the aqueous and organic streams have significantly different densities.)

2. To dissolve the TBP while remaining immiscible with the aqueous stream.

3. To serve as a fire suppressant in combination with the TBP, reducing the potential for fire in the process.

4. To reduce the viscosity of the TBP, thus improving mass transfer.

Carbon tetrachloride was also used, in lesser amounts, in the americium recovery process as a diluent for dibutyl butyl phosphonate (DBBP) and in lubrication oil for machining of metal parts.

The aqueous waste stream, characterized as a high-salt aqueous waste, was primarily a concentrated nitrate solution that had a pH of 1 (Kasper 1982). The aqueous phase was saturated with organic liquids consisting of carbon tetrachloride, TBP, and DBBP; the organic content of the aqueous phase was <1%. Large quantities of aqueous wastes were also discharged to the soil column through the same cribs which received the organic liquids described above.

The chemical processes used to recover plutonium resulted in the production of actinide-bearing aqueous and organic waste liquids. The primary radionuclide components of these liquids were $^{239/240}$plutonium and ^{241}americium.

B.2.1.1 Recuplex Operations. Recuplex, located in the 234-5Z Building (Figure B-3), operated from 1955 through 1962. It was initially a semiworks (pilot) plant and was later used as a semiproduction operation. It served as a multipurpose solvent extraction plant for plutonium purification and fabrication production lines. Its main purpose was to recover plutonium from various Z Plant streams.

Two solvents were used for the entire period of plant operation. An 85:15 ratio (by volume) of carbon tetrachloride to TBP was used in the extraction and stripping columns for the bulk of the separations. A 50:50 ratio of carbon tetrachloride to DBBP was used for batch rework of process liquids that did not meet waste discharge specifications because of plutonium concentrations.

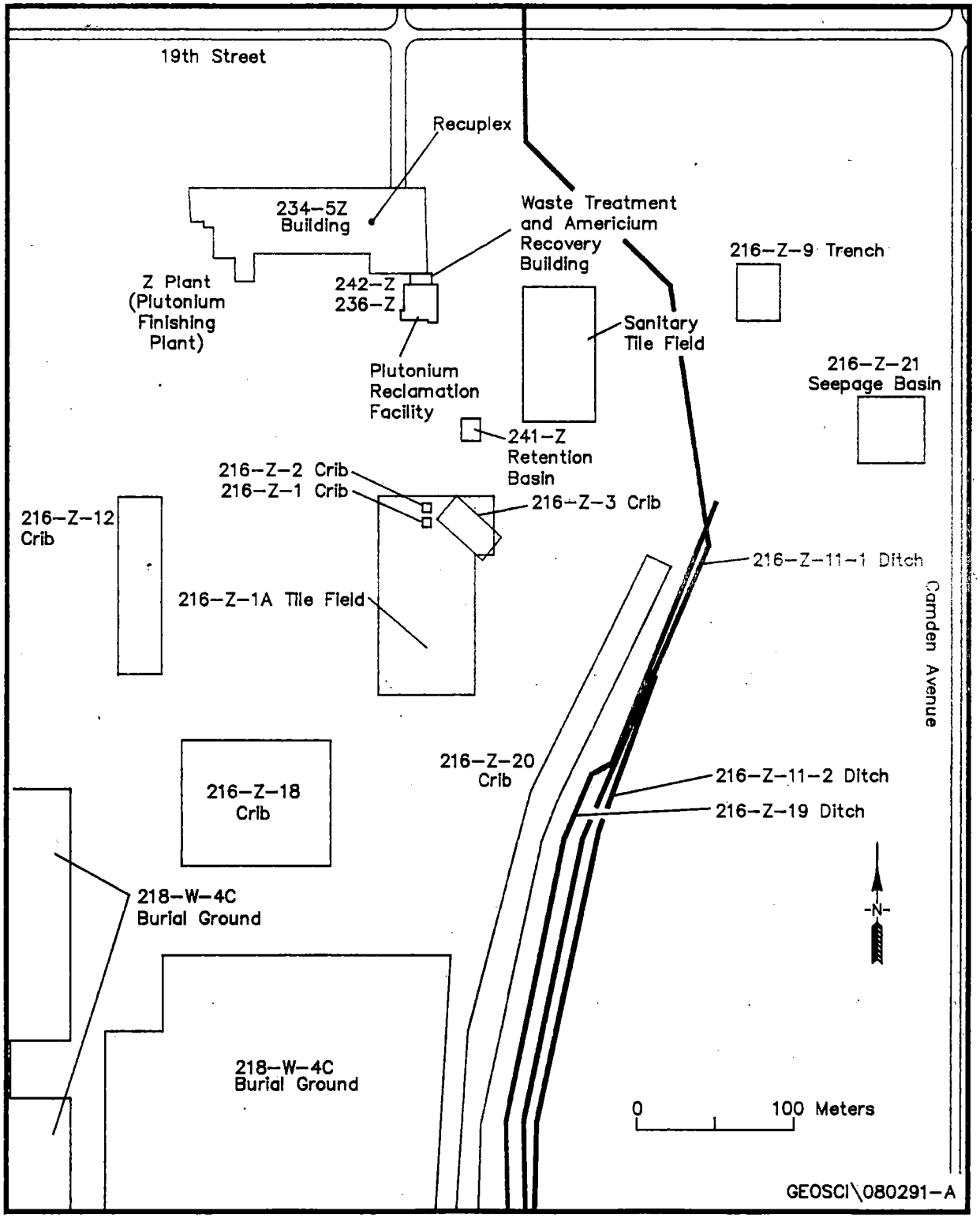
Other ratios of carbon tetrachloride to TBP were tested during the semi-works (pilot) period of operation and used during plant operation, but 85:15 gives the most conservative estimate and is used for all Recuplex waste volume calculations in this report.

With exposure to ionizing radiation and nitric acid, the TBP within the solvent would gradually degrade to dibutyl phosphate (DBP). DBP has a much greater affinity for plutonium than TBP and would not work in the process because of its poor stripping properties. The degraded solvent was periodically discharged batch-wise and replaced with fresh solvent. Each batch of TBP-based solvent was 200 L. All solvent discharges were received by the 216-Z-9 Trench.

Degradation products of carbon tetrachloride include chloroform and methylene chloride. Breakdown products of TBP include DBP, monobutyl phosphate (MBP), and butyl alcohol.

On occasion, through a process upset, aqueous liquid from the primary extraction column would exceed the maximum allowable plutonium concentration. To reclaim plutonium, a batch of aqueous liquid was mixed with DBBP solution. The organic phase would extract most of the plutonium, leaving aqueous phases that met the waste discharge concentration specification. The aqueous phase was discharged, and the DBBP solution was stripped, providing for the recycle of plutonium to the Recuplex feed. The DBBP solution was then discharged to the 216-Z-9 Trench. Each batch of DBBP-based solvent was 100 L.

Figure B-3. Site Map of the Z Plant Area.



The DBBP solution was not retained because of the danger of mixing it with the TBP-based solvent. It had to be kept completely separate from the TBP-based solvent because the two would ruin each other's properties if mixed.

Tetrachloroethylene (also called perchloroethylene) and tetrabromoethane were used at different times in combination with carbon tetrachloride as a diluent for TBP or for cleaning agents (Smith 1973).

B.2.1.2 PRF Operations. Recuplex operation was discontinued after a criticality incident in April 1962 and it was replaced in 1964 by PRF, which operated until 1979, and again from 1984 to 1987. The facility is scheduled to resume operation in late 1991. PRF is housed in the 236-Z Building (Figure B-3).

PRF had essentially the same mission as Recuplex and used similar but superior solvent extraction column technology with carbon tetrachloride/TBP as the extractant. An 80:20 ratio (by volume) was used (Sloat 1967, Appendix B); this ratio has remained the same to this date.

Solvent degradation continued to be a problem and degraded solvent was again disposed of to the soil column, this time through the 216-Z-1A Tile Field (1964-1969) and the 216-Z-18 Crib (1969-1973). No solvent was sent to cribs after May 1973 (Appendix A, Crawley 1974 memorandum). From 1973 to the present, these wastes were routed to tank farms.

An americium recovery facility, the Waste Treatment and Americium Recovery Facility in the 242-Z Building (Figure B-3), was added on to PRF and also began operation in 1964. The process used a 70:30 volumetric mixture of carbon tetrachloride and DBBP. Between 1964 and 1970, americium was recovered by a batch operation. Between 1970 and 1976, this process operated as a continuous countercurrent solvent extraction process. The carbon tetrachloride/DBBP mixture was discharged to the 216-Z-1A Tile Field from 1964 to 1969 and to the 216-Z-18 Crib from 1969 to 1973. This ancillary waste treatment facility was operated concurrently with PRF and was not considered a separate operation.

B.2.1.3 Lubrication Oil. Another source of carbon tetrachloride discharged to the soil was in a cutting oil used in Z Plant. "Fabrication oil" (a 75:25 volumetric mixture of carbon tetrachloride and lard oil) was used as a lubricant on Z Plant plutonium cutting and milling tools. In 1967, the composition of stored fabrication oil was estimated to be 50:50 volumetric mixture of carbon tetrachloride and lard oil due to evaporation of carbon tetrachloride (Sloat 1967, Appendix B). The carbon tetrachloride was also used to clean the cutting oil from the millings and work surfaces. The carbon tetrachloride/oil mixture was disposed to the same cribs used for solvent disposal.

B.2.2 Liquid Waste Disposal Facilities

Chemical and radiological wastes from the various Hanford production facilities have been segregated according to potential radionuclide contamination and stored or disposed of accordingly. High level wastes are stored in underground storage tanks while intermediate level wastes were, until 1973,

routed to underground cribs for disposal. Low level wastes such as cooling water were routed to ponds and open ditches for disposal (Smith 1980).

Recuplex- and PRF-generated wastes were chemically and radiologically contaminated, but they were disposed of based on their radiological content. The organic solvent-bearing wastes were classified as intermediate level wastes and, from 1955 until 1973, were disposed of to the several cribs which supported Z Plant operations.

Two types of cribs exist at Z Plant and both types received carbon tetrachloride. The first type is an underground chamber which received liquid wastes into a box-like, open-bottomed, underground structure, usually made of wooden timbers. The second type is a drain field or tile field. Not unlike a common septic tank drain field, these lack the large open-bottomed chamber and, instead, introduce liquid wastes to soil through many meters of perforated underground pipe. Both types typically rest on a gravel bed to aid in rapid dispersion of liquid to soil. Particulate matter contained in the waste liquid would be filtered by the first few centimeters or decimeters of soil and thus be effectively contained in the soils immediately beneath the crib. The two types of waste units were sometimes combined to provide a chambered crib overflowing into a drain field.

Certain cribs were designated as specific-retention cribs, meaning that the pore space in the soil column below the crib was intended to hold the disposal liquid against the force of gravity by the molecular attraction between sediment grains and the surface tension of the liquid. In practice, the total volume of liquid that could be discharged to a disposal site of known dimensions without leakage to the ground water was determined and specified before discharge to ensure that contaminants did not reach the ground water. After the specified quantity of liquid waste had been discharged, i.e., the specific-retention capacity had been reached, the specific-retention crib was no longer used to receive waste. Specific-retention cribs have not been used since 1973 (Brown et al. 1990, Price et al. 1979).

Z Plant disposed of liquid carbon tetrachloride-bearing solvents and associated aqueous wastes primarily to three waste sites from 1955 until 1973, when solvent discharge to soil was discontinued: the 216-Z-9 Trench (a chambered crib), the 216-Z-1A Tile Field (specific-retention drain field), and the 216-Z-18 Crib (specific-retention drain field) (Figure B-3). A small volume of carbon tetrachloride may have been discharged to other sites (e.g., 216-Z-1 and 216-Z-2 cribs, 216-Z-12 Crib, 216-Z-19 Ditch).

B.2.2.1 216-Z-9 Trench. The 216-Z-9 Trench operated from 1955 to 1962 to receive all solvent and aqueous wastes discharged to soil by the Recuplex facility. No other cribs were used for this purpose. Furthermore, 216-Z-9 only received wastes from Recuplex.

The 216-Z-9 Trench is an enclosed earthen trench, located about 215 m east of the 234-5Z Building and about 150 m south of 19th Street. The base of the trench is a 18.3- by 9.1-m excavation, 6.1 m deep. The surface is a 36.5- by 27.4- by 0.23-m-thick concrete trench cover at ground level. Waste was transferred by gravity through one of two 3.8-cm stainless steel lines which entered the trench about 5 m above its bottom. The concrete pad is supported by six 7-m-tall concrete columns (Ludowise 1978, Owens 1981, WHC 1991a).

Due to the high salt content and acidic nature of the Recuplex wastes, considerable gassing and soil plugging were expected when the wastes contacted the soil. As a result, the enclosed trench volume and active floor area were designed to handle the slow percolation rates of the wastes. However, the 216-Z-9 Trench was not designed as a specific retention facility (Brown et al. 1990).

B.2.2.2 216-Z-1A Tile Field. The 216-Z-1A Tile Field was constructed in 1949 and was used between 1949 and 1959 to receive overflow liquid waste from three adjacent cribs (216-Z-1, 216-Z-2, and 216-Z-3). The waste stream consisted of basic (pH 8 to 10) process waste and analytical and development laboratory waste from Z Plant via the 241-Z Settling Tank. Disposal to these facilities ceased in 1959. However, in 1964, the 216-Z-1A Tile Field was reactivated to receive aqueous and organic waste from the PRF in the 236-Z Building and the 242-Z Waste Treatment and Americium Recovery Building. This waste stream was routed directly to the tile field.

Between 1964 to 1969, the tile field was divided into three operational sections (Z-1AA, Z-1AB, Z-1AC) to preclude waste buildup at the northern end of the field. This tile field was designed and operated as a specific-retention facility. No other facility received PRF wastes from 1964 to 1969 except on two brief occasions while modifications were being made to the tile field effluent piping and PRF wastes were discharged to the 216-Z-1 and -2 cribs.

The 216-Z-1A Tile Field is a drain field located about 150 m south of the 234-5Z Building and about 300 m west of Camden Avenue. The tile field has surface dimensions of approximately 60 by 110 m. The side walls of the 5.8-m-deep excavation were sloped inward, resulting in a floor dimension for the facility of approximately 35 by 84 m. The floor of the excavation was covered by a 1.2-m-thick cobble layer with a minimum north-to-south surface slope of 1%. A herringbone pattern of 20-cm-diameter pipe, composed of a 79-m-long, north-south central distributor pipe and seven pairs of 21-m-long laterals, was placed on this cobble layer. The 30- by 79-m rectangular area covered by the piping system was then overlain with 15 cm of cobbles and 1.5 m of sand and gravel. A sheet of 0.05-cm-thick polyethylene covered by 30 cm of sand and gravel was also added to the facility. Effluent piping in the 216-Z-1A Tile Field is vitrified clay pipe. The central distributor pipe is a continuous line, without perforations; the laterals are divided into 0.3-m-long segments. A 5-cm-diameter stainless steel pipe was added inside the central distributor clay pipe as the field was modified into three operational sections (Price et al. 1979, Owens 1981). The tile field has not been backfilled; the surface remains about 2.5 m below grade.

The 216-Z-1 and -2 cribs received PRF aqueous and organic wastes for a few weeks in 1966 and again in 1967 while modifications were being made to the 216-Z-1A Tile Field. They are located immediately north of the 216-Z-1A Tile Field. They are wooden box structures arranged in a north-south line. Each is 3.7 by 3.7 by 4.3 m high, is constructed of 15- by 15-cm timbers, and has a open bottom. Each box stands in a 4.3-m square by 6.4-m-deep, backfilled excavation. By design, the 216-Z-2 Crib overflowed into 216-Z-1, which overflowed into the tile field (WHC 1991a).

B.2.2.3 216-Z-18 Crib. The 216-Z-18 Crib operated from 1969 to 1973, receiving PRF aqueous and organic wastes as a replacement for the 216-Z-1A Tile Field. It is a drain field type crib located southwest of 216-Z-1A and about 300 m south of the 234-5Z Building. It consists of five parallel, north-south oriented excavations, each 63 by 3 m, ranging from 4.5 to 5.5 m deep. A 91-m-long, 7.6-cm-diameter steel pipe runs east and west, bisecting the length of each excavation. Two 30-m-long, 7.6-cm-diameter, perforated, fiberglass-reinforced, epoxy pipes exit each side of the steel pipe in each excavation (two lines north and two lines south). These distribution lines are 0.3 m above the crib bottom in a 0.6-m-thick bed of 3.8 to 7.6 cm gravel. The gravel is covered by a membrane barrier overlain by approximately 15 cm of sand. The excavations are backfilled to grade. The westernmost of the five trenches was never used (WHC 1991a). This crib was designed and operated as a specific-retention facility.

B.2.2.4 Other Facilities. Two other sites in the vicinity of Z Plant that probably received a small volume of carbon tetrachloride are the 216-Z-12 Crib and the 216-Z-19 Ditch.

The 216-Z-12 Crib, located near the northwest corner of the 216-Z-18 Crib, received analytical and development laboratory waste from the 234-5Z Building from 1959 to 1973. The contribution from the Development and Analytical Laboratories constituted approximately 8% of the total monthly input to the crib. Although little information is available on the nature of this waste, it is assumed to be representative of the nature of experimental and analytical work done during that time period. Most of the development work would have been related to studies of separation processes in support of Z Plant operations and probably involved nitrate solutions and organic phases containing carbon tetrachloride. Bulk organics were collected and disposed of in batches to the active carbon tetrachloride disposal site (216-Z-9, 216-Z-1A, or 216-Z-18). Thus, only a small volume of organics would have been discarded to the 216-Z-12 Crib (Kasper 1981).

The 216-Z-19 Ditch was used to convey process cooling water and steam condensate from the 234-5Z Building to the 216-U-10 Pond from 1971 to 1981. The Crawley memorandum (Appendix A) states that "heavy organic was noted in the outfall to the 216-Z-19 Ditch" in 1973. This organic probably contained carbon tetrachloride.

B.2.3 Waste Inventories

The following estimates of the volumes and quantities of various liquids and contaminants discharged to the three principal carbon tetrachloride disposal facilities are based on research into existing documentation, eye witness descriptions, and process knowledge. A total of 363,000 to 580,000 L of carbon tetrachloride is estimated to have been discharged to the soil column between 1955 and 1973 (Table B-1).

Table B-1. Contaminant Inventory in Carbon Tetrachloride Liquid Waste Disposal Sites.

Contaminant	216-Z-9	216-Z-1A[a]	216-Z-18
Carbon tetrachloride (L)	83,000-300,000	170,000[b]	110,000
Plutonium (kg)	106[c]	57	23
Americium (kg)	2.5	1	~0.4
Total liquid (L)	4.09×10^6	5.2×10^6	3.86×10^6
Period of Use	1955-1962	1964-1969	1969-1973

[a]From 1949-1959, the 216-Z-1A Tile Field received approximately 1×10^6 L of slightly basic, aqueous waste via overflow from associated 216-Z-1, -2, and -3 cribs prior to disposal of PRF waste (Price et al. 1979). From 1964-1969, PRF wastes were discharged directly to 216-Z-1A.
[b]Includes fabrication oil.
[c]58 kg were later removed (Ludowise 1978).

B.2.3.1 216-Z-9 Trench. The Recuplex waste solutions consisted of aluminum, magnesium, sodium, calcium, and other metal nitrate salt wastes, degraded solvents (TBP or DBBP in carbon tetrachloride), other organics such as solvent washings, fabrication oil, and other waste materials from hood and equipment flushes (Ludowise 1978). The aqueous wastes were accumulated in a large stainless steel tank and periodically batch neutralized to a pH of 2.5 by the addition of sodium hydroxide before transfer to the 216-Z-9 Trench (Judson 1956). Organic liquids were also disposed to the trench in batches.

The total volume of both aqueous and organic liquid waste discharged to 216-Z-9 was 4,090,000 L (Ludowise 1978). Of this, approximately 83,000 to 300,000 L was carbon tetrachloride, as discussed below.

Recuplex managers, engineers, and technicians were interviewed regarding operating practices and frequency and quantity of discharges to the 216-Z-9 Trench. From these interviews, process knowledge, and research into existing documents, the quantity of carbon tetrachloride to 216-Z-9 was estimated to be 300,000 L.

Owens (1981) reports the following quantities of carbon tetrachloride discharged to the 216-Z-9 Trench:

- 120 tons (73,000 L) of 75-85 vol % carbon tetrachloride in combination with TBP, DBBP, and trace MBP
- 60 tons (44,000 L) cutting oil: 50 vol % carbon tetrachloride in combination with lard oil.

Combined, these represent approximately 83,000 L of carbon tetrachloride.

When the 216-Z-9 Trench was deactivated in April 1962, accountability records indicated that it contained 27.4 kg of plutonium. Based on the size of the trench, the depth of the soil layer containing plutonium, and plutonium concentrations, the plutonium content was estimated to be 100±50 kg; 150 kg was carried on official records. Based on another nuclear and soil analysis in 1973, the plutonium content of the soil was estimated to be 26 to 69 kg with 38 kg in the top 30 cm of soil. A potential for a criticality incident was recognized, and cadmium nitrate (a neutron absorber) was sprayed onto the trench floor. Subsequent studies determined that the risk of criticality had been less than originally believed. Even so, removal of the top 30 cm of contaminated soil from the trench bottom was viewed as a means of reducing the risk of environmental contamination. This was completed in July 1978 through a mining operation which successfully removed 58 kg of plutonium from the crib floor. The 58 kg of plutonium actually removed in the top 30 cm of soil was 54% higher than the estimated 38 kg. If this 54% correction factor is applied to the total plutonium content of the trench, then at most 106 kg was originally present and 48 kg still remains (Ludowise 1978). The americium-241 inventory is estimated to be 2.5 kg. The site still contains equipment from these mining operations (Owens 1981).

The 11,000 L of aqueous cadmium nitrate solution sprayed on the soil at 216-Z-9 contributed 11 kg of cadmium to the soil. Tests in 1973 indicated that the bulk of the cadmium solution was retained in the top 30 cm of soil (Smith 1973). Therefore, a significant proportion of the cadmium was probably removed during the 1976-78 mining operations. Other co-contaminants include aluminum, calcium, chromium, fluoride, chloride, iron, iodine, magnesium, nickel, nitrate, rubidium, sodium, sulfate, sulfamate, cesium-137, uranium, ruthenium-106, and strontium-90 (WHC 1991a, Owens 1981).

B.2.3.2 216-Z-1A Tile Field and 216-Z-18 Crib. The PRF high-salt aqueous waste was approximately 2.5M nitric acid with other dissolved metal nitrates (aluminum, magnesium, calcium, sodium), bringing the total nitrate concentration to approximately 5 to 6M. The pH of the wastes discharged to the soil column ranged from 1 to 2.5. Solvent and plutonium-bearing aqueous wastes from PRF were deposited to soil primarily through the 216-Z-1A Tile Field and the 216-Z-18 Crib. The 216-Z-1 and -2 cribs received PRF wastes for two periods of a few weeks.

The total volume of all types of liquid waste deposited to PRF waste sites is reported by Brown et al. (1990) and Price et al. (1979) as follows:

216-Z-1 & -2 cribs	33,500,000 L	1949-1952
216-Z-1 & -2 cribs	211,000 L	1966-1969
216-Z-1A Tile Field	1,000,000 L	1949-1959
216-Z-1A Tile Field	5,200,000 L	1964-1969
216-Z-1AA	1,910,000 L	1964-1966
216-Z-1AB	1,900,000 L	1966-1967
216-Z-1AC	1,410,000 L	1967-1969
216-Z-3 Crib	178,000,000 L	1952-1959
216-Z-18 Crib	3,860,000 L	1969-1973

Review of existing documentation combined with process knowledge suggests that approximately 280,000 L of carbon tetrachloride was discharged to soil from PRF.

Organic solvents consumed at PRF between 1964 and 1973 were reported to be: 1,777 drums (370,000 L) of carbon tetrachloride; 71,144 lb (32,300 kg) of DBBP; and 106,080 lb (48,100 kg) of TBP (Appendix A, Crawley 1974 memorandum). The carbon tetrachloride consumption cannot be used to estimate discharge to ground because a large fraction of the carbon tetrachloride brought into the plant was undoubtedly lost to the ventilation system through evaporation (Appendix A). However, the consumption of TBP and DBBP should provide keys to a better estimate of the carbon tetrachloride discharged in liquid form because (1) TBP and DBBP are very insoluble in water and have very low vapor pressures; and (2) during operation, the composition of the solvent was well controlled. Based on TBP and DBBP consumption, an estimated 270,000 L of liquid carbon tetrachloride was discharged to 216-Z-1A Tile Field and 216-Z-18 Crib. Of that total, it is estimated that 160,000 L went to the tile field and 110,000 L went to the crib.

Sloat (1967, Appendix B) estimates that about 6,000 gal (22,000 L) of fabrication oil was accumulated, washed in 10M nitric acid to remove the plutonium, and then routed to the 216-Z-1A Tile Field. At 50 vol % carbon tetrachloride, this represents an additional 11,000 L of carbon tetrachloride discharged to 216-Z-1A.

An estimated 57 kg of plutonium and 1 kg of americium were discharged to the 216-Z-1A Tile Field (Price et al. 1979). The 216-Z-18 Crib received 23 kg of plutonium (Owens 1981). Applying the tile field ratio of 1 kg americium per 57 kg plutonium to the crib suggests that approximately 0.4 kg of americium was discharged to the crib.

Other co-contaminants discharged in PRF waste include: fluoride, nitrate, sodium, aluminum, magnesium, calcium, sulfate, strontium-90, ruthenium-106, cesium-137, cobalt-60, and uranium (WHC 1991a, Owens 1981).

B.3 CHARACTERISTICS OF THE SITE

This section discusses the characteristics of the Hanford Site and the 200 West Area, including the carbon tetrachloride disposal sites. These characteristics include topography, meteorology, surface water hydrology, geology, hydrogeology, ecology, and cultural resources.

B.3.1 Topography

The Hanford Site lies within the Pasco Basin, a sediment-filled, topographic low in the Columbia Plateau of southeastern Washington. The Pasco Basin occupies about 4,900 km^2 and is centrally located within the Columbia Plateau. The Basin is bounded to the north, west, and south by anticlinal

structures that form local topographic highs (e.g., Saddle Mountains, Rattlesnake Hills), and to the east by a broad regional buried monoclinal structure (Palouse Slope) (Figure B-4). Surface elevations within the Pasco Basin range from >910 m above mean sea level at Rattlesnake Mountain to <105 m above mean sea level along the Columbia River at Wallula Gap.

Within the central part of the basin, late Pleistocene cataclysmic flooding and Holocene eolian processes have created an extensive system of anastomosing flood channels, giant flood bars, flood plains, sand dunes, and wind-blown silt deposits. The 200 West Area is located on the Cold Creek Bar, a broad, flat plateau with escarpments to the north, northwest, and east which have elevation changes of 15 to 30 m. In the 200 West Area, the surface elevation ranges from approximately 200 to 225 m above mean sea level; the ground surface slopes at <2 degrees toward the south.

In the vicinity of Z Plant, surface topography is primarily a result of excavation and construction activities associated with waste management practices (Plate 1). For example, the 216-Z-1A Tile Field, immediately south of the 234-5Z Building, was excavated to a depth of 6 m. It was not backfilled to grade and remains as a local, 2.5-m topographic low.

B.3.2 Meteorology

The climate of the Hanford Site is classified as mid-latitude semiarid or mid-latitude desert. The summers are warm and dry with abundant sunshine and winters are cool with occasional precipitation. Overcast skies and fog occur periodically in the winter (DOE 1988).

The mean surface air temperature at the Hanford Meteorology Station (located about 0.4 km east of the 200 West Area) averages approximately 12°C. July tends to be the warmest month of the year with temperatures averaging 24.7°C. The highest temperature ever recorded at the Hanford Site was 46°C on July 27, 1939. January tends to be the coolest month of the year with temperatures averaging -1.4°C. The lowest temperature ever recorded at the Hanford Site was -32.8°C on December 12, 1919. The average day of the last frost is April 23 and the average day of the first frost is October 15. There are an average of 174 d/yr which are free of freezing temperatures (DOE 1988).

Mean annual precipitation at the Hanford Meteorology Station is about 16 cm. On average, 42% of the annual precipitation falls during November, December, and January. January is the wettest month with an average of nearly 100 h of precipitation producing 2.3 cm of water. July is the driest month with an average of only 10 h of precipitation producing <0.4 cm of water. Even though precipitation is less frequent in the summer months, when it does occur, it is on the average twice as intense as winter precipitation. The average annual snowfall is 33.5 cm and accounts for approximately 38% of all precipitation from December through February (Stone et al. 1983).

The average atmospheric pressure for the Hanford Site is 29.2 inches of mercury (742 mm of Hg) (Figure B-5). In general, the atmospheric pressure is higher in the winter than in the summer, although both the highest and lowest recorded pressures at the Hanford Site occurred during winter (DOE 1988).

Figure B-4. Topography of the Hanford Site.

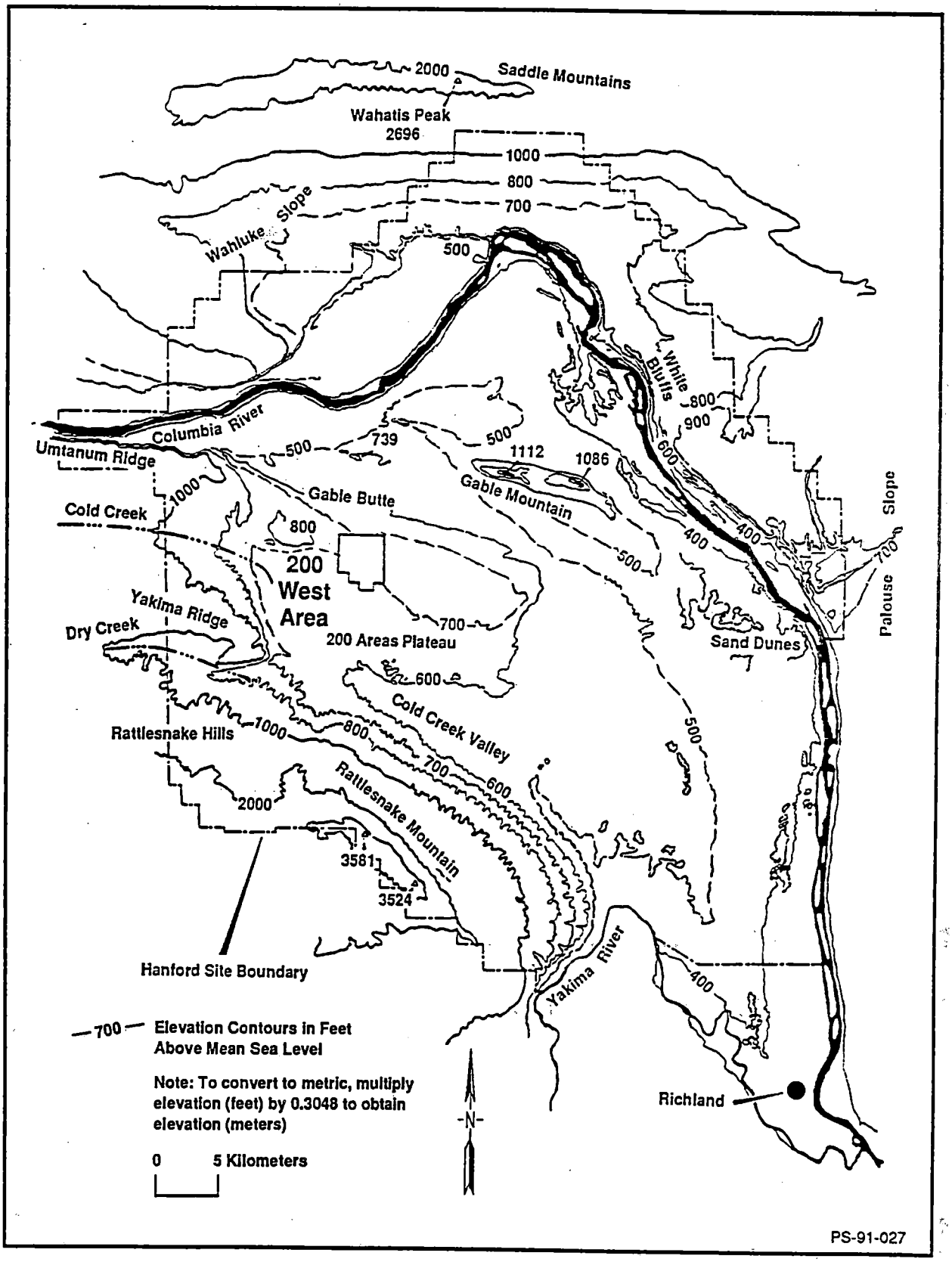
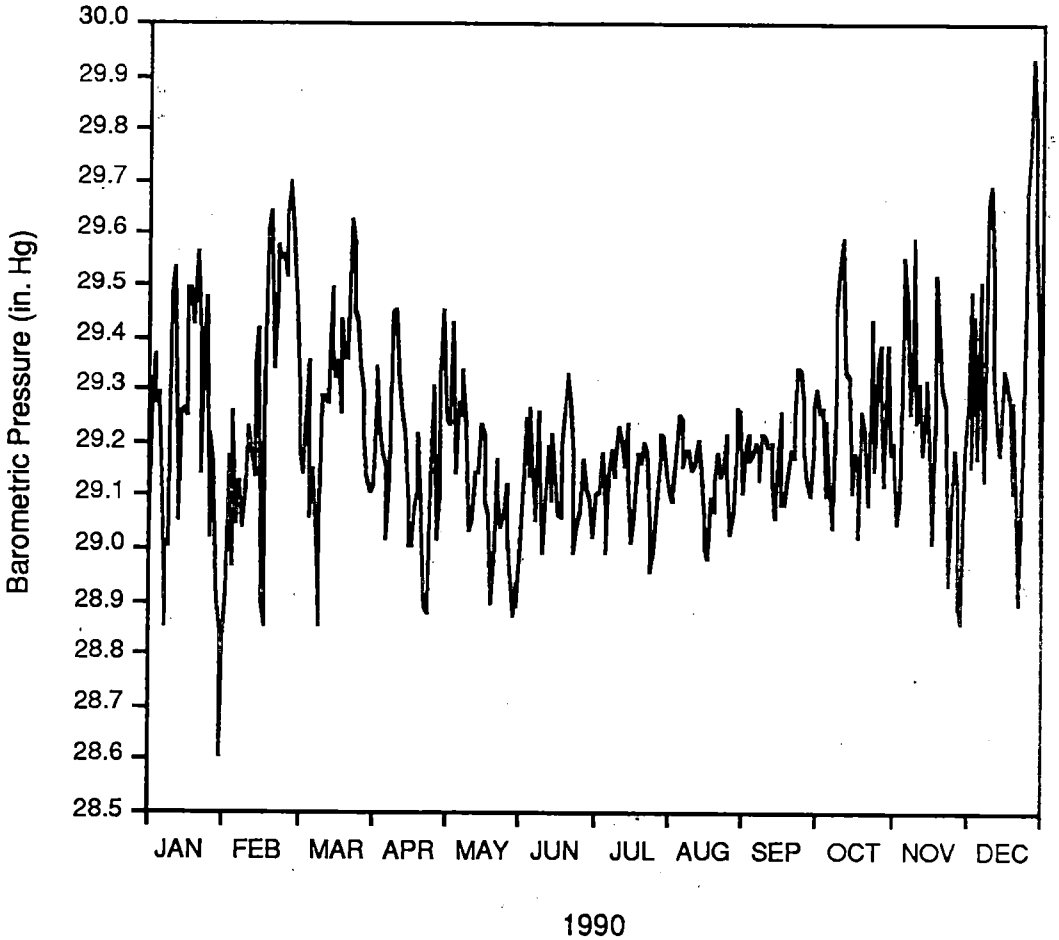


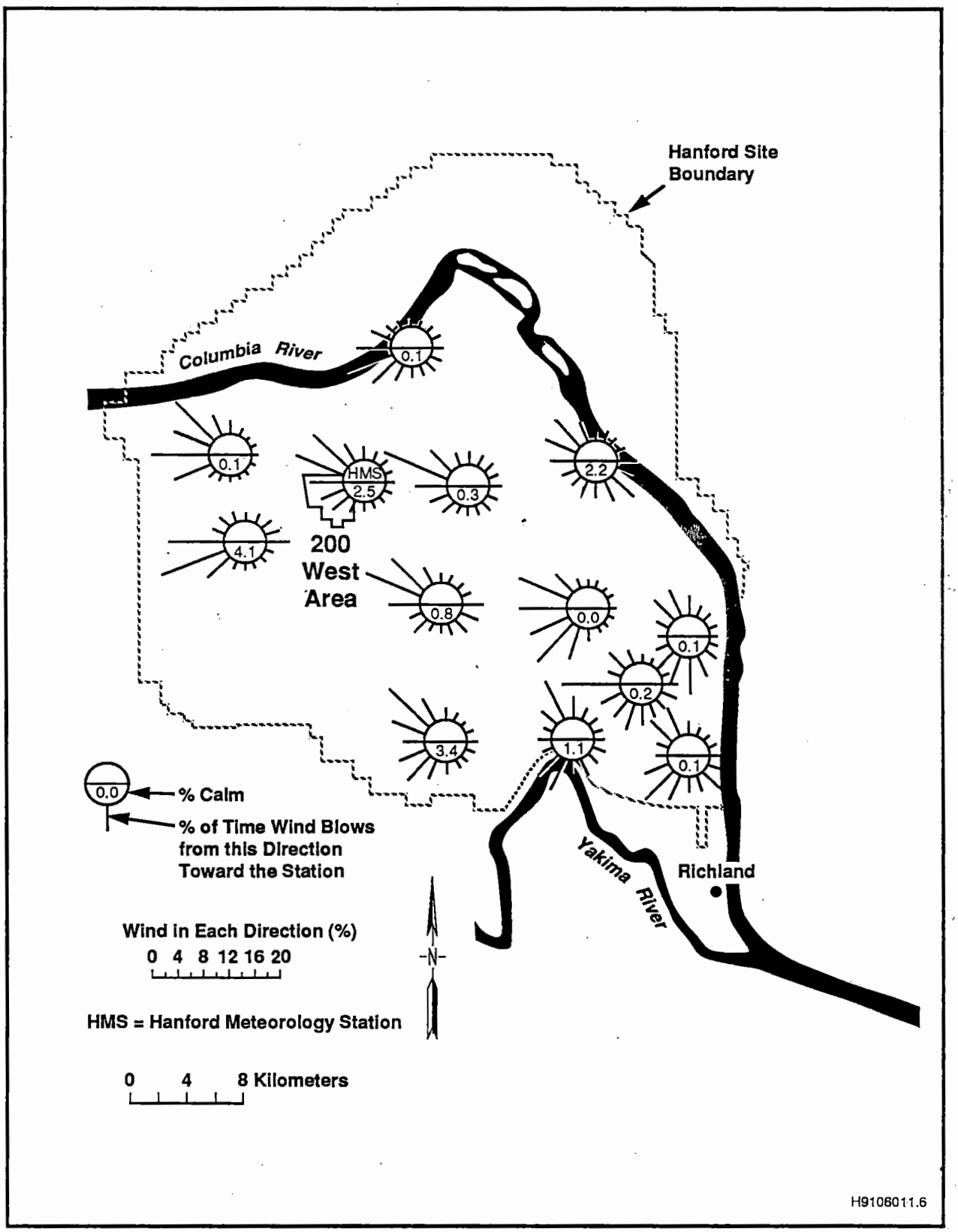
Figure B-5. Average Daily Barometric Pressure at Hanford Meteorology Station, 1990.



Note: To convert inches of Hg to mm of Hg, multiply inches by 25.4 to obtain mm.

Prevailing near-surface wind in the vicinity of the Hanford Meteorology Station is primarily from the west to northwest with an average wind speed of 4.8 km/h. Seasonal changes in the average wind direction are not very large, but seasonal changes in the average wind speed are more variable. June has the highest average monthly wind speed 5.8 km/h and the prevailing wind direction is from the west-northwest. In November and December, average wind speeds fall to about 3.8 km/h and the prevailing wind direction is from the northwest (Stone et al. 1983). Wind roses for the Hanford Site indicate the frequency distribution of wind direction at each station (Figure B-6).

Figure B-6. Wind Roses for the Hanford Site.



B.3.3 Surface Water Hydrology

The Pasco Basin is the topographic low within the Columbia Plateau into which flow the Columbia River and its major tributaries, the Snake, Yakima, and Walla Walla rivers. These rivers compose the principal surface-water features in southeastern Washington. No perennial streams originate within the Pasco Basin (DOE 1988).

Total estimated precipitation over the basin averages <20 cm/yr (DOE 1988). Mean annual runoff from the Pasco Basin is estimated to be approximately 3% of the total precipitation; the remaining precipitation is assumed to be lost through evapotranspiration with a small component (perhaps <1%) recharging to the ground water system (DOE 1988).

West Lake, at the west end of Gable Mountain, is the only natural lake within the Hanford Site; it is <1 m deep and about 4 ha in size (DOE 1988). The primary surface-water features of the Hanford Site are the Columbia and Yakima rivers. About two-thirds of the Hanford Site drains into the Columbia River; the remaining one-third (in the western and southern portions of the Site) drains into the Yakima River. The 200 West Area, except the northeast corner, lies within the Yakima River watershed (DOE 1988).

Two intermittent streams, Cold Creek and its tributary Dry Creek, are part of the Yakima watershed and originate in synclinal valleys west of the Hanford Site (DOE 1988).

There are no natural surface drainage channels within the 200 West Area. However, artifical drainage channels, ponds, and cribs have been used for the ground discharge of liquid wastes created by chemical processing operations. The two major surface water bodies created by past waste disposal practices were two ponds, one at the northern end of the 200 West Area and one at the southern end (Figure B-2). The northern pond, 216-T-4 (T Pond), was 1 ha at its base and received 4.25×10^{10} L of waste water between 1944-1976. The southern pond, 216-U-10 (U Pond), was 9 ha at its base and received 1.62×10^{11} L of waste water between 1944-1984 (ERDA 1975, Aldrich 1985). These ponds have been drained and backfilled. Existing surface water features within the 200 West Area are the 216-Z-21 seepage basin and the 200 West Powerhouse Pond. The 216-S-10 Ditch, just south of the 200 West Area, also contains water.

B.3.4 Geology

This section discusses the regional and site stratigraphy and geologic structure.

B.3.4.1 Regional Stratigraphy. The Pasco Basin and Hanford Site are underlain by up to 230 m of sediments deposited on Miocene-aged basalts. The sediments and basalts thicken into the Pasco Basin, a structural depression, and generally reach maximum thicknesses in the Cold Creek syncline, which trends southeast under the 200 West Area. Older Cenozoic sedimentary and volcaniclastic rocks underlying the basalts are not exposed at the surface near Hanford.

The principal geologic units underlying the Pasco Basin (from oldest to youngest) are:

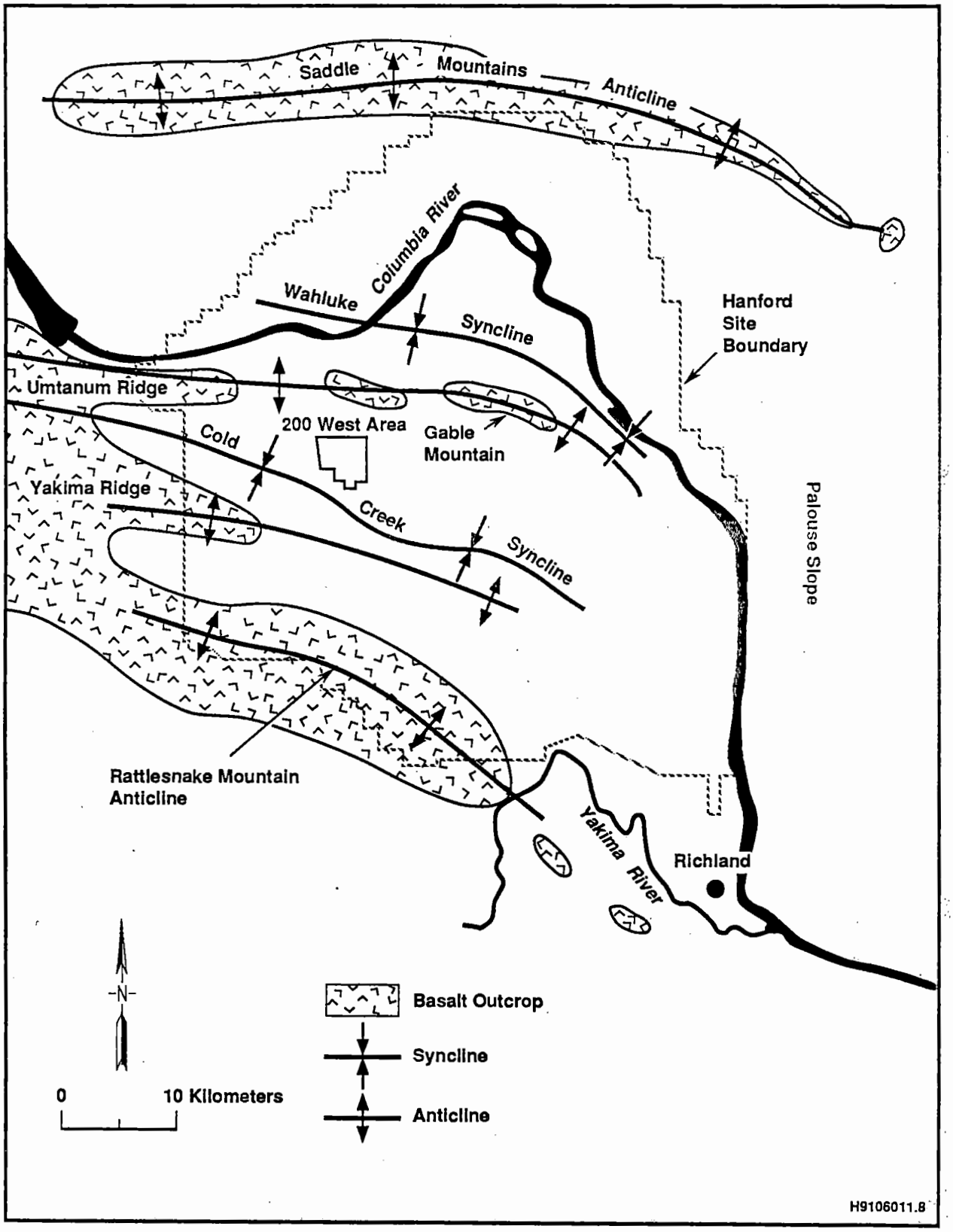
- The Columbia River Basalt Group, composed of an assemblage of continental flood basalts of Miocene age.
- The Ellensburg Formation, which includes all the sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the Pasco Basin.
- The Ringold Formation, a series of alluvial gravels and sands, overbank deposits, and lacustrine deposits of late Miocene to Pliocene age.
- The Plio-Pleistocene unit (DOE 1988), which overlies the Ringold Formation in the western Pasco Basin and consists of basaltic detritus and a carbonate-rich paleosol that developed on top of a post-Ringold erosional surface.
- The early "Palouse" soil, which overlies the Plio-Pleistocene unit in the western Pasco Basin and consists of eolian silt and fine-grained sand.
- The Hanford formation, composed of glaciofluvial gravels, sands, and silts deposited by middle to late Pleistocene cataclysmic flood waters.
- Holocene surficial deposits, which consist of alluvial and eolian silt, sand, and gravel and form a thin veneer across much of the Hanford Site.

These units are discussed in greater detail in Section B.3.4.3, Site Stratigraphy.

B.3.4.2 Regional Structure. The Hanford Site is located in the eastern portion of the Yakima Fold Belt. The Yakima folds are a series of segmented, narrow, asymmetric anticlines separated by broad, flat synclines that, in many cases, contain thick accumulations of sediments. The northern limbs of the generally east-west trending asymmetric synclines usually dip at relatively shallow angles to the south; the southern limbs dip steeply to the north and are often faulted. The 200 West Area is on the northern limb of the Cold Creek syncline.

The Pasco Basin is bound on the north by the Saddle Mountains anticline, on the west by Umtanum Ridge, Yakima Ridge, and Saddle Mountains anticlines, on the south by the Rattlesnake Mountain anticline. The Palouse slope, a west-dipping monocline, bounds the Pasco Basin on the east. The Pasco Basin is divided into the Wahluke and Cold Creek synclines by the Gable Mountain anticline, the easternmost extension of the Umtanum Ridge anticline (Figure B-7).

Figure B-7. Structural Geology of the Hanford Site.



B.3.4.3 Site Stratigraphy. An east-west cross section across the Hanford Site through the 200 West Area illustrates the lateral extent of the geologic units underlying the Pasco Basin (Figure B-8); a series of cross sections across the area south of Z Plant are shown in Plate 2. The stratigraphy of the Z Plant area is summarized in Figure B-9. Elevations of contacts between units and thicknesses of the various geologic units in the 200 West Area were interpreted from borehole lithologic logs and/or cores and are summarized in Appendix C6. The interpretation of the Ringold stratigraphy is based on Lindsey (1991).

B.3.4.3.1 Columbia River Basalt. The top of the Columbia River Basalt ranges in depth from approximately 120 to 180 m under the 200 West Area; depth to basalt in the vicinity of the carbon tetrachloride disposal sites is about 163 m. As indicated by the surface of the uppermost basalt flow in this area, the Elephant Mountain Basalt, the basalts dip to the southwest across the 200 West Area toward the axis of the Cold Creek syncline (Figure B-10).

B.3.4.3.2 Ringold Formation. The Ringold Formation in the Pasco Basin contains up to five separate stratigraphic intervals dominated by fluvial gravels. These gravels are separated by intervals containing deposits typical of overbank and lacustrine facies associations. These units are not continuous across the Hanford Site; only the lowermost and uppermost gravel units occur in the 200 West Area (Figure B-8).

The strata forming the fluvial gravel facies consist dominantly of clast-supported granule to cobble gravel with a sandy matrix. Low angle to planar stratification, massive bedding, channels, and large-scale cross-bedding are found in outcrops. The strata were deposited in a gravelly fluvial system characterized by wide, shallow, shifting channels.

Lowermost Ringold deposits, overlying the Elephant Mountain Basalt, consist of the fluvial gravel designated fluvial sequence A (FSA). The FSA correlates to strata assigned to the lower, coarse-grained basal unit of the Ringold Formation in the western Cold Creek syncline and 200 West Area (DOE 1988). In the vicinity of the carbon tetrachloride disposal sites, this unit is 12 m thick.

The FSA is overlain by a sequence of overbank sediments. The overbank deposits in the 200 West Area consist of clayey to silty paleosols containing variable amounts of calcium carbonate. These sediments record the formation of soils and are not present in the northeastern portion of the 200 West Area. These paleosols correlate to the fine-grained section of the basal unit of the Ringold Formation as described by DOE (1988).

The paleosols or, in their absence, the FSA, are overlain by the lacustrine sediments. These deposits are characterized by plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation. These sediments were likely deposited under lacustrine conditions. The lacustrine sediments correlate with the lower unit of the Ringold Formation, as described by DOE (1988).

Figure B-8. Cross Section Across the Hanford Site Through the 200 West Area.

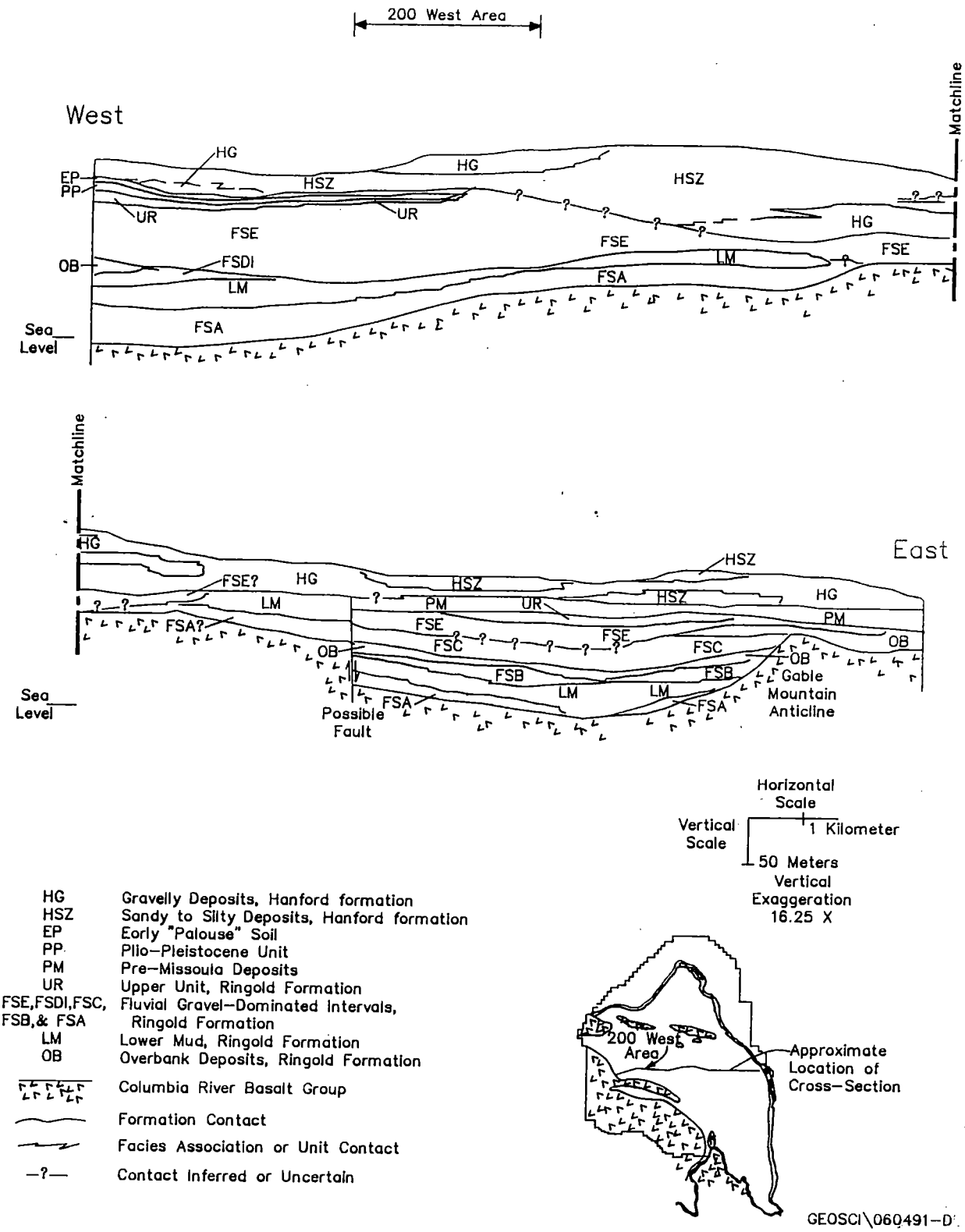


Figure B-9. Generalized Hydrostratigraphic Column for the Z Plant Area.

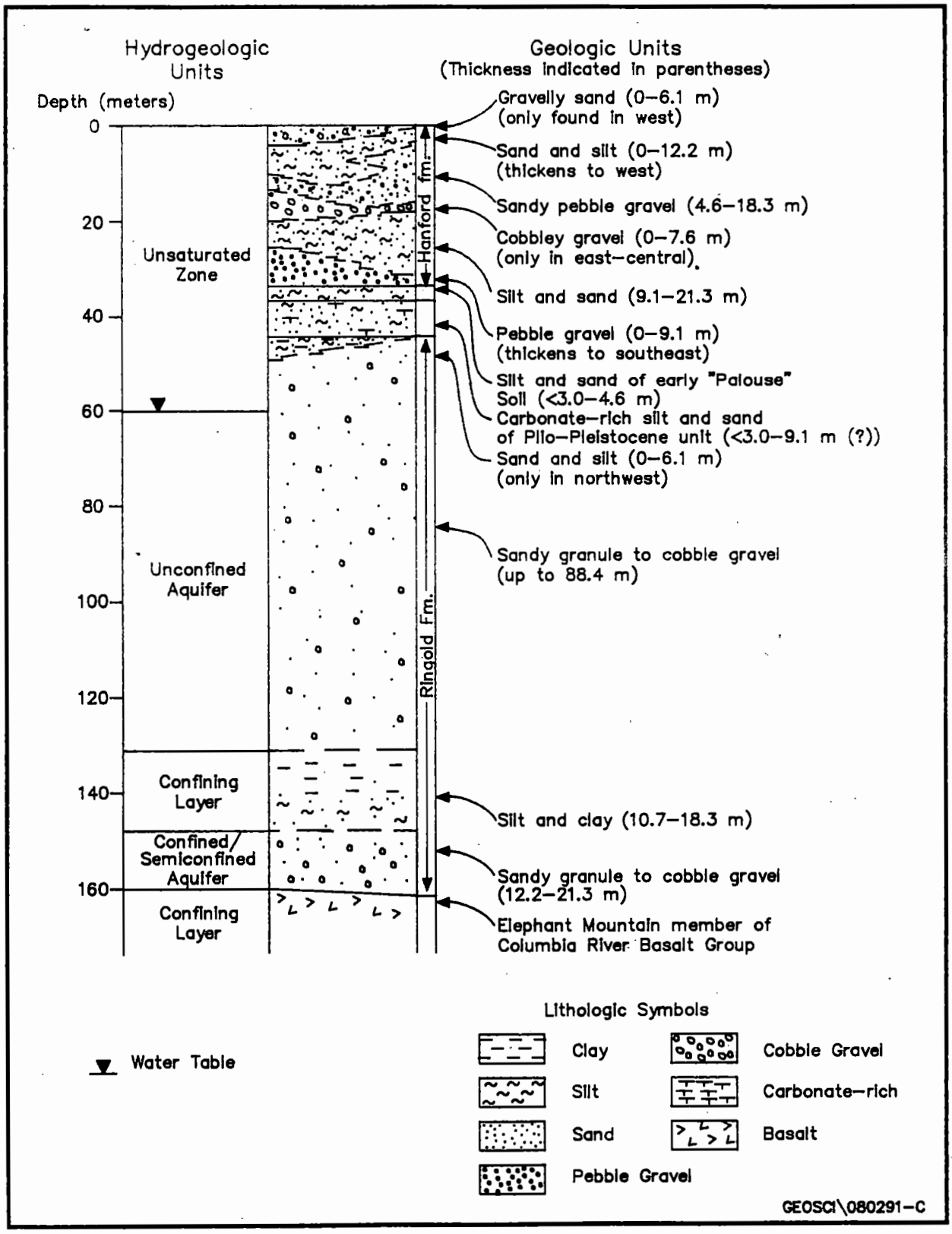
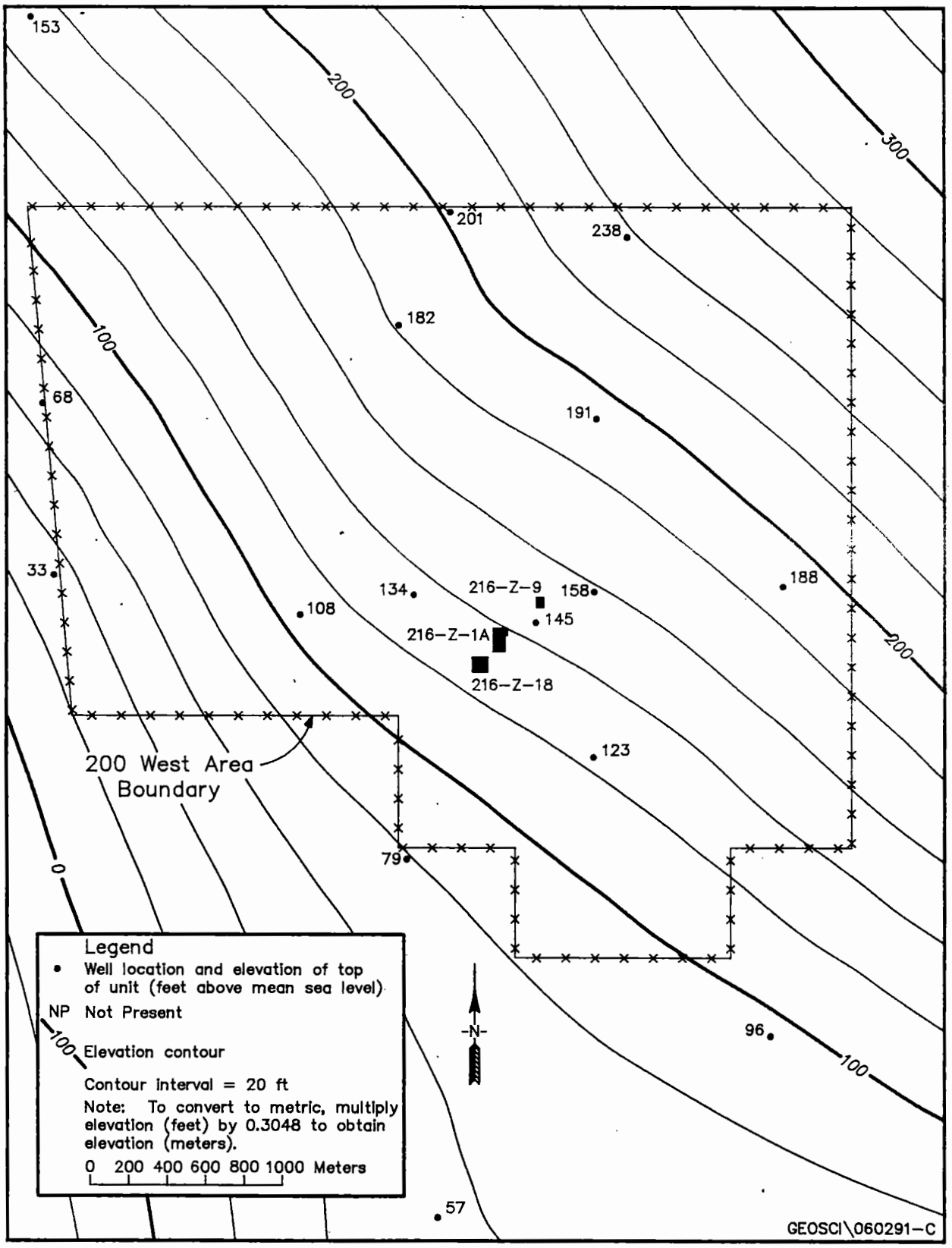


Figure B-10. Top of Elephant Mountain Basalt in the 200 West Area.



The paleosol and lacustrine deposits together compose the lower mud sequence of the Ringold Formation. The definition of the lower mud sequence is based on site-wide stratigraphic data, which indicate that it is the lowest of the three mud sequences in the Cold Creek syncline. The other two (e.g., "OB", Figure B-8) are not found at the 200 West Area (Lindsey 1991).

The lower mud sequence thickens from zero in the northeast corner of 200 West Area to nearly 60 m at the western boundary. The top of this mud sequence slopes in general from east to west, but defines several local topographic highs and lows; one such low occurs immediately south of the carbon tetrachloride disposal sites (Figure B-11).

The uppermost fluvial gravel-dominated interval, designated as fluvial sequence E (FSE), is the most widespread of the gravel intervals. The FSE is found throughout the Cold Creek syncline forming a west-thickening wedge which is up to 100 m thick south and west of the 200 West Area. The FSE correlates to the middle Ringold Unit of the Ringold Formation in the 200 West Area, as described by DOE (1988).

The Ringold gravel unit FSE overlies the lower mud sequence, where the mud is present. Where the lower mud sequence is not present the FSE overlies the gravel unit FSA or the Elephant Mountain Basalt. The FSE gravel is present throughout the 200 West Area and ranges in thickness from about 60 m to at least 125 m; it is approximately 87 m thick in the vicinity of the carbon tetrachloride disposal sites. In general, the FSE gravel slopes to the southwest in the northern half of the 200 West Area and to the south in the southern half of the area. Locally, the top of the FSE has many undulations.

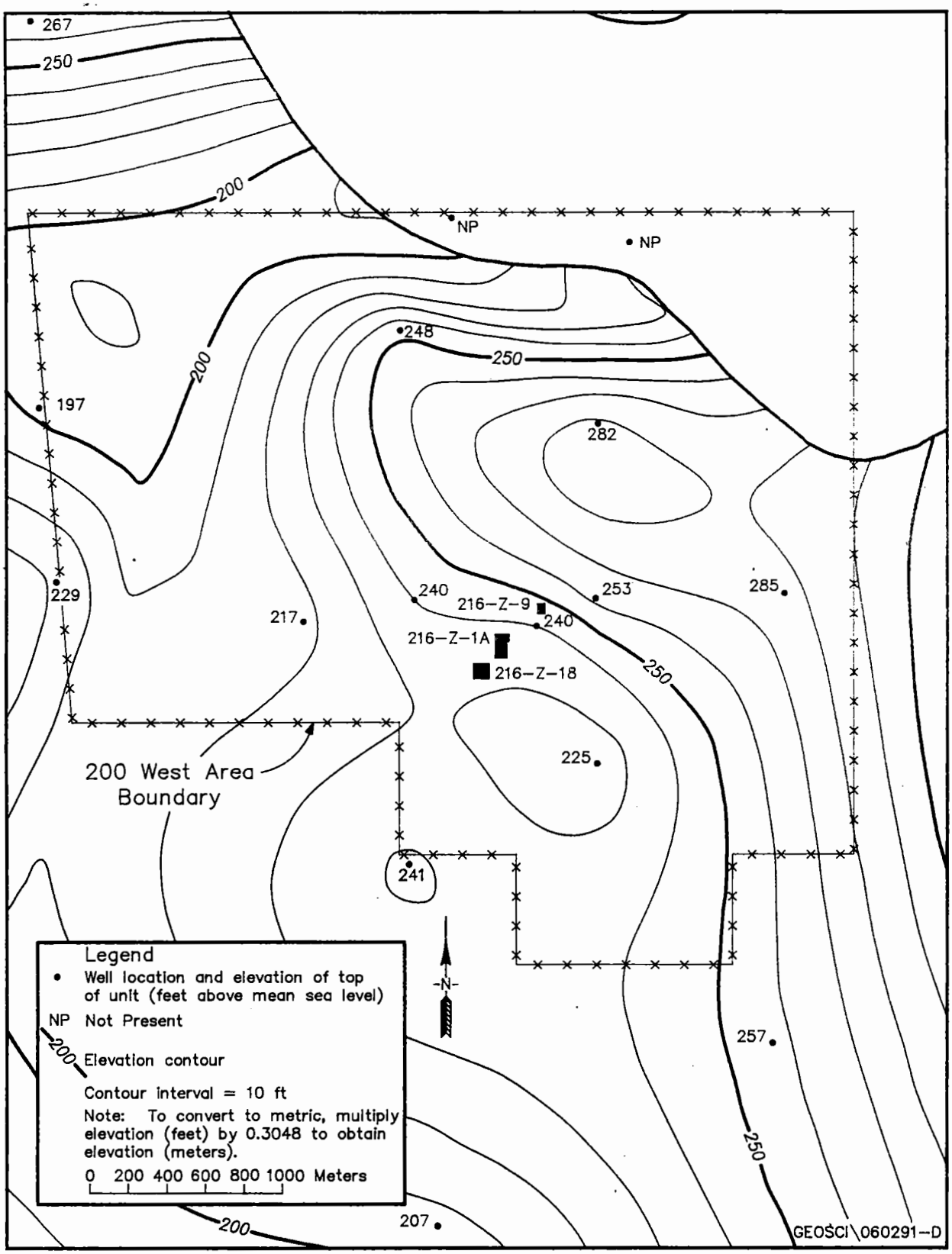
Interbedded fluvial sand and overbank deposits overlie the FSE. The fluvial sands commonly form fining upward sequences <1 to several meters thick that were deposited in wide, shallow channels incised into a muddy floodplain, represented by the overbank deposits. These sediments compose the upper unit of the Ringold Formation as originally described by Newcomb (1958).

Erosional remnants of these fluvial sands and overbank muds occur locally in the 200 West Area. For example, the upper Ringold is 7.6 m thick in a small area northwest of the 216-Z-1A Tile Field and may extend under the tile field, but it is apparently missing under the 216-Z-9 Trench and 216-Z-18 Crib. This unit reaches thicknesses of at least 15 m in two local highs in the eastern portion of the 200 West Area.

B.3.4.3.3 Plio-Pleistocene Unit. Unconformably overlying the Ringold Formation in the western Cold Creek syncline in the vicinity of the 200 West Area is the Plio-Pleistocene unit (DOE 1988). The unit is separated into two facies: basaltic detritus and pedogenic calcrete. Depending on the location, one or both facies may be present; the calcrete facies predominates in the 200 West Area.

The calcrete facies, which generally consists of interfingering carbonate-rich silt and sand and carbonate-poor silt and sand, is locally referred to as the "caliche layer". However, the character of this caliche varies from three to four distinct, compact layers in the northern 200 West Area to one or more less compact layers in the Z Plant area to a diffuse zone in the southern 200 West Area.

Figure B-11. Top of the Lower Mud Sequence in the Ringold Formation in the 200 West Area.



The Plio-Pleistocene unit ranges from 0 to more than 15 m in thickness in the 200 West Area; it is 6 to 7.6 m thick under the three carbon tetrachloride disposal sites (Figure B-12). The Plio-Pleistocene unit dips generally from the north to the south-southwest (Figure B-13).

B.3.4.3.4 Early "Palouse" Soil. The early Palouse soil consists of wind-blown silt and fine-grained sand that overlies the Plio-Pleistocene unit in the western Cold Creek syncline around the 200 West Area (Tallman et al. 1981, Bjornstad 1984, DOE 1988). The unit is differentiated from overlying slackwater deposits by greater calcium carbonate content, cohesive structure in core samples, and high natural gamma response in geophysical logs (Bjornstad 1984). The upper contact of the unit is poorly defined and it may grade up-section into the lower part of the Hanford formation. The soils range in thickness from 0 to more than 17 m in the 200 West Area and dip from the north to the south.

B.3.4.3.5 Hanford Formation. In the 200 West Area, the Hanford formation can generally be divided into two main facies: coarse-grained, or gravelly, deposits and fine-grained, or sandy and silty, deposits. The gravelly facies ("HG" on Figure B-8) consists of coarse-grained sand and granule to boulder gravel that display massive bedding, plane to low angle bedding, and large scale cross-bedding in outcrop. Matrix commonly is lacking in gravels, giving them an open framework appearance. In the 200 West Area, the gravel facies association generally fines to the south, containing less gravel. The gravelly facies was deposited by high energy flood waters.

The sand and silt facies ("HSZ" on Figure B-8) consists of fine- to coarse-grained plane to cross-bedded sand and silt that commonly display normally graded rhythmites a few centimeters to several tens of centimeters thick in outcrop (Myers and Price 1979, DOE 1988). These sediments were deposited in transitional areas adjacent to main flood channels and in slackwater conditions and backflooded areas (DOE 1988).

The Hanford formation ranges from 6 to >60 m thick in the 200 West Area; it is 34 to 40 m thick in the vicinity of the three carbon tetrachloride disposal sites. The surface of the Hanford formation dips from the northeast to the southwest. The Hanford formation can be locally subdivided into subunits based on dominant lithology. The description and thicknesses of the six subunits for the Z Plant Area are shown on Figure B-9. Last et al. (1989) suggest that a flood channel filled with the coarse-grained gravel sequence runs north-south under Z Plant toward U Pond, bisecting the 200 West Area. The thickness of the Hanford formation in this area ranges from approximately 24 to nearly 46 m.

B.3.4.4 Site Structure. Local structural features in the vicinity of the 200 West Area include the Cold Creek syncline and the Gable Butte-Gable Mountain extention of the Umtanum Ridge anticline (Figure B-7). The axis of the Cold Creek syncline lies approximately 980 m south of the 200 West Area; the 200 West Area is located on the northern flank of the Cold Creek syncline. In this area, the bedrock dips gently (about 5 degrees) to the south. The deepest parts of the Cold Creek syncline include the Cold Creek depression which is located beneath the 200 West Area (Myers 1981).

Figure B-12. Isopach Map of the Plio-Pleistocene Unit in the 200 West Area.

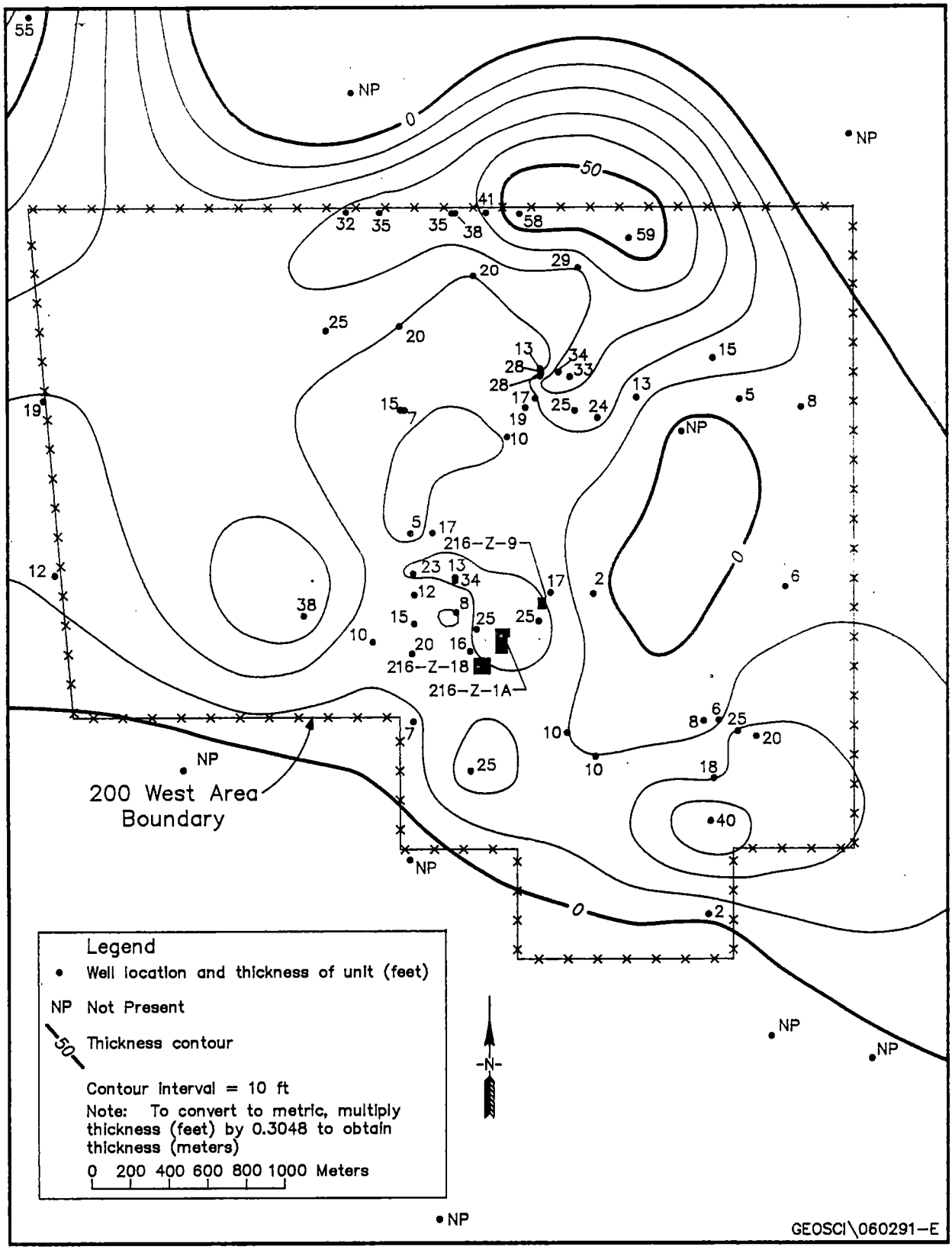
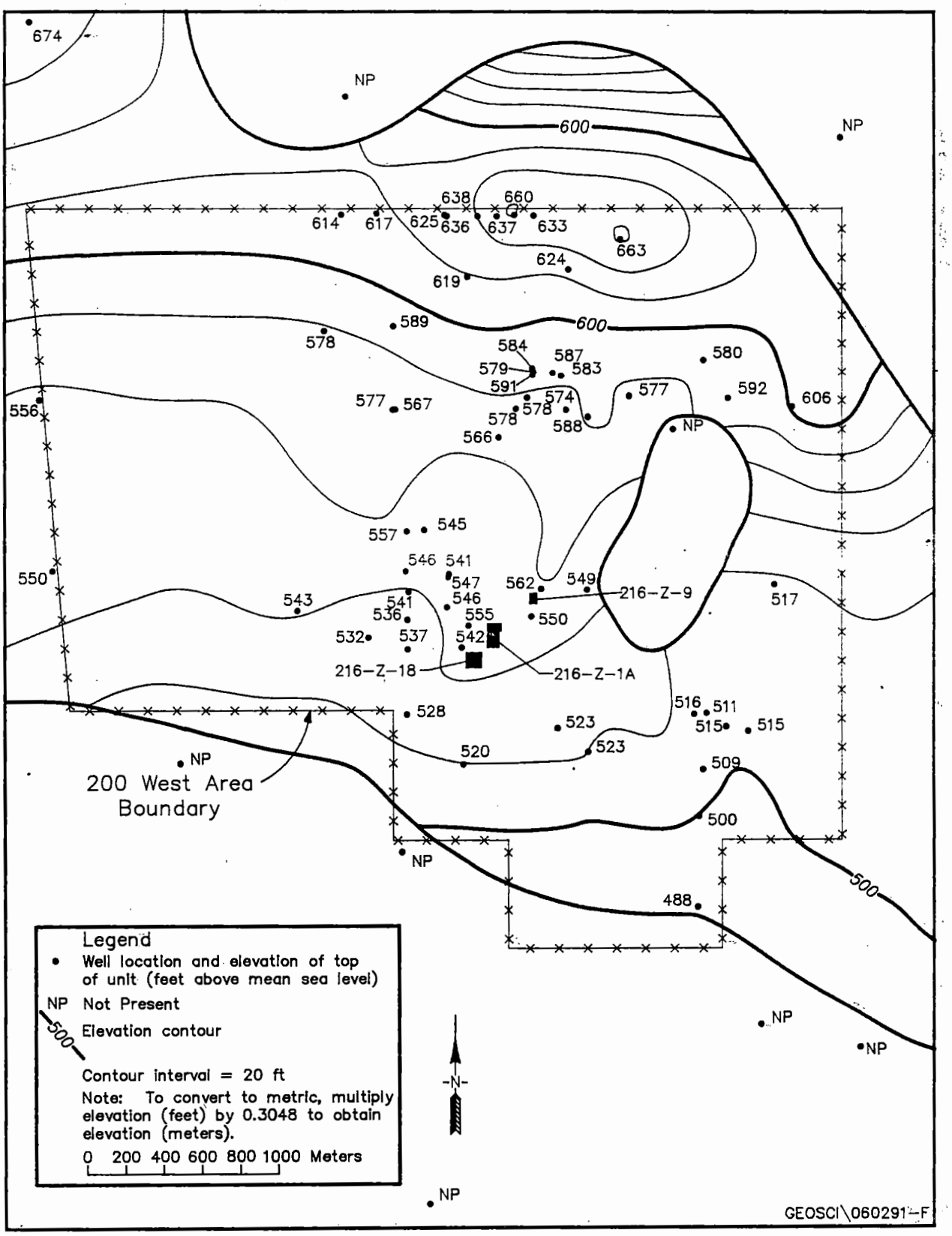


Figure B-13. Top of the Plio-Pleistocene Unit in the 200 West Area.



Local faults are associated with the deformation at Gable Mountain (PSPL 1982). The greatest offset along these faults occurs within the basalt bedrock (>49 m) with much less offset (perhaps 6 cm) in the overlying glaciofluvial sediments. The latest Quaternary movement along the Gable Mountain faults has been dated as 13,000 yr ago (PSPL 1982). No faults have been identified beneath the 200 West Area facilities.

Other faults within the Pasco Basin generally are identified with deformation of the surrounding anticlinal structures. These faults are typically high-angle reverse faults, subparallel to the fold axes, and generally are located along the steeper limb of the folds (Myers and Price 1979). Other tectonic features including tear faults, shatter breccias, and tectonic joints are also associated with the folds and are related to the folding process (Price 1981).

B.3.5 Hydrogeology

B.3.5.1 Regional. The hydrogeology of the Pasco Basin is characterized by a multiaquifer system that consists of four hydrogeologic units that correspond to the three formations of the Columbia River Basalt Group and the suprabasalt sediments. The basalt aquifers are confined and occur in the sedimentary interbeds and/or interflows zones located between dense basalt flows. The uppermost aquifer consists of the suprabasalt sediments comprised of fluvial, lacustrine, and glaciofluvial sediments. The uppermost aquifer is regionally unconfined and is contained largely within the Ringold and Hanford formations.

Local recharge to the shallow basalt aquifers results from infiltration of precipitation and runoff along the margins of the Pasco Basin. Regional recharge of the deep basalt aquifers is inferred to result from interbasin ground water movement originating northeast and northwest of the Pasco Basin in areas where the deeper basalts crop out extensively (DOE 1988). Ground water discharge from shallow basalt aquifers is probably to the overlying aquifers and to the Columbia River. The discharge area(s) for the deeper ground water system is uncertain, but flow is inferred to be generally southeastward with discharge thought to be south of the Hanford Site (DOE 1988). An erosional "window" through the dense basalt flow interiors has been identified in one portion of the Hanford Site (north of the 200 East Area) which may allow direct interconnection between the uppermost aquifer system and underlying confined aquifers if downward vertical gradients are present.

The uppermost aquifer system is regionally unconfined beneath the Hanford Site and lies at depths ranging from <0.3 m below ground surface near West Lake and the Columbia and Yakima rivers, to >107 m in the central portion of the Cold Creek syncline. Ground water in this aquifer system occurs within the glaciofluvial sands and gravels of the Hanford formation and the fluvial and lacustrine sediments of the Ringold Formation.

The water table in the southwestern Pasco Basin is generally within Ringold fluvial gravels of unit FSE. In the northern and eastern Pasco Basin, the water table is generally within the Hanford formation. Hydraulic conductivities of the Hanford formation (150 to 6,100 m/d) are much greater than those of the gravel facies of the Ringold Formation (6 to 180 m/d). The main body of the unconfined aquifer occurs within the Ringold Formation.

The base of the uppermost aquifer system is defined as the top of the uppermost basalt flow. However, the fine-grained overbank and lacustrine deposits of the lower mud sequence in the Ringold Formation locally form confining layers for Ringold fluvial gravels underlying FSE. The uppermost aquifer system is bounded laterally by anticlinal basalt ridges and is approximately 150 m thick near the center of the Pasco Basin.

Sources of natural recharge to the uppermost aquifer system are rainfall and runoff from higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima and Columbia rivers. No downward percolation occurs on the 200 Area Plateau where sediments are layered and vary in texture; in this area, all of the moisture is removed by evapotranspiration (Gee 1987, Routson and Johnson 1990). In areas where soils are coarse-textured and precipitation is above normal, downward movement below the root zone is common (Rockhold et al. 1990).

Artificial recharge of the upper aquifer system occurs from the disposal of large volumes of waste water on the Hanford Site (principally in the 200 Areas) and large irrigation projects surrounding the Hanford Site. Artificial recharge has resulted in changes in the water table and ground water flow directions since operation of the Hanford Site began (Figure B-14).

Regional ground water flow across the Hanford Site is generally to the east. South of Gable Mountain, flow is interrupted locally by the ground water mounds in the 200 Areas which produce local areas of radial flow (Figure B-14). Ground water flow velocities for the 200 Areas are estimated to range from 0.3 to 27 m/d (Graham et al. 1981).

B.3.5.2 Site. The hydrostratigraphy, hydraulic properties, recharge, and ground water flow for the 200 West Area are discussed in this section. The hydrostratigraphic units in the Z Plant Area are the: Ringold Formation, Plio-Pleistocene unit, early Palouse soil, and Hanford formation (Figure B-9).

B.3.5.2.1 Saturated Zone. In the 200 West Area, the uppermost aquifer is contained in the Ringold Formation and displays unconfined to locally confined or semiconfined conditions. The depth to ground water ranges from approximately 58 m near the former U Pond to 82 m in the northeast corner of the 200 West Area; in the vicinity of the carbon tetrachloride disposal sites, the depth to ground water ranges from about 60 to 66 m. The saturated thickness of the unconfined aquifer is approximately 67 m southeast of Z Plant, but elsewhere in the 200 West Area reaches approximately 113 m.

The lower part of the upper aquifer system consists of Ringold unit FSA which generally is confined by fine-grained sediments of the overlying lower mud sequence. The thickness of this confined zone ranges from >30 m in the southern portion of the 200 West Area to 0 m beneath the northern portion (Lindsey 1991). The confining layer overlying the FSA is up to 60 m thick below the western section of the 200 West Area before pinching out in the eastern section. The surface of the confining layer dips to the southeast in the vicinity of Z Plant (Figure B-11). A mean hydraulic conductivity for the confining material of 1.6×10^{-5} m/d has been obtained from permeameter testing of core samples from the top of the unit (Last et al. 1989).

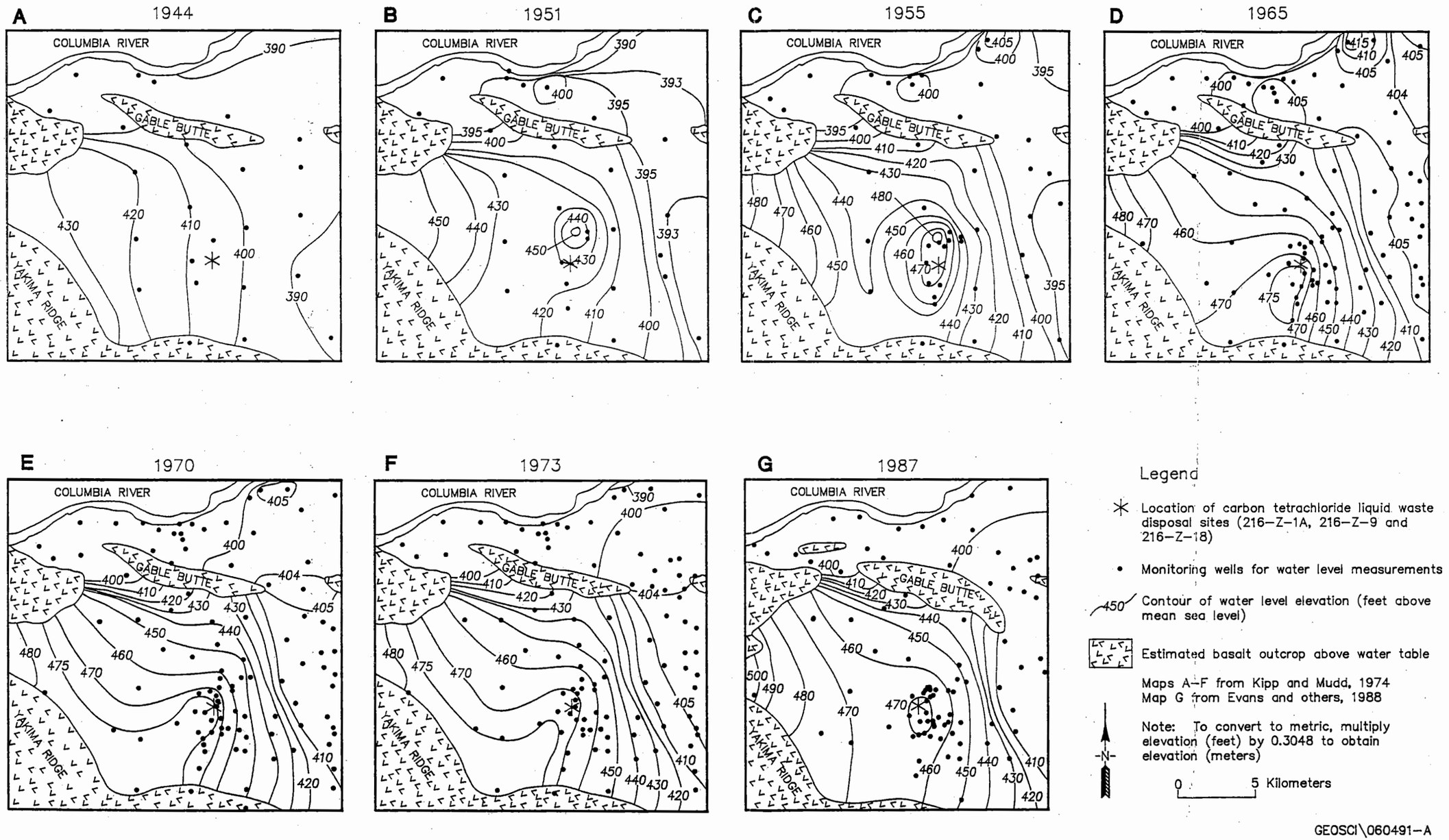


Figure B-14. Water Table in the Region of the 200 West Area, 1944-1987.

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The lower mud sequence is absent in the northernmost portion of the 200 West Area, and a single, undifferentiated gravel sequence consisting of FSA and overlying deposits of FSE is found. In this area, it is not possible to hydraulically differentiate the FSA from FSE.

The water table in the 200 West Area is contained within the fluvial gravel and sand of Ringold unit FSE. This unit consists of more than 76 m of gravel, sand, and minor silt. The hydraulic conductivities of this unit have been determined from pump tests and slug tests (Table B-2).

B.3.5.2.2 Unsatured Zone. The unsaturate zone beneath the 200 West Area ranges in thickness from 58 m beneath the former U Pond to 82 m in the northeast portion of the 200 West Area. The unsaturated zone is 60 to 66 m thick underlying the carbon tetrachloride disposal sites. Sediments in the unsaturated zone consist of the: (1) fluvial gravel of Ringold unit FSE, (2) upper Ringold unit, (3) Plio-Pleistocene unit, (4) early Palouse soil, and (5) Hanford formation. Few of these units are continuous across the 200 West Area. The thickness of the Ringold unit FSE above the water table in the 200 West Area ranges from 0 to >49 m. The variation is the result of both the variable thickness of the unit and the ground water mound derived from waste water disposal.

The FSE is overlain by fluvial sands composing the upper unit of the Ringold Formation. Calcretes of the Plio-Pleistocene unit (the caliche layer) overlie the Ringold Formation throughout most of the 200 West Area. The top of the Plio-Pleistocene unit dips approximately 1.5 degrees to the southwest beneath the northern portion of the 200 West Area and flattens to the south where it pinches out (Figure B-13). The higher degree of cementation and laterally continuous nature of this unit may create a layer with relatively low permeability. Thus, a potential exists for lateral movement of unsaturated zone recharge water above the Plio-Pleistocene unit and relatively slow movement of water through this layer. Perched water has been reported at a depth of approximately 37 m (5 m above the caliche layer), approximately 565 m south of Z Plant in a well drilled in April 1991 (W18-29).

A sequence of unconsolidated loess and sandy silt up to 5 m thick and designated the early Palouse soil overlies the Plio-Pleistocene unit beneath the southern portion of the 200 West Area. The deposit is uniformly fine-grained, micaceous, and moderately calcium carbonate-rich.

The Hanford formation is the uppermost unit in the unsaturated zone except for discontinuous recent eolian sands present in the northwestern section of the 200 West Area. The hydraulic conductivity of air in the Hanford formation and the permeability have been calculated by applying suction to unsaturated zone borings (Table B-2).

Moisture data have been collected from most of the wells drilled in the 200 West Area for the *Resource Conservation and Recovery Act* (RCRA) *of 1976* program. The moisture in the Hanford formation ranges from 0.31 to 33.16% and averages 5.3%. In the early Palouse soil, the moisture content ranges from 2.7 to 29.5% and averages 13.9%. The moisture content in the Plio-Pleistocene unit averages 3.8% and ranges between 1.8 and 5.8%. The upper Ringold moisture content ranges from 1.9 to 11.4% and averages 6.6%. The moisture content of the middle Ringold averages 2.4% and ranges from 0.87 to 6.6%.

Table B-2. Hydraulic Properties for the 200 West Area.

HANFORD FORMATION

K_{air} (at 17- to 23-m depth) = 1.3×10^{-4} to 3.7×10^{-4} cm/s[a]

K_{sat} = 600 to 3,000 m/d (range for the 200 Areas)[b]

K[c] (at 17- to 23-m depth) = 2×10^{-8} to 5.6×10^{-8} cm^2[a]

Effective porosity = approximately 30%[b]

Storativity = 0.07[b]

RINGOLD FORMATION (FSE unit)

Near LLWMA-3[g]	K_{sat} = 0.3 to 210 m/d	T = 1.3 to 650 m^2/d[d]
Near LLWMA-4	K_{sat} = 7 to 1,550 m/d	T = 27 to 4,700 m^2/d[d]
Near U-12	K_{sat} = 2.4 to 6.4 m/d	T = 13 to 32 m^2/d[e]
200 Areas	K_{sat} = 9 to 230 m/d	T = 3 to 70 m^2/d[b]

Effective porosity = 10%[h] to 20%[b]

Storativity = 0.05 to 0.2[f]

RINGOLD FORMATION (lower mud sequence)

K_{sat} = 1 to 3.6 m/d (range for the 200 Areas)[b]

Effective porosity = approximately 10%[b]

Storativity = 0.002[b]

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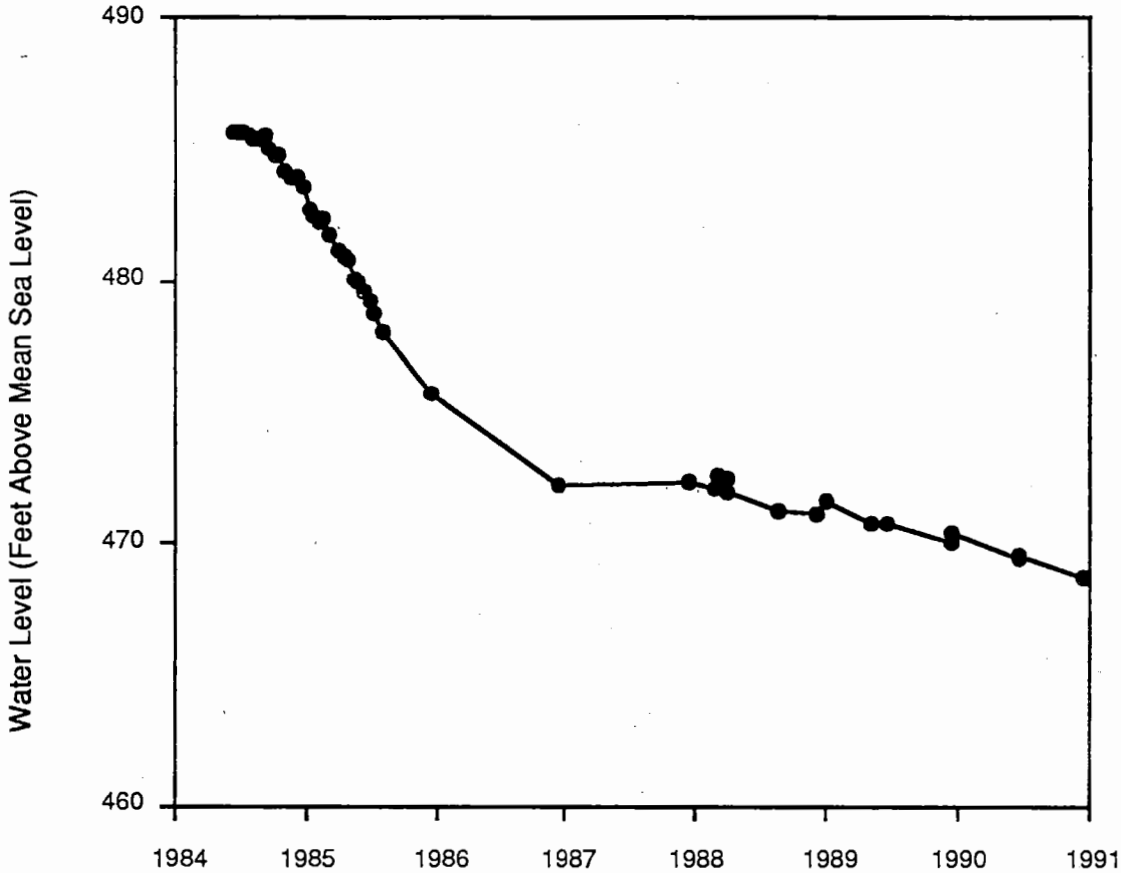
[a]See Appendix F.
[b]From Graham et al. 1981.
[c]Soil permeability.
[d]From Last et al. 1989 and Barton 1990.
[e]From Goodwin 1990, all of these values are from slug tests.
[f]From Last et al. 1989.
[g]LLWMA = low level waste management area.
[h]From Bierschenk 1959.

B.3.5.2.3 Recharge. Artificial recharge to the unconfined aquifer is estimated to be ten times greater than natural recharge (Graham et al. 1981). The major source of artificial recharge in the 200 West Area has been from the U Pond. It is estimated that the water table elevation beneath the U Pond was 20 m lower in 1944, prior to use of the pond. U Pond was decommissioned in 1984. Figure B-15 shows a hydrograph of well W18-15 which is located immediately north of the former U Pond site and shows that the water level has declined about 5 m since the pond was decommissioned. In the first few years, the water level declined relatively rapidly and has since leveled out.

Figure B-15. Water Levels in Well W18-15, 1984 Through 1991.



Note: To convert to metric, multiply elevation (feet) by 0.3048 to obtain elevation (meters).

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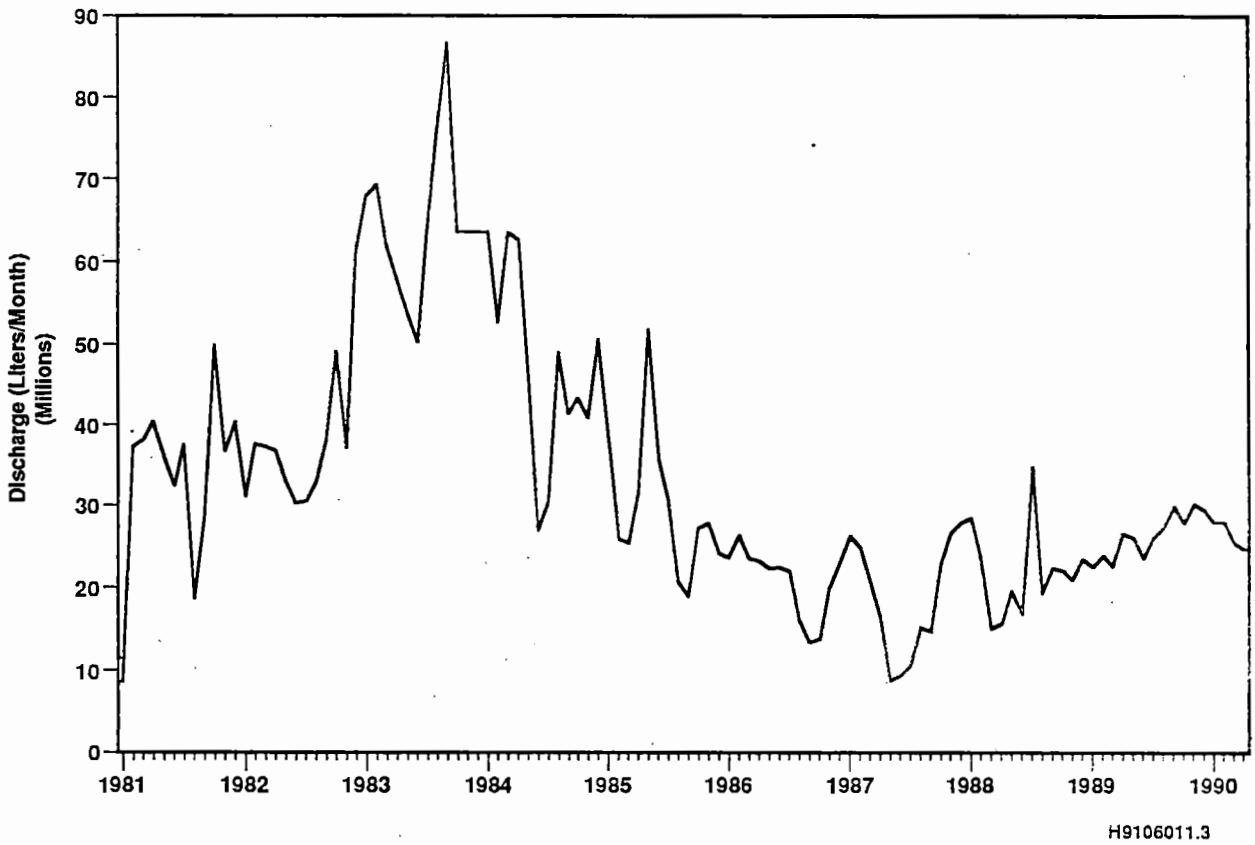
Until the mid-1950s, the ground water mound at T Pond dominated flow directions in the 200 West Area. Between 1944 and 1955, the ground water table under the T Pond area rose 29 m; in 1955, the top of the ground water mound under T Pond was at an elevation of approximately 149 m (Kipp and Mudd 1974). The highest elevations in nearby wells were observed in 1956.

More recently large quantities of waste water have been discharged to the 216-Z-20 Crib (Figure B-2) and are expected to continue (WHC 1990a), although at reduced discharge rates. Because this crib is adjacent to the carbon tetrachloride disposal sites, it potentially affects ground water movement in this area. The historical discharge record for this crib is shown in Figure B-16. The water table in the vicinity of the crib is shown in Figure B-17 for 1991 (the time period of interest). Comparison of the discharge history and the hydrograph of a nearby well (Figure B-18) show the major drop in water level is related more to U Pond closure in 1984 than to declining discharge to the 216-Z-20 Crib. A small increase in water table elevation during 1990 appears to correlate with the secondary maximum effluent discharge peak that occurred during 1988-89.

Figure B-16. Monthly Discharges of Liquid Waste to the 216-Z-20 Crib, 1981-1990.



Two other areas that currently receive waste water in the Z Plant area are the Sanitary Tile Field and the 216-Z-21 Seepage Basin (Figure B-3). It is estimated that 1.5 x 10^7 L/yr are discharged to the Sanitary Tile Field and 9.8 x 10^7 L/yr are discharged to the seepage basin.

B.3.5.2.4 Ground Water Flow. Ground water elevations in December 1990 for the unconfined aquifer in the 200 West Area are shown in Figure B-19. Ground water flow is generally toward the east, with some flow to the north. The mound originating from U Pond appears to be centered northeast of the former U Pond site. Continuing liquid discharges to other sites southeast of Z Plant (e.g., 216-Z-20 Crib) may be responsible in part for this apparent shift.

The horizontal hydraulic gradient is expected to decrease and shift to the east as the ground water mounds dissipate. The horizontal hydraulic gradient in the 200 West Area is relatively high, ranging from 0.0009 to 0.003. Downward vertical hydraulic gradients are expected to be present within the unconfined aquifer in parts of the 200 West Area as a result of the U Pond ground water mound (Graham et al. 1981). Using the gradients above and the hydraulic parameters shown in Table B-2, the ground water velocity can be calculated to range from <0.1 to about 47 m/d.

Figure B-17. Water Table Elevation in the Vicinity of Z Plant, December 1990-February 1991.

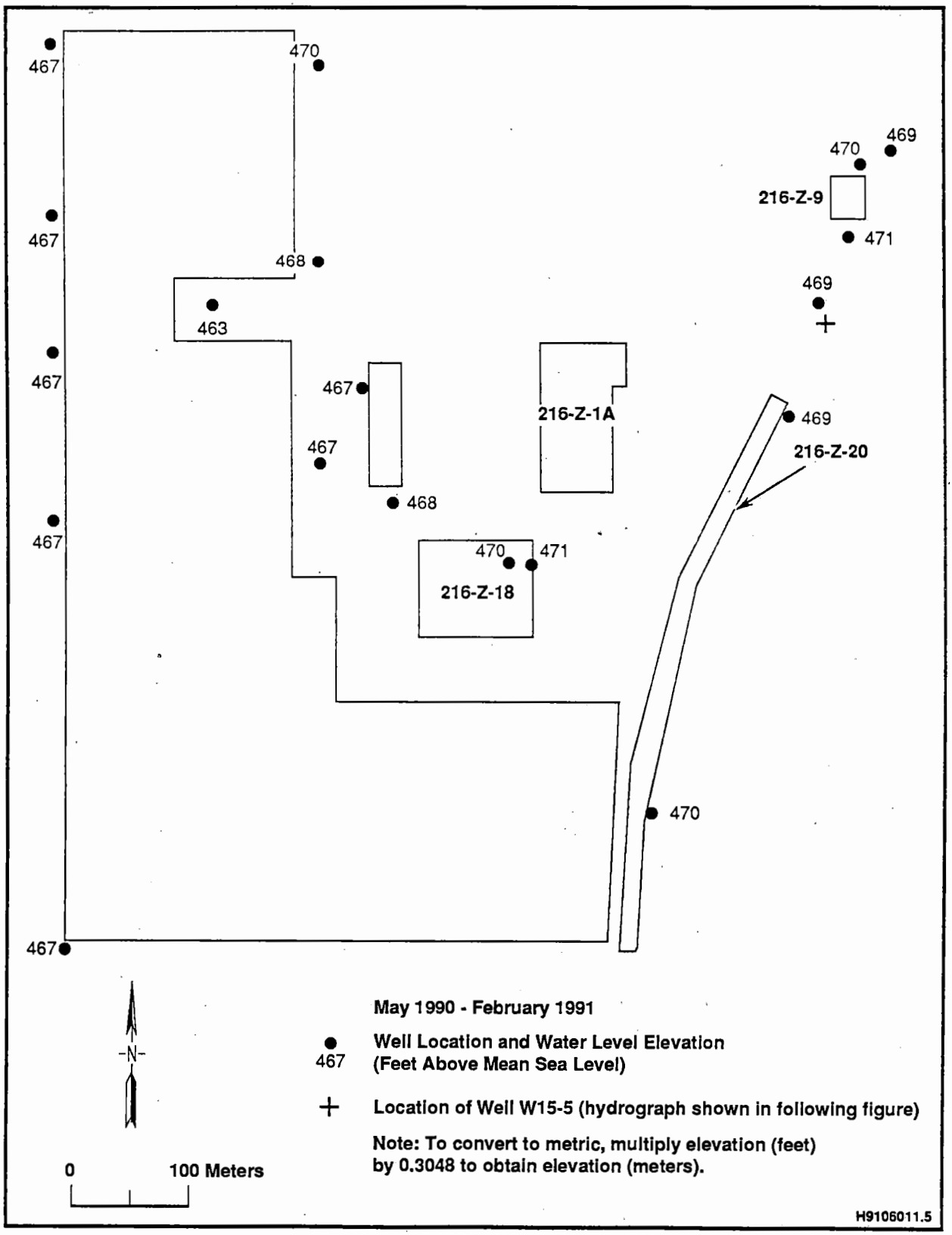
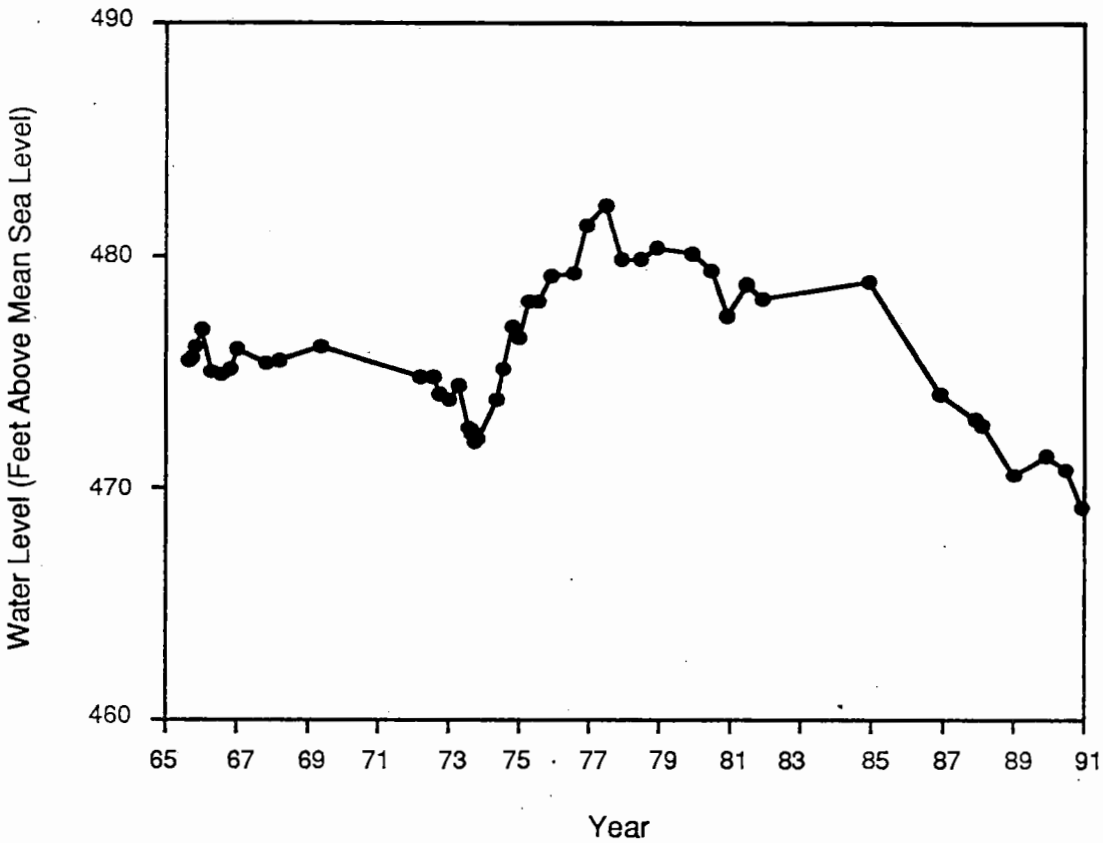


Figure B-18. Water Levels in Well W15-5, 1965-1991.



Note: To convert to metric, multiply elevation (feet) by 0.3048 to obtain elevation (meters).

(Location of Well 299-W15-5 indicated on preceding figure.)

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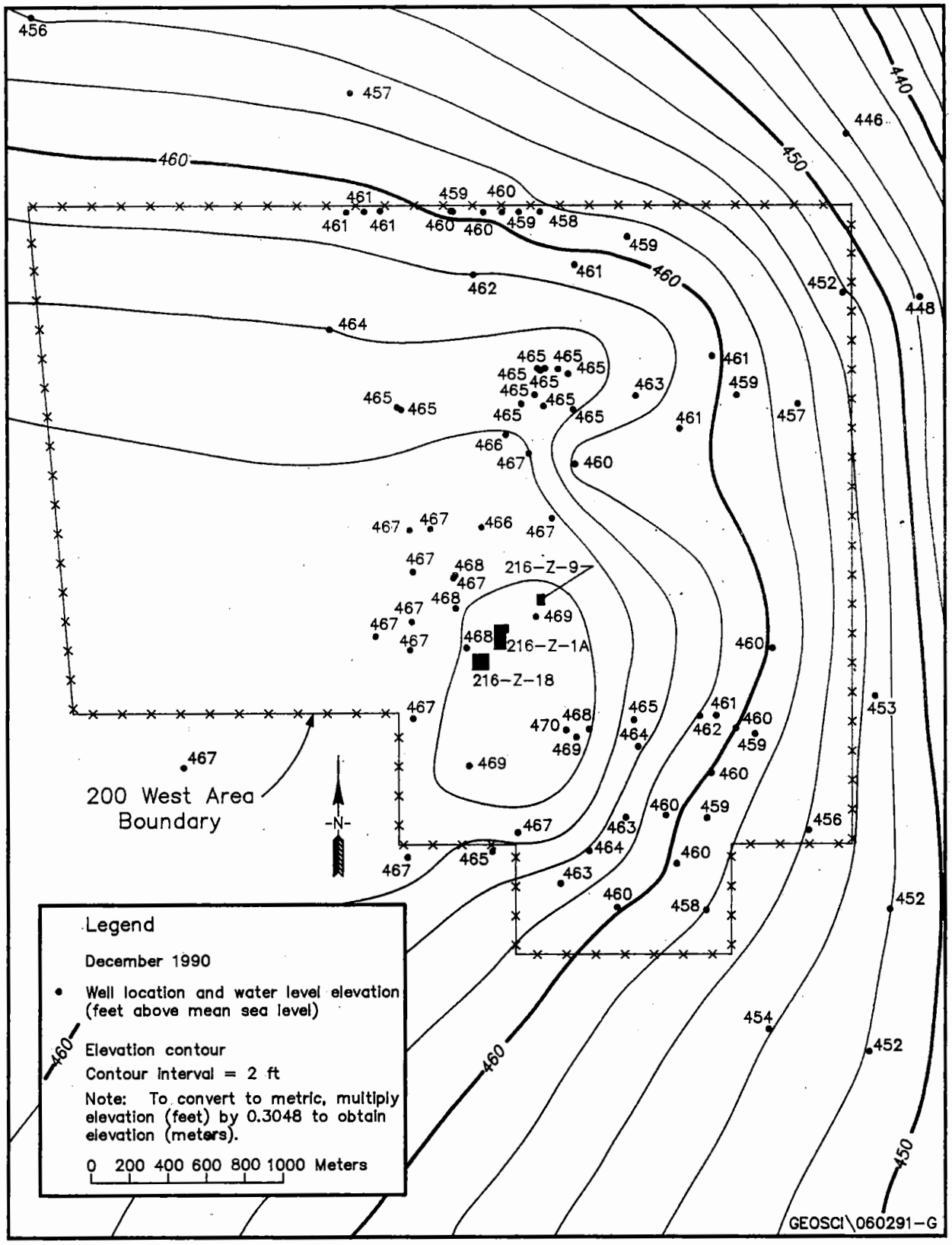
B.3.5.3 Water Use. Ground water beneath the 200 West Area is only used for ground water monitoring. There are no domestic ground water supply wells within the 200 West Area. Drinking, emergency, and process water are drawn from the Columbia River, treated, and imported to the 200 West Area. The nearest well used to supply drinking water is located at the Yakima Barricade (Well 699-49-100C), which is about 5 km west of the 200 West Area. The nearest water supply wells are located offsite about 15 km northwest of the 200 West Area (the Berk well and Ste. Michelle #1 and #2). These wells obtain their water from the basalt and the basalt interbeds, from depths of more than 140 m. The wells are reportedly used for irrigation although they may also be used to supply drinking water.

Figure B-19. Water Table in the 200 West Area, December 1990.



B.3.6 Ecology

Natural vegetation in the 200 West Area consists of a sparse covering of desert shrubs and drought-resistant grasses. Big sagebrush, bitterbrush, rabbitbrush, and spiny hopsage are the dominant shrubs in the area with an understory of grasses. Cheatgrass and Sandberg bluegrass are the predominant grass types in the area, although cheatgrass is an alien species thought to be attributable to past lifestock grazing. Cottontail, jackrabbit, Great Basin pocket mouse, horned lark, and the western meadowlark are species associated with the sagebrush/grass community. Raptors, mule deer, and coyotes also forage in this habitat type. Grasshoppers are the most conspicuous insect community.

Only a few species of small birds nest in the steppe vegetation. Semiannual peaks in avian variety and abundance occur during migration seasons. The bald eagle, a federally listed threatened species, is a regular winter resident at the Hanford Site, and the peregrine falcon, federally listed as endangered, is an occasional winter visitor to the Hanford Site. Bald eagles roost and forage along the Columbia River, primarily near the 100-H Area, during the winter (October to March). American white pelicans and ferruginous hawks, state-listed endangered and threatened vertebrate species, can also be foundon the Hanford Site; sandhill crane, a state-endangered species, migrate over the Hanford Site but have been observed to land only rarely. The state-endangered plant species persistent sepal yellowcress may occur along the shoreline of the Columbia River. The state-threatened plants, Columbia milk-vetch and Hoover's desert parsley, exist in Benton County. No species of plant or animal registered as rare, threatened, or endangered are known to depend on the habitats in the immediate vicinity of the proposed ERA.

B.3.7 Cultural Resources

Cultural resources at the Hanford Site consist of Native American archaeological sites. The sites are the result of approximately 10,000 yr of river-oriented activity from various Plateau Indian tribes. The remains are villages which consist of houses, fishing camps, game traps, cemeteries, and sites for religious observations. Approximately five sites are located north of the 200 West Area near Gable Mountain and approximately 15 km from the site of the proposed action. An archaeological survey has been conducted on a 50% random sample of the undeveloped portions of the 200 West Area (Chatters 1990). The survey did not indicate that any archaeological sites or Native American Indian interests exist in the area. A cultural clearance has been granted for the proposed activities by the Hanford Cultural Resources Laboratory of Pacific Northwest Laboratories.

B.4 EXTENT OF CONTAMINATION

Data on the nature and extent of contamination in both the unsaturated and saturated zones were compiled from existing data and from investigations conducted during Phase I Site Evaluation. The phased approach to site characterization precluded drilling new wells during Phase I and, thus, limited borehole activities to the use of existing wells. A total of 65 ground water and unsaturated zone wells, ranging in depth from 5 to 125 m, have been drilled within approximately 30 m of the three carbon tetrachloride disposal sites; the majority of these are at the 216-Z-1A Tile Field (Plate 3). Only 46 of these wells are still accessible. Construction details for these boreholes are described in Appendix C and summarized in Table C-1.

B.4.1 Contamination in the Unsaturated Zone

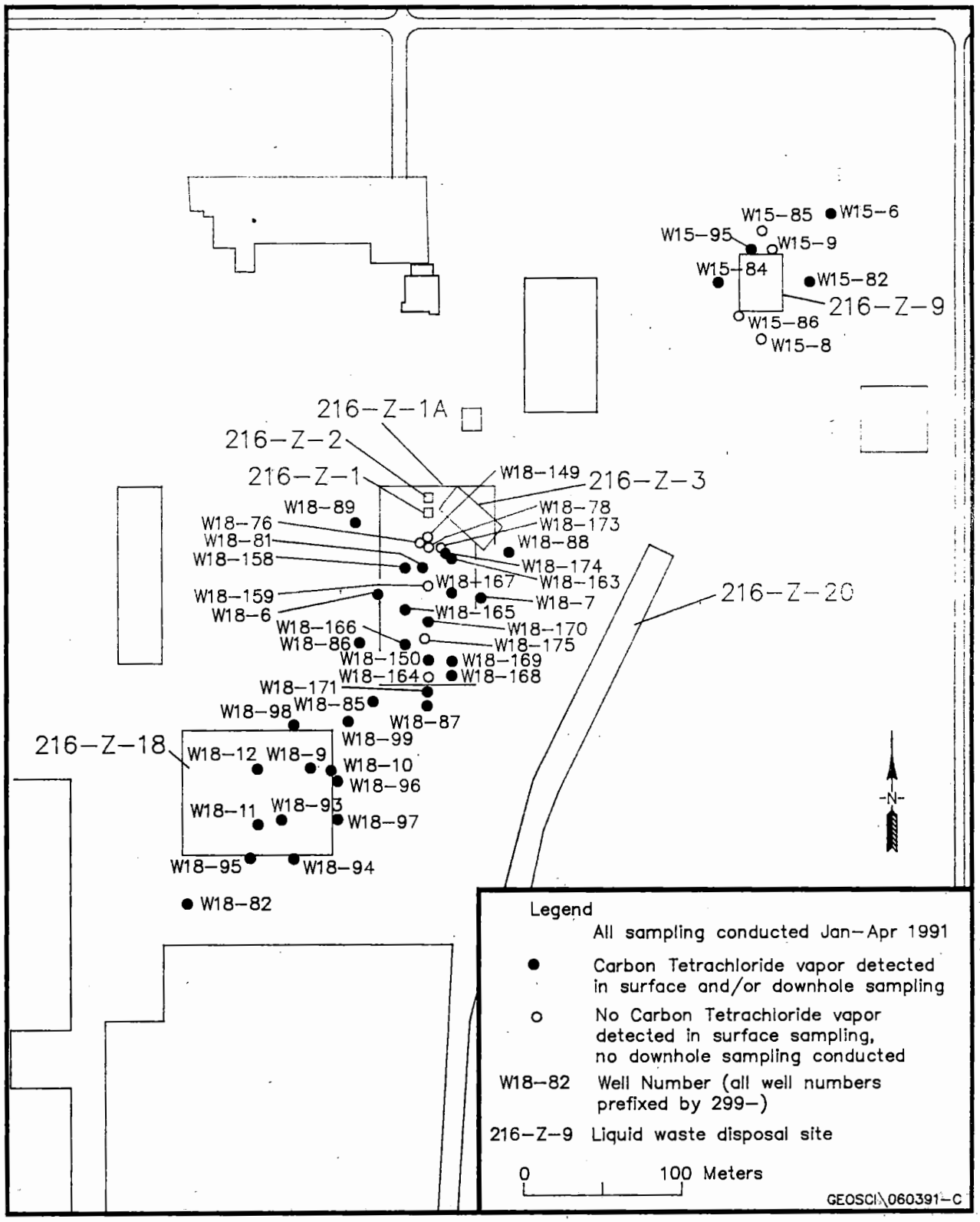
This section discusses organic and radiological contamination in the unsaturated zone in the vicinity of the three primary carbon tetrachloride disposal sites and in the 200 West Area. Details of the test methods for sampling and analysis conducted during Phase I activities are included in Appendix C (field investigation reports, Part 2), Appendix D (soil gas measurements), and Appendix F (vapor extraction system test). Quality assurance documentation is also included in the appendices.

B.4.1.1 Organic Contamination. The data on organic contaminant distribution consist of soil gas analyses, historical well log data, measurements of carbon tetrachloride vapors in boreholes, soil analyses, and data collected during the vapor extraction system test. The organic contamination data are divided into two sections, the near field (which includes the three primary carbon tetrachloride disposal sites) and the far field (which includes the 200 West Area).

B.4.1.1.1 Near Field. Carbon tetrachloride vapors have been detected in the unsaturated zone in the vicinity of the three primary carbon tetrachloride disposal sites. During the Westinghouse Hanford soil gas survey, values of 1.5 to 15 p/m vol of chlorinated hydrocarbons were detected 1.5 m below the surface using field screening equipment (Appendix D2). Draeger (tradename of Draegerwerk Aktien Gesellschaft, Federal Republic, Germany) tubes were used to confirm that the chlorinated hydrocarbons included carbon tetrachloride.

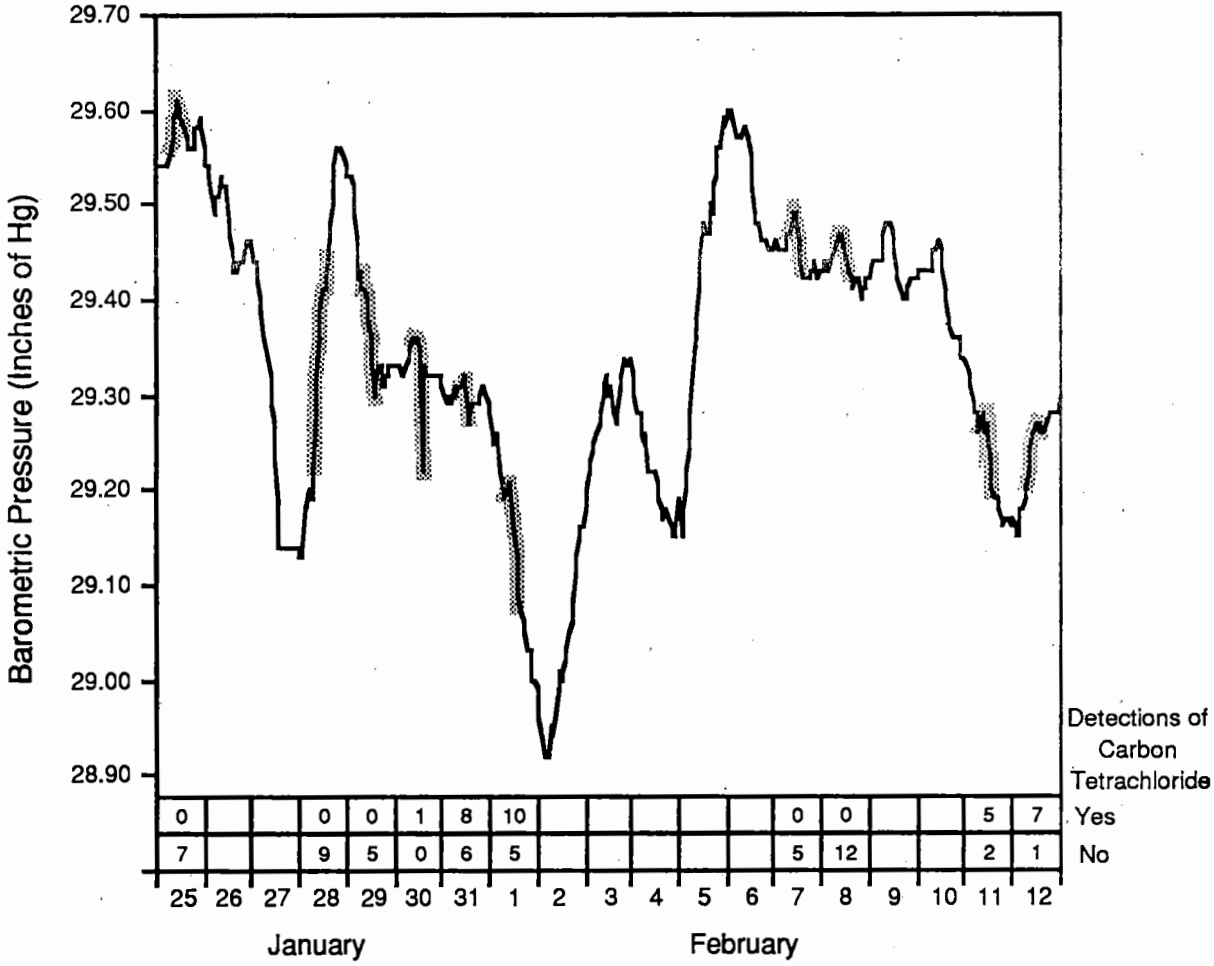
Chlorinated hydrocarbon vapors were detected at the wellhead and/or downhole at virtually every well associated with the three carbon tetrachloride disposal sites (Figure B-20). Every sample tested with a Draeger tube confirmed the presence of carbon tetrachloride (Appendices C2, D1). On that basis, carbon tetrachloride is assumed to be present in all the wells with positive vapor detections.

Figure B-20. Wells in Which Carbon Tetrachloride Vapor was Detected in the Z Plant Area, 1991.



Several of the wells that did not have detectable carbon tetrachloride (W15-9, W15-8, W15-86, W15-85, and W18-164) at the wellhead were only uncapped on relatively high pressure days. There appears to be a correlation between barometric pressure and the detection of vapors at the surface. Figure B-21 shows the relationship between barometric pressure and days during which vapors were detected. An example of the possible effects of barometric pressure on the vapor concentrations can be seen by comparing the measurements from the same well on different days (Appendix C2, Appendix D1). In well W18-6, no organic vapor was detected on January 28 (a high pressure day), but 170 p/m vol were detected at the wellhead on February 12 (a low pressure day). This pattern was observed in 18 wells.

Figure B-21. Comparison of Barometric Pressure to Wellhead Detections of Carbon Tetrachloride Vapor, January-February 1991.



Note: To convert inches of Hg to mm of Hg, multiply inches by 25.4 to obtain mm.

Shaded intervals represent 8 a.m. to 3 p.m. (Period of day during which sampling was conducted)

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Other wells that did not have detectable carbon tetrachloride at the surface include W18-76 and W18-78, which are both <6 m deep, and wells W18-149, W18-159, W18-164, W18-173, and W18-175, which have cement plugs and may have no openings to the soil (based on the drilling/completion logs and the present depth to the bottom of the wells).

Based on the surface sampling, it appears that carbon tetrachloride vapor is present beneath the entire 216-Z-18 Crib, the 216-Z-1A Tile Field, and the 216-Z-9 Trench area. Carbon tetrachloride vapors do not emanate from the wells when the wells are capped, as they are when not in use.

Downhole sampling was conducted in each of the disposal areas. All of the downhole values should be considered as minima because the sampling device may have been leaking (Appendix D1). In the 216-Z-9 Trench area, wells W15-82, W15-84, W15-95, and W18-87 were sampled and showed downhole carbon tetrachloride levels ranging from 2.3 to 106 p/m vol. The highest downhole concentrations were observed in well W15-84, and a Draeger tube was used to confirm that the chlorinated hydrocarbons included carbon tetrachloride.

In the 216-Z-18 Crib area, the downhole concentrations of carbon tetrachloride ranged from <1 to 140 p/m vol, with well W18-99 having the highest concentration. Wells W18-98, W18-94, W18-95, and W18-82 all had carbon tetrachloride concentrations above 10 p/m vol. Well W18-96 had a concentration of 51 p/m vol at the surface.

In the 216-Z-1A Tile Field, downhole concentrations of carbon tetrachloride ranged from 1.7 to 16.2 p/m vol, with the highest concentration in well W18-150. Surface concentrations in well W18-6 were 170 p/m vol; in well W18-85, they were 105 p/m vol; and in well W18-86, they were 53 p/m vol.

Based on the downhole sampling, carbon tetrachloride is present in the vicinity of the 216-Z-9 Trench, the 216-Z-18 Crib, and the 216-Z-1A Tile Field at depths ranging from 24 to 63 m below ground surface.

Additional downhole sampling was conducted during the soil vapor characterization tests. Samples were analyzed in a laboratory using a gas chromatograph/mass spectrometer. The higher observed concentration of carbon tetrachloride was 100 p/m vol at a depth of 26 m. The data indicate that concentrations of up to 89 p/m vol of carbon tetrachloride have migrated to a depth of at least 40 m below the tile field (Plate 4). The carbon tetrachloride has also migrated laterally at least 24 m outside of the tile field as seen in the 19 p/m vol concentration observed in well W18-87.

An 80-h venting test was conducted at well W18-171 in the 35- to 42-m depth interval. During the test, the initial carbon tetrachloride concentration was 200 p/m vol, which gradually increased to 600 to 700 p/m vol after 30 h of venting. A peak of 915 p/m vol was observed at 67 h. The venting flow rate was 8.5 to 8.8 m^3/min, with a well vacuum of 89 to 102 cm water gage. During this test, 136 kg of carbon tetrachloride were removed from the unsaturated zone.

A 24-h vent test was performed at well W18-167 in the depth interval of 35 to 36 m. At this well, carbon tetrachloride concentrations remained fairly constant between 180 and 200 p/m vol.

Vapor samples collected during the vapor extraction system tests at the 216-Z-1A Tile Field were also analyzed for other organic compounds (Appendix F3). Chloroform was detected, but it was below the quantitation limit, which ranged from 5 to 10 p/m vol. The analyses also indicated the presence of 2-butanone up to 148 p/m vol, but this may be a reflection of the analytical method, in which alcohol is used. In addition, 2-butanone was detected in a sample blank.

Vapor samples from boreholes in the vicinity of the 216-Z-9 Trench and the 216-Z-18 Crib were only analyzed for carbon tetrachloride.

Cadmium concentrations in the soil at the 216-Z-9 Trench were measured in 1973. Of the samples collected then from soil which was not subsequently excavated, concentrations up to 87 µg/g were observed at a depth of 46 to 61 cm (Smith 1973).

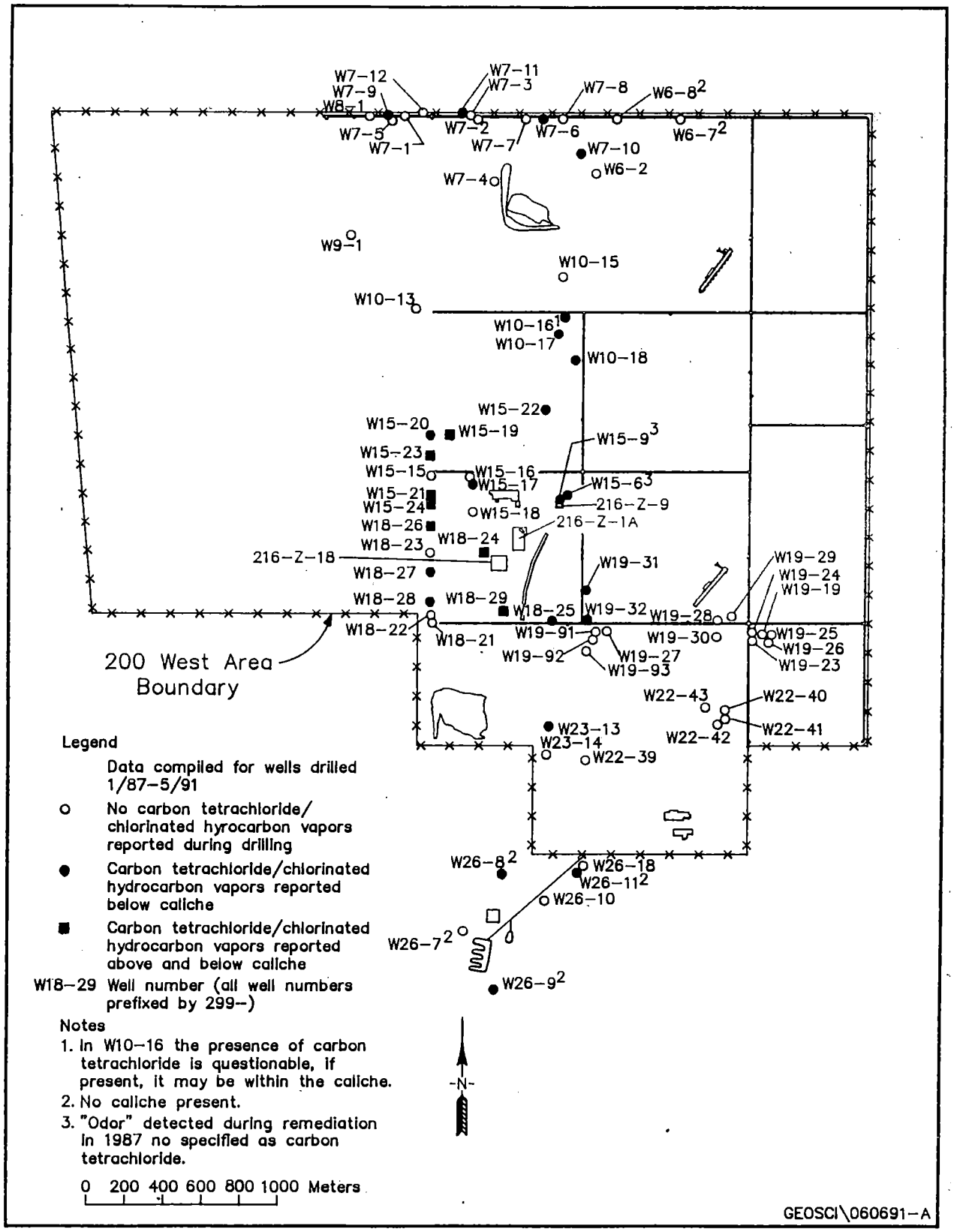
B.4.1.1.2 Far Field. Carbon tetrachloride or chlorinated hydrocarbons was detected at the well head using field screening instruments during drilling in over half of the wells drilled in the 200 West Area since 1987 (Figure B-22). The wells are differentiated with respect to whether the organic was detected from intervals above and/or below the caliche layer, which occurs at depths of approximately 40 m in the 200 West Area and is up to 15 m thick. Most of the reported detections were below the caliche layer, although wells west of the 216-Z-18 Crib had detections both above and below the caliche.

Soil samples were collected from 16 boreholes in the 200 West Area during 1989-1990 and analyzed for volatile organic compounds (Airhart 1990, Barton 1990, Goodwin 1990, Goodwin and Bjornstad 1990). Eleven of the wells sampled had carbon tetrachloride levels above the detection limits (Table B-3). Distribution of carbon tetrachloride concentrations does not appear to have a pattern. Carbon tetrachloride is found above and below the caliche layer, although the highest concentrations are found below (except in well W7-7). In six wells, concentrations are highest just above the water table. Carbon tetrachloride concentrations measured in soil samples from four wells west of Z Plant are indicated in relation to the geology in Figure B-23.

The concentrations of carbon tetrachloride vapor observed at the well-head with field screening instruments during drilling are also indicated on Figure B-23. The pattern of relative highs and lows is similar between the field screening and the laboratory analyses, but the field screening values are usually higher than the laboratory values. This may be a reflection of the loss of volatile organics during sampling.

Throughout the 200 West Area the detections of carbon tetrachloride in soil samples match fairly well with the observed vapor detections during drilling. However, there are wells that had detections during drilling but not in soil samples (wells W7-10, W26-9, and W26-11). This may be a reflection of the sampling frequency or the detection of other chlorinated hydrocarbons during drilling. There are also wells that did not have detections during drilling but had carbon tetrachloride detections in the soil samples (wells W7-7 and W7-8). This may be a reflection of the monitoring frequency, the effect of barometric pressure, or the detection limits of the field instruments.

Figure B-22. Wells in Which Carbon Tetrachloride/Chlorinated Hydrocarbon Vapor was Detected During Drilling in the 200 West Area, 1987-1991.



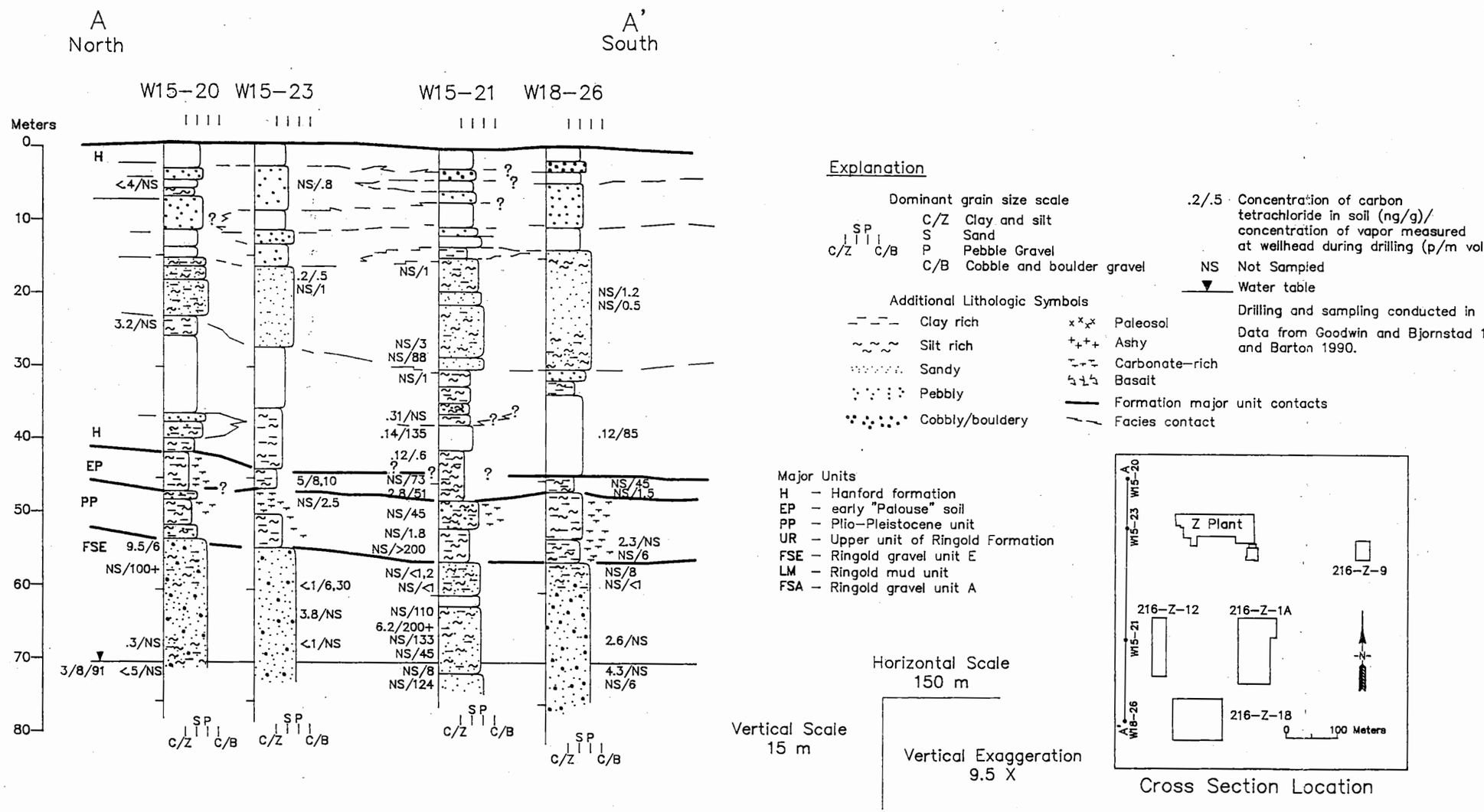


Figure B-23. Carbon Tetrachloride Concentrations in Soil Samples from Four Wells in the 200 West Area, 1990.

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Table B-3. Carbon Tetrachloride Concentrations in Soil Samples.

Depth, ft	Concentration, ng/g	Depth, ft	Concentration, ng/g	Depth, ft	Concentration, ng/g
Well W7-7:		Well W15-19		Well W22-41:	
5	6.5	40	0.55	100	<0.2
100	<0.01	80	1.4	160	<0.2
120	<0.02	120	0.56	220	ND
160	0.53	220	5.8	240	ND
180	<0.13	240	8.1		
220	0.75			Well W22-42:	
		Well W15-20:		40	<0.7
Well W7-8:		20	<0.4	100	<0.5
20.5	<0.05	80	3.2	160	<0.2
30.5	<0.08	180	9.5	220	ND
41	<0.05	220	0.3	240	ND
48	<0.07	240	<0.5		
50	0.09			Well 22-43:	
55	0.09	Well W15-21:		20	<0.5
62	0.07	120	0.31	140	<0.2
78	<0.07	126	0.14	160	ND
90	<0.06	140	0.12	220	0.13 ng/mL
110	<0.06	159	2.8	240	0.28 ng/mL
130	<0.06	220	6.2		
150	<0.05	230	<0.1	Well W26-8:	
170	<0.07			120	<0.4
190	<0.11	Well W15-23:		165	<0.3
210	0.30	60	0.2	175	<0.1
230	0.36	155	0.5	190	<0.1
		200	<0.1	190	2.1
Well W7-9:		220	3.8	200	<0.2
40	<0.2	240	<0.1	215	<0.1
102	<0.2				
184	0.2	Well W18-26:		Well W26-9:	
220	12	130	0.12	40	<0.4
240	<0.08	180	2.3	130	<0.3
		220	2.6	170	<0.2
Well W7-10:		240	4.3	190	<0.2
80	<0.1			200	<0.1
160	<0.2	Well W22-40:			
200	<0.3	43	<1.0	Well W26-11:	
220	<0.3	64	<0.8	78	<0.1
240	<0.3	87	<1.0	100	<0.2
		220	0.01 ng/mL	120	<0.3
		240	0.04 ng/mL	130	<0.1
				130	<0.1
				149.41	<0.1
				167.92	<0.1

Sources: Wells W7-7, W7-8, W15-19, W15-20, W15-21, and W18-26 from Goodwin and Bjornstad 1990.
Wells W7-9, W7-10, and W15-23 from Barton 1990.
Wells W22-40, W22-41, W22-42, and W22-43 from Goodwin 1990.
Wells W26-8, W26-9, and W26-11 from Airhart 1990.

NOTE: To convert to metric, multiply feet by 0.3048 to obtain meters.

In general, carbon tetrachloride is present in the soil to the west and north of the three disposal sites. The highest concentrations are found below the caliche layer (except in well W7-7), although carbon tetrachloride is also found above the caliche layer.

In addition to carbon tetrachloride, each of the following substances has been identified in a soil sample from at least one of these 16 boreholes:

- acetone
- benzene
- chlorobenzene
- chloroform
- 1,2-dichloroethane
- 1,1-dichloroethylene
- cis-1,2-dichloroethylene
- trans-1,2-dichloroethylene
- ethyl benzene
- fluoromethane
- methylene chloride
- methyl isobutyl ketone
- tetrachloroethylene
- toluene
- 1,1,1-trichloroethane
- trichloroethylene
- m-xylene
- p-xylene
- o-xylene

B.4.1.2 Radiological Contamination. The presence and extent of plutonium and americium have been investigated in the vicinity of the 216-Z-1A Tile Field (Price et al. 1979). As part of that study, 16 wells were installed (W18-149, W18-150, W18-158, W18-159, W18-163 through W18-169, W18-171 through W18-175) to determine the lateral and vertical extent of contamination (Figures B-24 and B-25). The study determined that:

- The distribution patterns of plutonium and americium in the sediments are similar. The highest measured concentration of plutonium (about 4×10^4 nCi/g) and americium (about 2.5×10^3 nCi/g) occurs in sediments located immediately beneath the central distributor pipe.

- The concentration of plutonium and americium in sediments generally decreases with depth below the bottom of the tile field. An increase in concentration with depth is generally associated with an increase in the silt content of the sediments or with boundaries between sedimentary units.

- The bulk of the actinide contamination appears to be contained within the first 15 m of sediments beneath the bottom of the tile field. The maximum vertical penetration of plutonium and americium contamination (defined by the 10^{-2} nCi/g isopleth) is approximately 30 m below the bottom of the facility, or about 30 m above the water table.

Figure B-24. Map of 1977 Plutonium Concentrations in Unsaturated Zone 1.5 m Below Bottom of the 216-Z-1A Tile Field.

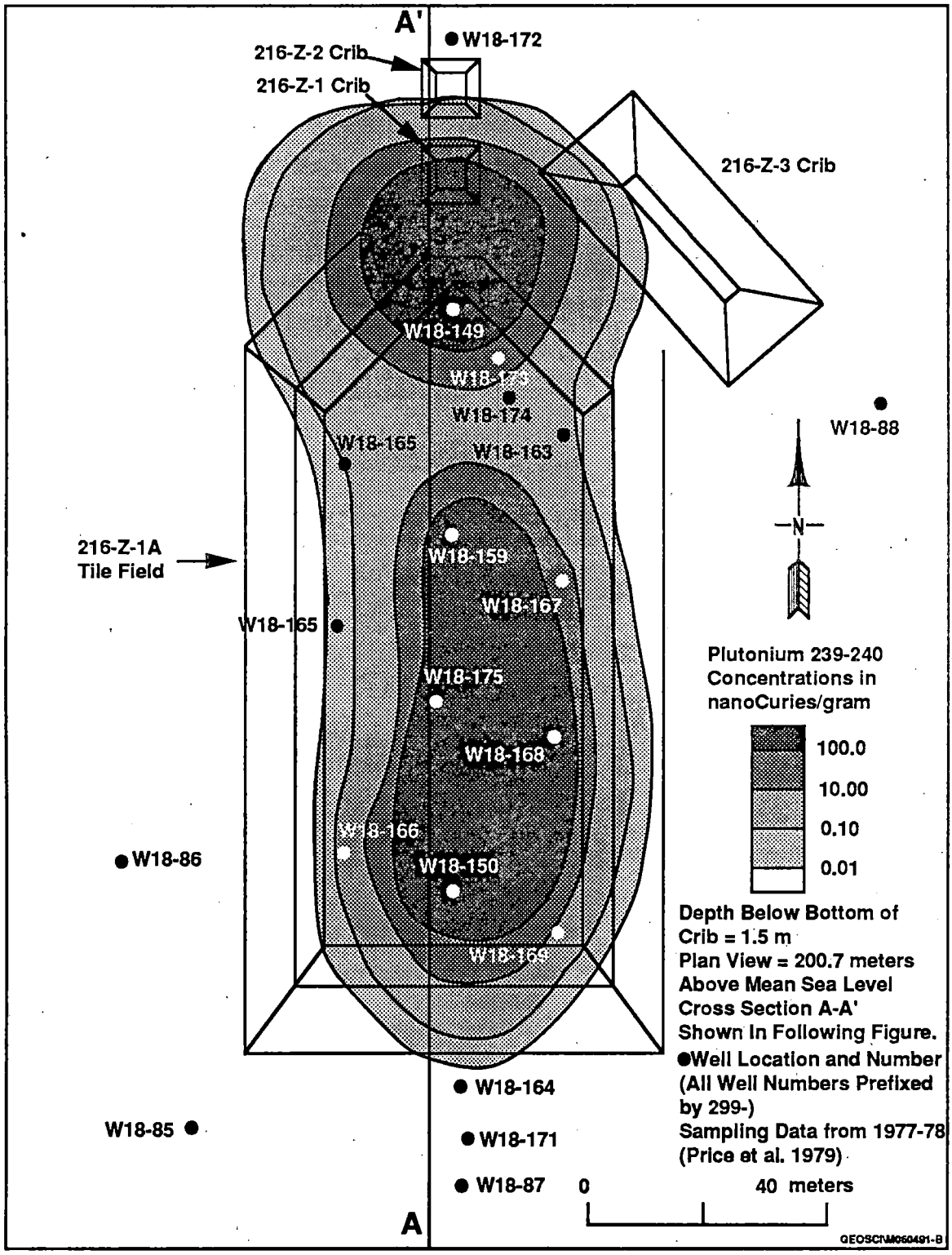
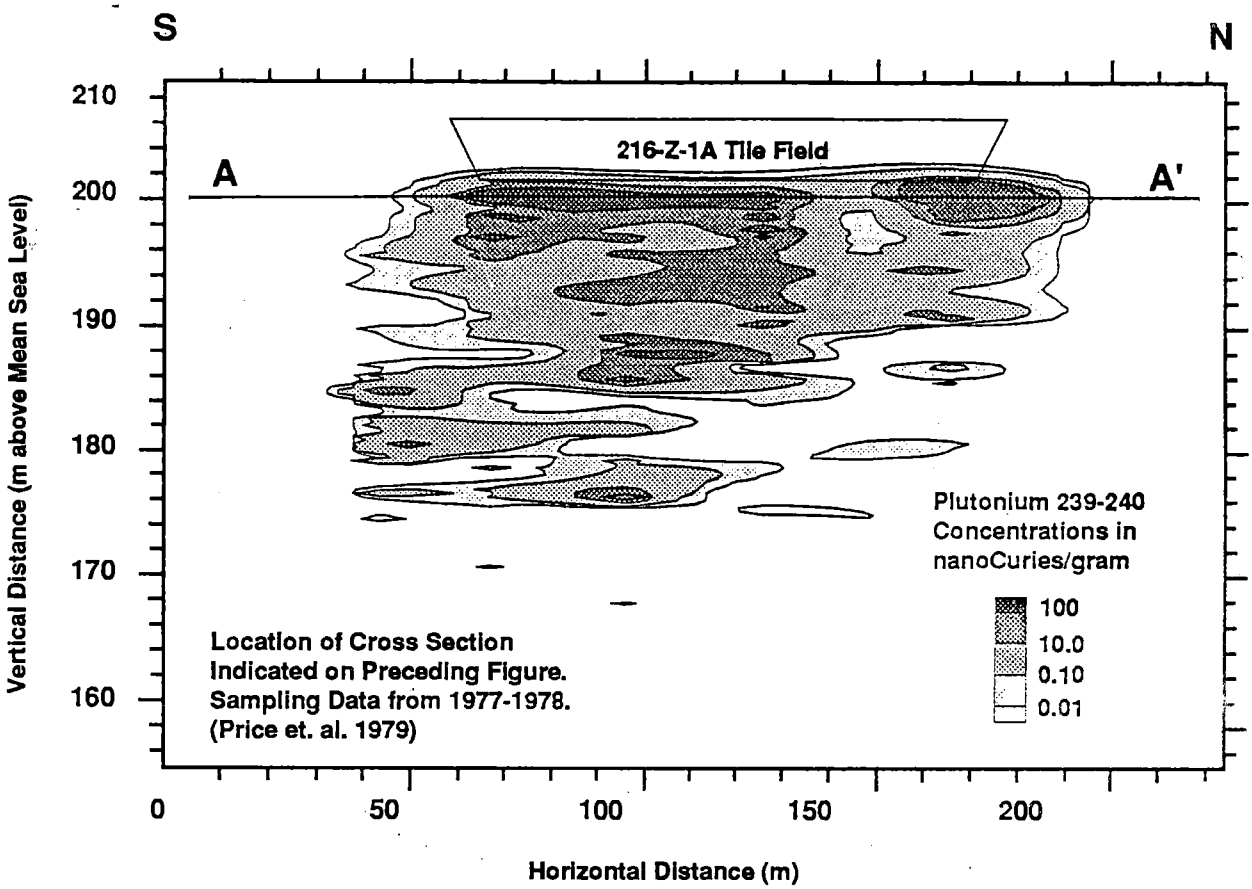


Figure B-25. Cross Section of 1977 Plutonium Concentrations in Unsaturated Zone Under the 216-Z-1A Tile Field.



- The distribution of activity in unsaturated zone wells around the perimeter of the tile field is discontinuous with depth. The waste appears to have been released to the ground within a few meters of the central distributor pipe and then spread laterally along boundaries between sedimentary units. The lateral spread was limited within a 9-m wide zone around the perimeter of the tile field.

Gross gamma and spectral gamma logging were conducted in well W18-171, 15 m south of the tile field, on February 21, 1991 and February 6, 7, and 13, 1991, respectively (Appendix C5). The logging was performed for safety considerations to identify radioactively contaminated intervals prior to perforating the well casing for use during the vapor extraction system test. The gross-gamma logging indicated the possible presence of radiological contamination at a depth of 26 m. The spectral-gamma logging determined that man-made radionuclides were present only in the interval between a 25- and 26-m depth. These radionuclides were identified as americium and plutonium. This contamination appears to be at or above a thin zone of silty sand.

During the long term vent tests of the vapor extraction system test, radon gas was detected in the granular activated carbon (GAC) canister that was used for both extraction wells, W18-164 and W18-171 (Appendix F3). It is uncertain what proportion of the radon came from each well because the canister was used during the testing of both wells (Appendix F).

Soil samples were collected from the 216-Z-9 Trench in 1973 to determine the concentrations and distribution of plutonium. Subsequently, the upper 30 cm of soil was removed. Samples collected in 1973 from a depth of 2.4 m contained plutonium-239 concentrations of 0.30 to 0.1 g Pu/L of soil and americium-241 concentrations of 200 to 500 µCi/L of soil (Smith 1973).

In addition to the above studies, information can be gained about other contamination by reviewing well logs in the area. The following wells had detectable amounts (on field screening instruments) of radioactivity during drilling: W18-78 through W18-81, W18-164 through W18-171, W18-173, W18-174, and W18-175. All of these wells are located within or very near the 216-Z-1A Tile Field. Radiation was not detected during drilling in the vicinity of the 216-Z-9 Trench and 216-Z-18 Crib. This may be because these wells are all outside of the cribs, whereas wells at 216-Z-1A Tile Field were drilled in the tile field. Due to the disposal history at 216-Z-9 Trench and 216-Z-18 Crib, radioactive compounds are expected to be in the soil in these areas.

B.4.2 Ground Water Contamination

This section summarizes results of ground water sampling and analysis conducted during the first quarter of 1991 to further characterize the areal and vertical extent of volatile organic contaminants, primarily carbon tetrachloride. Sampling and analytical procedures, quality assurance documentation, well characteristics, well locations, and analytical results are included in Appendix E.

B.4.2.1 Areal Distribution. The areal extent of existing ground water contamination is presented at two levels of detail: (1) near field, which includes the immediate area around the disposal sites, and (2) far field, which includes the 200 West Area.

B.4.2.1.1 Near Field. The distribution of carbon tetrachloride in the vicinity of the disposal sites is shown in Figure B-26. The ground water data used for this interpretive plot are primarily from the recent (1991) sampling results, but include previously published results (Appendix E). The highest observed concentration of carbon tetrachloride was 7,430 µg/L in well W15-16 on January 31, 1991.

In addition to carbon tetrachloride, chloroform and traces of tetrachloroethylene and trichloroethylene were detected near and downgradient from the 216-Z-9 Trench. The concentration of chloroform detected ranged from 5.5 to 2,400 µg/L. The concentrations of tetrachloroethylene and trichloroethylene were as high as 1.1 and 15 µg/L, respectively. The occurrence of these constituents is consistent with records of input to the 216-Z-9 Trench (Section B.2). Chloroform also may be present as a result of degradation of carbon tetrachloride. Methyl ethyl ketone (MEK) was detected in trace amounts at the 216-Z-20 Crib (well W18-20) and at over 1,000 µg/L from a single bailed

sample at the 216-Z-18 Crib (well W18-9). MEK is a common solvent used in past and present processes; no specific source can be identified at the present time.

Other major co-contaminants, TBP, DBP, and DBBP, associated with the carbon tetrachloride solvent waste streams were not analyzed in ground water samples collected during this study. However, existing data for TBP and DBP acquired for other programs between 1987 and 1990 are available from the Hanford Ground Water Data Base (HGWDB). Results for samples from several wells in the vicinity of the Z cribs, as well as from wells within the core of the 200 West Area carbon tetrachloride plume, were all below detection limits for TBP and DBP. DBBP has not been previously analyzed. The apparent absence of TBP and DBP in 200 West Area ground water is attributed to biodegradation of these organic constituents and/or because they have a moderate affinity for sediments (Ames and Serne, 1991).

B.4.2.1.2 Far Field. Data acquired for this study were combined with previous carbon tetrachloride data (1988 to present) to update the plume map for the 200 West Area and environs (Figure B-27). The data were combined because of the limited amount of data available from each sampling period. Average values were used for wells with multiple sampling results (Appendix E).

Figure B-27 illustrates the location (relative to source area) and extent of a "core" of high concentrations. The plot also shows a widely distributed, low concentration halo surrounding the core. The core of the plume appears to consist of two lobes: a higher concentration lobe close to the Z crib sources; and a lower concentration lobe to the north.

B.4.2.2 Estimated Mass of Carbon Tetrachloride in the Ground Water Plume. An estimated mass of carbon tetrachloride contained within the plume boundary defined by the 10-µg/L contour (Figure B-27) was computed as follows:

$$\text{Mass (kg)} = \sum_i A \cdot Z \cdot \theta \cdot C \cdot K$$

where:

A = area between selected contour lines (m^2)
Z = depth (m)
θ = porosity (unitless)
C = median concentration (µg/L) between contours
K = conversion factor [10^{-6} (kg/m^3)/(µg/L)].

The median carbon tetrachloride concentration for each contour interval (Table B-4) was assumed to be constant over a depth of 10 m. Two porosity values (10% and 30%), thought to be representative of the portion of the Ringold Formation in which the upper portion of the unconfined aquifer occurs in the 200 West Area, were used for the computed results shown in Table B-4.

Figure B-26. Carbon Tetrachloride Concentration Contours in the Z Plant Area Ground Water, 1990-1991.

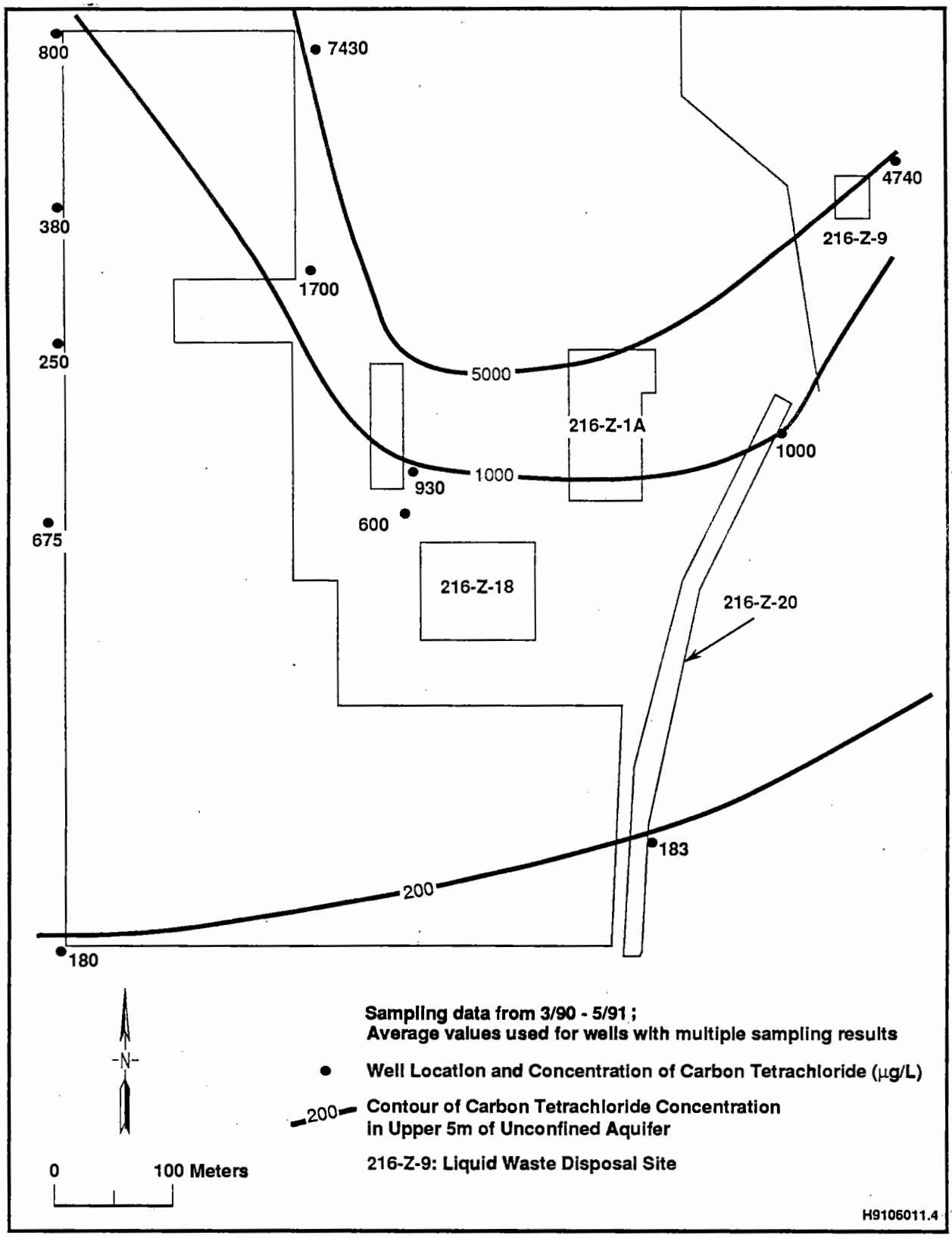


Figure B-27. Carbon Tetrachloride Concentration Contours in the 200 West Area Ground Water, 1988-1991.

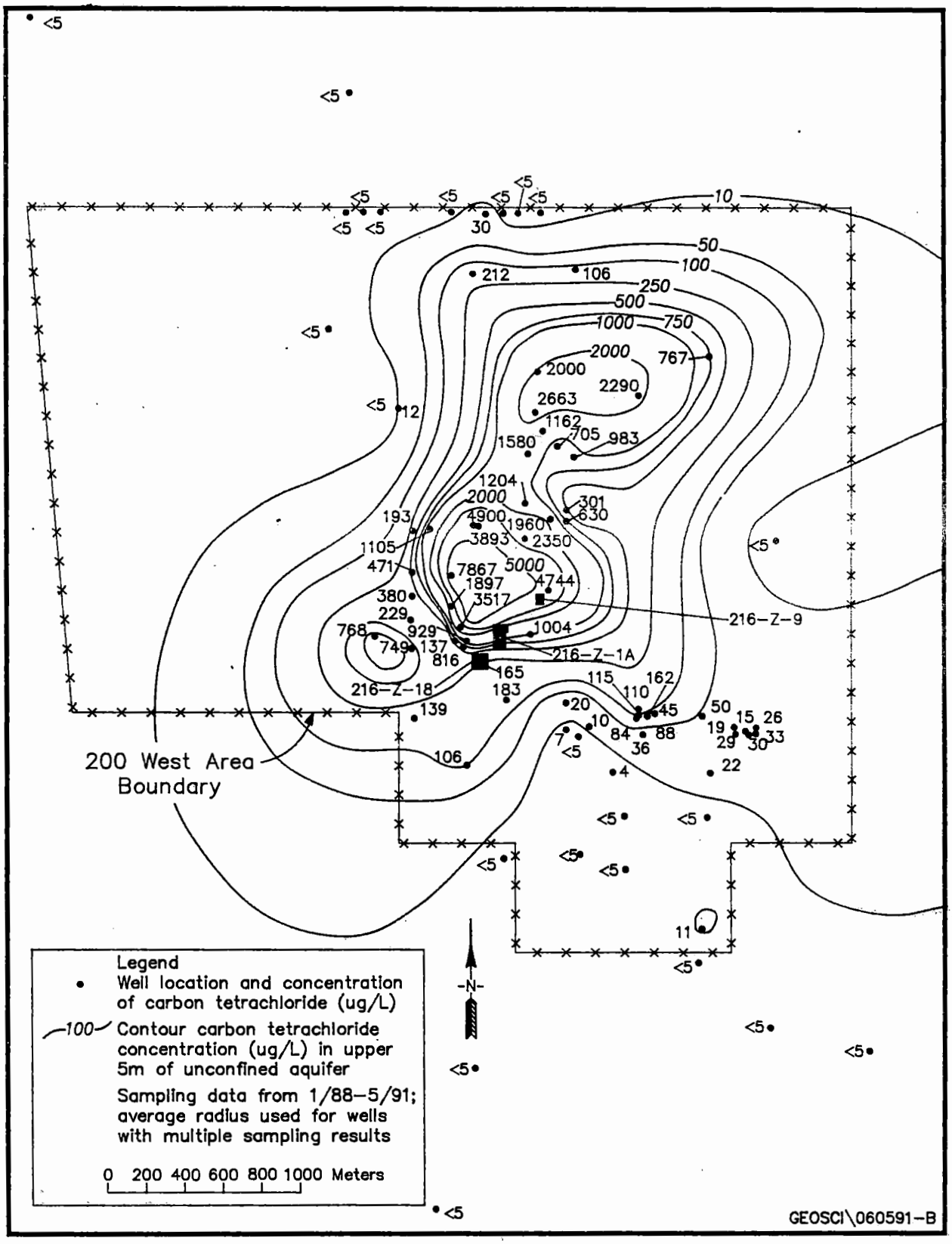


Table B-4. Mass Estimate of Carbon Tetrachloride Contained in Ground Water Plume.

Contour Interval, i, (μg/L)	Area (m^2)	Median Concentration (μg/L)	Calculated Mass (kg)		Percent of Total
			$\theta = 0.1$	$\theta = 0.3$	
10-100	8.34×10^6	55	460	1,380	8.75
100-1,000	3.09×10^6	550	1,700	5,100	32.39
1,000-2,000	0.64×10^6	1,500	970	2,900	18.44
2,000-3,000	0.30×10^6	2,500	760	2,280	14.49
>3,000	0.27×10^6	5,000	1,360	4,080	25.93
Total	12.65×10^6		5,250	15,740	100.00

The estimate of total dissolved carbon tetrachloride in the 200 West Area plume (Table B-4) accounts for only about 2% of the total indicated from disposal records (Section B.2.3). The greatest uncertainty is the actual depth distribution within the aquifer over the area of the plume. Depth profile data would be needed to refine this estimate. However, even with this uncertainty, the calculation illustrates that a very small fraction of the inventory disposed to the ground resulted in significant and widespread ground water contamination.

B.4.2.3 Vertical Distribution. Depth distribution of carbon tetrachloride and other contaminants is poorly defined within the study area. An attempt was made to supplement this information by sampling at various depths in a well (W15-6) with a long perforated interval located near and downgradient from the 216-Z-9 Trench, as described in Appendix E.

Results of preliminary deep interval sampling and other depth-related data are superimposed on the stratigraphy along a transect running from just north of the 216-Z-9 Trench to the southern end of the 216-Z-20 Crib (Figure B-28). These data suggest there is deeply distributed carbon tetrachloride and chloroform, at least near the 216-Z-9 Trench. There is also a suggestion of carbon tetrachloride at somewhat greater depths below the water table in well W18-17 at the 216-Z-20 Crib. However, the mechanism by which the contaminants reached these depths is uncertain (Section B.5). It should be noted that two wells (W15-17 and W18-22) west of this cross section are screened at the bottom of the aquifer. Carbon tetrachloride is below detection levels in samples from these wells.

B.5 CONCEPTUAL MODELS

The 200 West Area carbon tetrachloride ERA was predicated on the model that a significant amount of the carbon tetrachloride disposed to the ground in the 200 West Area is still present within the unsaturated zone (Hagood and

Rohay 1991). In this model, carbon tetrachloride discharged as a dense, non-aqueous phase liquid, has not reached the uppermost aquifer as a separate phase; however, the carbon tetrachloride vapors in the unsaturated zone move downward and laterally away from the primary disposal sites to provide a continuous source of contamination to the ground water (Figure B-29).

An alternative model is that carbon tetrachloride discharged as a dense, nonaqueous phase liquid has also reached the unconfined aquifer in a liquid phase. There, the liquid carbon tetrachloride remains in a separate phase and slowly dissolves, providing a continuous source of contamination to the ground water (Figure B-30).

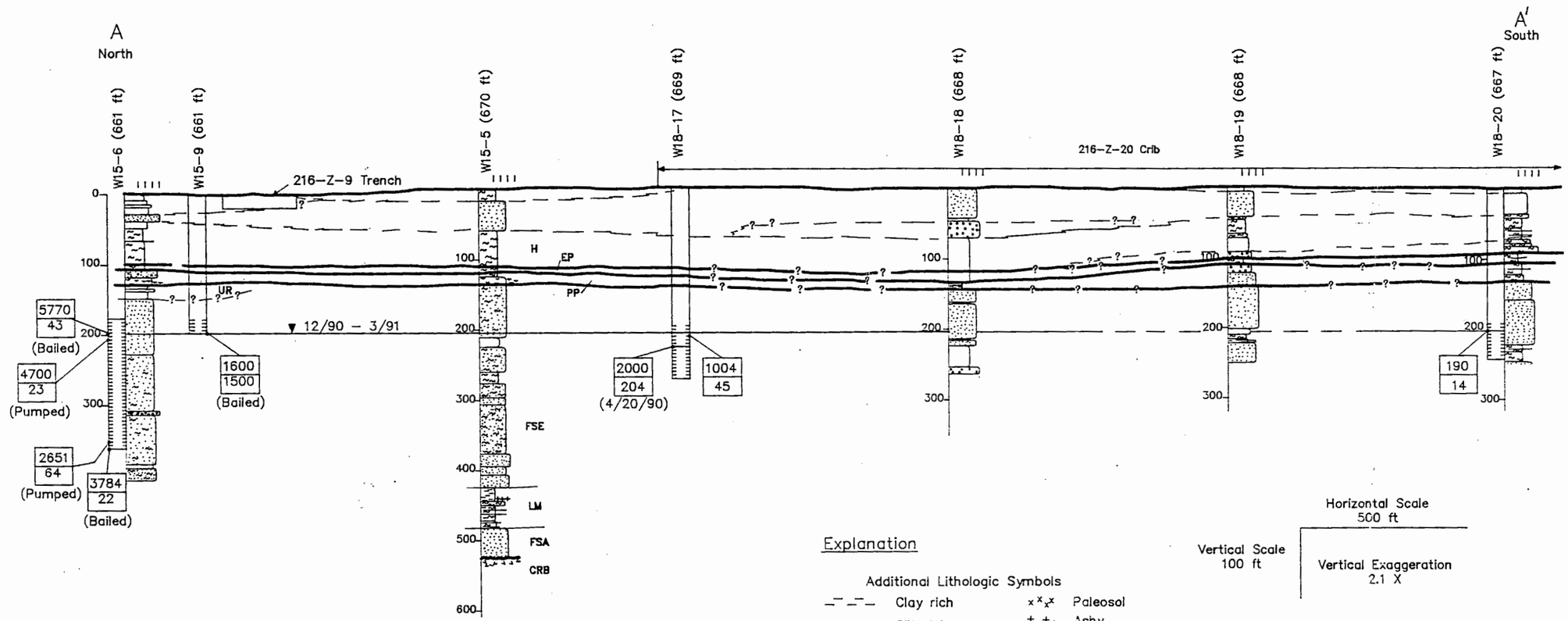
In both models, aqueous phases containing dissolved carbon tetrachloride migrate to and contaminate the ground water. Carbon tetrachloride vapors in the unsaturated zone, which equilibrate with perched water and/or waste water from other sources, may then be transported to the water table in dissolved form ("intersection of aqueous phase and carbon tetrachloride vapor" on Figure B-29). The discharges of aqueous phase containing dissolved carbon tetrachloride may also have reached and contaminated the ground water (Figure B-30).

The observed distribution of carbon tetrachloride in the subsurface suggests that all these mechanisms may be operating. Because of the differences in crib sizes and quantities of waste received at the three disposal sites, it may be that one conceptual model is appropriate for one or two crib sites and the other conceptual model is appropriate for the other(s).

In any of these scenarios, some carbon tetrachloride vapors would have been lost to the atmosphere, through volatilization and diffusion through the near-surface soils and through atmospheric pumping from boreholes and vents as a result of changing barometric pressures. (Carbon tetrachloride has only been detected at the wellhead during drilling or when a well was temporarily uncapped for use.) Carbon tetrachloride may also be destroyed by biological and chemical degradation. However, the percentage of the total inventory lost from the system by these mechanisms is unknown.

B.5.1 Waste Disposal

Carbon tetrachloride was discharged to the subsurface in the Z Plant area both in an aqueous solution and as separate batches of nonaqueous phase liquid containing other organics (Section B.2). At each of the three carbon tetrachloride disposal sites, the total volume of carbon tetrachloride discharged was 3 to 7% of the total volume of liquid discharged. Thus, it is assumed that initially carbon tetrachloride was present and migrated through the unsaturated zone as an aqueous phase (i.e., as a solute in water) and as a separate nonaqueous phase (i.e., not mixed with water).



Horizontal Scale
500 ft

Vertical Scale
100 ft

Vertical Exaggeration
2.1 X

Data sampled and analyzed
Feb–May 1991 (appendix)

1600 / 1500 = Carbon Tetrachloride µg/L / Chloroform µg/L

Perforated Interval

Water Table

Explanation

Additional Lithologic Symbols

- Clay rich
- Silt rich
- Sandy
- Pebbly
- Cobbly/bouldery
- Paleosol
- Ashy
- Carbonate–rich
- Basalt
- Formation major unit contacts
- Facies contact

Major Units

- H – Hanford formation, divided into stratigraphic intervals labeled A, Al, B, C, D, AND E
- EP – early "Palouse" soil
- PP – Plio–Pleistocene unit
- UR – Upper unit of Ringold Formation
- FSE – Ringold gravel unit E
- LM – Ringold lower mud unit
- FSA – Ringold gravel unit A
- CRB – Columbia River Basalt

Water Table Elevation (Dashed Where Approximate)

W18–18 Well Number (all well numbers are prefixed by 299–)

Note: To convert to metric, multiply elevation (feet) by 0.3048 to obtain elevation (meters)

geosci\061491–a

Figure B-28. Carbon Tetrachloride and Chloroform Concentrations Versus Aquifer Sampling Depth and Stratigraphic Position Between the 216-Z-9 Trench and 216-Z-20 Crib, 1989-1991.

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Figure B-29. Conceptual Model of Migration Paths and Distribution of Carbon Tetrachloride that Remains Primarily in the Unsaturated Zone.

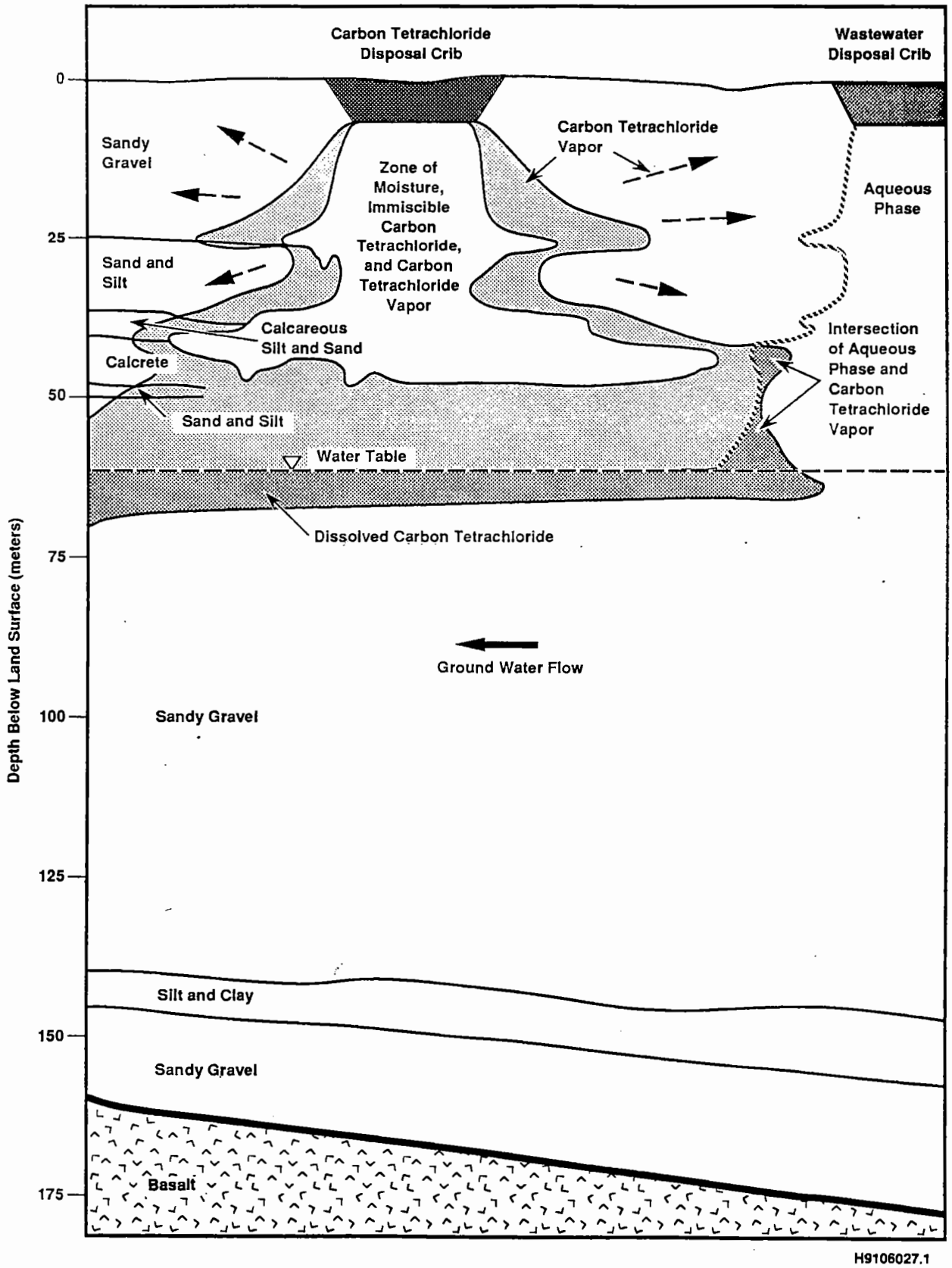
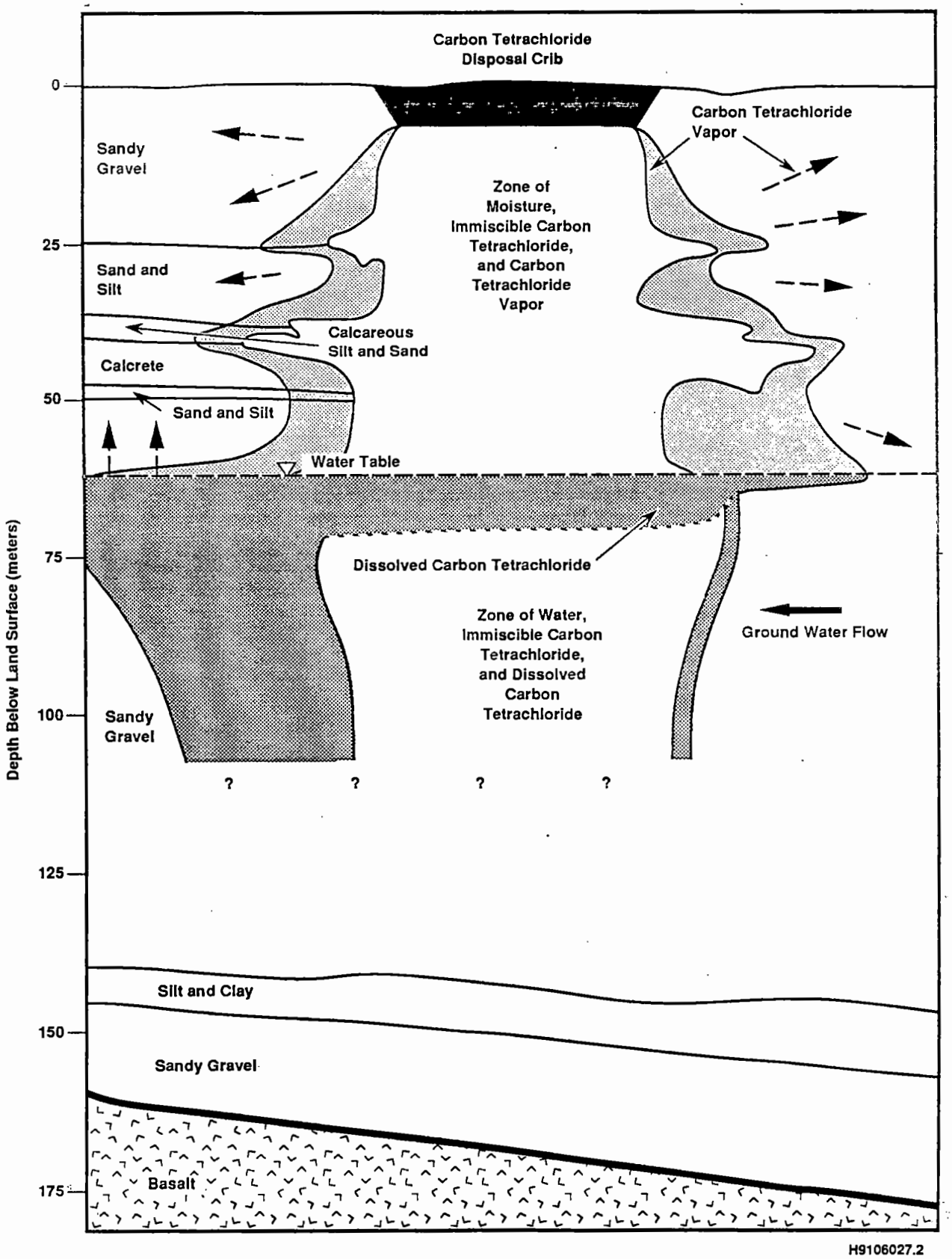


Figure B-30. Conceptual Model of Migration Paths and Distribution of Carbon Tetrachloride that has Reached the Ground Water as an Immiscible Phase.



As a first approximation, the likelihood that carbon tetrachloride in an aqueous or nonaqueous phase reached ground water can be estimated by comparing volume of liquid discharged to volume of pore space in the unsaturated zone available to store the liquid. To make this estimation, volume of the soil column (area of bottom of crib multiplied by distance from bottom of crib to water table) is multiplied by the porosity to estimate the volume of pore space. If the volume of liquid exceeds the volume of pore space, then it is assumed that the liquid reached the ground water. If the volume of liquid does not exceed the volume of pore space, the likelihood that the liquid reached the ground water will depend on the capacity of the unsaturated soils to hold liquid against the force of gravity. Lateral spreading of liquid in the unsaturated zone would enlarge the volume of soil contacted by the liquid.

At the 216-Z-9 Trench, the total volume of liquid discharged was 4.1×10^6 L (4,100 m^3). The base of the trench is 18.3 by 9.1 m, the depth of the base is 6.1 m, and the depth to the water table is 57.6 m. The volume of this column of soil is 8,600 m^3. Assuming a porosity of 30%, the pore volume is 2,600 m^3. The volume of liquid discharged is 1.5 times the calculated pore volume, indicating a high probability that discharge fluids containing carbon tetrachloride could have reached the water table at this site.

It is uncertain whether liquids containing carbon tetrachloride reached the ground water at the 216-Z-1A Tile Field and 216-Z-18 Crib. The 216-Z-1A Tile Field was used for disposal on a specific-retention basis because laboratory work indicated that plutonium and americium in high-salt acid waste were not retained on the soil by mechanisms such as ion exchange, adsorption, filtration, etc. The 6,200 m^3 of liquid discharged to the tile field was estimated to be approximately 60% of the calculated specific-retention volume of the crib (Price et al. 1979). In 1977, the plutonium and americium contamination extended 30 m below the tile field. The volume of liquid discharged to the tile field (6,200 m^3) was approximately 10% of the calculated pore volume (50,400 m^3), based on the tile field base cross section dimensions of 35 by 84 m, depth from the base to the water table of 57 m, and a porosity of 30%. However, because this estimation does not take into account the capacity of the soils to retain moisture, it cannot be used to determine that the liquid did not reach the ground water.

The 216-Z-18 Crib was also designed as a specific-retention facility. The volume of liquid discharged (3,900 m^3) was approximately 30% of the calculated pore volume (13,300 m^3). Each of the four excavations that received liquid waste measures 63 by 3 by 5 m deep, 59 m above the water table. As with the 216-Z-1A Tile Field, this estimation cannot be used to conclude that the liquid did not reach ground water.

The quantity of carbon tetrachloride dissolved in the aqueous phase discharged to the cribs can be estimated by assuming that the total volume of liquid discharged to each site was all aqueous phase containing carbon tetrachloride at its solubility limit of 800 mg/L.

	216-Z-9 Trench	216-Z-1A Tile Field[a]	216-Z-18 Crib
Volume, L	4.1×10^6	5.2×10^6	3.9×10^6
Carbon tetrachloride in aqueous phase, kg	3,300	4,200	3,100

[a]Total volume only includes the PRF waste.

These quantities of carbon tetrachloride represent approximately 2% of the carbon tetrachloride discharged to these sites. At any of the three sites, carbon tetrachloride in an aqueous or non-aqueous phase could have reached the ground water by migrating along preferential pathways.

B.5.2 Barriers and Inducements to Vertical Migration

Migration of fluids, both liquid and vapor, are influenced by the natural stratification and variability of the sediments. The Plio-Pleistocene paleosurface (caliche layer) is a relatively continuous, low permeability barrier to vertical movement of fluids in the unsaturated zone (Figure B-13). This layer most likely temporarily diverted carbon tetrachloride liquid and/or vapor laterally away from primary carbon tetrachloride disposal sites until a sufficient amount built up to force the liquid or vapor through the lower permeability layer. Vapors volatilizing off the ground water may be temporarily trapped below this layer until they find a vertical pathway upward.

The surface of the Plio-Pleistocene generally slopes toward the south/southwest from the primary carbon tetrachloride disposal sites (Figure B-13). However, the character of this layer varies across the 200 West Area (Section B.3.4.3) and includes locally less-cemented, more-permeable areas and fractures which allow more rapid fluid flow through the layer. East of the Z Plant area, this layer is not present (Figure B-13).

The fine-grained sediments of the lower mud sequence in the Ringold Formation form the base of the unconfined aquifer and may act as a barrier to vertical movement of liquids. Dense nonaqueous phase liquids on the surface of this mud sequence would move structurally downslope toward the southwest, possible collecting in the apparent low south of 216-Z-18 Crib (Figure B-11). Although dense nonaqueous phase liquids would locally pool on this layer, they may eventually penetrate to underlying gravels by migration through the sediments or along preferential pathways such as fractures or erosional windows.

The fine-grained sediments of the lower mud sequence are not present in the northeast corner of the 200 West Area; the base of the unconfined aquifer is defined in this region as the top of the underlying basalt (Figure B-10). If liquid-phase carbon tetrachloride were to migrate to the bottom of the unconfined aquifer here (which seems unlikely given the structural dip of the lower mud sequence), it would move to the southwest along the relatively uniform slope of the top of the uppermost basalt layer. Fractures, joints, and other discontinuities in the basalt, in turn, could give the carbon tetrachloride access to the confined aquifer system. All of these stratigraphic layers would act to divert fluids in directions opposite to the regional ground water flow direction (Figure B-19). All of these surfaces may contain pockets of nonaqueous fluid pooled in local topographic lows.

Older, poorly sealed wells, which penetrate either the Plio-Pleistocene and/or the water table, may provide a vertical conduit for fluids. Liquid organics which intercept the borehole in the subsurface may migrate downward along the outside casing of the well; however, there is no documented evidence of this.

It is also important to note that carbon tetrachloride, due to its low dielectric constant, can increase the permeability of subsurface materials and, hence, strongly influence its own migration pathway. The dielectric constant for carbon tetrachloride is 2.2, whereas the dielectric constant for water is 78.5 (Table B-5). Solutions with high dielectric constants, such as water, will cause expanding alumino-silicate clays to swell. A liquid with a low dielectric constant, such as carbon tetrachloride, causes clays to shrink, and therefore increases the permeability of the soil through the introduction of cracks and fissures. Evans et al. (1985) have shown that the influence of saturated carbon tetrachloride in 7% bentonite-sand resulted in 100-fold increase in the hydraulic conductivity. This increase in hydraulic conductivity is a physical process, and as such, is reversible. Flushing the soil with water, i.e., waste water disposal to cribs, can remove the carbon tetrachloride, significantly decreasing the hydraulic conductivity.

Table B-5. Physical and Chemical Properties of Carbon Tetrachloride.

Property	Carbon Tetrachloride Value	Water Value
Solubility in water	800 mg/L at 20°C	N/A
Vapor pressure	113.8 mm Hg at 25°C	24 mm Hg at 25°C
Saturated vapor concentration	754 mg/L at 20°C	---
Henry's Law constant (K_H)	9.4×10^{-1}	N/A
Liquid density	1.59 g/mL at 20°C	1.0 g/mL at 20°C
Vapor density	5.5	Air = 1
Dielectric constant	2.2	78.5

N/A = Not applicable.

Thus, carbon tetrachloride can alter the permeability of sediments that might otherwise impede vertical migration and perch the carbon tetrachloride. This may happen both in the unsaturated zone and beneath the water table. In addition, this phenomenon may be responsible for the formation of higher permeability channels throughout the unsaturated and saturated zones. These channels can act as preferential pathways and in effect shunt separate phase carbon tetrachloride through subsurface materials.

B.5.3 Predictions and Observations in the Unsaturated Zone

Observations and measurements of carbon tetrachloride vapors in the unsaturated zone have been recorded both above and below the Plio-Pleistocene layer. In the near field, boreholes sampled at the wellhead and downhole at the three carbon tetrachloride disposal sites (Figure B-20) indicate vapors

present both above and below the caliche layer. In the far field, observations of carbon tetrachloride vapors reported during drilling since 1987 indicate that most of the detections were below the caliche layer, although wells west of 216-Z-18 Crib had detections both above and below the caliche (Figure B-22). Soil samples collected from wells west of 216-Z-18 Crib confirm this pattern, although the highest concentrations are found below the caliche layer. Soil sampling also detected the presence of carbon tetrachloride both above and below the caliche layer in two wells along the northern border of the 200 West Area.

The presence of vapors above the caliche layer west of 216-Z-18 Crib suggests that the Plio-Pleistocene layer may have laterally diverted fluids from 216-Z-18 Crib to the west. Carbon tetrachloride and other organic vapors were reported during drilling of ground water wells W18-9, W18-10, and W18-11 at 216-Z-18 Crib in 1968, before the crib was placed into service. Carbon tetrachloride vapors and/or fluids probably migrated laterally from the 216-Z-1A Tile Field. The vapor extraction system tests also indicate that vapors are migrating laterally within the unsaturated zone. The distribution of wells with detections below the caliche layer matches fairly well with the distribution of carbon tetrachloride in the ground water and suggests that the source of vapors in these wells may be carbon tetrachloride volatilizing from the ground water.

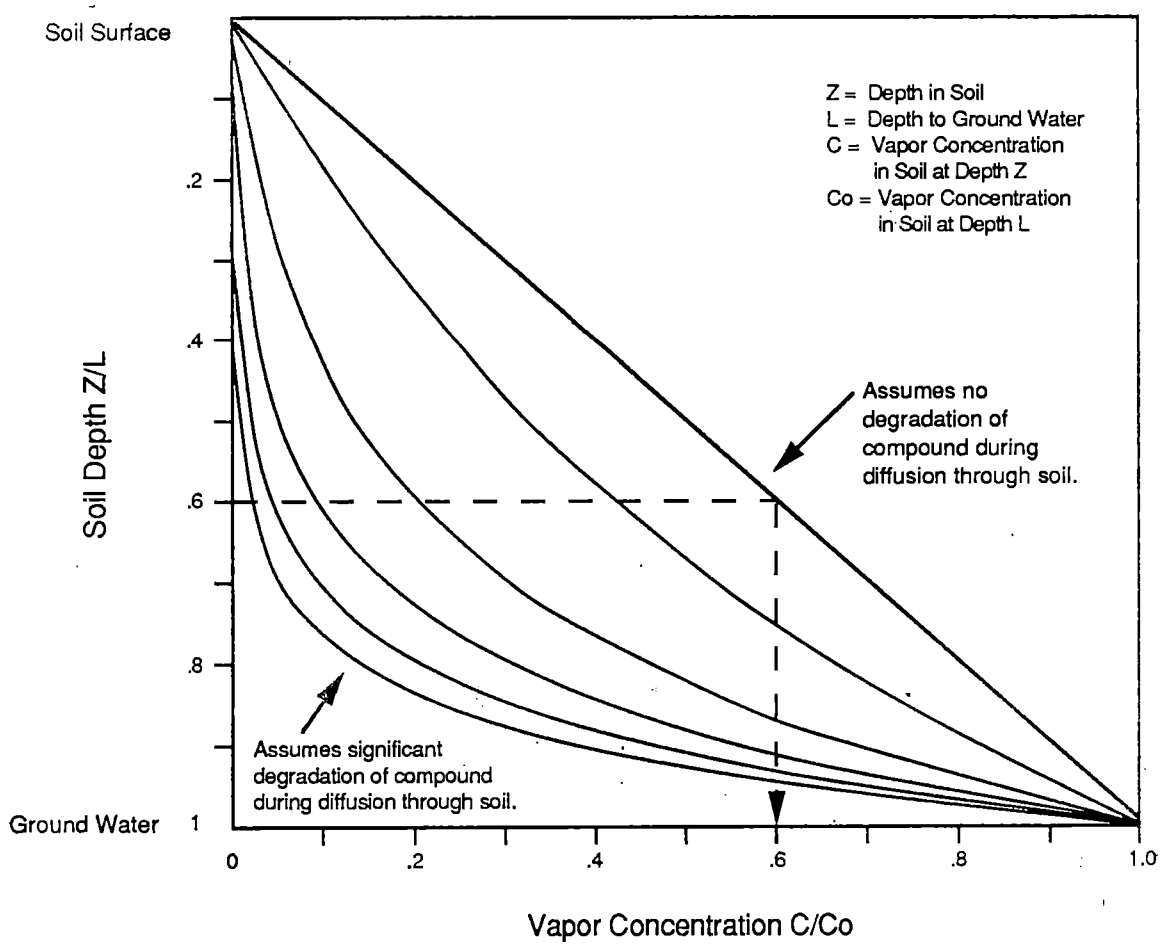
Thus, the vapor and soil sampling in the unsaturated zone confirms the presence of carbon tetrachloride vapors. However, the proportions of vapor occurring above and below the Plio-Pleistocene layer are unknown.

Movement of the carbon tetrachloride plume in the unsaturated zone is difficult to characterize because of the complexity of the reactions between the soil and the carbon tetrachloride, the effect of the porous media on the physical and chemical properties of the organic compound, and the altering of the physical and chemical properties of pure carbon tetrachloride when in aqueous or nonaqueous solution.

Liquid carbon tetrachloride has a high vapor pressure and a low solubility (Table B-5), making it relatively volatile. Therefore, at discharge sites, carbon tetrachloride vapor can be expected to be present to some degree in the soil pores. Carbon tetrachloride in the nonaqueous phase or dissolved in an aqueous phase acts to maintain a continual equilibrium with the vapor phase. The vapor phase is then subject to migration through either diffusion or advection. Due to the density of the carbon tetrachloride vapor, the density of the contaminated vapor phase is greater than uncontaminated vapor in the unsaturated zone. Recent studies have indicated that this contrast in vapor densities can result in density-driven advection.

This density-driven advection can act to move carbon tetrachloride vapor out of the contaminated zone. As the contaminated vapor moves into uncontaminated areas, it may partition into the water and soil phase and act to establish equilibrium. Thus, carbon tetrachloride can migrate through and contaminate the unsaturated zone, eventually reaching the water table and contaminating ground water.

Figure B-31. Theoretical Steady-State Vapor Concentration Profiles Between the Ground Water and the Soil Surface.



From Devitt et al. 1987

As a point of reference for comparison with soil gas concentrations from the vapor extraction system test and other soil gas data, it is of interest to consider the theoretical soil gas concentrations above the water table. Figure B-31 shows the predicted steady-state vapor concentrations between the ground water and surface soil for a volatile compound in the ground water under equilibrium conditions. Based on Henry's Law, the pore space immediately above the water should contain approximately 1 µg/L of carbon tetrachloride vapor per µg/L of carbon tetrachloride in the water at 20°C (Devitt et al. 1987) or 0.16 p/m vol per µg-L. This implies a soil gas concentration above the water table due to escape of carbon tetrachloride from the ground water of 160 p/m vol for the 1,000-µg/L contour and of 800 p/m vol for the 5,000-µg/L contour.

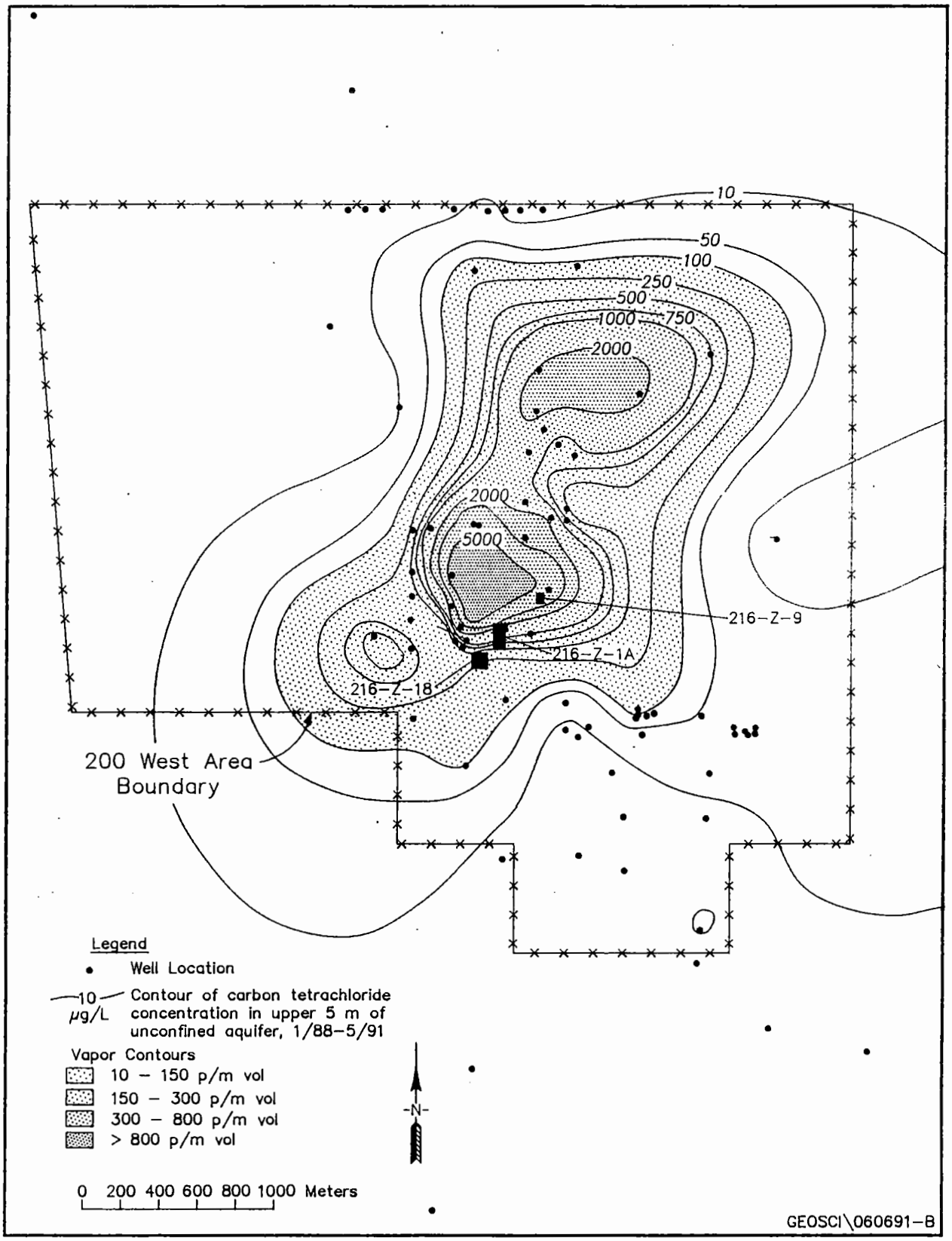
Using the straight line (no degradation curve) on Figure B-31 and the data above, the predicted vapor concentrations in the soil are calculated for just below the caliche (assuming a uniform depth to water of 61 m and a depth to the caliche of 37 m) and shown in Figure B-32. The concentrations observed during drilling through the caliche layer (Section B.4.1) do not correspond to the predicted concentrations. The concentrations observed during drilling also do not show a continuous decrease from the ground water to the ground surface. In fact, the observed concentrations do not appear to have any consistent pattern. However, the presence of detectable vapor concentrations is dependent, at least in part, on the barometric pressure, the monitoring frequency, and the detection limits of field instruments. In addition, vapor concentrations measured during drilling tend to be low because of dilution in the borehole.

Using the actual depth to ground water, the depth of the middle of the perforated zone, and the concentration of carbon tetrachloride in the underlying ground water, carbon tetrachloride vapor concentrations at the perforated zone were predicted using the relationships shown in Figure B-31. Of the 25 detections of carbon tetrachloride at the wellhead during field inspections in 1991 (Appendices C and D), only three of the observed concentrations were within 20% of the predicted concentrations. These measurements are subject to similar limitations as those taken at the wellhead during drilling.

Based on these comparisons, it appears that the vapor and ground water may not be in a steady-state condition. However, the set of available, observed concentrations were not collected specifically for comparison with predicted equilibrium conditions and may not be not suitable for this purpose.

The disposal of both aqueous phase and nonaqueous phase carbon tetrachloride to the unsaturated zone should have initially left significant amounts of residual carbon tetrachloride contamination in the unsaturated zone. As the nonaqueous phase carbon tetrachloride migrated downward, a significant proportion may have been left behind as residual saturation. Based on the volumes of soil and nonaqueous phase carbon tetrachloride involved and a potential residual saturation of 10%, a large percentage of the nonaqueous carbon tetrachloride could have been held in the soils above the water table. However, many factors are involved in this process which make reliable prediction of residual nonaqueous saturation difficult. For example, the amount of residual nonaqueous carbon tetrachloride left in place could be significantly reduced if the nonaqueous phase liquid migrated primarily through preferential flow paths rather than through a diffuse flow path in the unsaturated zone. In addition, subsequent discharge of aqueous solution may have acted to dissolve nonaqueous phase from the soil column, but this is a slow process. Thus, the amount of residual left behind is very difficult to predict.

Figure B-32. Comparison of Predicted Steady-State Vapor Concentrations Under the Base of the Plio-Pleistocene Unit with Ground Water Concentrations.



If a major fraction of the carbon tetrachloride originally added to the disposal sites is still present in the soil column as a dissolved phase or as a nonaqueous phase, a relatively high soil vapor concentration would be expected. For example, either an aqueous phase at its solubility limit for carbon tetrachloride or a nonaqueous carbon tetrachloride phase in the soil pore space would result in a maximum or saturated soil vapor concentration of 754 mg/L at 20°C (Table B-5). This vapor concentration is equivalent to approximately 120,000 p/m vol. The maximum soil vapor concentration observed during either the soil gas sampling or the vapor extraction system test at 216-Z-1A Tile Field was 915 p/m vol. Possible explanations for this apparent discrepancy include: (1) most of the carbon tetrachloride has been lost from the soil column in the vicinity of the disposal cribs; (2) the depths and locations of the venting or test wells were not optimal; or (3) a gap between the outside of the casing and the soil allowed inleakage of air or noncontaminated soil vapor during the vapor extraction tests. The proposed remediation work will hopefully resolve these ambiguities.

B.5.4 Predictions and Observations in the Ground Water

Ground water contamination due to residual chlorinated hydrocarbon sources from the carbon tetrachloride cribs involves: (1) diffusion of a vapor phase into the aquifer from residual sources in the unsaturated zone; (2) dissolution of a dense, nonaqueous phase liquid that is residual saturation in the aquifer or is pooled along the bottom contact of the aquifer; (3) contamination from aqueous solutions of carbon tetrachloride that migrated through the unsaturated zone to the water table; and/or (4) a combination of these three primary sources depending on the timing and crib-specific disposal conditions.

A vapor phase source should result in a shallow vertical distribution in the aquifer due to the relatively slow process of molecular diffusion, the process by which the carbon tetrachloride vapor enters the ground water (Pinder and Abriola 1986). A source involving dissolution of residual dense, nonaqueous phase liquid in aquifer sediments should behave more as a "point" source (i.e., on the scale of the crib dimensions) and would be expected to exhibit a greater depth distribution of dissolved DNAPL in the aquifer. Preferential pathways (e.g., unsealed well casings) close to the cribs represent "mini" point sources that would exhibit irregular areal distribution patterns in the aquifer.

The two concentration lobes in the core of the plume (Figure B-27) may represent two release events from the same general area (Z cribs). Two possible release scenarios are (1) an early time period of a sinking vapor/perched water source; and (2) a slow dissolution of residual DNAPL in the aquifer. The vapor-related source would have prevailed during the southward net flow of ground water due to the T Pond mound that controlled direction until the late 1950s. This southward flow may also account for the low-concentration lobe to the southwest. After flow reversal due to U Pond in the early to mid 1960s, the plume moved north in response to the new gradients from the ground water mounding at U Pond. Settling, free phases or droplets of carbon tetrachloride may have taken longer to reach the water table, where they would slowly dissolve. This source would have been the largest at the 216-Z-9 Trench, based on the holding capacity of the trench in relation to the

total amount discharged at this disposal site. This type of source (the free phase carbon tetrachloride) could explain why the high-concentration core still appears to be emanating from the 216-Z-9 Trench area, 20 to 30 yr after discharges ceased.

An alternative explanation for the two lobes of the plume is that some carbon tetrachloride waste may have been discharged to disposal facilities in the T Plant area. Such an occurrence would be consistent with the plume patterns and the known ground water mounding that occurred from the large volumes of waste water discharged in the vicinity of T Plant. No records of such an occurrence have been found to either support or reject this possibility. The T Plant area however was known to be used as a decontamination facility for large equipment and tank cars. Solvents and degreasers may have been used in these operations.

The residual ground water mound in the 200 West Area now appears to be centered beneath the study area, complicating the predicted direction of contaminant movement in the vicinity of these potentially continuing sources. Ground water contaminated by sinking vapor that diffuses into the near-surface aquifer would move radially from the mound (assuming uniform transmissivities in all directions). A spreading carbon tetrachloride plume approximately uniform in all downgradient directions would result if this were the case. The observed contaminant distribution pattern, however, suggests the center of maximum ground water contamination is displaced north to northwest of the approximate center of maximum source strength represented by the three principal carbon tetrachloride cribs (Figures B-27). The line source of recharge from the Z-20 Crib may restrict movement to the east, although the observed water levels do not suggest such a barrier exists.

An additional contaminant pathway involving desorption of residual carbon tetrachloride vapor in the soil column beneath the 216-Z-1A Tile Field and 216-Z-18 Crib by adjacent perched water sources from active liquid waste disposal (e.g., 216-Z-20 Crib) may result in a continuing source of intermediate ground water contamination. The waste water discharged to the 216-Z-20 Crib can create a perched water zone parallel to the crib that may permit equilibration of residual carbon tetrachloride vapor with the infiltrating and/or perched water. Well W18-17, the monitoring well closest to a potential vapor source (near 216-Z-1A Tile Field), has the highest ground water carbon tetrachloride concentration of the two wells located next to the 216-Z-20 Crib. Evaluation of perched water/vapor phase interaction was attempted at a new well (W18-29, Figure B-22) located at the south end of the 216-Z-20 Crib, which encountered perched water during drilling. Sampling results were not available for this report. However, vapor concentrations above the caliche layer on the order of 20 to 30 p/m vol were encountered during drilling of the well. Equilibrium between perched water and vapor of this concentration would theoretically result in a water concentration of (20 to 30 p/m vol)/(0.16 p/m vol per µg-L) = 125 to 188 µg/L at 20°C which could thus be a source of ground water contamination. (NOTE: The warm process water discharged to the 216-Z-20 Crib raises the near-surface aquifer temperature to 20° to 22°C as compared to an ambient natural temperature of 15° to 16°C (field records, Appendix D). The elevated temperature will also increase the carbon tetrachloride vapor concentration in the pore space above the water.)

The major uncertainty concerning the extent of ground water contamination is the vertical distribution throughout the plume area. Supplemental sampling of some new and existing wells suggest the vertical as well as areal extent of high ground water concentrations (>3,000 µg/L) of carbon tetrachloride is greater than previously thought. The zone of highest ground water contamination and the large-scale contaminant distribution patterns in the upper aquifer appear to be consistent with ground water transport and dispersion of a contaminant from a point source from near the 216-Z-9 Crib (Figure B-27). The dispersion pattern implies contaminant plume movement in more than one direction. This is attributed to a previous ground water mound north of the carbon tetrachloride cribs (T Pond) that caused water to flow to the south-southwest during the 1950s followed by flow direction reversal when U Pond became operational (Figure B-14). Flow to the north occurred from the early to mid 1960s to the present due to the dominating influence of U Pond.

If vapor transport is the primary mechanism for explaining the ground water contamination, the carbon tetrachloride should occur in a relatively shallow zone (1 to 2 m thick) at the top of the aquifer near major source(s). Preliminary test results at a "deep" perforated well near the 216-Z-9 Trench suggest concentrations at about 3,000 µg/L occur to a depth of at least 52 m below the aquifer surface at a location close to the trench (Figure B-28). However, west and north of the carbon tetrachloride cribs, wells completed and sampled near the bottom of the unconfined aquifer (W15-17, W18-22) do not have carbon tetrachloride above the detection limit. These observations again suggest a point source near the 216-Z-9 Trench.

B.5.5 Conclusions

Carbon tetrachloride vapors are present in the unsaturated zone in the 200 West Area. In the vicinity of the three disposal cribs, and west of the three disposal cribs, the vapor is found both above and below the caliche zone. The vapor above this zone is probably migrating laterally in the vapor phase downslope along the caliche surface or volatilizing off of sorbed or migrating liquid phase.

The vapors below the caliche are found in an area roughly coincident with the area underlain by the ground water plume, suggesting that these vapors may have volatilized from the ground water.

The maximum observed concentration of carbon tetrachloride in the unsaturated zone is two orders of magnitude lower than the maximum concentration expected for vapors in equilibrium with an aqueous phase saturated with carbon tetrachloride or a nonaqueous carbon tetrachloride liquid phase. No reports of liquid phase carbon tetrachloride encountered in the subsurface are known.

Vapors in the unsaturated zone may equilibrate with waste water from other liquid waste disposal facilities which then contaminates the unconfined aquifer.

The unconfined aquifer is contaminated with carbon tetrachloride above the maximum contaminant level of 5 µg/L covering an area of over 10 km^2 beneath the 200 West Area. Assuming uniform distribution over a 10-m depth,

nearly half of the total estimated ground water inventory is in a relatively small area of 0.6 km^2, with approximately 1/4 of the total in an area of 0.3 km^2. Thus, there is a core of high concentrations surrounded by increasingly lower concentrations.

A vapor phase source of ground water contamination should result in a shallow (1- to 2-m) vertical distribution in the aquifer due to molecular diffusion. A source involving dissolution of residual liquid phase carbon tetrachloride in the aquifer should behave more as a "point" source and would be expected to exhibit a greater depth distribution of dissolved carbon tetrachloride in the aquifer. Additional discharge will also increase the vertical distribution of contaminants.

The zone of highest ground water contamination, and its spatial relation to 216-Z-9 Trench, is consistent with a carbon tetrachloride point source emanating from near 216-Z-9 Trench. Furthermore, sampling in the upper 55 m of the aquifer at W15-6 indicates deeply distributed carbon tetrachloride. This point source may be a result of the relatively large volumes of liquid containing carbon tetrachloride discharged, relative to the retention capacity of the sediments in the unsaturated zone under 216-Z-9 Trench, or may be due to liquid phase carbon tetrachloride moving downward along preferential pathways (e.g., an older well casing). The dispersion pattern is attributed to contaminant movement in more than one direction as a result of changing liquid waste disposal practices in the 200 West Area.

B.6 DATA LIMITATIONS

A considerable quantity of data -- both existing and new -- was compiled and analyzed during Phase I Site Evaluation. These data are being used for characterization, remedial design input, and baseline monitoring. However, each set of data is associated with uncertainties which must be kept in mind when interpretations and remediation decisions are being made based on those data. This section discusses the limitations for data presented in the Phase I Site Evaluation.

The Phase I field activities were designed to be safe, timely, and cost effective. To that end, no new wells were drilled. Characterization using boreholes was limited to existing wells. This meant that wells might not be optimally placed for data coverage or testing. Existing unsaturated and ground water wells around the three disposal sites were constructed to different standards and for different purposes over a 42-yr period. Many older wells do not have surface seals.

Phase I evaluation relied on field screening instruments to save on laboratory turnaround time and costs. While the use of lower quality data was acceptable to meet the goals of the site evaluation, it must be recognized that field screening instruments may not be as sensitive or accurate as laboratory instruments, may not be comparable to one another, and are usually not compound-specific.

Near-surface and subsurface soil gas measurements were made to assess the lateral and vertical distribution of the carbon tetrachloride vapor plume in the unsaturated zone. Although the results of various field activities can

be used to make qualitative estimates of the extent of the vapor plume, the data do not lend themselves to quantitative interpretations. The ability to detect soil gas vapors in the near-surface (1.5 m below ground), at the wellhead, and downhole is a function, in part, of the barometric pressure, so that a lack of detection may be a function of the weather. Soil gas samples at the wellhead, downhole, and from soil samples are subject to dilution and/or sample loss. Monitoring of vapors during drilling, which is done for safety reasons, may not have an optimum frequency for characterization efforts; samples measured in situ at the wellhead may be diluted by atmospheric vapors; and wellhead and downhole measurements in completed wells are affected by the construction depths and details.

Data limitations of the vapor extraction system tests include uncertainty in the exact interval being sampled or tested (because of possible variations in lithology or leakage along the outside of the casing). In addition, the effects of barometric pressure on the observed vapor concentrations are unclear.

Samples of volatile organics were measured in the ground water to assess the lateral and vertical distribution of carbon tetrachloride in the unconfined aquifer. The samples were analyzed in the laboratory using accepted laboratory techniques for detecting volatile organic chemicals. However, the wells in the vicinity of the carbon tetrachloride cribs and on the perimeter of the ground water plume include an assortment of construction methods and sampling techniques which qualifies direct comparisons. For example, sampling involved a mix of old wells with submersible pumps, newer wells constructed to RCRA standards and equipped with positive displacement piston pumps, and older wells which could only be sampled by bailer.

The screened or perforated intervals in this set of wells have an irregular distribution in relation to water depth. In most cases, the existing depths of the screened/perforated intervals limit the sampling to the upper part of the unconfined aquifer, leading to uncertainty as to the depth distribution/concentration profile and to the presence of a large residual dense, nonaqueous phase liquid source in the aquifer sediments. The long time period of existing contamination allows the possibility that contamination may have been introduced into the borehole during drilling and casing emplacement during the last 35 yr. Similarly, older unsealed boreholes may provide preferential pathways for vertical migration.

The water table in the vicinity of the three carbon tetrachloride disposal sites influences the flow direction of ground water. The water table appears to be a relatively flat-topped mound centered under the area of the three disposal sites. However, many of the wells used for water level measurements have not been accurately surveyed, which could affect the interpretation of which direction is downgradient.

B.7 REFERENCES

Aldrich, R. C., 1985, *Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1984*, RHO-HS-SR-84-3, Rockwell Hanford Operations, Richland, Washington.

Airhart, S. P., 1990, *Borehole Completion Data Package for the 216-S-10 Ditch and Pond*, WHC-MR-0206, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Ames, L. L., and R. J. Serne, 1991, *Compilation of Data to Estimate Groundwater Migration Potential for Constituents in Active Liquid Discharges at the Hanford Site*, PNL-7660, Pacific Northwest Laboratory, Richland, Washington.

Barton, K. R. O., 1990, *Borehole Completion Data Package for Low-Level Burial Grounds - 1990*, WHC-MR-0205, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Bierschenk, W. H., 1959, *Aquifer Characteristics and Ground-Water Movement at Hanford*, HW-60601, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

Bjornstad, B. N., 1984, *Suprabasalt Stratigraphy Within and Adjacent to the Reference Repository Location*, SD-BWI-DP-039, Rockwell Hanford Operations, Richland, Washington.

Brown, M. J., R. K. P'Pool, and S.P. Thomas, 1990, *Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989: 200/600 Areas*, WHC-EP-0141-2, Westinghouse Hanford Company, Richland, Washington.

Chatters, J. C., and N. A. Cadoret, 1990, *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site, Washington*, PNL-7264, Pacific Northwest Laboratory, Richland, Washington.

Devitt, D. A., R. B. Evans, W. A. Jury, and T. H. Starks., 1987. Soil Gas Sensing For Detection and Mapping of Volatile Organics, published by *National Water Well Association*, 3375 Riverside Drive, Dublin, Ohio, 270 pp.

DOE, 1988, *Consultation Draft, Site Characterization Plan, Reference Respository Location, Hanford Site, Washington*, DOE/RW-0164, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA, 1985, *National Oil and Hazardous Substances Pollution Contingency Plan*, Title 40, Code of Federal Regulations, Part 300, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991, *Innovative Treatment Technologies Semi-Annual Status Report, First Studies Under CERCLA, Interim Final*, EPA/540/G-89/004, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

ERDA, 1975, *Final Environmental Statement, Waste Management Operations, Hanford Reservation, Richland, Washington*, ERDA-1538, U.S. Energy Research and Development Association, Washington, D.C.

Evans, J. C., H-y Fang, and I. J. Kugelman, 1985, Containment of Hazardous Materials with Soil-Bentonite Slurry Walls, in *Proceedings of the 6th National Conference on the Management of Uncontrolled Hazardous Waste Sites*, November 4-6, Washington, D.C., Hazardous Materials Control Research Institute, Silver Springs, Maryland.

Evans, J. C., D. I. Dennison, R. W. Bryce, P. J. Mitchell, D. R. Sherwood, K. M. Krupka, N. W. Hinman, E. A. Jacobson, and M. D. Freshley, 1988, *Hanford Site Ground-Water Monitoring for July Through December 1987*, Pacific Northwest Laboratory, Richland, Washington.

Gee, G. W., 1987, *Recharge at the Hanford Site: Status Report*, PNL-6403, Pacific Northwest Laboratory, Richland, Washington.

Goodwin, S. M., 1990, *Borehole Completion Data Package for the 216-U-12 Crib*, WHC-MR-0208, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Goodwin, S. M., and B. N. Bjornstad, 1990, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, WHC-MR-0204, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Graham, M. J., M. D. Hall, S. R. Strait, W. R. Brown, 1981, *Hydrology of the Separations Areas*, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.

Hagood, M. C., and Rohay, V. J., 1991, *200 West Area Carbon Tetrachloride Expedited Response Action Project Plan*, WHC-EP-EN-AP-046, Rev. 0. Westinghouse Hanford Company, Richland, Washington.

Judson, B. F., 1956, *Semi-Works Operation of the RECUPLEX Facility*, HW-44776, Vols. 1 and 2, General Electric Company, Richland, Washington.

Jury, W. A., W. F. Spencer, and W. J. Farmer, 1983, *Behavior Assessment Model for Trace Organics in Soil: I, Model Description*, J. Environ. Qual. 12:558-564.

Jury, W. A., W. F. Spencer, and W. J. Farmer, 1984, *Behavior Assessment Model for Trace Organics in Soil: IV, Review of Experimental Evidence*. J. Environ. Qual., Vol. 13, No. 4.

Kasper, R. B., 1981, *216-Z-12 Crib Status Report*, RHO-LD-166, Rockwell Hanford Operations, Richland, Washington.

Kasper, R. B., 1982, *216-Z-12 Transuranic Crib Characterization: Operational History and Distribution of Plutonium and Americium*, RHO-ST-44, Rockwell Hanford Operations, Richland, Washington.

Kenega, E. E., 1980, *Predicted Bioconcentration Factors and Soil Sorption Coefficients of Pesticides and Other Chemicals*, Ecotoxicol. Environ. Saf. 4:26-28.

Kipp, K. L., and R. D. Mudd, 1974, *Selected Water Table Contour Maps and Well Hydrographs for the Hanford Reservation 1944-1973*, BNWL-B-360, Battelle Northwest Laboratories, Richland, Washington.

Last, G. V., B. N. Bjornstad, M. P. Bergeron, D. W. Wallace, D. R. Newcomer, J. A. Schramke, M. A. Chamness, C. S. Cline, S. P. Airhart, and J. S. Wilbur, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds - An Interim Report*, PNL-6820, Vols. 1 and 2, Pacific Northwest Laboratory, Richland, Washington.

Lindsey, K. A., 1991, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-Central Washington*, WHC-SD-EN-EE-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Looney, B. B., and D. S. Kaback, 1991, *Field Demonstration of In-Situ Air Stripping Using Horizontal Wells*, WSRC-MS-91-122, Westinghouse Savannah River Laboratory, Aiken, South Carolina.

Ludowise, J. D., 1978, *Report on Plutonium Mining Activities at 216-Z-9 Enclosed Trench*, RHO-ST-21, Rockwell Hanford Operations, Richland, Washington.

Myers, C. W., 1981, "Bedrock Structure of the Cold Creek Syncline Area" in *Subsurface Geology of the Cold Creek Syncline*, edited by C. W. Myers and S. M. Price, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Myers, C. W., and S. M. Price, eds., 1979, *Geologic Studies of the Columbia Plateau: A Status Report*, RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.

Newcomb, R. C., 1958, "Ringold Formation of Pleistocene Age in the Type Locality, the White Bluffs, Washington," *American Journal of Science*, Vol. 256, pp. 328-340.

Owens, K. W., 1981, *Existing Data on the 216-Z Liquid Waste Sites*, RHO-LD-114, Rockwell Hanford Operations, Richland, Washington.

Pinder, G. F., and L. A. Abriola, 1986, "On the Simulation of Nonaqueous Phase Organic Compounds in the Subsurface", *Water Resources Research*, 22(9):109S-119S.

PNL, 1990, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415, Rev. 3, Pacific Northwest Laboratory, Richland, Washington.

Price, E. H., 1981, "Distribution of Strain Features Within Selected Yakima Fold Structures and Extrapolation of Their Nature into the Cold Creek Syncline Area", in *Subsurface Geology of the Cold Creek Syncline*, edited by C. W. Myers and S. M. Price, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Price, S. M., R. B. Kasper, M. K. Additon, R. M. Smith, and G. V. Last, 1979, *Distribution of Plutonium and Americium beneath the 216-Z-1A Crib: A Status Report*, RHO-ST-17, Rockwell Hanford Operations, Richland, Washington.

PSPL, 1982, *Skagit/Hanford Nuclear Project, Preliminary Safety Analysis Report*, Vol. 4, App. 20, Amendment 23, Puget Sound Power and Light Company, Bellevue, Washington.

Rockhold, M. L., M. J. Fayer, G. W. Gee, and M. J. Kanyid, 1990, *Natural Groundwater Recharge and Water Balance at the Hanford Site*, PNL-7215, Pacific Northwest Laboratory, Richland, Washington.

Routson, R. C., and V. G. Johnson, 1990, "Recharge Estimates for the Hanford Site 200 Areas Plateau", *Northwest Science*, Vol. 64, No. 3, pp. 150-158.

Sloat, R. J., 1967, *Hanford Low Level Waste Management Reevaluation Study*, ARH-231, Atlantic Richfield Hanford Company, Richland, Washington.

Smith, A. E., 1973, *Nuclear Reactivity Evaluations of 216-Z-9 Enclosed Trench*, ARH-2915, Atlantic Richfield Hanford Company, Richland, Washington.

Smith, R. M., 1980, *216-B-5 Reverse Well Characterization Study*, RHO-ST-37, Rockwell Hanford Operations, Richland, Washington.

Stone, W. A., J. M. Thorp, O. P. Gifford, and D. J. Hoitink, 1983, *Climatological Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

Tallman, A. M., J. T. Lillie, and K. R. Fecht, 1981, "Suprabasalt Sediments of the Cold Creek Syncline Area", in *Subsurface Geology of the Cold Creek Syncline*, edited by C. W. Myers and S. M. Price, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

WHC, 1990a, *Liquid Effluent Study Final Project Report*, WHC-EP-0367, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *Liquid Effluent Study: Ground Water Characterization Data*, WHC-EP-0366, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *WIDS Database Field Descriptions and Data*, WHC-MR-0056, Rev.1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Safety Assessment for Task #7 of the 200 West Area Carbon Tetrachloride Expedited Response Action*, WHC-SD-ER-HC-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

BOREHOLE INFORMATION

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Appendix C contains data, compiled during Phase I Site Evaluation, pertaining to existng boreholes in the 200 West Area:

- C1 - Well Construction and Completion Summaries
- C2 - Field Inspection Reports
- C3 - Camera Surveys
- C4 - Lithologic and Well Construction Diagrams
- C5 - Borehole Geophysical Logging Results
- C6 - Stratigraphic Data Table.

The Borehole Construction Summary (Table C1) summarizes information about the 54 boreholes associated with the three primary carbon tetrachloride disposal sites (216-Z-1A Tile Field, 216-Z-9 Trench, and 216-Z-18 Crib). The information was summarized from the Hanford Ground Water Data Base, extracted with Westinghouse Hanford Geosciences Group's Paradox software, the 1989 Pacific Northwest Laboratory document PNL-6907, entitled *Hanford Wells*, prepared by V. L. McGhan, and results of the data compilation reported in C1 and C2.

The initial borehole data compilation task was to prepare the Well Construction and Completion Summaries (C1) for the existing boreholes associated with the three carbon tetrachloride disposal sites and for the boreholes initially slated for ground water sampling. Summaries were not prepared for boreholes identified as "destroyed". A total of 64 summaries were prepared by Westinghouse Hanford Environmental Field Services staff per environmental investigations instructions (EII) 6.6, "Resource Protection Well Characterization and Evaluation" as provided in the Westinghouse Hanford Company's *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, dated 1988. Because the summaries are based on drilling records only, they were considered to be preliminary and subject to revision when results of the field inspections were received. The diagrams of the well constructions are not to scale.

A Field Inspection Report (C2) was then prepared for each of these wells by Westinghouse Hanford Environmental Field Services staff per EII 6.6. The field inspections included measuring both the depth to the bottom of the borehole and the distance between the top of the casing and the ground surface (or cement pad). As noted on the reports, several wells could not be inspected either because they are in areas to which access is restricted or because the well cap could not be removed.

Finally, television Camera Surveys (C3) were run on the four wells -- W18-87, W18-150, W18-164, and W18-171 -- identified for use in the vapor extraction system test. The surveys were performed by Westinghouse Hanford Environmental Field Services staff per EII 6.6.

The Lithologic and Well Construction Diagrams (C4) graphically depict the information from the Well Construction and Completion Summaries as supplemented by the Field Inspection Reports. These drawings are to scale.

Borehole Geophysical Logging (C5) was conducted to identify radioactively contaminated depth intervals in the well (W18-171) selected for use during the vapor extraction system test. The objective was to avoid perforating the well at any such intervals. The well was logged twice: once by Westinghouse Hanford Geosciences Group using the spectral gamma ray logging tool and once by Pacific Northwest Laboratory using a gross gamma ray logging tool.

The Stratigraphic Data Table (C6) lists the elevations of contacts between geologic unit in the 200 West Area. The contacts were chosen by K. A. Lindsey of the Westinghouse Hanford Geosciences Group based on his interpretation of geologists' logs and examination of core.

9 1 1 2 4 7 0 5 7 6

APPENDIX C1

WELL CONSTRUCTION AND COMPLETION SUMMARIES

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Table C-1. Borehole Construction Summary. (Page 1 of 2).

Well	Coordinates EW	Coordinates NS	Casing Elevation (ft)	Ground Elevation (ft)	Casing Diameter (in.)	Drilled Depth (ft)	Date Drilling Completed	Total Depth[a] (ft)	Depth to Water[a] (ft)	Perf/Scrn Interval (ft)
216-Z-9 Trench										
W15-6	75765	40005	661.50	658.57	6	410	05/24/59	361.1	189.5	175-408
W15-8	75910	39740	667.79	665.69	4	206	11/23/66	201.6	196.9	N/A
W15-9	75890	39930	662.30	660.58	4	195	12/14/66	190.8	190.4	186-189
W15-82	75810	39860	660.09	659.57	8	101	10/04/54	99.1	N/A	N/A
W15-84	76000	39860	669.82	668.35	8	110	10/10/54	106.3	N/A	N/A
W15-85	75910	39970	664.11	662.67	8	106	10/12/54	103.7	N/A	N/A
W15-86	75958	39790	661.22	658.16	4	144	08/14/57	140.8	N/A	N/A
W15-95	75925	39930	660.00	657.35	8	100	01/21/59	99.3	N/A	N/A
W15-101	75860	39890	660.00	ND	6	50	01/16/67	ND	N/A	N/A
216-Z-1A Tile Field										
W18-6	76706	39212	678.47	675.91	6	300	01/15/64	201.0	N/A	190-298
W18-7	76491	39204	678.99	676.49	6	300	01/13/64	203.3	N/A	190-298
W18-65	76589	39373	676.94	ND	4	150	04/30/49	ND	N/A	N/A
W18-67	76534	39399	668.00	ND	8	47	09/30/49	ND	N/A	N/A
W18-68	76506	39371	668.00	ND	8	46	09/30/49	ND	N/A	N/A
W18-76	76610	39318	669.00	668.16	6	19	03/28/67	18.8	N/A	N/A
W18-77	76608	39273	669.00	668.63	6	25	03/30/67	ND	N/A	N/A
W18-78	76600	39308	669.00	668.48	6	17	03/30/67	14.0	N/A	N/A
W18-79	76594	39274	669.00	668.76	6	23	03/30/67	ND	N/A	N/A
W18-80	76596	39246	669.00	668.62	6	21	03/31/67	ND	N/A	N/A
W18-81	76605	39283	669.00	665.80	6	41	04/03/67	37.7	N/A	N/A
W18-85	76717	38989	679.75	676.83	6	150	08/05/69	150.0	N/A	N/A
W18-86	76742	39106	683.49	681.48	6	150	08/21/69	149.1	N/A	N/A
W18-87	76604	38980	677.23	674.86	6	150	09/05/69	149.2	N/A	N/A
W18-88	76432	39298	679.76	677.01	6	150	09/19/69	146.7	N/A	N/A
W18-89	76752	39360	681.32	678.50	6	150	10/21/69	141.7	N/A	N/A
W18-149	76602	39329	672.56	670.56	6	100	04/12/74	24.7	N/A	N/A
W18-150	76601	39075	671.81	668.85	6	128	07/21/77	115.9	N/A	N/A
W18-158	76650	39266	672.61	669.97	6	131	09/08/77	125.6	N/A	N/A
W18-159	76602	39228	670.77	669.63	6	130	01/11/78	120.9	N/A	N/A
W18-163	76552	39284	670.00	667.50	8	135	02/16/77	130.3	N/A	N/A
W18-164	76602	39040	678.75	675.68	6	153	02/01/77	143.4	N/A	N/A
W18-165	76650	39180	672.09	668.99	6	135	03/29/77	125.4	N/A	N/A
W18-166	76650	39108	671.11	668.36	6	137	04/14/77	129.4	N/A	N/A
W18-167	76552	39214	669.00	665.68	8	134	05/17/77	126.2	N/A	N/A
W18-168	76552	39043	669.00	665.70	8	131	06/16/77	124.1	N/A	N/A
W18-169	76552	39073	669.00	665.94	8	132	09/05/77	125.7	N/A	N/A
W18-170	76602	39154	672.32	668.59	6	30	09/21/77	28.0	N/A	N/A
W18-171	76604	39010	677.65	675.14	8	136	08/09/77	128.7	N/A	N/A
W18-172	76595	39435	678.07	ND	8	134	08/25/77	ND	N/A	N/A
W18-173	76574	39307	673.31	670.02	8	51	10/14/77	44.6	N/A	N/A

Table C-1. Borehole Construction Summary. (Page 2 of 2)

Well	Coordinates EW	Coordinates NS	Casing Elevation (ft)	Ground Elevation (ft)	Casing Diameter (in.)	Drilled Depth (ft)	Date Drilling Completed	Total Depth[a] (ft)	Depth to Water[a] (ft)	Perf/Scrn Interval (ft)
216-Z-1A Tile Field (cont)										
W18-174	76565	39296	673.21	669.85	8	51	10/11/77	46.4	N/A	N/A
W18-175	76600	39117	670.00	667.07	6	130	12/07/77	118.4	N/A	N/A
216-Z-18 Crib										
W18-9	76846	38852	682.47	679.56	6	220	12/13/68	217.6	210.7	180-218
W18-10	76803	38847	682.63	679.51	6	220	12/11/68	ND	ND	180-218
W18-11	76955	38735	683.00	679.66	6	220	01/04/69	188.6	N/A	180-220
W18-12	76955	38850	683.00	680.52	6	220	ND	212.6	N/A	190-218
W18-82	77101	38570	680.00	677.58	6	146	ND	148.3	N/A	N/A
W18-93	76905	38744	665.00	662.00	6	140	02/08/72	139.7	N/A	N/A
W18-94	76880	38662	665.00	661.77	6	80	02/10/72	84.4	N/A	N/A
W18-95	76970	38665	665.00	661.88	6	80	02/15/72	78.1	N/A	N/A
W18-96	76790	38825	665.00	662.02	6	80	02/18/72	78.2	N/A	N/A
W18-97	76790	38745	665.00	662.00	6	85	02/24/72	83.2	N/A	N/A
W18-98	76880	38940	665.00	662.03	6	80	02/29/72	76.3	N/A	N/A
W18-99	76768	38949	665.00	662.13	3	135	03/08/72	131.4	N/A	N/A

[a]Measured in January and February 1991.

ND = Not Determined.

N/A = Not Applicable.

NOTE: To convert from metric, multiply feet by 0.3048 to obtain meters and multiply inches by 2.54 to obtain centimeters.

December 11, 1990
(Page 1 of TBD)

WELL NUMBER	HANFORD COORD NORTH	WEST	DRILL DATE	DRILL DEPTH	MEAS DEPTH	DEPTH WATER	CASNG DIAM	CASNG ELEV	PERFORATE INTERVAL	SCREENED INTERVAL	FACILITY	DRAFT COMMENTS
*299-W15-6	40005	75765	Mar59	410	370	190	6.0	661.50	175 - 408	NA	216-Z-9	FIR required
*299-W15-8	39740	75910	Nov66	206	203	196	8.0	667.79	None	NA	216-Z-9	FIR required
*299-W15-9	39930	75890	Dec66	195	191	190	8.0	662.30	None	NA	216-Z-9	FIR required
299-W15-82	39860	75810	Oct54	101	98	Vad	8.0	660.09	None	NA	216-Z-9	FIR required
299-W15-84	39860	76000	Oct54	110	106	Vad	8.0	669.82	None	NA	216-Z-9	FIR required
299-W15-85	39970	75910	Oct54	106	103	Vad	8.0	664.11	None	NA	216-Z-9	FIR required
299-W15-86	39790	75958	Aug57	144	136	Vad	8.0	661.22	None	NA	216-Z-9	FIR required
299-W15-95	39930	75925	Jan59	100	100	Vad	8.0	660.00	None	NA	216-Z-9	FIR required
299-W15-101	39890	75860	Jan67	50	46	Vad	6.0	660.00	None	NA	216-Z-9	FIR required
*299-W18-6	39212	76706	Jan64	300	200	200	8.0	678.47	190 - 298	NA	216-Z-1A	FIR required, 6-in liner grouted to 156-ft
*299-W18-7	39204	76491	Jan64	300	207	ND	8.0	678.99	190 - 298	NA	216-Z-1A	FIR required, 6-in liner grouted to 156-ft
*299-W18-9	38852	76846	Dec68	220	217	208	6.0	682.47	180 - 218	NA	216-Z-18	FIR required
*299-W18-10	38847	76803	Dec68	220	212	207	6.0	682.63	180 - 218	NA	216-Z-18	FIR required
*299-W18-11	38735	76955	?	220	189	208	6.0	683.00	190 - 219	NA	216-Z-18	FIR required
*299-W18-12	38850	76955	?	220	214	208	6.0	683.00	190 - 218	NA	216-Z-18	FIR required
299-W18-24	38998	77180	Aug87	240	235	213	4.0	684.35	NA	205 - 235	216-Z-18	FIR required, Hydrostar pump installed
x 299-W18-56	39301	76615	Mar49	150	150	Vad	8.0	670.61	NA	NA	216-Z-1A	Destroyed
x 299-W18-57	39309	76587	Mar49	150	150	Vad	8.0	670.94	NA	NA	216-Z-1A	Destroyed
x 299-W18-58	39161	76651	Mar49	150	150	Vad	8.0	668.66	NA	NA	216-Z-1A	Destroyed
x 299-W18-59	39161	76552	Mar49	150	150	Vad	8.0	669.87	NA	NA	216-Z-1A	Destroyed
x 299-W18-60	39424	76614	Apr49	150	150	Vad	8.0	676.86	NA	NA	216-Z-1A	Destroyed
x 299-W18-61	39424	76589	Apr49	150	150	Vad	8.0	676.68	NA	NA	216-Z-1A	Destroyed
x 299-W18-62	39398	76614	Apr49	151	151	Vad	8.0	676.34	NA	NA	216-Z-1A	Destroyed
x 299-W18-63	39398	76589	Apr49	150	150	Vad	8.0	676.36	NA	NA	216-Z-1A	Destroyed
x 299-W18-64	39373	76614	Apr49	150	150	Vad	8.0	676.33	NA	NA	216-Z-1A	Destroyed
299-W18-65	39373	76589	Apr49	150	140	Vad	8.0	676.94	NA	NA	216-Z-1A	4-in liner to 140-ft.
x 299-W18-66	39063	76601	Apr49	150	150	Vad	8.0	669.11	NA	NA	216-Z-1A	Destroyed
299-W18-67	39399	76534	Sep49	47	47	Vad	8.0	668.00	NA	NA	216-Z-1A	FIR required
299-W18-68	39371	76506	Sep49	46	46	Vad	8.0	668.00	NA	NA	216-Z-1A	FIR required
299-W18-76	39318	76610	Mar67	19	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-77	39273	76608	Mar67	25	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-78	39308	76600	Mar67	17	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-79	39274	76594	Mar67	23	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-80	39246	76596	Mar67	21	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-81	39283	76605	Apr67	41	ND	Vad	6.0	669.00	NA	NA	216-Z-1A	FIR required
299-W18-82	38570	77101	ND	ND	146	Vad	8.0	680.00	None	NA	216-Z-18	FIR required
299-W18-85	38989	76717	Jul69	150	148	Vad	6.0	679.75	NA	NA	216-Z-1A	FIR required
299-W18-86	39106	76742	Aug69	150	147	Vad	6.0	683.49	NA	NA	216-Z-1A	FIR required
299-W18-87	38980	76604	Sep69	150	148	Vad	6.0	677.23	NA	NA	216-Z-1A	FIR required
299-W18-88	39298	76432	Sep69	150	150	Vad	6.0	679.76	NA	NA	216-Z-1A	FIR required

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(Page 2 of TBD)

WELL NUMBER	HANFORD NORTH	COORD WEST	DRILL DATE	DRILL DEPTH	MEAS DEPTH	DEPTH WATER	CASNG DIAM	CASNG ELEV	PERFORATE INTERVAL	SCREENED INTERVAL	FACILITY	DRAFT COMMENTS
299-W18-89	39360	76752	Sep69	150	150	Vad	6.0	681.32	NA	NA	216-Z-1A	FIR required
299-W18-93	38744	76905	Feb72	140	138	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-94	38662	76880	Feb72	80	83	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-95	38665	76970	Feb72	80	77	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-96	38825	76790	Feb72	80	77	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-97	38745	76790	Feb72	85	82	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-98	38940	76880	Feb72	80	75	Vad	6.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-99	38949	76768	Mar72	135	129	Vad	3.0	665.00	NA	NA	216-Z-18	FIR required
299-W18-149	39329	76602	Apr~~75~~ 74	100	75	Vad	6.0	672.56	NA	NA	216-Z-1A	FIR required, cement plug 75-100 ft.
299-W18-150	39075	76601	Jun~~73~~ 74	128	128	Vad	6.0	671.81	NA	NA	216-Z-1A	FIR required, deepened Jul77, grouted.
299-W18-158	39266	76650	Aug76	131	131	Vad	6.0	672.61	NA	NA	216-Z-1A	FIR required, deepened Sep77, grouted.
299-W18-159	39228	76602	Jan78	130	130	Vad	6.0	670.77	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-163	39284	76552	Feb77	163	163	Vad	8.0	670.00	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-164	39040	76602	Jan77	153	146	Vad	6.0	678.75	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-165	39180	76650	Mar77	135	128	Vad	6.0	672.09	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-166	39108	76650	Apr77	137	137	Vad	6.0	671.11	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-167	39214	76552	May77	134	ND	Vad	8.0	669.00	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-168	39043	76552	Jun77	131	ND	Vad	8.0	669.00	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-169	39073	76552	Sep77	132	ND	Vad	8.0	669.00	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-170	39154	76602	Sep76	30	30	Vad	6.0	672.32	NA	NA	216-Z-1A	FIR required, deepened Sep77, grouted.
299-W18-171	39010	76604	Aug77	136	127	Vad	8.0	677.65	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-172	39435	76595	Aug77	134	0	Vad	8.0	678.07	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-173	39307	76574	Oct77	51	0	Vad	8.0	673.31	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-174	39296	76565	Oct77	51	0	Vad	8.0	673.21	NA	NA	216-Z-1A	FIR required, grouted.
299-W18-175	39117	76600	Dec77	130	0	Vad	6.0	670.00	NA	NA	216-Z-1A	FIR required, grouted.

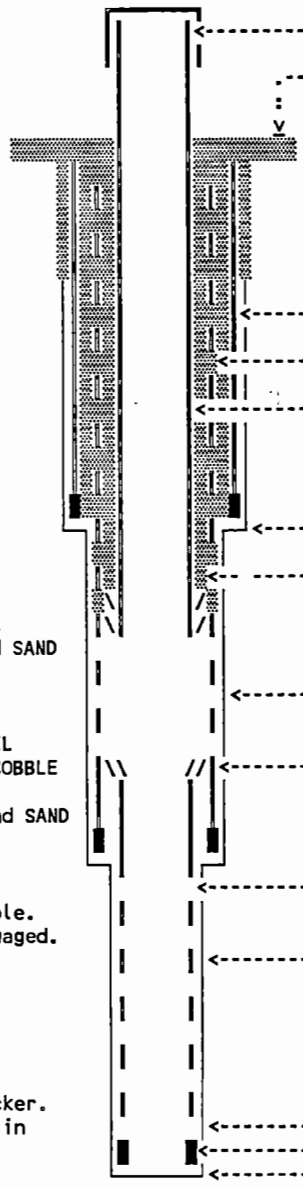
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Osborn	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 27Jan59	Date Complete: 24May59

WELL NUMBER: 299-W15-6	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,005	E/W W 75,765
State Coordinates: N 445,112	E 2,219,457
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: 190 ft May59
(Ground surface) ___

GENERALIZED STRATIGRAPHY	Driller's Log
0-10:	SAND and DIRT
10-15:	SAND
15-20:	SAND and GRAVEL
20-30:	SAND
30-35:	SAND and COBBLE
35-40:	SAND, GRAVEL and COBBLE
40-50:	SAND
50-65:	SAND and SILT
65-70:	SAND and GRAVEL
70-109:	SAND and SILT
109-110:	GRAVEL
110-115:	GRAVEL, CLAY and ROCK
115-120:	SAND and ROCK
120-130:	SAND, GRAVEL and CALICHE
130-135:	SAND
134-140:	COBBLE, GRAVEL and SAND
140-150:	SAND
150-160:	COBBLE, GRAVEL and SAND
160-175:	SAND and COBBLE
175-230:	SAND, GRAVEL and COBBLE
230-280:	COBBLE, CLAY, GRAVEL and SAND
280-285:	SAND, GRAVEL and COBBLE
285-305:	SAND
305-310:	COBBLE, CLAY and GRAVEL
310-315:	BOULDERS, CLAY and GRAVEL
315-385:	SAND, GRAVEL, CLAY and COBBLE
385-390:	SAND and GRAVEL
390-410:	COBBLES, CLAY, GRAVEL and SAND



Elevation of reference point: (top of casing) [661.50 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [0-10 ft]
Type of surface seal: Grout outside 10 in casing, 12 in pulled.
10 in casing 0-164 ft
8 in casing 0-307? ft.
6 in casing 301-410 ft and 0-178 ft
Type of riser pipes: All carbon steel
Diameter of borehole, 0-164 ft: [11 in nom]
Type of filler: Cement grout 0-178 ft 342 gals
Diameter of borehole, 164-307 ft [9 in nom]
8 in casing perforated: 175-300 and 0-175 ft
Depth top of perforations: 6 in casing [307 ft]
Diameter of borehole, 306-410 ft [7 in nom]
depth bottom of perforations: [408 ft]
Depth bottom 6 in casing: [410 ft]
Depth bottom of borehole: [410 ft]

DRILLER'S NOTES:
Attempted to pull 8 in casing, parted and left 125 ft (?) in hole. Cut 6 in casing at 301 ft and swaged.

REMEDIATION:
Mar87, by Garcia;
Perforated 8 in casing 0-175 ft, 2 cuts/ft/rd. Bad odor while perforating, went on mask.
Set 6 in casing to 178 ft on packer.
Grouted annulus between 6 and 8 in casing and poured pad.

Drawing By: RKL/2#W15#06.ASB Date: 11Dec90

Reference: Golder 8831752\14535

WELL CONSTRUCTION AND COMPLETION SUMMARY

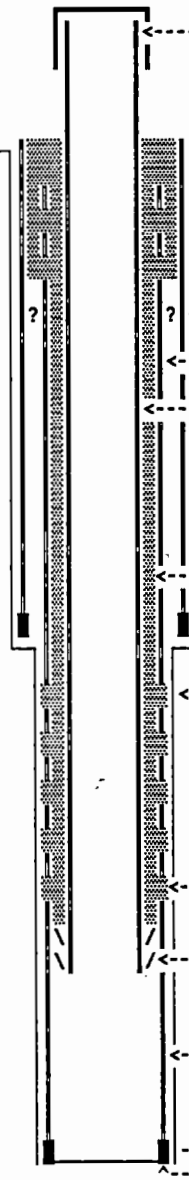
Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-W15-8	TEMPORARY WELL NO: 299-W15-83
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 39,740	E/W W 75,910
Driller's Name: Row/Jahnke; Bigham	WA State Lic Nr: Not documented	State Coordinates: N 444,847	E 2,219,313
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented	T___ R___ S___
Date Started: 04Oct54; 28Oct66	Date Complete: 06Oct54; 23Nov66	Elevation Ground surface (ft): Not documented	

Depth to water: 195 ft Nov66
(Ground surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-25: No log
25-55: GRAVEL and SAND
55-60: GRAVEL, SAND and SILT
60-65: SAND and SILT
65-106: Sandy SILT
▲ Oct54
▼ Nov66
106-113: SAND & SILT
113-120: SAND, SILT, GRAVEL & CALICHE
120-135: COBBLES
135-152: COBBLES & GRAVEL
152-155: GRAVEL, SILT & BOULDERS
155-185: BOULDERS & COBBLES
185-205: COBBLES & GRAVEL

REMEDIATION:
Mar87, by Garcia:
Perforated 6 in casing 1-15 and 112-175 ft, about 2 cuts/rd/ft.
Set 4 casing to 178 ft and grouted 4 and 6 in casing annulus.



Elevation of reference point: [667.79 ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [15 ft]
Type of surface seal: Partial, grout between 4, 6 and 8 in casing.
8 in casing 0-106.5 ft
6 in casing 0-206 ft
4 in casing 0-178 ft
Type of riser pipes: All carbon steel
Type of filler: Cement grout 0-178 ft
Diameter of borehole 0-107 ft [9 in nom]
Depth top of perforations: [112 ft]
Depth bottom of perforations: [175 ft]
4 in casing to 178 ft set on packer
No documentation of perforation, 175-205 ft.
Depth bottom 6 in casing: [205 ft]
Depth bottom of borehole: [205 ft]

Drawing By: RKL/2#W15#08.ASB Date: 27Nov90

Reference:
Golder 8831752\14534

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Osborn/Bigham	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 22Jan59; 23Nov66	Date Complete: 26Jan59; 14Dec66

WELL NUMBER: 299-W15-9	TEMPORARY WELL NO: 299-W15-94
Hanford Coordinates: N/S N 39,930	E/W W 75,890
State Coordinates: N 445,037	E 2,219,333
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

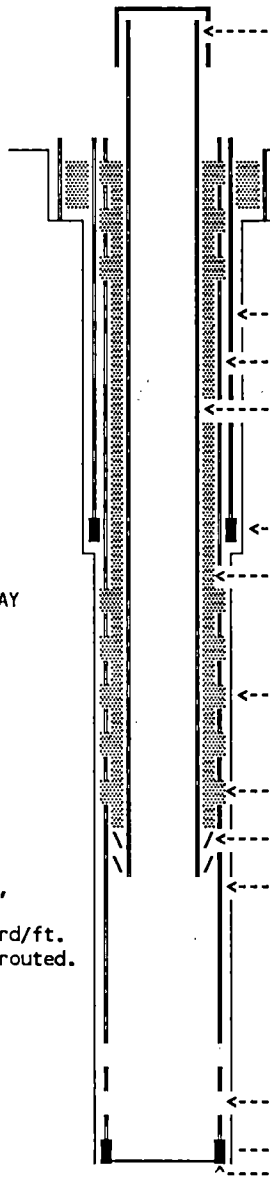
Depth to water: 184 ft Dec66
(Ground surface) ___

GENERALIZED STRATIGRAPHY — Driller's Log

0-20: SAND & SILT
20-33: SAND
33-38: SAND, GRAVEL & COBBLE
38-42: SAND & GRAVEL
42-50: SAND
50-62: SAND & SILT
62-74: SAND, SILT & COBBLE
74-100: SAND & SILT
▲ 1959
▼ 1966
100-107: SAND
107-112: SILTY CLAY
112-125: GRAVEL, SAND & SILT
125-135: SILT, SAND & COBBLE
135-140: SAND, CLAY & GRAVEL
140-150: GRAVEL, SAND & SILT
150-160: COBBLE, SAND & SILT
160-170: GRAVEL, SAND & SILT
170-175: SAND, SILT, GRAVEL & CLAY
175-180: SAND
180-182: SAND, GRAVEL & SILT
182-192: COBBLES & BOULDERS
192-194: BOULDERS, SAND & SILT

DRILLER'S NOTE:
Sealed 6 and 8 in casing. No perforation documented.

REMEDIATION:
Feb87, by Garcia;
Perforated 0-15 ft 2 cuts/rd/ft, 4 cuts at 20 ft and perforated 115-170 and 186-189 ft, 2 cuts/rd/ft.
Set 4 in casing to 180 ft and grouted.



Elevation of reference point: (top of casing) [662.30 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: ND
12 in casing to 10 ft (may be pulled?)
8 in casing 0-100 ft
6 in casing 0-194 ft
4 in casing 0-180 ft
Type of riser pipes: All carbon steel
Diameter of borehole, 10-100 ft [9 in nom]
Type of filler: Cement grout 0-180 ft, 300 gals
Diameter of borehole, 100-194 ft [7 in nom]
Perforated 115-170 ft, 2 cuts/rd/ft
4 in casing set to 180 on packer
Perforations not documented 170-186 ft
Perforated 186-189 ft, 2 cuts/rd/ft
Depth bottom 6 in casing: [194 ft]
Depth bottom of borehole: [194 ft]

Drawing By: RKL/2#W15#09.ASB Date: 27Nov90

Reference: Golder 8831752\14533

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: D. Ludtke
Drilling Company: Onwego Drilling Co
Date Started: 29Jul87

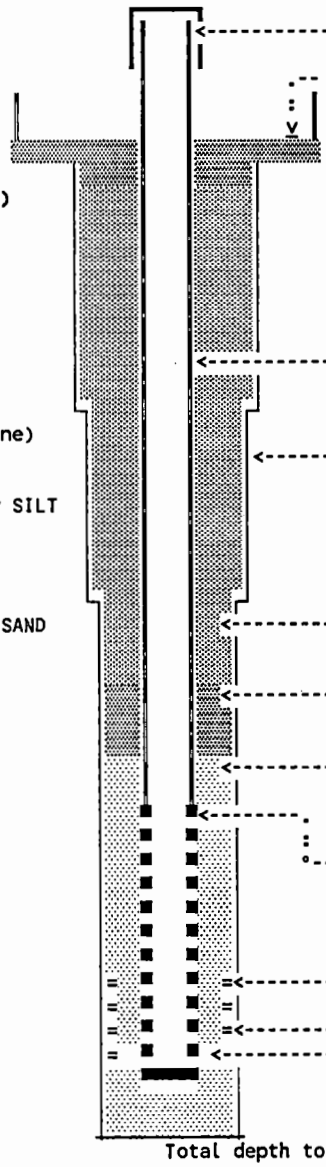
Sample Drive barrel Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Kennewick, WA
Date Complete: 10Sep87

WELL NUMBER: 299-W15-16
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 40,269 E/W W 77,387
State Coordinates: N 445,372 E 2,217,835
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 682.62 (Brass cap)

Depth to water: 214.5 Sep87
(Ground surface)

GENERALIZED Geologist's STRATIGRAPHY Log

*4-5: Slightly silty SAND
9-10: SAND (= Backhoe samples)
10-15: Sandy GRAVEL
15-20: SAND
20-35: Sandy GRAVEL
35-75: SAND
75-80: Sandy GRAVEL
80-85: Gravelly SAND
85-110: Sandy GRAVEL
110-115: Gravelly SAND
115-120: SAND to sandy GRAVEL (Lost drilling water zone)
120-135: Sandy GRAVEL
135-140: Sandy clayey GRAVEL
140-145: Slightly gravelly sandy SILT
145-160: Gravelly silty SAND and CALICHE
160-165: Gravelly silty SAND
165-170: Silty SAND
170-175: Slightly gravely silty SAND
175-180: Silty sandy GRAVEL
180-185: Slightly gravelly SAND
185-200: Silty sandy GRAVEL
200-205: Sandy GRAVEL
205-225: Silty sandy GRAVEL
225-235: Sandy GRAVEL
235-240: Slightly sandy GRAVEL
240-243.5: Sandy GRAVEL



Elevation of reference point: (top of casing) [684.89 ft]
Height of reference point above ground surface [2.27 ft]
Depth of surface seal [0-2 ft]
Type of surface seal: Pre-mix concrete 4-ft x 4-ft x 6-in surface pad. 4 equidistant protective posts.
I.D. of surface casing: (If present) [Removed]
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole,
0-62.6 ft, 13 in nominal
62.6-154.75 ft, 11 in nominal
154.75-243.5 ft, 9 in nominal
Type of filler: Bentonite slurry
Depth top of seal: [196.5 ft]
Type of seal: Volclay pellets
Depth top of sand pack: [202 ft]
10-20 mesh silica sand
Depth top of screen: [208.0 ft]
4-in, 20-slot stainless steel
Telescoping screen, top [227.5 ft]
8 in stainless steel, 10 slot
Telescoping screen, bottom [237.5 ft]
Depth bottom of screen [238.0 ft]

Total depth to bottom of borehole: [243.5 ft]

Drawing By: RKL/2#W15#16.ASB Date: 25Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

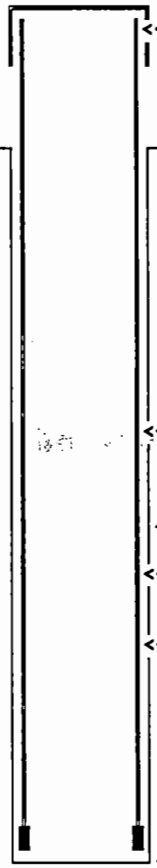
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Row/Gentz	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 30Sep54	Date Complete: 04Oct54

WELL NUMBER: 299-W15-82	TEMPORARY WELL NO: 2904 #1
Hanford Coordinates: N/S N 39,860	E/W W 75,810
State Coordinates: N 444,967	E 2,219,333
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: BACKFILL
15-44: GRAVEL
44-80: SAND & SILT
80-100: Sandy SILT



- Elevation of reference point: (top of casing) [660.09 ft]
- Height of reference point above ground surface [ND]
- Depth of surface seal [ND]
- Type of surface seal: None documented
- I.D. of surface casing (If present) [ND]
- I.D. of riser pipe: [8-in]
- Type of riser pipe: Carbon steel
- Diameter of borehole: [9-in nom]
- Type of filler: Not documented
- Elevation/depth top of seal
- Type of seal: Not documented
- No perforations documented:
- Depth bottom of casing
- Depth bottom of borehole: [101 ft]

Drawing By: RKL/2#W15#82.ASB Date: 28Nov90

Reference: _____

WELL CONSTRUCTION AND COMPLETION SUMMARY

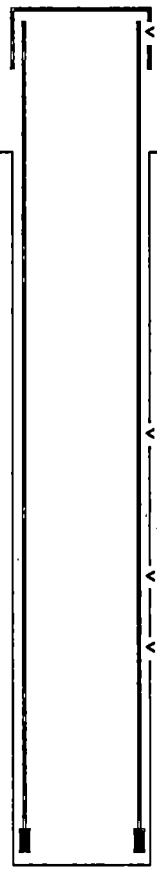
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Row/Jahnke	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 06Oct54	Date Complete: 10Oct54

WELL NUMBER: 299-W15-84 TEMPORARY WELL NO: 2904 #3
Hanford Coordinates: N/S N 39,860 E/W W 76,000
State Coordinates: N 444,967 E 2,219,223
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-20: Not documented
20-25: Blow SAND, GRAVEL
25-54: GRAVEL
54-110: SAND & SILT



Elevation of reference point: (top of casing) [669.82 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [110 ft]

Drawing By: RKL/2#W15#84.ASB Date: 27Nov90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

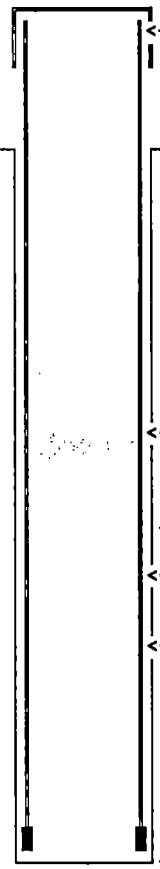
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Row/Jahnke	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 11Oct54	Date Complete: 12Oct54

WELL NUMBER: 299-W15-85 TEMPORARY WELL NO: 2904 #4
Hanford Coordinates: N/S N 39,970 E/W W 75,910
State Coordinates: N 445,077 E 2,219,313
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY Driller's Log

0-15: Backfill, SAND & SILT
15-20: SAND-SILT-GRAVEL
20-35: GRAVEL-SAND
35-45: Black SAND-fine GRAVEL
45-48: GRAVEL
48-55: SAND-very little SILT
55-90: SAND-some SILT
90-105: Sandy SILT



Elevation of reference point: (top of casing) [664.11 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [106 ft]

Drawing By: RKL/2#W15#85.ASB Date: 28Nov90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Osborn/Bigham	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 22Jan59; 23Nov66	Date Complete: 26Jan59; 14Dec66

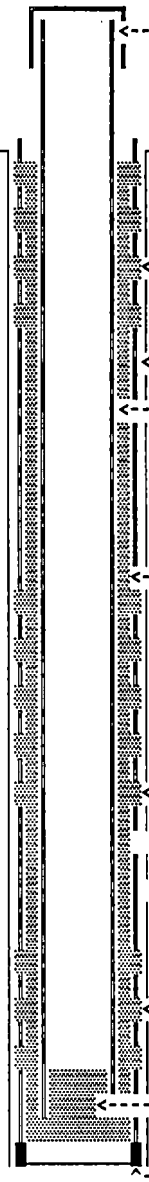
WELL NUMBER: 299-W15-86 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,790 E/W W 75,958
State Coordinates: N 444,897 E 2,219,265
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY Driller's Log

0-10: Topsoil-SAND & SILT
10-13: GRAVEL
13-15: SAND-GRAVEL-SILT
15-22: Black SAND-small GRAVEL
22-24: GRAVEL-SAND
24-32: GRAVEL
32-40: Coarse SAND
40-44: GRAVEL
44-47: GRAVEL-some SAND
47-66: SAND-some SILT
66-78: SAND-more SILT
78-112: SAND & 30% SILT
112-122: 75% GRAVEL-15% SAND-10% SILT-some CALICHE
122-132: 60% GRAVEL-20% SAND-20% SILT-CONGLOMERATION
132-136: 60% SAND-20% GRAVEL-20% SILT
136-142: Fine SAND

REMEDIATION:
Mar87, by Garcia
Perforated 0-20, 90-105 and 115-135 ft. Set 6 in casing to 142 ft. Plugged 6 in with 9 gals cement. Grouted 6 and 8 in casing annulus.



Elevation of reference point: (top of casing) [660.00 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: ND
Perforated 0-20, 2 cuts/rd/ft
8 in casing 0-144 ft
4 in casing 0-142 ft
Type of riser pipes: All carbon steel
Diameter of borehole, 0-144 ft [9 in nom]
Type of filler: Cement grout 0-142 ft 216 gals
Perforated 90-105 ft, 2 cuts/rd/ft
Perforated 115-135 ft, 2 cuts/rd/ft
Cement plug to about 136 ft
Depth bottom 8 in casing: [144 ft]
Depth bottom of borehole: [144 ft]

Drawing By: RKL/2#W15#86.ASB Date: 27Nov90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

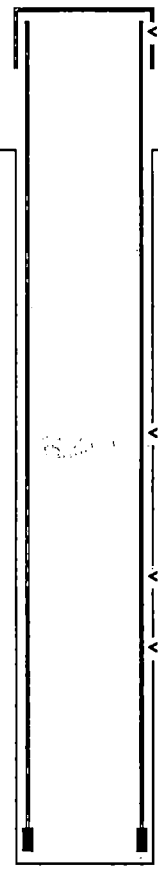
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Osburn	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 19Jan59	Date Complete: 21Jan59

WELL NUMBER: 299-W15-95	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,930	E/W W 75,925
State Coordinates: N 445,037	E 2,219,298
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: SAND & DIRT
5-13: SAND-GRAVEL
13-18: Pea GRAVEL
18-30: SAND-GRAVEL
30-38: SAND-GRAVEL & COBBLE
38-43: SAND
43-80: SAND & SILT
80-91: Sandy SILT
91-100: SAND & SILT



Elevation of reference point: (top of casing)	[660.00 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[100 ft]

Drawing By: RKL/2#W15#95.ASB Date: 28Nov90

Reference: _____

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Bigham
Drilling Company: Hatch Drilling Co
Date Started: 16Jan67

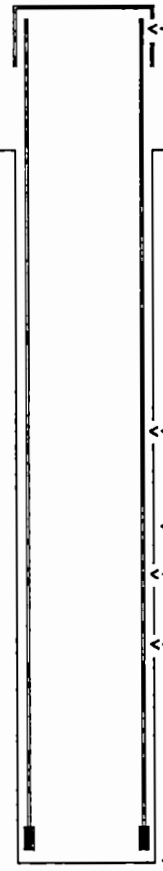
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: Not documented

WELL NUMBER: 299-W15-101
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,890 E/W W 75,860
State Coordinates: N 444,997 E 2,219,363
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: Fine SAND-SILT
5-10: Fine SAND-SILT-some small GRAVEL
10-20: Coarse SAND-pea GRAVEL
20-25: Coarse SAND-pea GRAVEL, little SILT
25 : Nedium SAND & SILT, with GRAVEL to 3 in.
25-50: Not documented



Elevation of reference point: (top of casing) [660.00 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [50 ft]

Drawing By: RKL/2W15-101.ASB Date: 28Nov90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: L. Bach
Drilling Company: Bach Drilling Co.
Date Started: 26Nov63

Sample Method: Drive barrel & Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 15Jan64

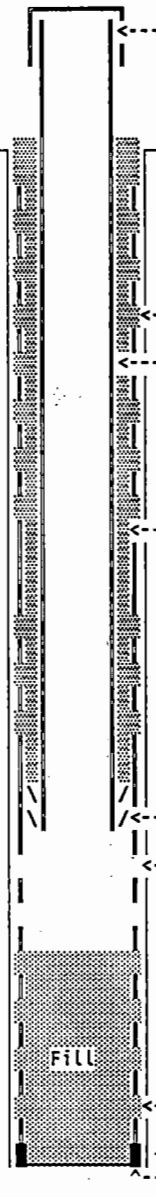
WELL NUMBER: 299-W18-6
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,212 E/W W 76,706
State Coordinates: N 444,317 E 2,218,519
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 200 ft Jan64
(Ground surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: SAND
15-25: Coarse GRAVEL
25-32: Medium coarse GRAVEL
32-50: GRAVEL
50-65: Fine SAND, medium GRAVEL
65-70: Fine SAND
70-90: Moist fine SAND
90-95: Moist fine SAND to coarse GRAVEL
95-114: Fine SAND to small BOULDERS with GRAVEL
114-116: Big BOULDERS
116-121: SAND, CLAY big BOULDERS
121-130: SAND, CLAY
130-148: SAND, CLAY, GRAVEL
148-155: SAND, GRAVEL
155-160: GRAVEL
160-172: SAND, GRAVEL, BOULDERS
172-178: SAND, GRAVEL
178-180: COBBLES, SAND, GRAVEL
180-185: COBBLES, SAND
185-205: BOULDERS, COBBLES, SAND
205-275: SAND, GRAVEL/COBBLES
275-277: SAND, pea GRAVEL to COBBLES
277-287: SAND, GRAVEL
287-300: SAND, CLAY, GRAVEL

REMEDIATION:
May83 by Evans;
Pulled piezometer, perforated and ran 6 in liner. Grouted annulus 0-156 ft with 236 gals cement and cleaned out to about 210 ft.



Elevation of reference point: [678.47 ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: ND

8 in casing 0-300 ft

6 in casing 0-156 ft

Type of riser pipes:
All carbon steel

Type of filler:
Cement grout 0-150 ft
Perforated 2 cuts/rd/ft
0-85 and 100-150 ft

6 in casing to 156 ft set on packer

Depth top of perforations: [190 ft]
6 cuts rd/ft, 190-249 ft
4 cuts rd/ft, 250-298 ft

Depth bottom of perforations: [298 ft]

Depth bottom 6 in casing: [300 ft]
Depth bottom of borehole: [300 ft]

Drawing By: RKL/2#W18#06.ASB Date: 04Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

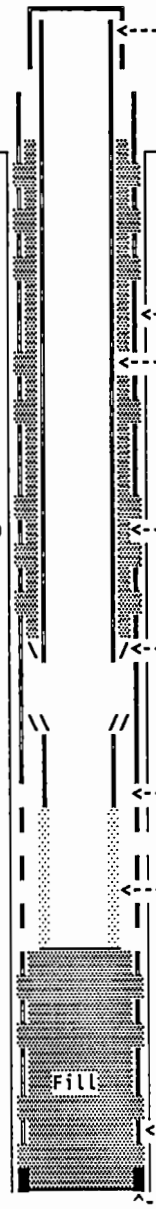
Drilling Method: Cable tool	Sample Drive barrel Method: Hard tool	WELL NUMBER: 299-W18-7	TEMPORARY WELL NO:
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 39,204	E/W W 76,491
Driller's Name: E. Close	WA State Lic Nr: Not documented	State Coordinates: N 444,309	E 2,218,734
Drilling Company: Bach Drilling Co	Company Location: Not documented	Start Card #: Not documented	T___ R___ S___
Date Started: 27Nov63	Date Complete: 13Jan64	Elevation Ground surface (ft): Not documented	

Depth to water: 204 Dec63
(Ground surface)

GENERALIZED STRATIGRAPHY Driller's Log

0-15: Fine SAND
15-25: 1/2 in GRAVEL to fine SAND
25-30: Coarse SAND and small GRAVEL
30-60: Small GRAVEL to fine SAND
60-85: Brown SAND
85-90: Brown SAND, some CLAY
90-95: Brown SAND with GRAVEL
95-105: 1/4-1/2 GRAVEL to fine SAND
105-115: GRAVEL
115-124: Large GRAVEL to fine SAND
124-133: CLAY with brown SAND
133-160: CLAY, SAND and GRAVEL
160-220: GRAVEL and brown SAND
220-225: COBBLE STONES to fine brown SAND
225-245: Heavy GRAVEL to fine brown SAND
245-250: GRAVEL and fine SAND
250-255: GRAVEL and fine SAND and BOULDERS
255-265: GRAVEL to fine SAND
265-295: GRAVEL and SAND
295-300: GRAVEL and SAND, a little CLAY

REMEDIATION:
Mar72 by Bigham;
Cleaned well, had 100 ft of fill.
Set screen to 216 ft and developed
May83 by David;
Perforated well, noticed bad odor from well. Set packer to 157 ft and grouted annulus with 236 gals of cement.



Elevation of reference point: [678.99 ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: ND

8 in casing +3-300 ft

6 in casing +3-157 ft

Type of riser pipes:
All carbon steel

Type of filler:
Cement grout 0-157 ft

6 in casing set to 157 ft on packer
Perforated 0-4-, 55-85 and 100-150 ft
2 cuts/rd/ft

Depth to top of perforations: [190 ft]
6 cuts/rd/ft,
190-250, 270-298 ft

Screen 196-216 ft, blank 186-196 ft
#15 screen, plate on bottom,
top split and belled out

Depth bottom of perforations: [298 ft]

Depth bottom 6 in casing: [300 ft]
Depth bottom of borehole: [300 ft]

Drawing By: RKL/2#W18#07.ASB Date: 04Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Bigham	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 19Nov68	Date Complete: 13Dec68

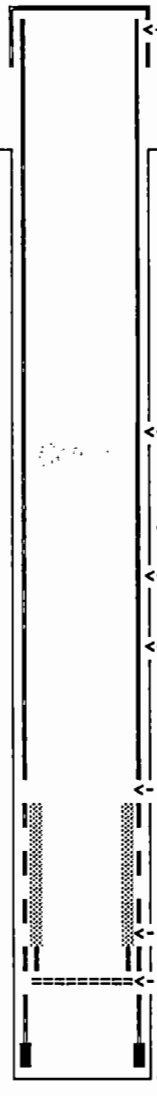
WELL NUMBER: 299-W18-9 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,852 E/W W 78,846
State Coordinates: N 443,956 E 2,218,380
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 194 ft Dec68

GENERALIZED STRATIGRAPHY — Driller's Log

0-35: Coarse SAND
35-45: SAND & GRAVEL
45-60: SAND, GRAVEL & COBBLES
60-110: SAND & SILT
110-115: SAND & GRAVEL
115-135: SAND, GRAVEL & COBBLES
135-140: SILT
140-150: CLAY
150-153: SAND & GRAVEL
153-158: SILT
158-165: GRAVEL & COBBLES
165-175: SILT, GRAVEL, Basalt BOULDERS
175-185: SAND, GRAVEL & BOULDERS
185-195: SAND, GRAVEL & COBBLES
195-220: SAND & GRAVEL

REMEDIATION:
Feb 72, by Evans;
Set 30 ft of 5 in #10 screen and 5 ft of 5 in pipe. Placed wood plug at 217 ft. 5 ft pipe placement not documented. Assumed on bottom.



Elevation of reference point: [682.47 ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [ND]
Type of surface seal: None documented

I.D. of surface casing [ND]
(If present)

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

Depth top of perforations: [180 ft]
Description of perforations:
180-189 ft, 4 cuts/rd/ft
190-200 ft, 4 cuts/rd/ft
200-218 ft, 2 cuts/rd/ft

5 in screen, #10 ~ 182-212 ft
5 ft tail pipe 212-217 ft
Wood plug at 217 ft
Depth bottom of perforations: [218 ft]

Depth bottom of casing
Depth bottom of borehole: [220 ft]

Drawing By: RKL/2#W18#09.ASB Date: 27Nov90

Reference: Golder 8831752\14554

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Hatch	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co.	Company Location: Pasco, WA
Date Started: 21Nov68	Date Complete: 11Dec68

WELL NUMBER: 299-W18-10 TEMPORARY WELL NO:

Hanford Coordinates: N/S N 38,847 E/W W 76,803

State Coordinates: N 443,952 E 2,218,422

Start Card #: Not documented T R S

Elevation Ground surface (ft): Not documented

Depth to water: 194 ft Dec68

GENERALIZED STRATIGRAPHY — Driller's Log

0-35: SAND
35-55: SAND & GRAVEL
55-60: SAND, SILT & GRAVEL
60-100: SAND & SILT
100-105: SAND, SILT, GRAVEL & CALICHE
105-110: SAND, SILT & GRAVEL
110-125: SAND & GRAVEL
125-135: SAND, SILT & GRAVEL
135-160: SAND & CLAY
160-175: SAND, CLAY & GRAVEL
175-200: SAND & GRAVEL
200-205: SAND
205-210: SAND & GRAVEL
210-220: SAND

Elevation of reference point: [682.63 ft]
(top of casing)

Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

Depth top of perforations: [180 ft]
Description of perforations: 180-218 ft, 4 cuts/rd/ft

Depth bottom of perforations: [218 ft]

Depth bottom of casing
Depth bottom of borehole: [220 ft]

Drawing By: RKL/2#W18#10.ASB Date: 27Nov90

Reference: Golder 8831752\14553

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Drive barrel & Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Bigham	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co.	Company Location: Pasco, WA
Date Started: 17Dec68	Date Complete: 04Jan69

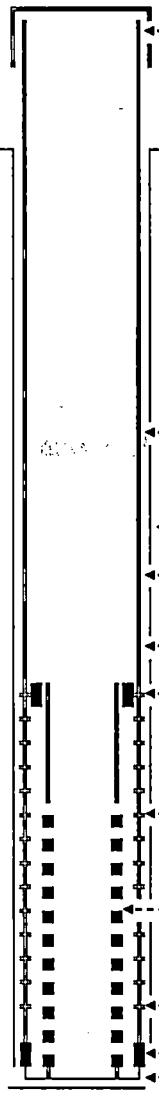
WELL NUMBER: 299-W18-11	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,735	E/W W 76,955
State Coordinates: N 443,839	E 2,218,271
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: 194 ft Jan69

GENERALIZED STRATIGRAPHY — Driller's Log

0-35: SAND, small GRAVEL
35-40: SAND, large GRAVEL
40-55: SAND, GRAVEL
55-57: SAND
57-85: 30% SAND & 70% SILT
85-110: SAND & SILT
110-115: SAND & GRAVEL
115-135: SAND, GRAVEL, COBBLES
135-140: SILT
140-150: Brown CLAY
150-155: SAND & GRAVEL
155-160: SILT
160-165: GRAVEL & COBBLES
165-170: SILT, GRAVEL, COBBLES
170-180: SAND, GRAVEL, BOULDERS
180-195: SAND, GRAVEL, COBBLES
195-220: SAND, GRAVEL

REMEDIATION:
Aug70, by Hatch
Cleaned well and installed screen



Elevation of reference point: (top of casing)	[683.00 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Depth top of perforations:	[180 ft]
Description of perforations: 180-200 ft, 4 cuts/ft; 200-218 ft, 2 cuts/ft	
Screen 190-220 ft; 1 ft blank with plug on bottom; 10 ft blank on top with lead packer	
Depth bottom of perforations:	[218 ft]
Depth bottom of casing:	[220 ft]
Depth bottom of borehole:	[220 ft]

Drawing By: RKL/2#W18#11.ASB Date: 08Mar91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name:
Drilling Company:
Date Started:

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location:
Date Complete:

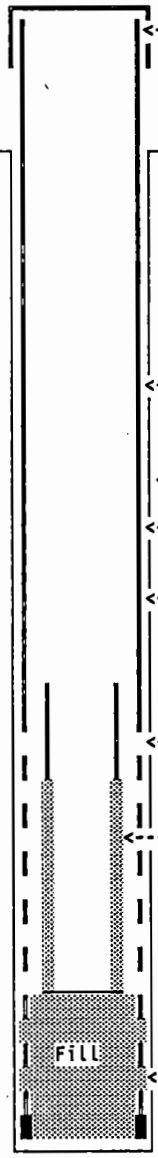
WELL NUMBER: 299-W18-12
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,850 E/W W 76,955
State Coordinates: N 443,954 E 2,218,270
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 203 ft Mar72

GENERALIZED STRATIGRAPHY — Driller's Log

0-220 ft: Not documented

REMEDIATION:
Mar72 by Bigham;
Cleaned well and installed screen.



Elevation of reference point: (top of casing) [683.00 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [190 ft]
Description of perforations:
Screen 194-214 ft, capped bottom
#10 Johnson stainless steel
Blank 189-194 ft
Depth bottom of perforations: [218 ft]
Depth bottom of casing
Depth bottom of borehole: [220 ft]

Drawing By: RKL/2#W18#12.ASB Date: 04Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

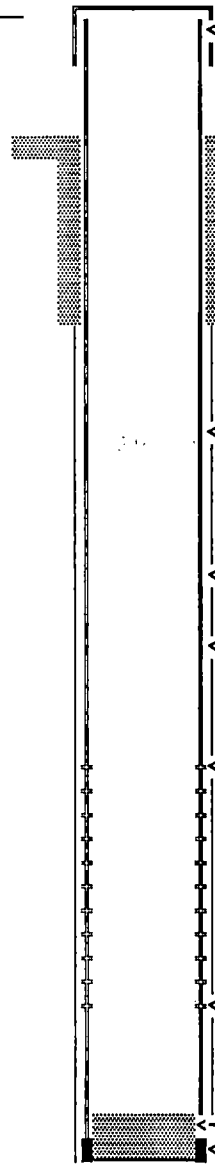
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Not documented	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 25Jun81	Date Complete: 15Sep81

WELL NUMBER: 299-W18-17 TEMPORARY WELL NO: Not documented
Hanford Coordinates: N/S N 39,256 E/W W 76,091
State Coordinates: N 444,362 E 2,219,133
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 205 ft Sep81
(Ground surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-246: No record
246-265: SAND with some PEBBLES, COBBLES and SILT



Elevation of reference point: (top of casing)	[Not Surveyed]
Height of reference point above ground surface	[2.5 ft]
Depth of surface seal	[20.0 ft]
Type of surface seal: Cement 2 ft round pad, grout to 20 ft	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Depth top of perforations:	[220.0 ft]
Description of perforations: 2 cuts/rd/ft	
Depth bottom of perforations:	[250.0 ft]
Cement plug to 262.0 ft	
Depth bottom of casing:	[265.0 ft]
Depth bottom of borehole:	[265.0 ft]

Drawing By: RKL/2#W18#17.ASB Date: 28Jan91

Reference: Golder 8831752\14549

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: John G
Drilling Company: Not documented
Date Started: 04Aug81

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documneted
Date Complete: 10Sep81

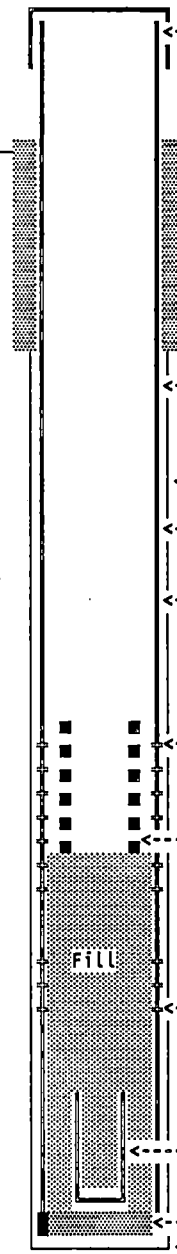
WELL NUMBER: 299-W18-18
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,903 E/W W 76,270
State Coordinates: N 444,009 E 2,218,955
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 205 ft Aug81
187 ft Oct84

GENERALIZED STRATIGRAPHY — Driller's Log

0-17: SAND & GRAVEL
17-45: Loose GRAVEL (Gray)
45-48: SAND layer
48-55: GRAVEL consolidated (brown)
55-72: BOULDERS & GRAVEL
72-135: SAND
135-140: Brown CLAY
140-146: White CLAY
146-162: Ringold
162-165: SAND layer (Heaving SAND)
165-170: SAND & GRAVEL (Heaving SAND)
170-185: Ringold
185-190: SAND - GRAVEL mix
190-205: Ringold
205-210: Ringold & SAND layer
210-215: Ringold SAND mix
215-218: SAND (Water heaving SAND)
218-220: SAND - small GRAVEL (Heaving)
220-225: 1/2 in minus GRAVEL
DRILLER'S NOTE: Fine sand starts at at 205, coarse enough to perforate at 215.
225-245: SAND small grain (screenable)
DRILLER'S NOTE: Large enough to perforate in, small slots
245-255: SAND
255-265: COBBLES & GRAVEL

REMEDIATION:
Feb84, L. Bultena
Perforated 185-210 ft.
Lost bailer, covered with sand.
Set screen 183-204 ft.



Elevation of reference point: [ND]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [20 ft]

Type of surface seal: Portland #2 cement to 20 ft

I.D. of surface casing [12 in pulled]
(If present)

I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [9-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

Depth top of perforations: [185 ft]
Description of perforations:
185-210 ft, 4 cuts/rd/ft
215-225 ft, 2 cuts/rd/ft

Screen 183-204
#10 slot

Depth bottom of perforations [225 ft]

Lost bailer, 245-260 ft

Cement plug at bottom
Depth bottom of borehole: [265 ft]
Depth bottom of casing

Drawing By: RKL/2#W18#18.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: J. Bultena
Drilling Company: Hatch Drilling Co
Date Started: 25May82

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 28Jun82

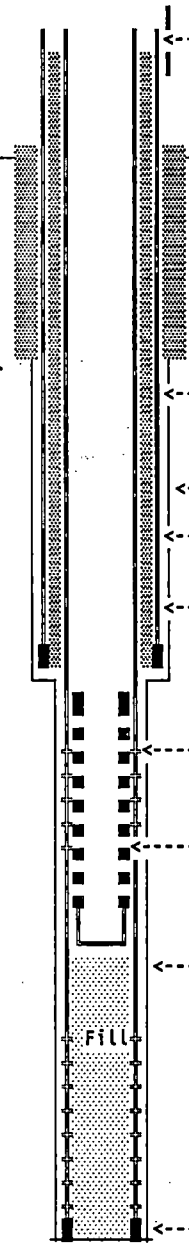
WELL NUMBER: 299-W18-19
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,503 E/W W 76,403
State Coordinates: N 443,609 E 2,218,823
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: ND Jun82
189 ft Feb84

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: TOP SOIL & some black SAND
15-25: Black SAND, SILT & GRAVEL
25-45: SAND & GRAVEL
45-70: SAND & SILT
70-75: Some black SAND & sandy SILT
75-85: Some fine SAND mixed with black SAND
85-90: More black SAND
90-95: Black SAND coming in with water
95-105: Black SAND with some small GRAVEL
105-110: Brown silty CLAY
110-115: Brown CLAY (no water coming in)
115-125: Heaving SAND & some small GRAVEL
125-130: Cemented spots of smalll GRAVEL & SAND
130-145: Cemented SAND & GRAVEL
145-160: COBBLES in RIngold
160-170: Ringold, tam, very hard
170-180: COBBLES cemented in Ringold (very hard to drill)
180-188: COBBLES & GRAVEL
188-200: COBBLE, SAND & GRAVEL
200-205: Cemented GRAVEL
205-215: Heaving SAND
215-220: Some SILT with heaving SAND
220-225: More consolidated SILT & some GRAVEL (darker brown)
225-230: Unconsolidated Ringold
230-240: SAND & GRAVEL (cemented in spots)
240-250: Cemented SAND, SILT & GRAVEL

REMEDIATION:
Feb84, L. Bultena
Perforated 185-195 ft
Set screen and bailed well



Elevation of reference point: (top of casing) [ND]
Height of reference point above ground surface [ND]
Depth of surface seal [20 ft]
Type of surface seal: Portland #2 cement to 20 ft
I.D. of surface casing (If present) [10 in pulled]
I.D. of riser pipe: [6 & 8-in]
Type of riser pipe: Carbon steel
Diameter of borehole; 0-178 ft [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [185 ft]
Description of perforations: 185-195 ft, 4 cuts/rd/2 rds ft; 220-250 ft, 4 cuts/rd/ft
6-in telescoping screen 175-205 ft # 10 slot with packer and 5 ft extension with plate on bottom
Diameter of borehole; 178-250 ft [7-in nom]
Depth bottom of perforations
Depth bottom of borehole: [250 ft]
Depth bottom of 6-in casing

Drawing By: RKL/2#W18#19.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

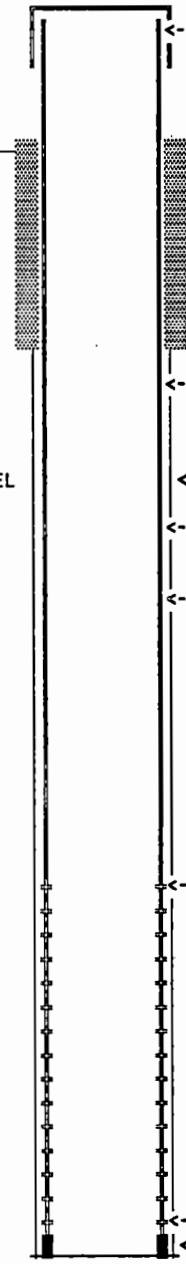
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: J. Bultena	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 25May82	Date Complete: 28Jun82

WELL NUMBER: 299-W18-20	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,103	E/W W 76,477
State Coordinates: N 443,209	E 2,218,750
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: ND Jun82
189 ft Feb84

GENERALIZED STRATIGRAPHY — Driller's Log

5-10: TOP SOIL & black SAND
10-25: Black SAND, & GRAVEL
25-40: SAND & GRAVEL
40-45: SAND, GRAVEL & some SILT
45-50: SAND, SILT & some small GRAVEL
50-60: SAND & SILT (tan)
60-65: SAND, SILT some GRAVEL (tan)
65-75: SILT & GRAVEL (tan & gray)
75-80: More GRAVEL, SAND & SILT
80-85: Cemented GRAVEL & SILT
85-90: Cemented BOULDERS
90-95: Cemented COBBLES & SILT
95-110: SILT & some small GRAVEL
110-125: SILT, SAND & some small GRAVEL
125-135: SILT & SAND
135-140: Cemented GRAVEL & fine SAND
140-160: Ringold
160-165: Ringold & COBBLES
165-175: Ringold & COBBLES & BOULDERS
175-190: Hard RInmgold & BOULDERS
190-200: Ringold & large COBBLES
200-210: Ringold cemented COBBLES & GRAVEL
210-220: Ringold & COBBLES
220-225: Hard RIngold
225-235: Ringold (tan) SAND & small GRAVEL in spots
235-245: Ringold (tan & gray) SAND in spots
245-250: Ringold (tan) making SAND in spots



Elevation of reference point: (top of casing)	[ND]
Height of reference point above ground surface	[ND]
Depth of surface seal	[20 ft]
Type of surface seal: Cement to 20 ft	
I.D. of surface casing (If present)	[10 in pulled]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole; 0-250 ft	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Depth top of perforations:	[220 ft]
Description of perforations: 220-249 ft, 4 cuts/rd/ft	
Depth bottom of perforations	[249 ft]
Depth bottom of borehole:	
Depth bottom of 8-in casing	[250 ft]

Drawing By: RKL/2#W18#20.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: R. Vance
Drilling Company: Onwego Drilling Co
Date Started: 21May87

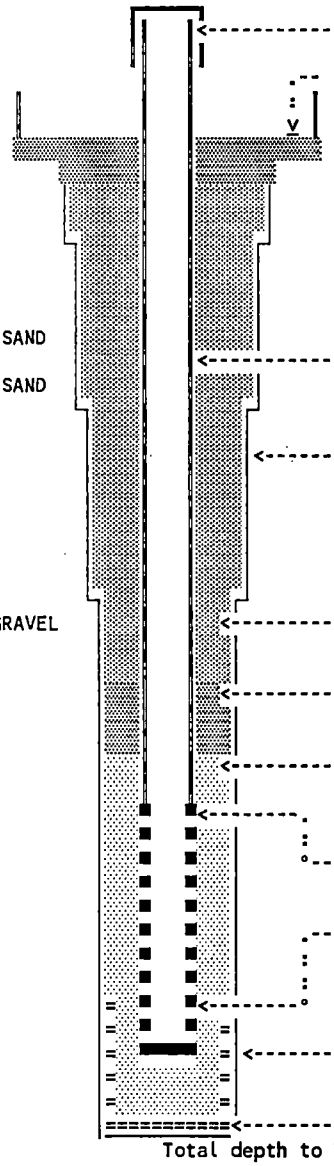
Sample Drive barrel Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Kennewick, WA
Date Complete: 10Aug87

WELL NUMBER: 299-W18-24
TEMPORARY WELL NO: Not documented
Hanford Coordinates: N/S N 38,998 E/W W 77,180
State Coordinates: N 444,102 E 2,218,045
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): 682.18 (Brass cap)

Depth to water: 213 ft Aug87
(Ground surface)

GENERALIZED STRATIGRAPHY Log — Geologist's Log

0-17: Slightly silty SAND
17-20: Slightly gravelly SAND
20-38: SAND
38-45: Gravelly SAND
45-50: Slightly gravelly SAND
50-55: Slightly silty, slightly gravelly SAND
55-65: Slightly silty, gravelly SAND
65-80: SAND
80-85: Slightly silty, gravelly SAND
85-90: Slightly silty SAND
90-112: Silty SAND
112-120: Sandy GRAVEL
120-125: GRAVEL
125-135: Sandy GRAVEL
135-150: Silty SAND
150-160: Sandy GRAVEL
160-170: SAND
170-175: Sandy GRAVEL
175-190: Slightly silty, sandy GRAVEL
190-195: Sandy GRAVEL
195-205: Silty sandy GRAVEL
205-210: Sandy GRAVEL
210-215: Gravelly silty SAND
215-220: Slightly sandy GRAVEL
220-240: Sandy GRAVEL



Elevation of reference point: [684.35 ft]
(top of casing)
Height of reference point above ground surface: [2.2 ft]
Depth of surface seal: [0-5 ft]
Type of surface seal: Portland cement 4-ft x 4-ft x 6-in surface pad. 4 equidistant protective posts.
I.D. of surface casing: [Removed]
(If present)
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole,
0-10.5 ft, 17 in nominal
10.5-70.2 ft, 13 in nominal
70.2-153.2 ft, 11 in nominal
153.2-240 ft, 9 in nominal
Type of filler: Volclay grout
Depth top of seal: [191 ft]
Type of seal: Volclay pellets
Depth top of sand pack: [198 ft]
20-30 mesh silica sand
Depth top of screen: [205.5 ft]
4-in, 20-slot stainless steel
Depth bottom of screen: [235.5 ft]
Depth bottom of plugged blank section: [NA]
Depth top of telescoping screen [230 ft]
8-in stainless steel 10 slot
Depth bottom telescoping screen [240 ft]
Total depth to bottom of borehole: [240 ft]

Drawing By: RKL/2#W18#24.ASB Date: 04Dec90
Reference: ___

WELL CONSTRUCTION AND COMPLETION SUMMARY

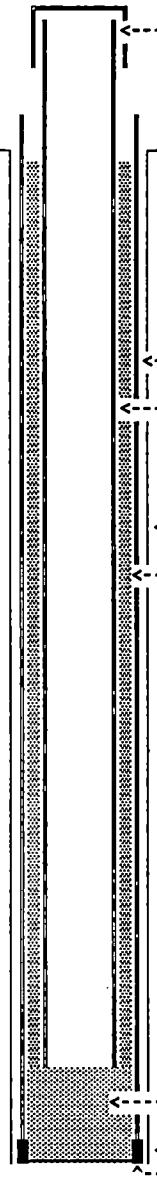
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Rodda	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: 28Mar49	Date Complete: Apr49

WELL NUMBER: 299-W18-65	TEMPORARY WELL NO: 234-5-6
Hanford Coordinates: N/S N 39,373	E/W W 76,589
State Coordinates: N 444,478	E 2,218,635
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: SAND & SILT
15-50: SAND, GRAVEL & SILT
(Backfill to 17 ft)
50-85: SAND & SILT
85-115: SAND, GRAVEL & SILT
115-125: SAND, CLAY & SILT
125-135: SILT, CLAY & SAND
135-145: CALICHE, SAND & GRAVEL
145-147: SAND, GRAVEL & CALICHE
147-150: Coarse SAND, GRAVEL & SILT



Elevation of reference point: (top of casing) [676.94 ft]

Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: ND

8 in casing 0-150 ft

4 in casing 0-140 ft

Type of riser pipes: All carbon steel

Diameter of borehole, 0-150 ft [9 in nom]

Type of filler: Bentonite and cement grout 0-140 ft between 4 and 8 in casing

Fill to about 140 ft

Depth bottom 8 in casing: [150 ft]

Depth bottom of borehole: [150 ft]

Drawing By: RKL/2#W18#65.ASB Date: 05Dec90

Reference: ___

WELL CONSTRUCTION AND COMPLETION SUMMARY

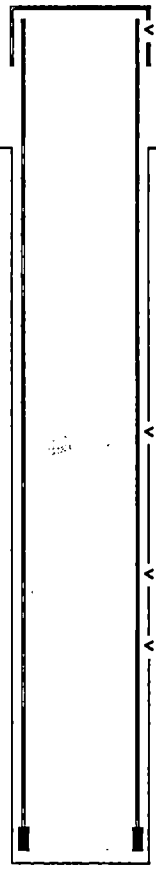
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Not documented	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: Not documented	Date Complete: Sep49

WELL NUMBER: 299-W18-67 TEMPORARY WELL NO: 234-12
Hanford Coordinates: N/S N 39,399 E/W W 76,534
State Coordinates: N 444,504 E 2,219,690
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY Driller's Log

0-47: Not documented



Elevation of reference point: [668.00 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [47 ft]

Drawing By: RKL/2#W18-67.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

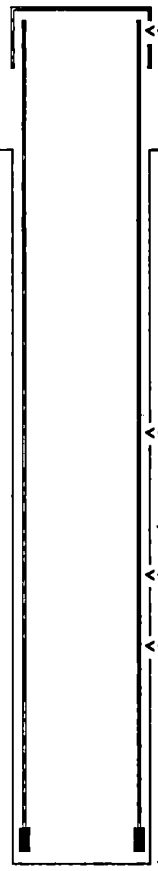
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Not documented	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: Not documented
Date Started: Not documented	Date Complete: Sep49

WELL NUMBER: 299-W18-68 TEMPORARY WELL NO: 234-13
Hanford Coordinates: N/S N 39,371 E/W W 76,506
State Coordinates: N 444,476 E 2,219,718
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-46: Not documented



- Elevation of reference point: (top of casing) [668.00 ft]
- Height of reference point above ground surface [ND]
- Depth of surface seal [ND]
- Type of surface seal: None documented
- I.D. of surface casing (If present) [ND]
- I.D. of riser pipe: [8-in]
- Type of riser pipe: Carbon steel
- Diameter of borehole: [9-in nom]
- Type of filler: Not documented
- Elevation/depth top of seal
- Type of seal: Not documented
- No perforations documented:
- Depth bottom of casing
- Depth bottom of borehole: [46 ft]

Drawing By: RKL/2#W18-68.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Not documented	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 27Mar67	Date Complete: 28Mar67

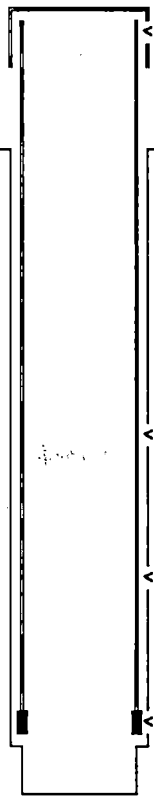
WELL NUMBER: 299-W18-76 TEMPORARY WELL NO: 299-W18-56A
Hanford Coordinates: N/S N 39,318 E/W W 76,610
State Coordinates: N 444,423 E 2,218,614
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-9: Fine SAND, dry
9-11: Large GRAVEL & fine SAND, dry
11-11.5: Large GRAVEL & SAND, light moisture
11.5-12: Large GRAVEL & coarse SAND, dry
12-19.5: Coarse SAND, dry
19.5 : SAND wet

DRILLER'S NOTES:
Contamination encountered:
4 & 7 ft = contaminated from barrel
8→18 ft = <500 dp/m
19.5 ft = 40,000 dp/m



Elevation of reference point: [669.00 ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
6 in casing to 18.5 ft
Depth bottom of borehole: [19.5 ft]

Drawing By: RKL/2#W18-76.ASB Date: 11Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Not documented
Drilling Company: Hatch Drilling Co
Date Started: 28Mar67

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 30Mar67

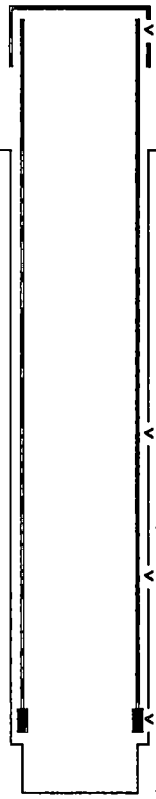
WELL NUMBER: 299-W18-77
TEMPORARY WELL NO: 299-W18-56B
Hanford Coordinates: N/S N 39,273 E/W W 76,608
State Coordinates: N 444,378 E 2,218,616
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

6-7: Fine SAND & some GRAVEL
light moisture
7-10: Large GRAVEL, fine SAND
light moisture
10-17.5: Coarse SAND & GRAVEL, dry
17.5-20: Coarse SAND, light moisture
20-25: Coarse SAND, dry
25 : Coarse SAND, very light moisture

DRILLER'S NOTES:
Contamination encountered:
None, 6-25 ft = <500 dp/m



Elevation of reference point: [669.00 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
6 in casing to 23 ft
Depth bottom of borehole: [25 ft]

Drawing By: RKL/2#W18-77.ASB Date: 11Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-78	TEMPORARY WELL NO: 299-W18-57A
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 39,308	E/W W 76,600
Driller's Name: Not documented	WA State Lic Nr: Not documented	State Coordinates: N 444,413	E 2,218,624
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented	T ___ R ___ S ___
Date Started: 30Mar67	Date Complete: 30Mar67	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

4-12: Fine SAND, some large GRAVEL
light moisture
12-14: Large GRAVEL, dry
14-17: Coarse SAND,
light moisture

DRILLER'S NOTES:
Contamination encountered:
17 ft = 40,000 dp/m

Elevation of reference point: [669.00 ft]
(top of casing)

Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal:
None documented

I.D. of surface casing [ND]
(If present)

I.D. of riser pipe: [6-in]
Type of riser pipe:
Carbon steel

Diameter of borehole: [7-in nom]

Type of filler:
Not documented

No perforations documented:

6 in casing to 15 ft

Depth bottom of borehole: [17 ft]

Drawing By: RKL/2#W18-78.ASB Date: 11Dec90

Reference: _____

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Not documented
Drilling Company: Hatch Drilling Co
Date Started: 30Mar67

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 30Mar67

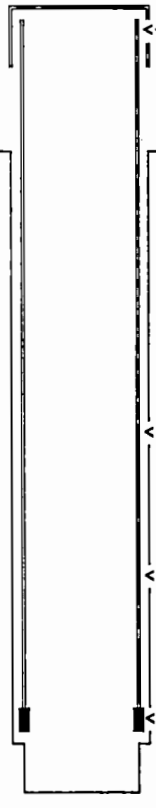
WELL NUMBER: 299-W18-79
TEMPORARY WELL NO: 299-W18-57B
Hanford Coordinates: N/S N 39,274 E/W W 76,594
State Coordinates: N 444,379 E 2,218,630
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

4-7: Fine SAND, light moisture
7-9: Fine SAND, large GRAVEL, light moisture
9-10: Fine SAND, large GRAVEL, dry
10-17: Coarse SAND, dry
17-21: Coarse SAND, light moisture
21-23: Fine SAND, light moisture

DRILLER'S NOTES:
Contamination encountered:
4-21 ft = <500 dp/m
23 ft = >30,000 dp/m



Elevation of reference point: [669.00 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
6 in casing to 21 ft
Depth bottom of borehole: [23 ft]

Drawing By: RKL/2#W18-79.ASB Date: 11Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Not documented
Drilling Company: Hatch Drilling Co
Date Started: 30Mar67

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 31Mar67

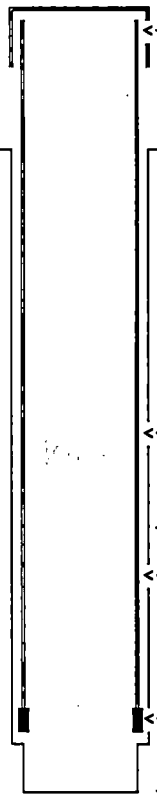
WELL NUMBER: 299-W18-80
TEMPORARY WELL NO: 299-W18-57C
Hanford Coordinates: N/S N 39,246 E/W W 76,596
State Coordinates: N 444,351 E 2,218,628
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

4-8: Fine SAND, light moisture
8-13: SAND, dry
13-19: Coarse SAND, dry
19-21.5: Coarse SAND, light moisture
21.5 : Fine SAND, moderate moisture

DRILLER'S NOTES:
Contamination encountered:
8 ft = 20,000 dp/m
11 ft = 2,000 dp/m
13 ft = 2,500 dp/m
14.5-19 ft = <500 dp/m
21.5 ft = 20,000 dp/m



Elevation of reference point: [669.00 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
6 in casing to 20 ft
Depth bottom of borehole: [21.5 ft]

Drawing By: RKL/2#W18-80.ASB Date: 11Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Not documented
Drilling Company: Hatch Drilling Co
Date Started: 31Mar67

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 03Apr67

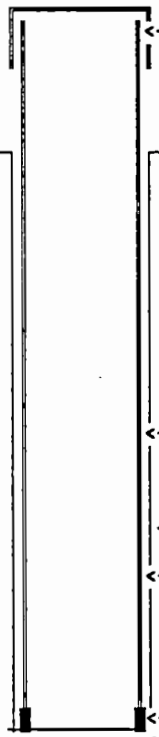
WELL NUMBER: 299-W18-81
TEMPORARY WELL NO: 299-W18-56C
Hanford Coordinates: N/S N 39,283 E/W W 76,605
State Coordinates: N 444,388 E 2,218,619
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

4-13.5: Fine SAND, light moisture
13.5-14: Small→large GRAVEL, dry
14-23: Coarse SAND, light moisture
23-32: Coarse SAND, light to moderate moisture
32-35.5: Coarse SAND & GRAVEL, light moisture
35.5-40: Coarse SAND w/GRAVEL, mixed w/fine SAND, light moisture
40-40.5: Coarse SAND w/small GRAVEL light moisture
41- : No sample, hit something solid

DRILLER'S NOTES:
Contamination encountered:
4 ft = contaminated from barrel
14 ft = 500 dp/m
16.5 ft = 5,000 dp/m
19 ft = 3,000 dp/m
21 ft = 5,000 dp/m
23 ft = 5,000 dp/m
25 ft = 10,000 dp/m
27.5 ft = 15,000 dp/m
29 ft = 10,000 dp/m
32 ft = 25,000 dp/m
34 ft = 1,000→20,000 dp/m
35.5 ft = 1,000→20,000 dp/m
38.5 ft = 20,000 dp/m
40-41 ft = 20,000 dp/m



Elevation of reference point: [669.00 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
6 in casing to 41 ft
Depth bottom of borehole: [41 ft]

Drawing By: RKL/2#W18-81.ASB Date: 11Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

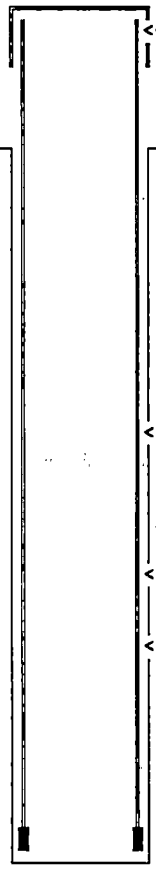
Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Not documented	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: Not documented	Date Complete: Not documented

WELL NUMBER: 299-W18-82	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,570	E/W W 77,101
State Coordinates: N 434,674	E 2,218,125
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-146: Not documented



- Elevation of reference point: (top of casing) [680.00 ft]
- Height of reference point above ground surface [ND]
- Depth of surface seal [ND]
- Type of surface seal: None documented
- I.D. of surface casing (If present) [ND]
- I.D. of riser pipe: [6-in]
- Type of riser pipe: Carbon steel
- Diameter of borehole: [7-in nom]
- Type of filler: Not documented
- Elevation/depth top of seal
- Type of seal: Not documented
- No perforations documented:
- Depth bottom of casing
- Depth bottom of borehole: [146 ft]

Drawing By: RKL/2#W18#82.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Hatch
Drilling Company: Hatch Drilling Co.
Date Started: 24Jul69

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 05Aug69

WELL NUMBER: 299-W18-85
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,989 E/W W 76,717
State Coordinates: N 444,094 E 2,218,508
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: SAND & SILT, damp
5-25: Coarse SAND, damp
25-40: Coarse SAND & small GRAVEL
40-51: SAND & SILT, GRAVEL to 4 in
51-51: BOULDER
51-80: SAND & SILT, dry
80-85: SAND & SILT, damp
85-105: SAND & SILT, dry
105-120: SAND & SILT, GRAVEL 2 to 4 in
120-124: Clean GRAVEL to 3 in
124-146: Not documented
146-150: CALICHE

DRILLER'S NOTES:
- Odor at 43.5 to 51 ft
- Odor down to 100 ft
- No odor 100 to 110 ft
- Odor strong 110 ft
- Odor real strong, 115-124 ft

Elevation of reference point: [679.75 ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

No perforations documented:

Depth bottom of casing
Depth bottom of borehole: [150 ft]

Drawing By: RKL/2#W18#85.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

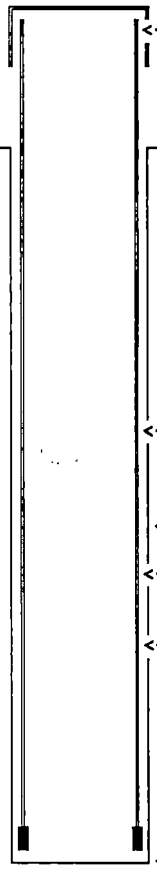
Drilling Method: Cable tool	Sample Drive barrel Method: Hard tool
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Hatch	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 05Aug69	Date Complete: 21Aug69
WELL NUMBER: 299-W18-86	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,106	E/W W 76,742
State Coordinates: N 444,211	E 2,218,483
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: Coarse SAND & SILT
5-15: SAND & SILT, moist
15-25: SAND & GRAVEL to 2 in
25-41: SILT & SAND, coarse
41-50: SAND & GRAVEL to 5 in
50-60: Coarse SAND & 2 in GRAVEL
60-105: SAND & SILT
105-110: SAND & SILT, GRAVEL
110-135; SAND & SILT, GRAVEL to 3-4 in
135-140: SAND & SILT, small GRAVEL
140-150: Soft, brown CLAY
150- : Brown CLAY, BASALT chunks (Possible BASALT BOULDER)

DRILLER'S NOTES:
- Odor at 44 ft
- Odor real strong all day (43-54 ft)
- Odor from 54-63 ft
- Strong odor again at 80 to 86 ft, slight odor at 100 ft
- Odor strong 111-116 ft
- Odor real strong all day (116-130 ft)
- Faint odor all day (130-149 ft)
- Unusual odor on completion (150 ft)



Elevation of reference point: (top of casing)	[683.49 ft]
Height of reference point above ground surface	[~ 3 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[150 ft]

Drawing By: RKL/2#W18#86.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Hatch	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 25Aug69	Date Complete: 05Sep69

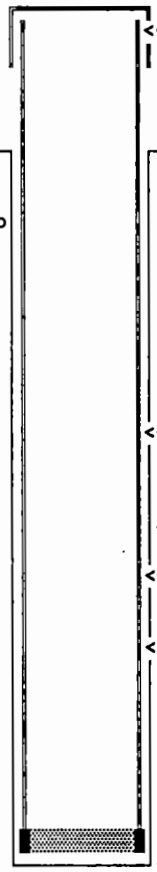
WELL NUMBER: 299-W18-87	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,980	E/W W 76,604
State Coordinates: N 444,085	E 2,218,621
Start Card #: Not documented	T R S
Elevation Ground surface (ft): 674.8 ft estimated	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: Moist SAND & SILT
5-20: Coarse SAND
20-25: Coarse SAND, GRAVEL to 2 in, damp
25-35: Fine damp SAND
35-40: GRAVEL to 4 in
40-45: SAND & GRAVEL to 4 in
45-55: SAND & SILT, GRAVEL to 4 in
55-60: Small GRAVEL, SAND & SILT
60-70: SAND & SILT
70-85: SAND & SILT, moist
85-87: SAND & SILT, wet
87-90: Large GRAVEL
90-95: SAND & SILT
95-100: CLAY, small GRAVEL
100-110: SAND & GRAVEL, 3 in
110-120: Small GRAVEL
120-130: Small GRAVEL & SAND
130-140: Brown CLAY
140-150: Sandy brown CLAY
150 : CALICHE

DRILLER'S NOTES:
- Faint odor from 12 to 16 ft
- Odor strong from 34 ft (to 41 ft)
- Odor strong all day (41-50 ft)
- Odor strong all day (50-65 ft)
- Odor strong from 87-92 ft
- Odor all day - strong (97-108 ft)
- Odor strong to 136 ft (116-136 ft), no odor to bottom



Depth to bottom Jan91
151.4 ft (TOC)

Elevation of reference point: (top of casing)	[677.23 ft]
Height of reference point above ground surface	[2.4 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[150 ft]

Drawing By: RKL/2#W18#87.ASB Date: 19Feb91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Bigham
Drilling Company: Hatch Drilling Co
Date Started: 10Sep69

Sample Method: Hard tool, Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 19Sep69

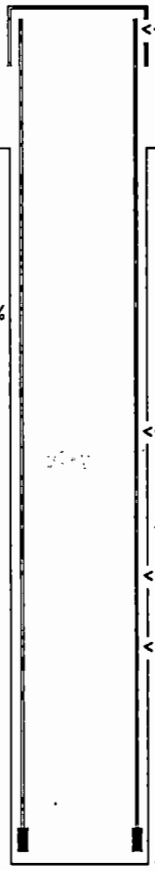
WELL NUMBER: 299-W18-88
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,298 E/W W 76,432
State Coordinates: N 444,404 E 2,218,792
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: 50% SAND, 50% SILT, (moist)
15-25: 25% SAND, 75% GRAVEL (dry)
25-35: Coarse SAND (moist)
35-40: Coarse SAND 95%, GRAVEL 5% (moist)
40-45: Coarse SAND 75%, GRAVEL 25%
45-55: SAND 25%, GRAVEL 50%, COBBLES 25%
55-60: SAND & GRAVEL
60-65: SAND
65-70: SILT & SAND
70-75: SAND
75-83: SAND & SILT
83-95: SAND & GRAVEL
95-97: SAND - a little GRAVEL
97-130: SAND & SILT
130-139: SILT
139-143: CALICHE
143-145: CALICHE & GRAVEL to 2 in
145-150: SAND, GRAVEL, COBBLES

DRILLER'S NOTES:
- Material at 12 ft was wet, slight odor at 40 ft
- Odor from 40 to 55 ft, strongest about 52 ft
- Odor at 83 ft
- Still some odor (85-95 ft)



Elevation of reference point: [679.76 ft]
(top of casing)
Height of reference point above ground surface [~ 3 ft]

Depth of surface seal [ND]

Type of surface seal: None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

No perforations documented:

Depth bottom of casing
Depth bottom of borehole: [150 ft]

Drawing By: RKL/2#W18#88.ASB Date: 05Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Drive barrel Method: Hard tool
Drilling Fluid Used: Water	Additives Used: Not documented
Driller's Name: Richard/Gentz	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 07Oct69	Date Complete: 21Oct69

WELL NUMBER: 299-W18-89 TEMPORARY WELL NO: _____

Hanford Coordinates: N/S N 39,360 E/W W 76,752

State Coordinates: N 444,465 E 2,218,472

Start Card #: Not documented T____ R____ S____

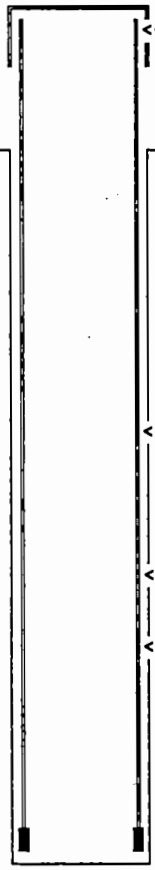
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY / Driller's Log

0-15: SAND
15-60: GRAVEL, SAND
60-98: SAND, SILT
98-100: GRAVEL, SAND, SILT
100-105: SAND, SILT and GRAVEL
105-110: GRAVEL, SAND, SILT
110-115: GRAVEL, SAND
115-127: Coarse GRAVEL, SAND
127-140: SAND, SILT
140-150: SAND, GRAVEL

DRILLER'S NOTES:
- Carbon tet odor at 87 ft
- Odor continued to about 140 ft odor not especially strong per driller (125?-140 ft)



Elevation of reference point: (top of casing) [681.32 ft]

Height of reference point above ground surface [~ 3 ft]

Depth of surface seal [ND]

Type of surface seal: None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

No perforations documented:

Depth bottom of casing
Depth bottom of borehole: [150 ft]

Drawing By: RKL/2#W18#89.ASB Date: 06Dec90

Reference: _____

WELL CONSTRUCTION AND COMPLETION SUMMARY

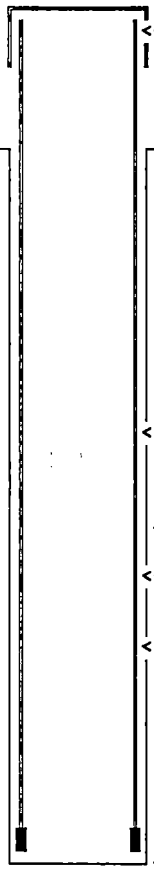
Drilling Method: Cable tool	Sample Hard tools Method: Drive barrel	WELL NUMBER: 299-W18-93	TEMPORARY WELL NO:
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 38,744	E/W W 76,905
Driller's Name: Bigham	WA State Lic Nr: Not documented	State Coordinates: N 443,848	E 2,218,321
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented	T___ R___ S___
Date Started: 28Jan72	Date Complete: 08Feb72	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: SAND
15-25: SAND & GRAVEL
25-26: SAND & GRAVEL, wet
26-30: SILT layer, wet
30-35: SAND
35-45: SAND & GRAVEL
45-50: SAND, GRAVEL, COBBLES
50-55: SAND
55-56: Coarse SAND
56-58: Med SAND
58-63: SILT layers, fine silty SAND
63-64: Fine SAND
64-92: Silty SAND
92-112: Med SAND
112-124: SAND up to large GRAVEL
124-134: Med SAND
134-140: SILT & fine SAND

DRILLER'S NOTES:
- (28Jan72 0-30 ft)
  20,000 d/pm - 4,000 c/m - max
  shutdown 4:15 - for fresh air mask
- (02Feb72 58-63 ft)
  no det cont.
- (03Feb72 64-92 ft)
  no det cont



Elevation of reference point: (top of casing)	[665.00 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[140 ft]

Drawing By: RKL/2#W18#93.ASB Date: 06Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

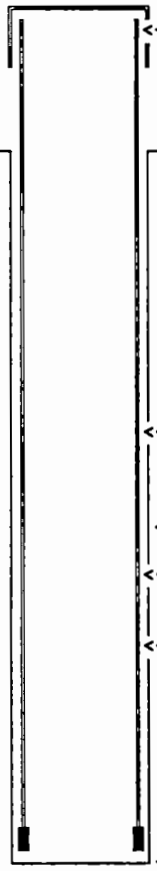
Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-94	TEMPORARY WELL NO:
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 38,662	E/W W 76,880
Driller's Name: Bigham	WA State Lic Nr: Not documented	State Coordinates: N 443,766	E 2,218,346
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented	T ___ R ___ S ___
Date Started: 08Feb72	Date Complete: 10Feb72	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-6: SILT, fine SAND, (dry)
6-12: Coarse SAND
12-22: Very coarse SAND, 25% small GRAVEL
22-31: Very coarse SAND
31-34: Very coarse SAND, 10% small GRAVEL
34-36: Very coarse SAND, wet
36-39: Coarse SAND, GRAVEL to 2½ in
39-45: Coarse SAND, very small GRAVEL
45-50: Very coarse SAND, GRAVEL to 2 in
50-60: SAND - GRAVEL
60-80: SAND, SILT

DRILLER'S NOTES:
- None



Elevation of reference point: (top of casing) [665.00 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [80 ft]

Drawing By: RKL/2#W18#94.ASB Date: 06Dec90

Reference: _____

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Bigham
Drilling Company: Hatch Drilling Co
Date Started: 11Feb72

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 15Feb72

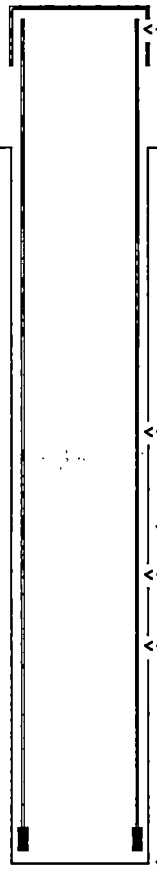
WELL NUMBER: 299-W18-95
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,665 E/W W 76,970
State Coordinates: N 443,769 E 2,218,256
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-8: SAND
8-15: 50% SAND, 50% GRAVEL
15-20: 10% SAND, 90% GRAVEL
20-25: SAND & GRAVEL
25-35: 90% SAND
35-48: 40% SAND, 60% GRAVEL to COBBLES
48-56: SAND & GRAVEL
56-69: SAND (fine, some SILT) some moisture
69-71: Medium SAND (dry)
71-76: Fine SAND (dry)
76-77: Fine SAND, SILT stringers (dry)
77-80: Fine SAND

DRILLER'S NOTES:
- Less moisture in soil this well than W18-93 & 94



Elevation of reference point: (top of casing) [665.00 ft]
Height of reference point above ground surface [~ 3 ft]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [80 ft]

Drawing By: RKL/2#W18#95.ASB Date: 06Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

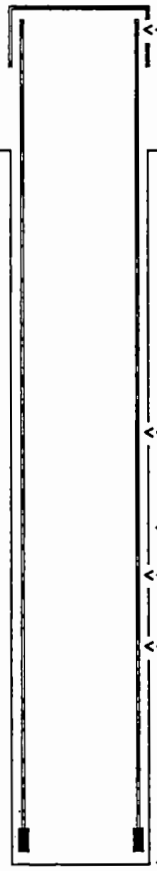
Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-96	TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 38,825	E/W W 76,790
Driller's Name: Bigham	WA State Lic Nr: Not documented	State Coordinates: N 443,930	E 2,218,436
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented	T___ R___ S___
Date Started: 16Feb72	Date Complete: 18Feb72	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-7: SAND & SILT (moist)
7-12: Very coarse SAND - small GRAVEL (dry)
12-21: Small to medium GRAVEL (dry)
21-22: Med SAND (moist)
22-24: Med SAND
24-35: Very coarse SAND
35-45: SAND - GRAVEL, COBBLES
45-47: Med SAND
47-50: SAND, GRAVEL, COBBLES
50-53: GRAVEL
53-55: Med SAND
55-75: Fine SAND & SILT (damp)
75-77: Med SAND (dry)
77-79: Fine SAND, 75% SILT (wet)
79-80: Med SAND (dry)

DRILLER'S NOTES:
- (18Feb72, 77-79 ft) carbon tet odor



Elevation of reference point: (top of casing)	[665.00 ft]
Height of reference point above ground surface	[~ 3 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[80 ft]

Drawing By: RKL/2#W18#96.ASB Date: 06Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Bigham	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 22Feb72	Date Complete: 24Feb72

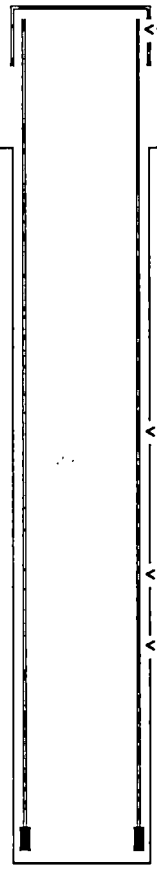
WELL NUMBER: 299-W18-97	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,745	E/W W 76,790
State Coordinates: N 443,850	E 2,218,436
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: Not documented
5-9: Med SAND
9-25: Very coarse SAND, GRAVEL
26-34: Very coarse SAND (wet)
34-50: SAND-GRAVEL, some COBBLES
50-55: SAND & GRAVEL
55-57: Med SAND
57-60: Fine SAND & SILT
60-72: Med SAND (dry)
72-85: Fine SAND, some SILT (dry)

DRILLER'S NOTE:
- (24Feb72)
  Very little moisture in this well
  No odors



Elevation of reference point: (top of casing)	[665.00 ft]
Height of reference point above ground surface	[~ 3 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[85 ft]

Drawing By: RKL/2#W18#97.ASB Date: 06Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Bigham
Drilling Company: Hatch Drilling Co
Date Started: 25Feb72

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 29Feb72

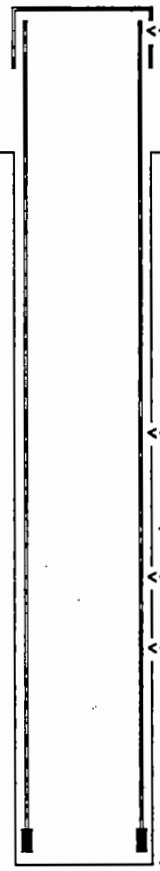
WELL NUMBER: 299-W18-98
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,940 E/W W 76,880
State Coordinates: N 444,044 E 2,218,345
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY | Driller's Log

0-6: Med SAND
6-12: Coarse SAND & GRAVEL
12-30: Very coarse SAND
(wet from 26 ft down)
30-50: SAND, GRAVEL, some COBBLES
50-58: SAND-GRAVEL, some COBBLES
58-62: Fine SAND & SILT
62-66: Med SAND
66-71: Fine SAND, some SILT
71-75: Fine SAND, 50% SILT
75-80: Fine SAND, SILT stringers

DRILLER'S NOTES:
- (28Feb72, 30-50 ft)
  Carbon tet odor at 35 ft,
  very strong at 48 ft to 50 ft
- (29Feb72, 50-80 ft)
  No odor today, soil dry all day



Elevation of reference point: (top of casing) [665.00 ft]
Height of reference point above ground surface [~ 3 ft]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of casing
Depth bottom of borehole: [80 ft]

Drawing By: RKL/2#W18#98.ASB Date: 06Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: Not documented	Additives Used: Not documented
Driller's Name: Bigham	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 01Mar72	Date Complete: 08Mar72

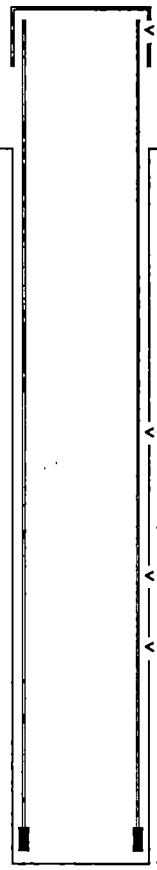
WELL NUMBER: 299-W18-99	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,949	E/W W 76,768
State Coordinates: N 444,054	E 2,218,457
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY / Driller's Log

0-9: SAND & SILT
9-20: Very coarse SAND-small GRAVEL (dry)
20-30: Med SAND (dry)
30-35: Very coarse SAND-small GRAVEL
35-51: SAND, GRAVEL, COBBLES
51-54: Med SAND
54-72: Fine SAND, some SILT
72-76: Fine SAND, 75% SILT
76-95: Fine SAND, SILT stringers
95-105: Med SAND, SILT stringers
105-110: GRAVEL up to COBBLES
110-128: SAND 20%, GRAVEL 70%, COBBLES 10%
128-132: 10% SAND, 70% GRAVEL 20% COBBLES
132-133: SILT
133-135: Fine SAND, SILT stringers

DRILLER'S NOTE:
- (07Mar72, 110-128 ft) Carbon tet odor from 115 ft



Elevation of reference point: (top of casing)	[665.00 ft]
Height of reference point above ground surface	[~ 3 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[3-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[4-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	
Depth bottom of borehole:	[135 ft]

Drawing By: RKL/2#W18#99.ASB Date: 06Dec90

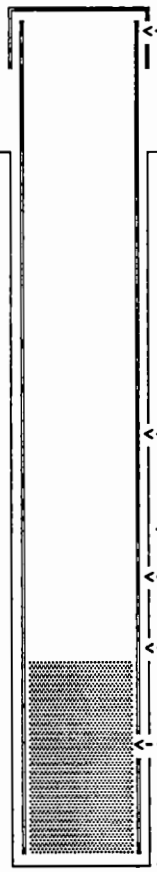
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tools / Drive barrel	WELL NUMBER: 299-W18-149	TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 39,329	E/W W 76,602
Driller's Name: Hatch	WA State Lic Nr: Not documented	State Coordinates: N 444,434	E 2,218,622
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented	T ___ R ___ S ___
Date Started: 21Jan74	Date Complete: 12Apr74	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY	Driller/Geologist Log w/notes
0-7: No recovery	
7-12: Dry SAND & GRAVEL (2-5 mr, 25-60,000 c/m)	
12-14: Dry SAND (2-5 mr, 25-50,000 c/m)	
14-15: Dry SAND, sparse ROCK (20,000 c/m)	
15-17: Dry coarse SAND (8,000 c/m)	
17-18.5: Moist coarse SAND (7,500-3,500 c/m)	
18.5-22: Coarse SAND and very fine GRAVEL (~1,500 c/m)	
22-24: Coarse to med SAND (1,800 c/m)	
24-27: Med SAND (850 c/m)	
27-29: Sandy SILT	
29-31: Coarse SAND and SILT (1,350-2,500 c/m)	
31-34: Not documented, reduced casing size	
34-46: Broken ROCK	
46-62: Brown hard packed SILT	
62-ND Broken ROCK	
ND-79 Fine brown SILT	
79-80 Grey SAND	
80-82 GRAVEL	
82-92 SAND	



Elevation of reference point: (top of casing)	[672.56 ft]
Height of reference point above ground surface	[~ 1 ft]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[6-in]
Type of riser pipe: PVC	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Cement plug?, 75-92 ft Placement not documented	
Depth bottom of casing	
Depth bottom of borehole:	[92 ft]

Drawing By: RKL/2W18-149.ASB Date: 06Dec90

Reference: _____

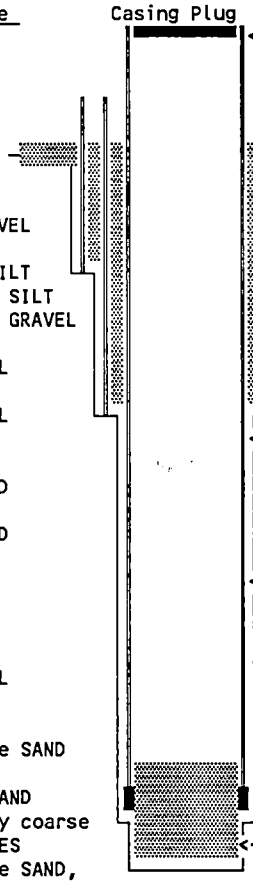
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Split spoon and Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Hatch/Baker	WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA
Date Started: 11Jun74/08Jul77	Date Complete: 01Aug74/21Jul77
WELL NUMBER: 299-W18-150	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,075	E/W W 76,601
State Coordinates: N 444,180	E 2,218,624
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): 668.8 ft estimated	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-13: Backfill, GRAVEL-SAND
13-17: Coarse SAND, damp
17-18: Coarse SAND, sparse GRAVEL
18-20: Fine SAND and SILT
20-25: Fine to med SAND with SILT
25-28: Fine SAND with CLAY and SILT
28-30: Medium SAND with sparse GRAVEL
30-40: SAND, GRAVEL, COBBLES
40-41: Fine SAND, SILT & GRAVEL
41-43.5: GRAVEL and SAND
43.5-46.5: Fine SAND and GRAVEL
46.5-53: Fine SAND and SILT
53-58: Fine, medium SAND
58-59: Very fine to medium SAND
59-69.5: Fine to medium SAND
69.5-74: Very fine to fine SAND
74-75: Silty fine-medium SAND
75-76.5: Fine-medium SAND with trace of coarse
76.5-84: Fine to coarse SAND
84-85.5: Fine to coarse SAND, few COBBLES and GRAVEL
85.5-90: Fine to coarse SAND
90-92: Fine to medium SAND
92-93: Silty, very fine to fine SAND
93-93.1: SILT
93.1-97.5: Very fine to fine SAND
97.5-100: Silty, medium to very coarse SAND, GRAVEL & COBBLES
100-103.5: SILT, fine to coarse SAND, PEBBLES, COBBLES
103.5-112: Fine to very coarse SAND, PEBBLES and COBBLES
112-114: Very fine SAND
114-117: Fine to medium SAND
117-120: Very fine silty SAND
120-122: Very fine to fine SAND, embedded SILT stringers
122-128: SILT



Elevation of reference point: (top of casing) [671.81 ft]
Height of reference point above ground surface [~ 3 ft]
Depth of surface seal [ND]
Type of surface seal: Concrete pad, 12 ft x 12 ft
I.D. of surface casing (If present) 0-7 ft [10 in]
8 in casing 0-48 ft
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
No perforations documented:
Depth bottom of casing: [122 ft]
Plugged, depth to bottom 115.9 ft
Depth bottom of borehole: [128 ft]

DRILLER'S NOTE:
- (31Jul74, 43.5 ft)
  Carbon tet odor strong at this point

CONSTRUCTION NOTE:
This well was drilled under complete containment and encountered extensive contamination while drilling. For detailed Geologic Log and record of contamination see Plate 12 of:
S. M. Price, et al., "Distribution of Plutonium and Americium beneath the 216-Z-1A Crib: A Status Report," RHO-ST-17, February 1979, Rockwell Hanford Operations, Richland, WA.
The well was drilled in two stages 0-53 ft in 1974 and 53-128 ft in 1977.

Drawing By: RKL/2W18-150.ASB Date: 27Feb91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

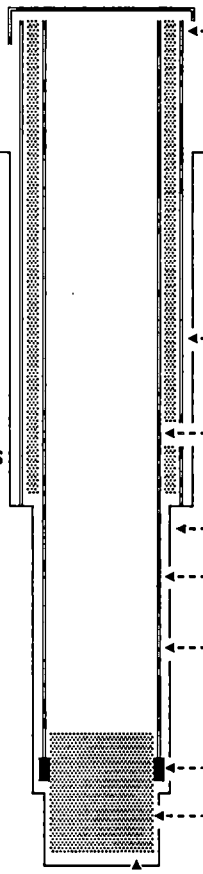
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Evans/Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 30Aug76/06Sep77	Date Complete: 30Sep76/08Sep77

WELL NUMBER: 299-W18-158	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,266	E/W W 76,650
State Coordinates: N 444,371	E 2,218,574
Start Card #: Not documented	T___ R___ S___
Elevation Ground surface (ft): 670.0 Estimated	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Geologist/ Driller Log

0-7: Medium-fine sandy SILT w/trace of fine GRAVEL
7-13: Coarse-medium sand fine-medium GRAVEL w/some COBBLES
13-13: 1/2 in SILT lens
13-18: Coarse-medium sand GRAVEL some small COBBLES
18-20: Fine gravelly coarse-medium SAND to small COBBLES
20-25: Very coarse sand fine-medium GRAVEL (85% basalt gravel)
25-35: Medium-very coarse SAND, some PEBBLES, GRAVEL & BOULDERS
35-47: Fine-coarse SAND w/PEBBLES, GRAVEL and COBBLES (broken)
47-48: About 9 in SILTY layer with a little fine GRAVEL
48-50: Medium-fine sandy SILT
50-51: Silty very fine-medium SAND
NOTE: Contamination encountered at 51 ft
51-90: Not documented
90-93: Medium-fine SAND
93-94: SILT stringer
94-95: Medium-fine SAND
95-96: Medium SAND, slightly pebbly w/trace of small COBBLES
▲ First phase of drilling
▼ Second phase of drilling
96-100: GRAVEL & COBBLES
100-107: Silty very fine to medium SAND, 60% GRAVEL few COBBLES
107-111: Fine to medium SAND, 20% GRAVE;, few COBBLES
111-112: Very fine SAND
112-118: Fine to medium SAND, few coarse particles
118-119: SILT layer
119-121: Very fine to fine SAND
121-123: SILT
123-125: Fine SAND and SILT
125-128: Silty very fine SAND
128-131.5: SILT



Elevation of reference point: (top of casing)	[672.61 ft]
Height of reference point above ground surface	[2.6 ft]
Depth of surface seal	[ND]
Type of surface seal: Grouted around top	
I.D. of surface casing (If present)	[ND]
8 in casing 0-94 ft	
I.D. of riser pipe:	[6-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[7-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Grouted	
No perforations documented	
Depth bottom of casing: Bottom cement plugged	[127.5 ft]
Depth to bottom Feb91 125.2 ft (128.2 ft from top-of-casing)	
Bottom borehole	[131 ft]

Drawing By: RKL/2W18-158.ASB Date: 18Mar91

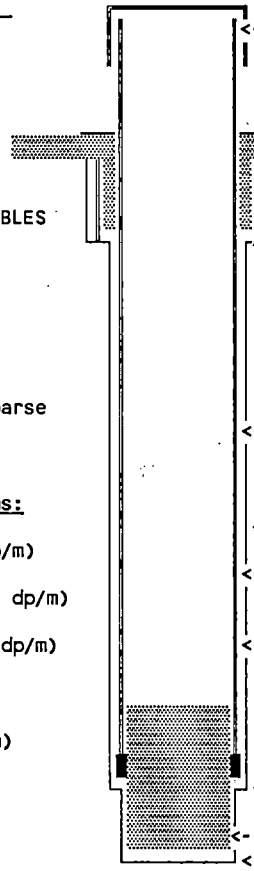
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Dual wall & Drive barrel	WELL NUMBER: 299-W18-159	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,228	E/W W 76,602
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,333	E 2,218,622
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T___ R___ S___
Date Started: 09Dec77	Date Complete: 11Jan78	Elevation Ground surface (ft): 669.6 ft estimated	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY | Driller's Log



Elevation of reference point: [670.77 ft] (top of casing)

Height of reference point above ground surface [1.2 ft]

Depth of surface seal [ND]

Type of surface seal: Concrete pad 20 ft x 30 ft Has 2 ft sq rubber mat around casing

I.D. of surface casing [8 in] (If present) 8 in casing 0-7 ft

I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [7-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: None documented

Depth bottom of casing: [126 ft]

Cement plug, not well documented

Depth bottom of borehole: [130 ft]

Depth to bottom, Feb91
120.8 ft (122.0 ft TOC)

Dual Wall Sample Descriptions:
11: Fine SAND, few PEBBLES
13: Med to coarse SAND, few PEBBLES
15.5: Med to coarse SAND, few PEBBLES
18: Coarse SAND, few PEBBLES
21: Fine to medium SAND
23.5: Med to coarse SAND
26: Fine to med SAND
28.5: Coarse SAND
32; 34.5; 37; Coarse to very coarse SAND
39.5: Coarse SAND
42: Fine SAND

Drive barrel sample descriptions:
42-47: Fine to medium SAND (Contamination 20,000 dp/m)
47-50.5: Very fine to fine SAND (Contamination 40-70,000 dp/m)
50.5-57: Fine to medium SAND (Contamination 5-30,000 dp/m)
57-62: Fine to medium SAND (Contamination 500 dp/m)
62-69: Fine to medium SAND (Contamination <500 dp/m)
69-75: Very fine to medium SAND
75-76: SILT
76-78: SILT to coarse SAND
78-81: Medium to coarse SAND
81-82: Fine to medium SAND, imbedded SILT
82-82.5: SILT stringer, fine to coarse SAND
82.5-85: Fine to medium SAND, some SILT
85-88.5: Fine to coarse SAND
88.5-93: Fine to coarse SAND, GRAVEL, silty
93-98: Silty GRAVEL, fine to coarse SAND
98-103: Silty, fine to very coarse SAND, GRAVEL
103-106: Fine to medium SAND, PEBBLES
106-116: Very fine to fine SAND, few PEBBLES
116-120: SILT to very fine SAND
120-125: SILT
125-127: Very fine to fine SAND, SILT
127-130: SILT

Drawing By: RKL/2W18-159.ASB Date: 27Feb91

Reference:

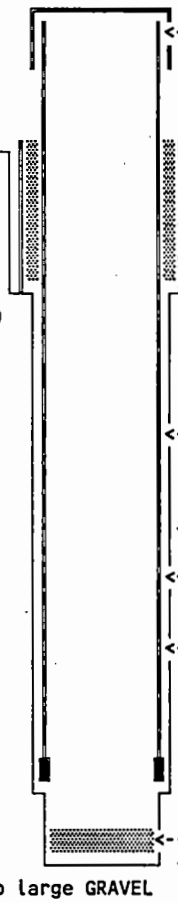
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-163	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,284	E/W W 76,552
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,389	E 2,218,672
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T R S
Date Started: 08Feb77	Date Complete: 16Feb77	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Geologist's Log

0-16: Backfill
16-20: Fine-med SAND & sparse GRAVEL
20-33: Med-coarse SAND; sparse GRAVEL
33-36: Med-coarse SAND, GRAVEL & COBBLES
36-40: Med-coarse SAND-50% GRAVEL (fine to coarse to cobble size)
40-46: Med coarse SAND-30% GRAVEL
46-49: Slighlty silty fine SAND
49-49.5: Med coarse SAND, 30% gravel; small fine SAND stringer, (Contaminated 5,000 dp/m)
49.5-50: Fine SAND w/very few PEBBLES (No contamination)
50-53: Fine-med SAND, very few small PEBBLES
53-55: Med-fine brown SAND
55-58: Slightly silty med-fine brown SAND
58-74: Med-fine brown SAND
74-76: Med-fine brown SAND, slightly silty
76-81: Med-fine lighter brown SAND
81-82: Light brown med-fine SAND; slightly SILTY
82-85: Silty SAND stringer (compacted sand?)
85-87: Med-coarse SAND; fine sand to silt matrix
87-92.5: Coarse SAND and GRAVEL
92.5-105: Coarse-med SAND and small to large GRAVEL
105-111: Very fine-fine silty SAND
111-115: Med-fine brown SAND
115-120: Med-coarse SAND
120-123.5: Silty very fine-fine SAND
123.5-124.5: Very slightly silty fine-med SAND
124.5-130: Silty, very fine-fine SAND; slight amount of $CaCO_3$
130-135: Silty very fine-fine SAND; >30% $CaCO_3$ stringers
135 : Silty very fine SAND; $CaCO_3$



Elevation of reference point: [670.00 ft] (top of casing)
Height of reference point above ground surface: [ND]
Depth of surface seal: [ND]
Type of surface seal: Cement grout
I.D. of surface casing: [10 in]
10 in casing 0-14 ft
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth bottom of casing: [130 ft]
Cement plug, not well documented
Depth bottom of borehole: [135 ft]

GEOLOGIST'S NOTES: Strong CCL_4 odor at 87, 102, 103, 105 and 112 ft

Drawing By: RKL/2W18-163.ASB Date: 07Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

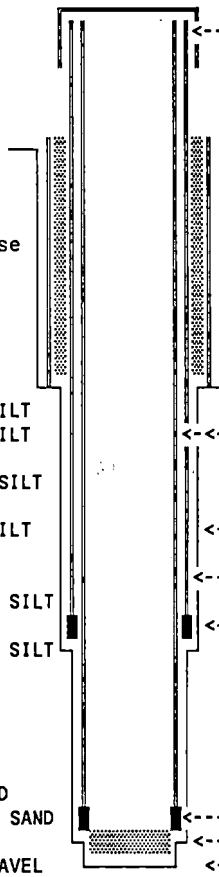
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 12Jan77	Date Complete: 01Feb77

WELL NUMBER: 299-W18-164 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,040 E/W W 76,602
State Coordinates: N 444,145 E 2,218,623
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY Driller's Log

0-10: Coarse SAND to SILT; sparse GRAVEL
10-20: Coarse SAND
20-27.5: Very coarse SAND with sparse GRAVEL; gray
27.5-30: Very coarse to fine SAND
30-35: Very fine-med SAND w/SILT
35-38: Med gray SAND w/some SILT (Contamination 35.5 ft)
38-40: Med gray-brown SAND
40-42: Fine-med brown SAND w/some SILT
42-50: Fine-med brown SAND w/some SILT and GRAVEL/COBBLE fragments
50-53: Very fine-fine brown SAND & SILT
53-65: Fine-med brown SAND
65-67: Very fine-fine SAND w/some SILT
67-68: Fine-med gray SAND
68-70: Fine-med brown SAND
70-72.5: Fine-med brown SAND w/some SILT
72.5-78.5: Fine-med BROWN sand
78.5-81: Fine-med brown SAND w/some SILT
81-82: Fine to silty brown SAND
82-84: Very silty fine brown SAND
84-85: Silty fine brown SAND
85-90.5: Slightly silty fine-med brown/gray-brown SAND
90.5-97.5: Fine-med black/brown SAND
97.5-100: Very fine-med silty brown SAND
100-101.5: "Pea" GRAVEL and SAND
101.5-102.5: SAND and "pea-size" GRAVEL
102.5-106: SAND w/GRAVEL & small COBBLES
106-107: Med-coarse SAND & GRAVEL, ("pea-size" to 2 in)
107-115: Coarse SAND & GRAVEL, ("pea-size" to 2 in)
115-118: Coarse SAND, small GRAVEL (15% gravel to 1 in)
118-120: Very fine SAND & SILT
120-128: Fine-med SAND; silty-slightly silty after 122 ft
128-139: Very fine-fine SAND & SILT; 4 in CLAY at 128 ft.
139-143: Very fine SAND & SILT; small amounts of $CaCO_3$ in sand
143-150: Very fine SAND & SILT w/CALICHE
150-153: Silty SAND w/sparse CALICHE & cobble-size fragments
153-153.5: Fine-med SAND w/SILT & sparse GRAVEL to COBBLES



Elevation of reference point: (top of casing) [678.75 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [0-30 ft]
Type of surface seal: Cement grout
I.D. of surface casing (If present) [10 in]
10 in casing to about 30 ft
I.D. of riser pipe: [8 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole, 30-111 ft [9-in nom]
Type of filler: Not documented
8 in casing to 111 ft
Elevation/depth top of seal
Type of seal: Not documented
No perforations documented:
Depth bottom of 6 in casing [~ 150 ft]
Plugged, not well documented
Depth bottom of borehole: [153 ft]

GEOLOGIST'S NOTES:
Extensive contamination encountered;
35.5 ft=500 d/m; 68 ft=3,600 d/m;
70 ft=16-20,000 d/m; 72.5 ft=10,000 d/m;
73-75.4 ft=1-4,000 c/m; 82 ft=10,000 d/m;
83 ft=1,000 d/m; 84 ft=4,000 c/m;
85 ft=5,500 d/m; 89 ft=2,500 d/m;
90-98 ft=500-5,000 c/m;
CCL_4 odor detected:
39 ft= smell slight; 55-57 ft=odor
60 ft=slight odor; 68 ft=odor;
100 ft=strong organic smell;
100-101 ft=strong odor;
104-104.5 ft=slight odor
120-125=odor

Drawing By: RKL/2W18-164.ASB Date: 03Dec90

Reference:

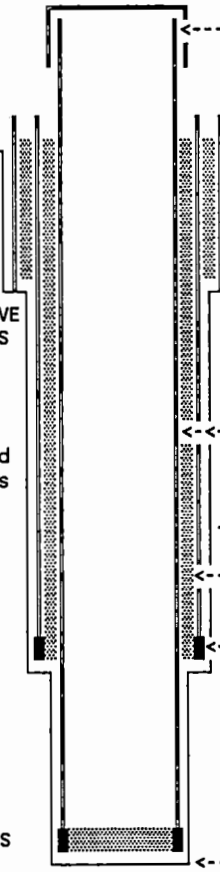
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-165	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,180	E/W W 76,650
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,285	E 2,218,575
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T ___ R ___ S ___
Date Started: 18Feb77	Date Complete: 29Mar77	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Geologist's Log

0-5: Not documented
5-10: Med SAND & SILT
10-15: COBBLE fill
15-18: Coarse SAND w/sparse GRAVEL & broken COBBLES
18-22: Coarse SAND, gray
22-33: Coarse SAND, gray, sparse GRAVE
33-36: Coarse SAND w/GRAVEL & COBBLES
36-39: Coarse SAND w/50% GRAVEL & COBBLES
39-45: Coarse to med SAND W/50% GRAVEL & COBBLES
45-47: 50-75% GRAVEL to COBBLES w/med to fine SAND matrix; in places appears cemented
47-60.5: Med-fine, brown SAND
60.5-65: Silty-slightly silty, very fine-fine SAND
65-70: Coarse-med SAND
70-71: Slightly silty, very fine-med SAND
71-78: Fine-med SAND
78-90: Med-coarse SAND
90-94: Fine-med SAND
94-96: SILT-fine SAND
96-97: Fine SAND
97-98: Fine-med SAND, GRAVEL
98-104: Med SAND & PEA GRAVEL
104-106: Med SAND & PEA GRAVEL>COBBLES
106-106.5: Med & coarse SAND, COBBLES & GRAVEL
106.5-111: Med to coarse SAND, GRAVEL to COBBLES
111-115: Med to fine SAND
115-119: Med SAND
119-123: Slighlty silty, fine SAND
123-135: SILT
135 : CALICHE



Elevation of reference point: [672.09 ft] (top of casing)
Height of reference point above ground surface: [ND]
Depth of surface seal: [20 ft]
Type of surface seal: Cement grout
I.D. of surface casing (If present) 10 in from 0-20 ft: [10 in]
I.D. of riser pipe: [6 & 8 in]
Type of riser pipe: Carbon steel
Diameter of borehole, 20-115 ft: [9-in nom]
Type of filler: Cement grout
8 in casing to 115 ft
Bottom plugged, not well documented
Depth bottom of 6 in casing
Depth bottom of borehole: [135 ft]

GEOLOGIST'S NOTES:
Extensive contamination encountered:
57 ft = up to 10,000 dp/m; 58 ft = <1,000 dp/m;
59 ft = core barrel hot; 60 ft = 3,000 dp/m;
91 ft = 40,000 dp/m, 8,000 c/m;
93 ft = 10,000 dp/m, 30,000 c/m;
94-97 ft = 500 dp/m, 200 c/m
98 ft = 350 c/m: 9 ft = <500 c/m; 100 ft = ~500 c/m
104 ft = ~500 c/m
CCL_4 odor detected at:
52 ft = slight odor
60.5 ft = odor

Drawing By: RKL/2W18-165.ASB Date: 10Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

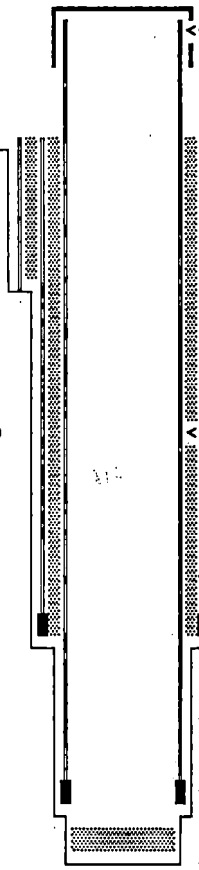
Drilling Method: Cable tool	Sample Split and Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 29Mar77	Date Complete: 14Apr77

WELL NUMBER: 299-W18-166	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,108	E/W W 76,650
State Coordinates: N 444,213	E 2,218,575
Start Card #: Not documented	T R S
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Geologist's Log

0-15: Backfill & GRAVEL
15-20: Coarse SAND, sparse GRAVEL
20-25: Med SAND, some fine SAND
25-35: Very coarse-coarse SAND
35-40.5: Very coarse SAND, GRAVEL & COBBLES
40.5-44.5: Med to coarse SAND, PEBBLES, GRAVEL
44.5-50: Very fine SAND to SAND
50-55: Fine-med SAND
55-60: Not documented
60-62: Slightly silty, fine-med SAND
62-65: Silty, fine-med SAND
65-66: SILT, med & coarse SAND
66-67: SILT layer
67-73: Fine-med SAND, SILT
73-79: SILT, fine-coarse SAND
79-83: Fine SAND
83-89: Fine & med to coarse SAND
89-94: Fine, med SAND
94-98: SILT
98-100: SILT & fine SAND
100-102: SILT layer
102-103: SILT, fine SAND
103-107: Fine, med SAND
107-110: Pea GRAVEL & SAND, COBBLES
110-114.5: Med SAND, small to large GRAVEL
114.5-117: Coarse-med SAND, GRAVEL
117-119.5: Med-very fine silty SAND
119.5-125: Fine-very fine silty SAND
125-132: SILT
132-135: SILT, some fine SAND
135-137: CALICHE



Elevation of reference point: (top of casing)	[671.11 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[20 ft]
Type of surface seal: Cement grout	
I.D. of surface casing (If present) 10 in 0-20 ft	[10 in]
I.D. of riser pipe:	[6 & 8 in]
Type of riser pipe: Carbon steel	
Diameter of borehole, 20-113 ft	[9-in nom]
Type of filler: Cement grout	
8 in casing 0-113 ft	
Diameter of borehole, 113-137 ft	[7 in nom]
Depth bottom of 6 in casing	[130 ft]
Depth bottom of borehole:	[137 ft]

GEOLOGIST'S NOTES:
Contamination encountered:
93 ft = 40,000 dp/m, 8,000 c/m;
94 ft = 20,000 dp/m, 3,000 c/m;
94.5 ft = <500 dp/m;
99 ft = 5,000 dp/m;
100 ft = 20,000 dp/m
102 ft = <500 dp/m
CCL_4 odor encountered:
114.5 ft = odor
116 ft = odor

Drawing By: RKL/2W18-166.ASB Date: 10Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

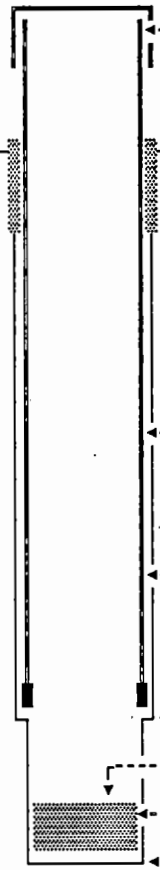
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 20Apr77	Date Complete: 17May77

WELL NUMBER: 299-W18-167	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,214	E/W W 76,552
State Coordinates: N 444,319	E 2,218,672
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): 665.7 Estimated	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: Backfill, very fine SAND/GRAVEL
15-20: Fine SAND, GRAVEL
20-25: Silty, fine→coarse SAND, GRAVEL
25-37: Med to coarse SAND
37-38.5: Coarse SAND, PEBBLES, COBBLES
38.5-44: Med→very coarse SAND, GRAVEL
44-48.5: Very fine→fine SAND
48.5-53: Very fine SAND, slightly silty
53-55: Very fine SAND; med SAND (moist)
55-58: Silty, very fine SAND; fine SAND
58-60: SILT, fine→med SAND
60-64: Fine→med SAND
64-67: Fine, med, coarse SAND
67-71: Very fine→fine SAND & silty
71-76: Fine→med SAND
76-78: SILT, some very fine SAND, brown
78-83: Silty, very fine→fine brown SAND
83-90: Fine→med SAND, slightly silty→silty
90-92: Small GRAVEL, fine→med SAND some SILT
92-97: All sizes of GRAVEL, SILT & coarse SAND
97-103: Med silty SAND, PEBBLES & COBBLES
103-108: Silty, very fine→fine SAND
108-118: Fine, med & coarse SAND
118-121: Very fine→fine silty SAND
121-124: SILT
124-134: Silty & very fine SAND (Layer of pure SILT)
134- : CALICHE



Elevation of reference point: (top of casing) [669.00 ft]
Height of reference point above ground surface [3.3 ft]
Depth of surface seal [ND]
Type of surface seal: Cement grout
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
8 in casing to about 124 ft
Depth to bottom 01Feb91 126.5 ft (129.5 from top-of-casing)
Cement plug, not well documented
Depth bottom of borehole: [134 ft]

DRILLER'S NOTES:
Contamination encountered:
55 ft = 2,000 dp/m & 51,000 dp/m
7,500-8,000 c/m
56 ft = <500 dp/m
CCL_4 odor encountered
10 ft in backfill

Drawing By: RKL/2W18-167.ASB Date: 14Mar91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

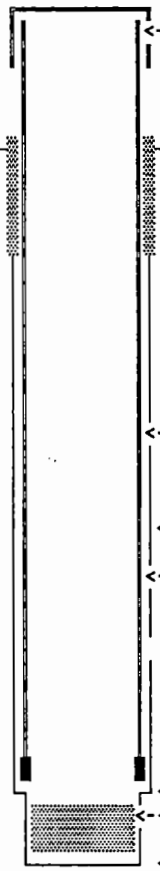
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 29May77	Date Complete: 16Jun77

WELL NUMBER: 299-W18-168 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,043 E/W W 76,552
State Coordinates: N 444,148 E 2,218,673
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY Driller's Log

0-5: Not documented
5-10: Med-fine SAND, sparse GRAVEL
10-12: Coarse SAND, GRAVEL/COBBLE backfill
12-16: 30% coarse, 30% med, 30% fine SAND
16-22: Very coarse-med SAND
22-41: Med→very coarse SAND, PEBBLES & COBBLES
41-45: Silty, PEBBLES & COBBLES
45-48.5: Slight amount of SILT, very fine→fine SAND
48.5-49: Med→coarse SAND at top, SILT & very fine SAND bottom
49-51: Very fine SAND & SILT
51-53: SILT→very fine SAND
53-55: Very fine→fine SAND
55-59: Fine→med SAND
59-60: Very fine→fine SAND
60-63: Very fine→med SAND
63-70: Very fine→fine SAND
70-74: Fine→med SAND
74-75: Silty, very fine SAND, w/mica
75-80: Very fine→med SAND
80-85: Fine→med SAND
85-89: Med→coarse SAND
89-93: Fine→med SAND, some coarse
93-95: SILT→very fine SAND
95-97.5: Med→fine SAND
97.5-101.5: Med→fine SAND
101.5-104: Med-fine silty SAND w/small→med GRAVEL
104-105: Med→very fine silty SAND
105-111.5: Med→coarse SAND
111.5-114: Fine→med SAND
114-117: Med→coarse SAND
117-119: Very fine→fine SAND w/SILT
119-122: Fine→med SAND, traces of coarse SAND
122-131: SILT



Elevation of reference point: [669.00 ft] (top of casing)
Height of reference point above ground surface: [ND]
Depth of surface seal: [ND]
Type of surface seal: Cement grout
I.D. of surface casing (If present): [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
8 in casing to ~127 ft
Cement plug not well documented
Depth bottom of borehole: [131 ft]

DRILLER'S NOTES:
Contamination encountered:
48.5-49 ft = >40,000 dp/m;
51 ft = <500 dp/m
55 ft = 18,000 dp/m
56 ft = 12,000 dp/m
58 ft = >40,000 dp/m
59 ft = 30,000 dp/m
60 & 61 ft = 5,000 dp/m
62 ft = 20,000 dp/m
63 ft = 10,000 dp/m
65 ft = >500 dp/m
CCL_4 odor encountered
10 and 12 ft = odor

Drawing By: RKL/2W18-168.ASB Date: 10Dec90
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

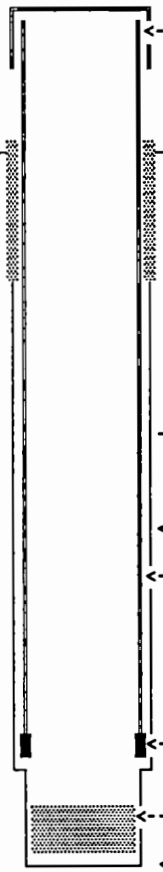
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 16Jun77	Date Complete: 05Sep77

WELL NUMBER: 299-W18-169	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,073	E/W W 76,552
State Coordinates: N 444,178	E 2,218,673
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-10: Backfill, no sample
10-12.5: Coarse SAND, COBBLES
12.5-23: Med-coarse SAND, COBBLES
23-28: Med→fine SAND
28-36: Fine→med SAND
36-37.5: Med, fine→coarse SAND, PEBBLES
37.5-39: Silty, med→coarse SAND, PEBBLES & COBBLES
39-43.5: Very coarse, grey SAND, SILT, PEBBLES & COBBLES
43.5-47: Silty, grey, coarse SAND→ PEBBLES & COBBLES
47-48: Very fine→med SAND & COBBLES
48-49: Very fine→fine SAND w/med SAND matrix, traces of SILT
49-53.5: Very fine→med SAND, PEBBLES & SILT
53.5-58: Very fine→coarse SAND, SILT stringers
58-66: Very fine→very coarse SAND
66-71: SILT, fine→coarse SAND, PEBBLES
71-72: Fine→very coarse SAND, some SILT & a few PEBBLES
72-73.5: Fine→coarse SAND
73.5-78: SILT, fine→med SAND
78-82: Fine→med SAND, trace coarse SAND
82-83: Fine→very coarse SAND, few COBBLES
83-86: Fine→med SAND, trace of coarse SAND & PEBBLES in stringers
86-88: Very fine→fine SAND
88-90: Fine→coarse SAND
90-91: Fine→coarse SAND w/SILT stringers
91-93: Fine→coarse SAND w/trace of SILT, GRAVEL
93-97: Med→very coarse SAND W/COBBLES, highly compacted
97-99: Med→very coarse SAND W/SILT; PEBBLES and some COBBLES
99-103: Med→very coarse SAND →"pea" GRAVEL; few COBBLES
103-104: Very fine SAND; some coarse SAND & few PEBBLES
104-108: Fine→coarse SAND
108-110: Med SAND
110-113: Very fine→coarse SAND w/some very coarse SAND
113-117: Fine→very coarse SAND W/SILT stringers
117-120: Silty very fine→SAND
120-122.5: SILT→very fine SAND
122.5-132: SILT



Elevation of reference point: [669.00 ft]
(top of casing)
Height of reference point above ground surface: [ND]
Depth of surface seal: [ND]
Type of surface seal: Cement grout
I.D. of surface casing (If present): [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
* in casing to ~128 ft
Cement plug not well documented
Depth bottom of borehole: [132 ft]

DRILLER'S NOTES:
Contamination encountered:
34.5 ft = 5,000 dp/m
36 ft = 1,000 dp/m, 500 c/m
37.5 ft = 15,000 dp/m, 2,000 c/m
38 ft = 15,000 dp/m, 900 c/m
39 ft = 600 dp/m
40 ft = <500 dp/m
43.5 ft = 600 dp/m
45 ft = 500 dp/m
47 ft = <500 dp/m
CCl_4 odor encountered
93 ft = odor
113-115 ft = odor

Drawing By: RKL/2W18-169.ASB Date: 10Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

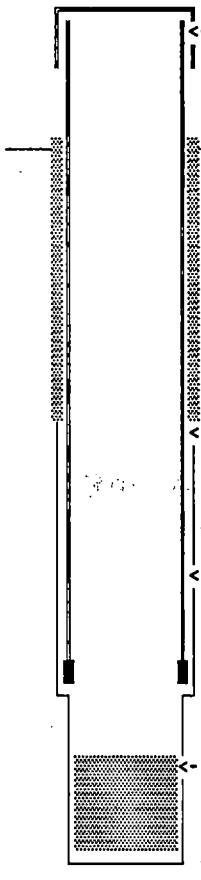
Drilling Method: Cable tool	Sample Method: Dual wall CB & Drive barrel	WELL NUMBER: 299-W18-170	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,154	E/W W 76,602
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,259	E 2,218,623
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T ___ R ___ S ___
Date Started: ~13Sep77	Date Complete: 21Sep77	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-14: Not documented
14-17.5: Med→very coarse SAND
17.5-20: Not documented
20-22: Coarse bronze colored SAND
22-23: Med→coarse SAND
23-24: Med→coarse SAND. few PEBBLES
24-25: Coarse SAND
25-26: Fine→coarse SAND
26-28.5: Coarse SAND
28.5-30.5: Med→coarse SAND (Hit hard object, may be metal)

DRILLER'S NOTES;
Contamination encountered:
20 ft = 30,000 dp/m, 2,000 c/m
22 ft = 3,500 dp/m, 1,000 c/m
23 ft = 12,000 dp/m, 1,500 c/m
24 ft = 11,000 dp/m, 1,100 c/m
24.5 ft = 28,000 dp/m
25 ft = 70,000 dp/m, 4,000 c/m
26 ft = 11,000 dp/m, 2,000 c/m
27 ft = 70,000 dp/m
28.5 ft = 30,000 dp/m, 2,200 c/m
30 ft = 20,000 dp/m, 2,000 c/m
30.5 ft = 20,000 dp/m, 2,000 c/m



Elevation of reference point: (top of casing) [672.32 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: Cement grout
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
6 in casing to ~25 ft
Cement plug in bottom depth not documented
Depth bottom of borehole: [30 ft]

Drawing By: RKL/2W18-170.ASB Date: 10Dec90

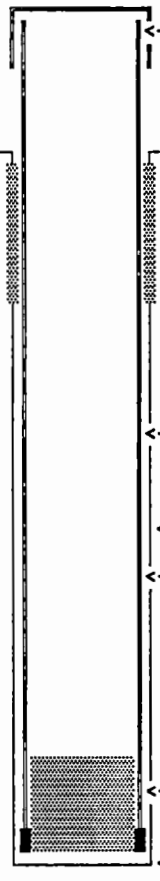
Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 26Jul77	Date Complete: 09Aug77

WELL NUMBER: 299-W18-171	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,010	E/W W 76,604
State Coordinates: N 444,115	E 2,218,621
Start Card #: Not documented	T R S
Elevation Ground surface (ft): 675.2 ft estimated	

Depth to water: Not applicable



Elevation of reference point: (top of casing) [677.65 ft]

Height of reference point above ground surface [2.5 ft]

Depth of surface seal [ND]

Type of surface seal: Cement grout

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [8-in]

Type of riser pipe: Carbon steel

Diameter of borehole: [9-in nom]

Type of filler: Not documented

Depth to bottom, Jan91 128.2 ft (131.2 ft TOC)

Cement plug in bottom, not well documented

Depth bottom of casing

Depth bottom of borehole: [136 ft]

GENERALIZED STRATIGRAPHY	Driller's Log
0-25:	Med-very coarse SAND, PEBBLES (Fill)
25-27.5:	Med-coarse SAND
27.5-37.5:	Med SAND
37.5-43:	Coarse→very coarse SAND, w/PEBBLES & COBBLES
43-47:	Fine→very coarse SAND, w/PEBBLES & COBBLES
47-48:	Fine→very coarse SAND & GRAVEL
48-49:	Med SAND
49-51:	Fine→very coarse SAND & GRAVEL
51-53:	Med SAND
53-58:	Very fine→fine SAND
58-62:	Fine→med→coarse SAND
62-65:	Med SAND (Dry)
65-67:	Very fine→fine SAND
67-69:	Silty very fine SAND
69-72.5:	Fine→med SAND
72.5-75:	Fine→coarse→very coarse SAND
75-87:	Very fine→med SAND
87-88:	Silty→very fine→fine→med SAND
88-91:	Med SAND
91-93:	Med→coarse SAND
93-95:	Fine→coarse SAND
95-98:	Very fine→coarse SAND
98-99:	Fine→coarse SAND w/SILT stringers, few PEBBLES, COBBLES
99-102:	Med→very coarse SAND, w/PEBBLES, COBBLES
102-103.5:	Fine→very coarse SAND, PEBBLES
103.5-105:	Coarse→very coarse SAND & pea GRAVEL, few COBBLES
105-107:	Very fine→very coarse SAND w/PEBBLES & COBBLES
107-119:	Med→very coarse SAND, PEBBLES & COBBLES
119-121:	Coarse→very coarse SAND, PEBBLES 50%
121-125:	Fine→med→very coarse SAND, pea GRAVEL
125-125.5:	Very fine→med SAND, few PEBBLES
125.5-127:	Very fine SAND→SILT
127-132:	SILT
132-136:	SILT, some $CaCO_3$

DRILLER'S NOTES:
Contamination encountered:
87 ft = 20,000 dp/m
87.5 ft = 20,000 dp/m

Drawing By: RKL/2W18-171.ASB Date: 19Feb91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

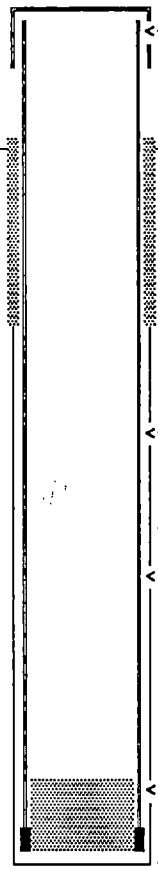
Drilling Method: Cable tool	Sample Method: Drive barrel
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Roberts/Baker	WA State Lic Nr: Not documented
Drilling Company: Bach	Company Location: ND
Date Started: 12Aug77	Date Complete: 25Aug77

WELL NUMBER: 299-W18-172	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,435	E/W W 76,595
State Coordinates: N 444,540	E 2,218,629
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-9: Not documented
9-15: Very fine SAND, GRAVEL
15-28: Med→very coarse SAND, PEBBLES
28-33: Med→coarse SAND
33-35: Coarse→very coarse SAND, few PEBBLES
35-40: Med→very coarse SAND, GRAVEL
40-43: Very fine→fine SAND, 40% GRAVEL
43-46: Coarse→very coarse SAND, GRAVEL & COBBLES
46-47: Very fine→very coarse SAND 25% GRAVEL
47-50: Med SAND, & 50% GRAVEL
50-50.5: Very coarse SAND & PEBBLES
50.5-54: Silty very fine SAND
54-60: Fine→med SAND
60-63: Fine→med SAND w/SILT stringers
63-64: Fine→med,trace coarse SAND w/COBBLES
64-67: Med→coarse SAND w/SILT stringers & COBBLES
67-69: Med SAND
69-69.5: Med→coarse SAND w/PEBBLES
69.5-73: Fine→med SAND
73-75.5: Silty, very fine→fine SAND
75.5-81.5: Fine→med→coarse SAND
81.5-83: Silty, very fine→coarse SAND w/sparse PEBBLES
83-83.5: Very fine→very coarse SAND w/PEBBLES
83.5-84: SILT→very fine SAND w/50% PEBBLES
84-85: SILT, very fine→very coarse SAND, 40% PEBBLES
85-88: Coarse→very coarse SAND w/40% PEBBLES
88-92: Fine→very coarse SAND w/fewer PEBBLES
92-93: Med→coarse SAND & GRAVEL
93-94: Med→very coarse SAND, pea-size GRAVEL, PEBBLES
94-98: Coarse→very coarse SAND, 50% PEBBLES & COBBLES
98-100: Coarse→very coarse SAND & PEBBLES, some brown sand
100-108: Very fine→very coarse SAND w/PEBBLES & COBBLES
108-112: Silty, very fine→coarse SAND w/PEBBLES & COBBLES
112-114: Med→very coarse SAND w/PEBBLES & COBBLES
114-116: Med SAND
116-121: Med→coarse SAND w/some PEBBLES
121-125: SILT & very fine SAND
125-127: SILT
127-129: Silty very fine SAND
129-134: SILT, flakes of CALICHE @ 134 ft



Elevation of reference point: (top of casing)	[678.07 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[0-20 ft]
Type of surface seal: Cement grout	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Cement plug not well documented	
Depth bottom of casing	
Depth bottom of borehole:	[134 ft]

DRILLER'S NOTES:
84 ft = wet sample, muddy, smells like sewage
92 ft = wet sample, sewage smell
93 ft = no odor

Drawing By: RKL/2W18-172.ASB Date: 11Dec90

Reference:

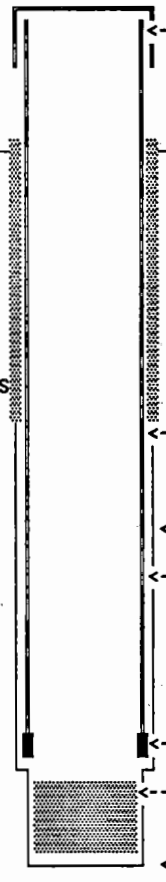
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-W18-173	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,307	E/W W 76,574
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,412	E 2,218,650
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T___ R___ S___
Date Started: 12Oct77	Date Complete: 24Oct77	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-15: Not documented
15-16.5: Med→coarse SAND
16.5-18: Med SAND
18-30: Med→very coarse SAND
30-31.5: Fine→coarse SAND
31.5-33: Med→coarse SAND
33-34.5: Med→very coarse SAND, GRAVEL
34.5-36: Med→very coarse SAND, GRAVEL COBBLES
36-39: Fine→coarse SAND, GRAVEL, COBBLES
39-40: Med→coarse SAND, GRAVEL, COBBLES
40-43: Med→very coarse SAND, GRAVEL
43-45: Fine→coarse SAND, GRAVEL
45-47: Very fine→fine SAND, SILT stringers
47-48: Fine→med SAND
48-51: Very fine→fine SAND



Elevation of reference point: (top of casing) [673.31 ft]

Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: Cement grout

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [9-in nom]

Type of filler: Not documented

8 in casing to ~47 ft

Cement plug not well documented

Depth bottom of borehole: [51 ft]

DRILLER'S NOTES:
Contamination encountered:
15 ft = 40,000 dp/m
16.5 ft = 4,000 dp/m
18 ft = <500 dp/m
24 ft = 20,000 dp/m
30 ft = 20,000 dp/m
31 ft = 90,000 dp/m
31.5 ft = 35,000 dp/m
33 ft = 35,000 dp/m
34.5 ft = 35,000 dp/m
36 ft = 20,000 dp/m
37 ft = 30,000 dp/m
39 ft = 500 to 1,000 dp/m
40 ft = 20,000 dp/m
41 ft = 500 dp/m
42 ft = 2,000 dp/m
43 and 45 ft = <500 dp/m
46 ft = 20,000 dp/m
47 ft = 5,200 dp/m
48 ft = <500 dp/m

Drawing By: RKL/2W18-173.ASB Date: 11Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: None	Additives Used: Not documented
Driller's Name: Baker	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 06Oct77	Date Complete: 11Oct77

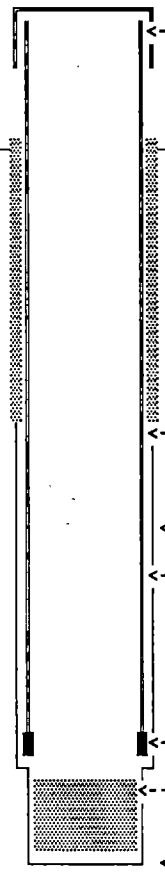
WELL NUMBER: 299-W18-174	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,296	E/W W 76,565
State Coordinates: N 444,401	E 2,218,659
Start Card #: Not documented	T ___ R ___ S ___
Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-14.5: Not documented
14.5-35: Med→coarse SAND, few PEBBLES
35-40: Fine→med→coarse SAND, GRAVEL, COBBLES
40-41: Med→coarse SAND, large COBBLES
41-43: Fine→med SAND, GRAVEL
43-44: Fine→coarse SAND, GRAVEL
44-46.5: Med→coarse SAND, GRAVEL
46.5-47: Very fine→fine SAND, GRAVEL
47-51: Very fine→fine SAND

DRILLER'S NOTES:
Contamination encountered:
14.5 ft = 40,000 dp/m
15 ft = 10,000 dp/m
16.5 ft = 500→1,000 dp/m
19 ft = 5,000 dp/m
20 ft = 500 dp/m
35 ft = 10,000→20,000 dp/m
36 ft = 10,000 dp/m
37 ft = 500 dp/m
38 ft = 2,000 dp/m
39 ft = 500 dp/m
39.5 ft = 1,000 dp/m
40 & 41 ft = <500 dp/m
42 ft = 2,000 dp/m
43 ft = 500 dp/m
45 ft = 20,000 dp/m
46 & 46.5 ft = 15,000 dp/m
46.75 ft = 20,000 dp/m
47 ft = <500 dp/m
48 ft = 2,000 dp/m
48.5 ft = barely 500 dp/m
49 & 51 ft = <500 dp/m



Elevation of reference point: (top of casing)	[673.21 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[0-19 ft]
Type of surface seal: Cement grout	
I.D. of surface casing (If present) Pulling of 10 in casing and grouting documented	[10 in pulled]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
8 in casing to ~47 ft	
Cement plug, not well documented	
Depth bottom of borehole:	[51 ft]

Drawing By: RKL/2W18-174.ASB Date: 11Dec90

Reference:

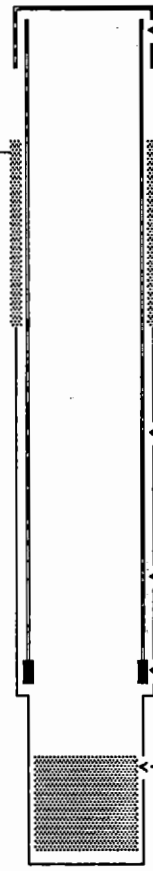
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Dual wall CB & Drive barrel	WELL NUMBER: 299-W18-175	TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: Not documented	Hanford Coordinates: N/S N 39,117	E/W W 76,600
Driller's Name: Baker	WA State Lic Nr: Not documented	State Coordinates: N 444,222	E 2,218,625
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T___ R___ S___
Date Started: 28Oct77	Date Complete: 07Dec77	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

GENERALIZED STRATIGRAPHY — Driller's Log

0-26: Not documented, sampled by dual wall core barrel
26-33.5: Coarse→very coarse SAND
35.5-40: Med→coarse SAND, GRAVEL, COBBLES
40-41: Sample lost
41-43.5: Silty→fine→coarse SAND, GRAVEL
43.5-48: Med→very coarse SAND, GRAVEL
48-49: Fine→med SAND
49-50: Sample lost
50-53: Fine→med SAND
53-58: Very fine→fine SAND
58-59: Very fine SAND
59-60: Silty fine SAND
60-63: Fine→med SAND
63-69.5: Very fine→med SAND
69.5-71: SILT & very fine SAND
71-77: Very fine to med SAND
77-78: Silty, very fine→fine SAND
78-79: SILT & very fine SAND
79-84.5: Very fine→med SAND
84.5-87: Med SAND, few PEBBLES
87-89: Med→coarse SAND
89-95: Fine→med SAND
95-96.5: SILT & very fine SAND
96.6-98: SILT
98-105: Fine→med SAND
105-109: Very fine→fine SAND
109-112: Fine→med SAND
112-115: SILT stringer & very fine SAND
115-118: Very fine→fine SAND
118-120: Silty very fine SAND
120-126: SILT & very fine SAND
126-130: SILT



Elevation of reference point: (top of casing) [670.00 ft]
Height of reference point above ground surface [ND]
Depth of surface seal [0-7 ft]
Type of surface seal: Cement grout
I.D. of surface casing (If present) [10 in pulled]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
6 in casing to 121 ft
Cement plug, Not well documented
Depth bottom of borehole: [130 ft]

DRILLER'S NOTES:
Contamination encountered:

Dual-wall GM readings
13.5 ft = 300 c/m
14 ft = 3,000 c/m
14.5 ft = 1,500 c/m
15 ft = 600-700 c/m

Samples
26 ft = 15,000 dp/m
28.5 ft = 30,000 dp/m
30 ft = 20,000 dp/m
32 ft = 20,000 dp/m
33.5 ft = 12,500 dp/m
35.5 ft = 12,500 dp/m
37.5 ft = 1,000 dp/m
38.5 ft = 10,000 dp/m
41 ft = 2,000 dp/m
41.5 ft = 10,000 dp/m
43.5 ft = 20,000 dp/m
46 ft = 40,000 dp/m
48 ft = 20,000 dp/m
49 ft = 30,000 dp/m
50 ft = 27,000 dp/m
51.5 ft = 51,000 dp/m
53 ft = 40,000 dp/m
55.5 ft = 24,000 dp/m
58 ft = 8,000 dp/m
59 ft = 3,000 dp/m
60 ft = 500 dp/m
61 ft = <500 dp/m
77 ft = 2,500 dp/m
78 ft = 5,000 dp/m
79 ft = <500 dp/m
93 ft = 10,000 dp/m
95 ft = 70,000 dp/m
96 ft = 10-20,000 dp/m
98-100 ft = 500 dp/m

Drawing By: RKL/2W18-175.ASB Date: 11Dec90

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

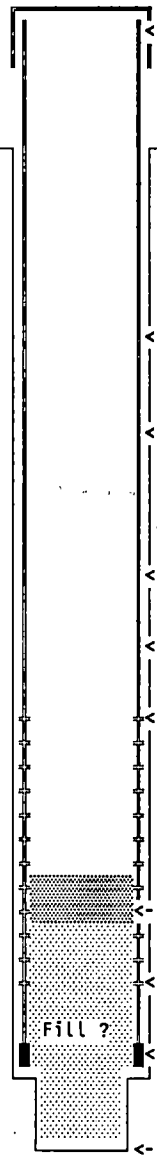
Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 699-38-70	TEMPORARY WELL NO:
Drilling Fluid Used: Water	Additives Used: Bentonite	Hanford Coordinates: N/S N 38,142	E/W W 70,226
Driller's Name: Swain	WA State Lic Nr: Not documented	State Coordinates: N 443,264	E 2,225,001
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T R S
Date Started: 17May57	Date Complete: 14Jun57	Elevation Ground surface (ft): Not documented	

Depth to water: 270 ft Jun87

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: SAND
5-15: Small GRAVEL
15-25: Sandy SILT-GRAVEL
25-30: SILT, coarse SAND
30-45: Sandy SILT
45-55: SAND-SILT-GRAVEL
55-70: SAND-SILT
70-72: SAND-small GRAVEL
72-80: SAND-coarse and clean
80-120: SAND-SILT
120-130: SAND-SILT (harder packed)
130-190: SAND-SILT
190-200: SAND-SILT-small GRAVEL (water)
200-205: SAND-SILT-small GRAVEL
205-220: SAND-SILT
220-230 SAND-SILT, soft, more CLAY than SAND
230-245: Small GRAVEL-CLAY
245-250: CLAY
250-260: CLAY-GRAVEL
260-265: SAND-SILT-GRAVEL
265-310: SAND-GRAVEL, mostly clean
310-315: SAND-GRAVEL, a little SILT
315-320: SAND-SILT-GRAVEL-CLAY
320-335: SAND, SILT and GRAVEL
335-345: SAND-GRAVEL
345-350: Clean coarse SAND
350-360: Fine clean SAND
360-365: SAND
365-369: SAND-small GRAVEL
369-375: SAND-hardpacked
375-380: SAND-softer, very fine
380-390: SAND-SILT, very fine
390-395: SAND-GRAVEL
395-400: SAND
400-413: Fine SAND and SILT (caving)

REMEDIATIONS:
Jun 64, Crowe
Installed plastic piezometer tubes
Jul75, M. Bultena, cleaned well
Jul77, Bigham. set cement plug 300-310 ft



Elevation of reference point: (top of casing)	[710.67 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
DRILLER'S NOTE: Casing may be parted at joint 50 ft from top	
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Depth top of perforations: 255-320 ft, 3 cuts/ft; 320-380 ft, 2 cuts/2 ft	[255 ft]
Cement plug, ~ 300-310 ft	
Depth bottom of perforations:	[380 ft]
Depth bottom of casing:	[388 ft]
Depth bottom of borehole:	[413 ft]

Drawing By: RKL/6#38#70.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Rumley
Drilling Company: Not documented
Date Started: 14Aug48

Sample Method: Hard tool (nom)
Additives Used: Aquagel
WA State Lic Nr: Not documented
Company Location: ND
Date Complete: 07Sep48

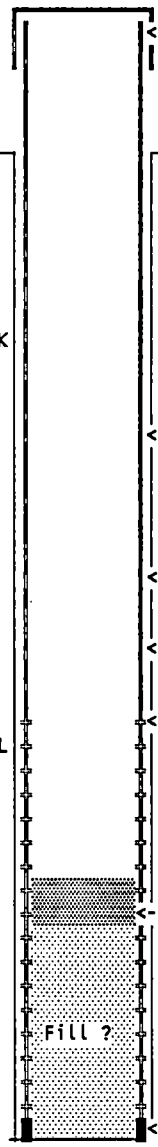
WELL NUMBER: 699-39-79
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,198 E/W W 78,751
State Coordinates: N 444,298 E 2,216,474
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: 265 ft Sep48
204 ft Sep56

GENERALIZED STRATIGRAPHY — Driller's Log

0-25: Fine SAND
25-27: Basalt GRAVEL and SAND
27-30: BASALT and some GRAVEL
30-35: BASALT and GRAVEL
35-45: BASALT, GRAVEL and ROCKS
45-53: Black SAND and GRAVEL
53-60: Basalt GRAVEL and SAND
60-70: Basalt GRAVEL, SAND and some ROCK
70-78: Fine black SAND
78-87: Black SAND and ROCKS and BASALT
87-92: CLAY and fine SAND
92-110: SILT and SAND
110-125: Coarse SAND and SILT
125-140: SILT and fine SAND
140-141: SILT, fine SAND and some CLAY
141-149: CALICHE cemented zone
149-158: Fine SAND, SILT and CLAY
158-162: GRAVEL, BASALT, SAND, SILT and CLAY
162-170: SAND and GRAVEL
170-183: SAND, GRAVEL and ROCKS
183-190: Basalt GRAVEL and SAND
190-195: Coarse SAND, ROCKS and GRAVEL
195-225: SAND. GRAVEL and ROCKS
225-240: Fine and coarse SAND and GRAVEL
240-250: CLAY, SAND and GRAVEL
250-260: GRAVEL, ROCKS and SAND
260-265: Cemented SAND, ROCK and GRAVEL
265-270: SAND, GRAVEL, ROCKS & BOULDERS
270-280: Fine water SAND and GRAVEL
280-295: Coarse SAND and GRAVEL

REMEDIATIONS:
Sep56, Gentz, perforated 210-265 ft
Aug 75, M. Bultena, cleaned fill
Jun77, Bigham, poured cement plug



Elevation of reference point: [673.58 ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal: None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel

Diameter of borehole: [9-in nom]

Type of filler: Not documented

Elevation/depth top of seal
Type of seal: Not documented

Depth top of perforations: [195 ft]
195-210 ft, 4 cuts/ft
210-265 ft, 3 cuts/ft
265-295 ft, 5 cuts/ft

Cement plug, ~ 240-250 ft

Depth bottom of perforations
Depth bottom of casing: [295 ft]
Depth bottom of borehole

Drawing By: RKL/6#39#79.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)
Drilling Fluid Used: Water	Additives Used: Aquagel
Driller's Name: Chausse	WA State Lic Nr: Not documented
Drilling Company: Not documented	Company Location: ND
Date Started: 12Aug48	Date Complete: 21Dec48

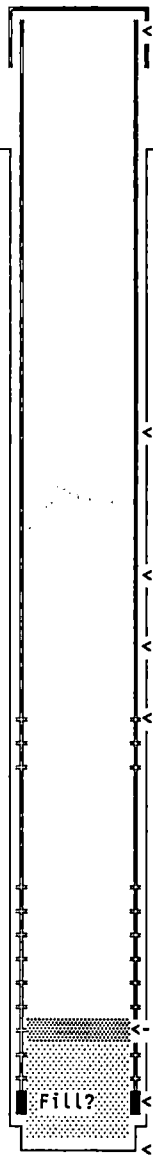
WELL NUMBER: 699-43-88 TEMPORARY WELL NO: 699-43-88.5
Hanford Coordinates: N/S N 43,209 E/W W 88,445
State Coordinates: N 448,284 E 2,206,769
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: Dry Dec48
176.5 ft Dec76

GENERALIZED STRATIGRAPHY — Driller's Log

0-10: Sandy LOAM
10-45: SAND, SILT and CLAY
45-50: SAND, GRAVEL and SILT
50-52: SAND, GRAVEL, SILT and BOULDERS
52-83: SAND, SILT and GRAVEL
83-87: SAND and SILT
87-100: SAND, SILT and GRAVEL
100-103: SAND and SILT
103-110: SAND, SILT and GRAVEL
110-135: SAND and SILT
135-142: SAND, SILT and GRAVEL
142-143: SAND and GRAVEL
143-147: SAND, GRAVEL and SILT
147-148: SAND, GRAVEL, BOULDERS and CLAY
148-162: SAND, CLAY and GRAVEL
162-167: SAND, GRAVEL, SILT and CLAY
167-186: SAND, GRAVEL and CLAY
186-190: Fine SAND and GRAVEL
190-196: Fine SAND, GRAVEL, CLAY
196-203: SAND, GRAVEL, CLAY and SILT

REMEDIATIONS:
Sep 69, by undocumented
Cleaned out to 200 ft. Perforated 178-198, 1 cut/ft spiraled
Dec76, M Bultena
Cleaned out and attempted to perforate 177-178 ft
Set cement plug to ~191.5 ft.



Elevation of reference point: (top of casing)	[644.82 ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
Depth top of perforations: 142-152 ft, 178-198 ft, 1 cuts/ft, 177-178 ft, 4 cuts/ft	[142 ft]
Cement plug, 191.5-~193 ft	
Depth bottom of perforations:	
Depth bottom of casing:	[198 ft]
Depth bottom of borehole:	[203 ft]

Drawing By: RKL/6#43#88.ASB Date: 28Jan91

Reference:

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Greenfield
Drilling Company: Not documented
Date Started: 24May48

Sample Method: Hard tool (nom)
Additives Used: Topsoil, clay
WA State Lic Nr: Not documented
Company Location: ND
Date Complete: 06Jul48

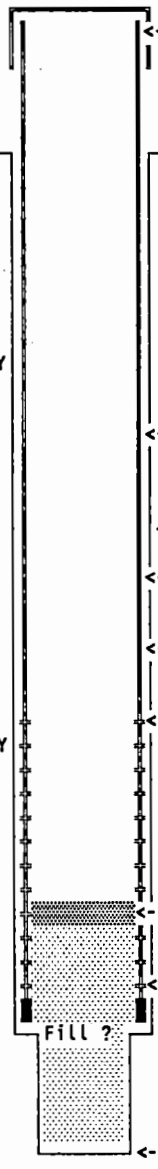
WELL NUMBER: 699-49-79
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 48,600 E/W W 79,122
State Coordinates: N 453,699 E 2,216,078
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

Depth to water: ~270 ft Jul48
241 ft Aug56

GENERALIZED STRATIGRAPHY — Driller's Log

0-20: ROCKS
20-22: Grey SAND
22-25: Black SAND
25-30: GRAVEL
30-35: Black SAND
35-40: Black and white SAND
40-45: CLAY, SAND and GRAVEL
45-47: Coarse B&W SAND & little GRAVEL
47-50: Fine B&W SAND, little GRAVEL/CLAY
50-85: SAND, CLAY & little GRAVEL
85-95: SAND & CLAY w/very little GRAVEL
95-117: SAND & CLAY
117-120: SAND, CLAY & ROCKS
120-123: SAND & GRAVEL w/little CLAY
123-130: SAND & GRAVEL
130-135: Grey SAND
135-140: SAND & GRAVEL
140-150: GRAVEL & little SAND
150-154: SAND & GRAVEL
154-159: SAND
159-160: SAND, GRAVEL & ROCKS
160-163: Fine grey SAND
163-180: SAND & GRAVEL some ROCKS
180-200: SAND & little GRAVEL & ROCKS
200-210: SAND, GRAVEL, ROCKS w/some CLAY
210-225: SAND, ROCKS & some CLAY
225-265: SAND, CLAY & ROCKS
265-270: SAND & silty GRAVEL
270-277: SAND, GRAVEL & little CLAY
277-280: SAND & GRAVEL, some ROCKS
280-285: Silty sandy GRAVEL
285-290: Silty SAND & GRAVEL
290- : SAND & GRAVEL

REMEDIATIONS:
Aug56, Gentz,
Perforated 235-265 ft
Aug74, M. Bultena
Perforated 225-235 ft
Fill to 280 ft
Mar80, M. Bultena
Set cement plug at 279 ft



Elevation of reference point: [689.20 ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [225 ft]
225-235 ft, 4 cuts/ft
235-245 ft, 4 cuts/ft
245-260 ft, 1 cut/ft
260-265 ft, 2 cut/ft
Cement plug, ~ 279-280 ft
Depth bottom of perforations: [265 ft]
Depth bottom of casing [~265 ft]
Depth bottom of borehole: [290 ft]

Drawing By: RKL/6#39#79.ASB Date: 29Jan91
Reference:

APPENDIX C2

FIELD INSPECTION REPORTS

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DON'T SAY IT - *WRITE IT!*

TO: V. J. Rohay H4-56

FROM: M. G. Gardner N3-06

DATE: February 21, 1990

SUBJECT: 200 West Carbon Tetrachloride IRA, Well Inspections.

Well inspections and borehole camera surveys for wells associated with the 200 West Carbon Tetrachloride Interim Response Action have been completed. A total of 46 wells were inspectedwith 4 wells being surveyed with the borehole camera. Copies of the field inspection and camera survey reports are attached for your review. The wells for which data is provided are as follows:

64

299-W15-6	299-W18-24	299-W18-97	699-38-70
299-W15-8	299-W18-65	299-W18-98	699-39-79
299-W15-9	299-W18-67	299-W18-99	699-43-88
299-W15-16	299-W18-68	299-W18-149	699-49-79
299-W15-82	299-W18-76	299-W18-150	
299-W15-84	299-W18-77	299-W18-158	
299-W15-85	299-W18-78	299-W18-159	
299-W15-86	299-W18-79	299-W18-163	
299-W15-95	299-W18-80	299-W18-164	
299-W15-101	299-W18-81	299-W18-165	
299-W18-6	299-W18-82	299-W18-166	
299-W18-7	299-W18-85	299-W18-167	
299-W18-9	299-W18-86	299-W18-168	
299-W18-10	299-W18-87	299-W18-169	
299-W18-11	299-W18-88	299-W18-170	
299-W18-12	299-W18-89	299-W18-171	
299-W18-17	299-W18-93	299-W18-172	
299-W18-18	299-W18-94	299-W18-173	
299-W18-19	299-W18-95	299-W18-174	
299-W18-20	299-W18-96	299-W18-175	

The record copies of these reports are on file at the Environmental Field Services office. Should you have any comments or questions, please contact me on 6-2908. Thank-you.

CC: D.J. Moak SO-03
MGG File/LB

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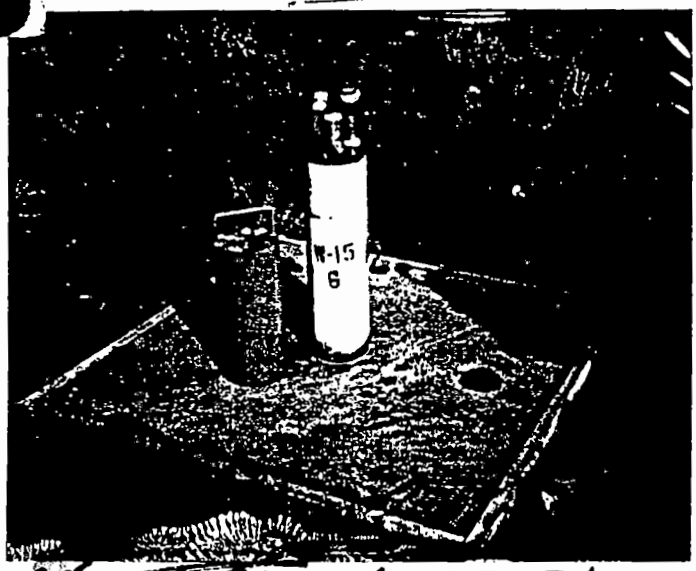
RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



MMB ~~1-26-91~~ 1-25-91
1-25-91
MMBaird-Simmons
299-W15-6

Well Number 299-W15-6 Date 1-25-91

Inspector (print) A. L. SCHATZ

Signature A. L. Schatz

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☒ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-9 tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

put a weather guard on the padlock

CONCRETE PAD

☐ None ☒ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) none

A 6000 499 (03/90)

BARRIER POSTS

Four posts, min. 3 in ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 6 5/8 / 6"	Type	carbon steel
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.93'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☒ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) none.

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

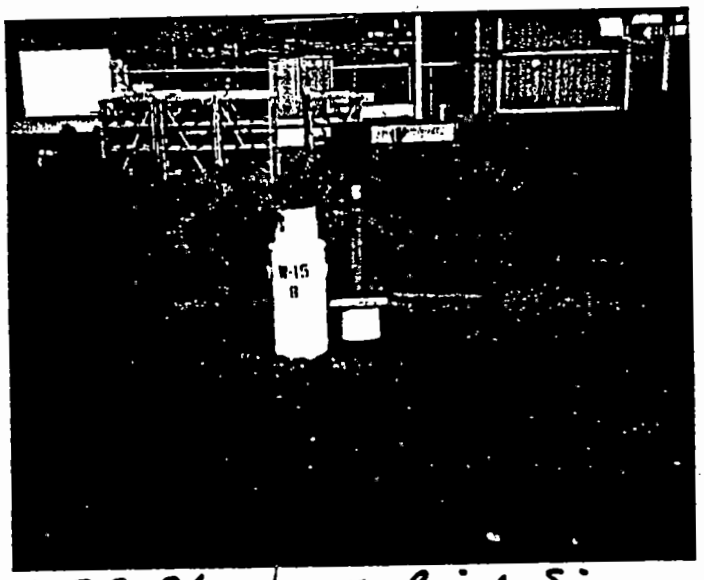
COMMENTS

No organic vapors detected by OVM ~4" above TOC
No DTW or DTB taken - didn't have a 500 ft Tape.
1-28-91 DTW 192.78' below top of pump tee. Unable to obtain DTB - weight too large to fit into the opening.
No radioactive contamination detected by the HPT.

192.78' - 2.93' - 0.33' = 189.5' DTW

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-29-81 | mm Baird-Simmons
299-W15-8

Well Number 299-W15-8 Date 1-29-91

Inspector (print) mm Baird-Simmons

Signature mm Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type surface contamination		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 9" Type carbon steel

Inner casing: OD/ID: 6 11/16" / 6" Type carbon steel

Other casing: OD/ID: ~~5~~ 4 1/2" / 4 1/4 Type core casing

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.10'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

boards, rope, wire, tubing

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

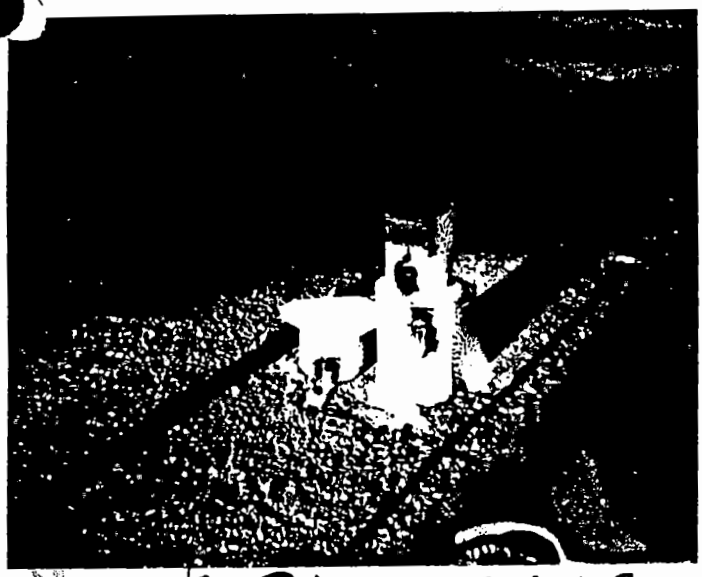
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

E-Tape DTW 199'. Steel tape 198.88' from Top of Core Casing.
DTB 200.78' + 2.96' = 203.74'
No organic vapors detected by HNU instrument
No radioactive contamination detected by HPT.
Mirror view shows casing curves slightly south.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-25-91 MM Baird-Summers
299-W15-9

Well Number 299-W15-9 Date 1-25-91

Inspector (print) A. L. SCHATZ

Signature A. L. Schatz

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9 crib		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) Well has a hole in the side of the casing

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) Thin layer - broken up

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: OD = 7" ID = ?	Type	carbon steel
Inner casing:	OD/ID: 6 3/4" / 6"	Type	carbon steel
Other casing:	OD/ID: Liner 3 3/4" / 3 1/2"	Type	carbon steel
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

hole in 6 3/4 casing

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 1.72'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

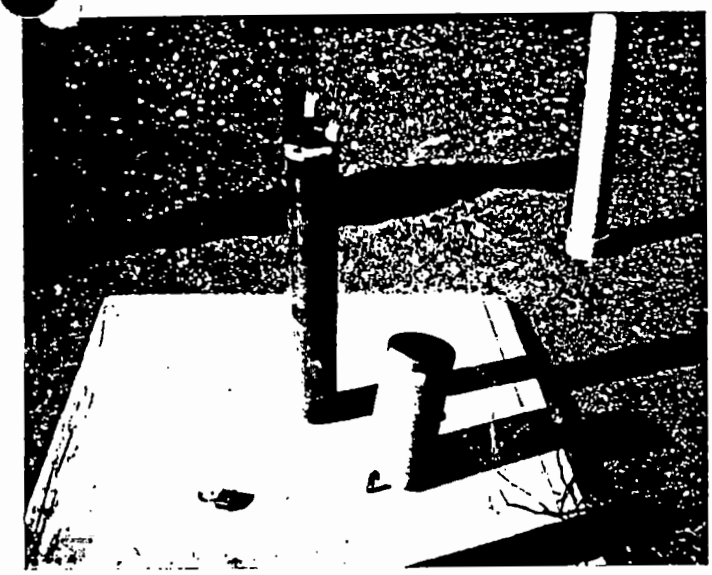
COMMENTS

No organic vapors detected by OVM
D-T-W = 192.12' below top of highest edge of casing
D-T-B = 189.54' + 2.96 = 192.50' below top edge of highest most casing
Viewed with mirror - no irregularities noted.
Stamped the well number on the 7" casing North side.

A-6000-499R (03/90)

9112217065 3

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W15-16
-21-91 RT Hotell

Well Number 299-W15-16 Date 2/21/91

Inspector (print) RT COFFMAN

Signature RT Coffman

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☑ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☑ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☑ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☑ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☑ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☑ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☑ Yes	☐ No	If yes, identify facility PFP, 234-5 bLDG		
Is well located in a radiation zone?	☐ Yes	☑ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☑ Yes	☐ No
Is the cap able to be locked?	☑ Yes	☐ No
Is the cap locked?	☑ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☑ None

_____

CONCRETE PAD

☐ None ☑ 4 ft x 4 ft ☐ 18 in x 18 in ☐ 2 ft round Is it damaged? ☐ Yes ☑ No

Irregular/Damage (describe) _____

A 6000 422 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☑ Yes ☐ No

If no, describe barrier posts: How many posts? 4 Diameter of posts? 4.5"

Is there a removable post? ☑ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 4.5" / 4"	Type	STAINLESS STEEL
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☑ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☑ None

Distance from: (check one)

☐ Ground Surface ☑ Cement Pad To top edge of highest most casing 2.3' TOP OF SUPP. PLATE

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☑ Hydrostar ☐ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☑ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☑ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☑ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☑ None

SURVEY INFORMATION

Describe survey mark location:

☑ Top edge of highest most casing ? ☐ Brass Marker ☐ Both ☐ None

Other (describe) PUMP SUPPORT PLATE COVERS TOP RIM OF CASING

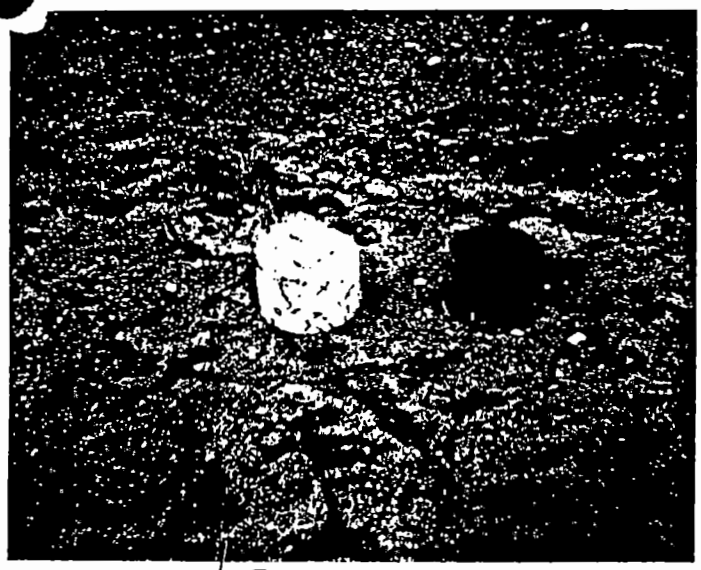
Is stamp clearly visible? ☐ Yes ☑ No

COMMENTS

DTW = 217.48' below top of pump support plate
DTB = 239.90' " " " " " "
No organic vapors detected by OVM
No radioactive contamination detected by HPT

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-25-91 A.L. Schatz
299-W15-82

Well Number 299-W15-82 Date 1-25-91

Inspector (print) A. L. SCHATZ

Signature A. L. Schatz

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities casing needs to be extended

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9 crib		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe)

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

Needs to be replaced (very old + paint is chipping off)

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) no surface seal apparent.

A 6000 499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 8 5/8" / 8"	Type	carbon steel
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 6 1/4"

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

One section of 1 1/2" ABS pipe

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

South side of blue 2-9 building

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

D-T-B 96.62' + 2.96' = 99.58' below top of casing
No organic vapors detected by OVM.
No radioactive contamination detected by HPT.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE-FIELD INSPECTION REPORT

1-25-91 MM Baird-Simmons
299-W15-84

Well Number 299-W15-84 Date 1-25-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9 crib		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? one Diameter of posts? 1½"

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) one fence post with underground radioactive material sign affixed to it.

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: Type

Other casing: OD/ID: Type

Other casing: OD/ID: Type

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe)

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

2 holes one each east & west sides.

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 1.47'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe)

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe)

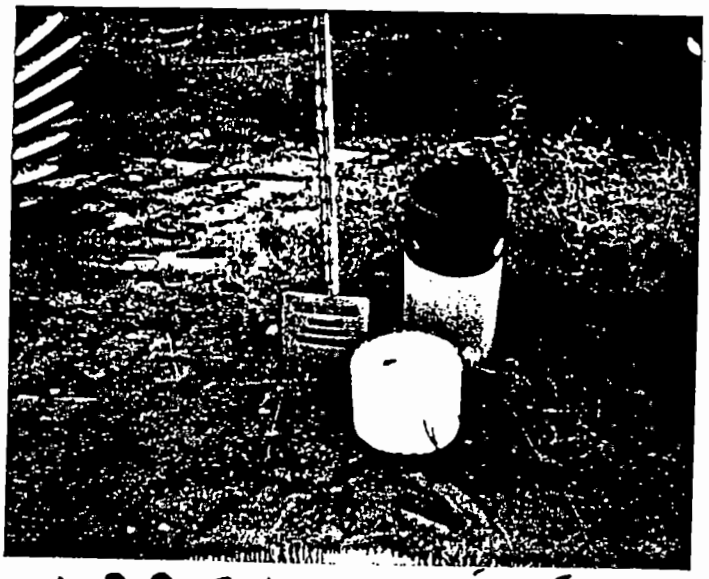
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

D-T-B: 104.82 + 2.96 Meas. by M.G.G. (soft @ bottom)
= 107.78' below the top of the casing.
No organic vapors detected by OVM.
No radioactive contamination detected by HPT.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-25-91 mm Baird-Simmons
299-W15-85

Well Number 299-W15-85 Date 1-25-91

Inspector (print) Mm Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-9 crib	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

2 - 1 1/2" holes on east + west sides

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 1.44'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

few tumbleweeds

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

No organic vapors detected with OVM.

D-T-B ~~102.82~~ MWB 1-25-91 102.2 feet + 2.96' = 105.16'

No radioactive contamination detected by HPT.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

1-25-91 MM Baird-Simmons
299-W15-86

Well Number 299-W15-86 Date 1-25-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9 crib		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	8.5" / 8"	Type	Carbon steel
Inner casing:	OD/ID:	6.5" / 6"	Type	Carbon steel
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.06'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

Well nearly surrounded by tumble weeds

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

at the edge of the crib radiation surface contamination zone.

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

No organic vapors detected with OVM.
DF-B 139.73' + 2.96 = 142.69' below Top of highest mast casing.

A-6000-499R (03/90)

9112270563

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

1-25-91 MM Baird-Simmons
299-W15-95

Well Number 299-W15-95 Date 1-25-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-9 crib		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

2 holes on both sides heavy steel

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? ~~None~~ Diameter of posts? 1½"?

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) fence post with underground radioactive material posting attac on North side of well casing.

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type Carbon steel

Inner casing: OD/ID: Type

Other casing: OD/ID: Type

Other casing: OD/ID: Type

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe)

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

2 holes on east + west sides

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.65'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe)

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe)

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

D-TB - 98.95' + 2.96' = 101.91' below top of casing
No organic vapors detected by OVM
No radioactive contamination detected by HPT.

A-6000-499R (03/90)

9112217056 5

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

Well Photo. Include appurtenance description of well site. Include additional photographs as needed to document unusual conditions. Label photograph(s) with well number and date. Sign photograph(s) then attach to field inspection report.

Well Number 299-W15-101 Date 1-25-91

Inspector (print) MM Baird-Simmons

Signature M.M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

N/A

Is the well labeled?	☐ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☐ No	If yes, identify facility _____		
Is well located in a radiation zone?	☐ Yes	☐ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

SEE Comments ON back of this form

INSPECT WELL SURFACE PROTECTION MEASURES

WELL CAPS

Is the well capped?	☐ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☐ No
Is the cap locked?	☐ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☐ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: _____ Type _____

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

_____

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing _____

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

_____

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Inside a locked building

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

The building ~~maybe~~ May be TH 2-20-91 building TH 2-20-91 over or around the well. The building was locked and we couldn't get in.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

1-28-91 MM Baird Simmons
299-W18-6

Well Number 299-W18-6 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☒ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

Rubber seal plug type cap difficult to open

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☒ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☒ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.56'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☒ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

203.58' NJR

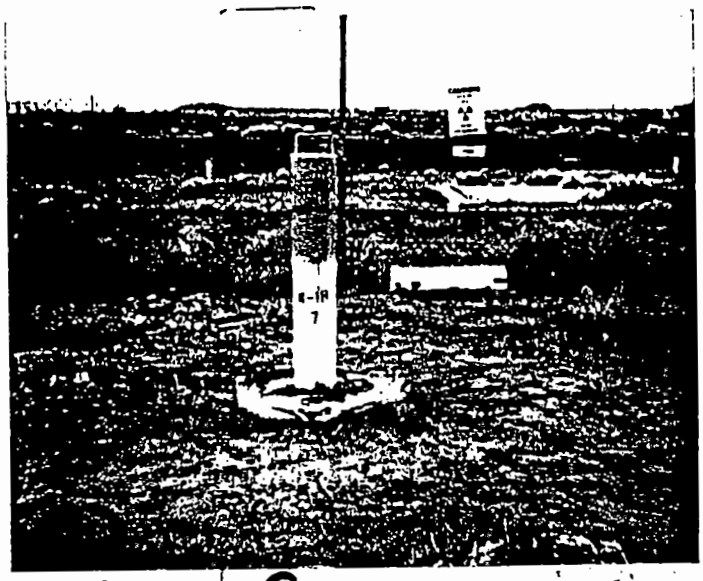
DT-B 200.62' + 2.96' = 203.68' below top of casing

No organic vapors detected by OVM.

No radioactive contamination detected by HPT.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 MM Baird-Simmons
299-W18-7

Well Number 299-W18-7 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☒ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☒ 2 ft round Is it damaged? ☒ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type Carbon Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☒ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None 1-28-91

2 small holes in casing - 1 in the north 1 to the west.

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.5'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☒ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

207 drill depth

D-T-B 202.84' + 2.96' = 205.80 below top of casing.

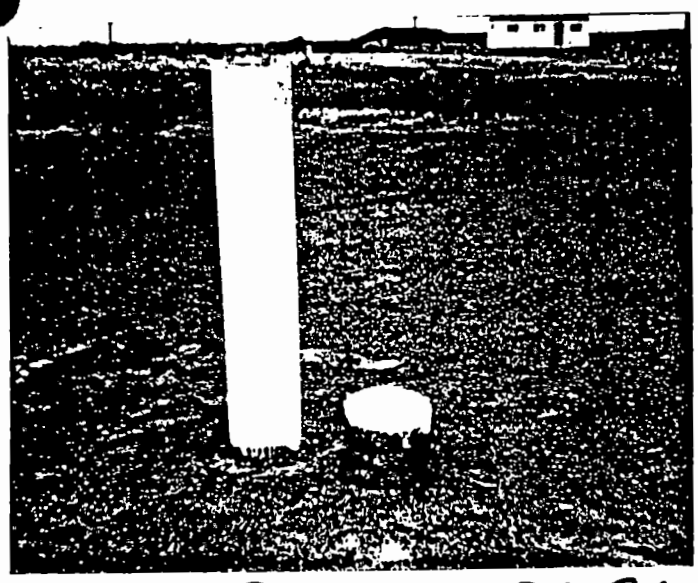
No organic vapors detected by OVM.

No radioactive contamination detected by HPT.

DTW - ~~0~~ E-Tape was cut and the well is dry

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-9 1-31-91
MM Baird-Simmons

Well Number 299-W18-9 Date 1-31-91
Inspector (print) MM Baird-Simmons
Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities none

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-18		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type underground radiation		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8 / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.91'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

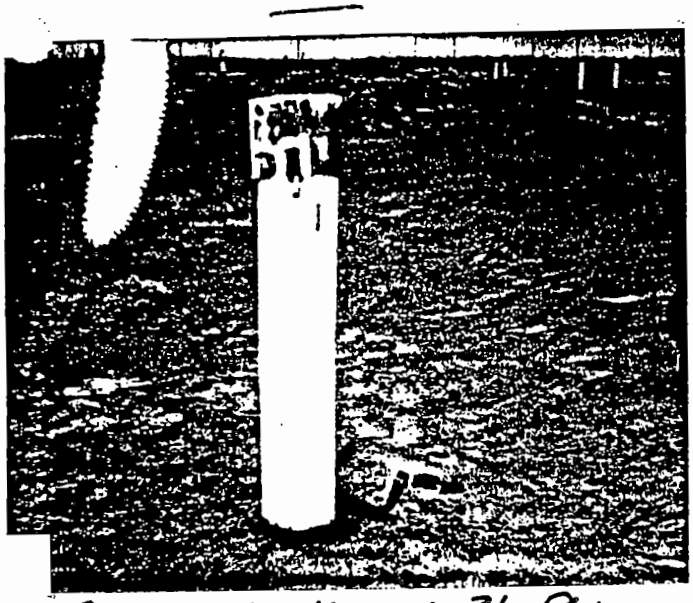
COMMENTS

D-T-W 213.64' E-tape D-T-B
D-T-B 217.47 + 3.01 = 220.48
HNU detected 2.2 ppm organic vapors
HPT detected no radioactive ~~rad~~ umbs contamination. 1-31-91

A-6000-499R (03/90)

9112270573

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-10 1-31-91
MM Baird Simmons

Well Number 299-W18-10 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-18 crib		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type Underground radioactive		

Irregular/Damage (describe) none

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) none

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.).

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.12'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☒ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

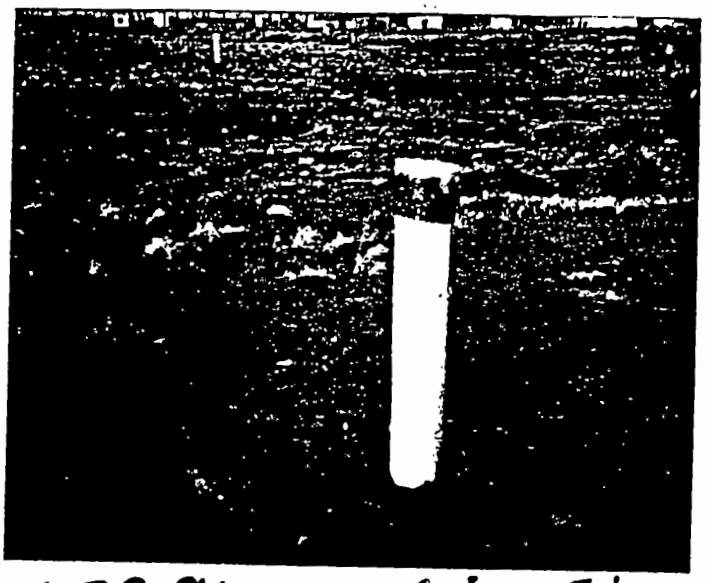
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

D-T-W + D-T-B not determined due to obstruction in well (pump.
HNU detected 2.2-4 ppm organic vapors
HPT detected no radioactive contamination.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-29-91 MM Baird Simmons
299-W18-11

Well Number 299-W18-11 Date 1-29-91

Inspector (print) MM Baird-Simmons

Signature _____

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-18 crib		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type underground		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☒ Jagged ☒ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.34

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

broken glass jar

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

191.91 KJK

D-T-B 188.95' +2.96 = 191.90

No organic vapors detected by HNU.

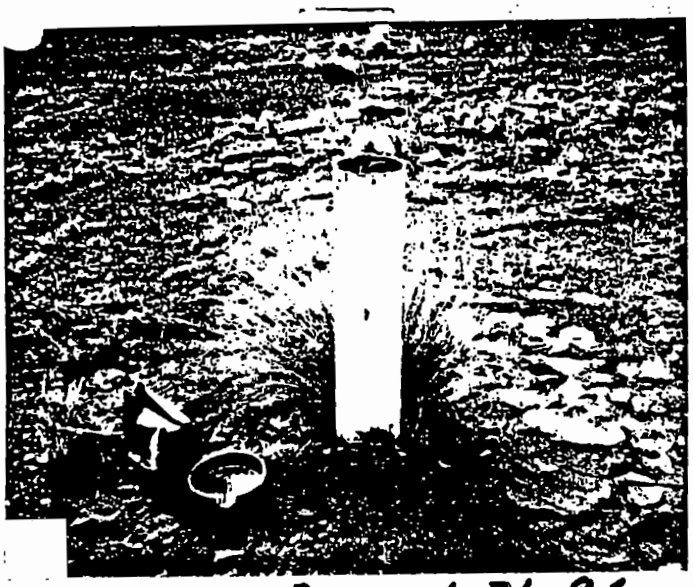
No radioactive contamination detected by HPT.

Mirror survey down the well casing looked ok.

DTW ~~0~~ Ran a E-Tape no water well is Dry

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-12 1-31-91
MM Baird-Simmons

Well Number 299-W18-12 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	underground ~~contam~~ radioactive mms-3	

Irregular/Damage (describe) none

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

aluminum bolt down cap/other cap present but bent (see photo)

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8 / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.48'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☒ None MMB-5 1-31-91

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☒ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☒ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

broken glass

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

2-8-91

D.T.B 212.10 + 2.98 = 215.08 below TOC

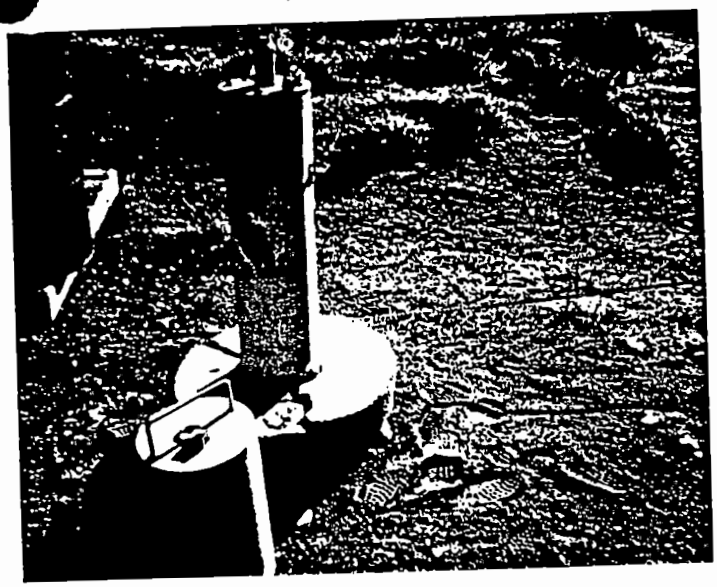
DTW - Dry

1-31-91

HNU detected avg. 1.8 ppm at top of casing up to 14 ppm organic at 6" inside. Contacted safety (B. Tuttle) and was advised to cap the well and delay work.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-17
2-21-91 RL Hatfield

Well Number 299-W18-17 Date 2/21/91

Inspector (print) RT COFFMAN

Signature RT Coffman

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☑ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☑ No
Does the well have a brass marker?	☑ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☑ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☑ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☑ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☑ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☑ Yes	☐ No	If yes, identify facility 216-Z-1 Ditch		
Is well located in a radiation zone?	☐ Yes	☑ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☑ Yes	☐ No
Is the cap able to be locked?	☑ Yes	☐ No
Is the cap locked?	☑ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☑ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☑ 2 ft round Is it damaged? ☒ Yes ☐ No

Irregular/Damage (describe) PAD IS BROKEN IN TWO.

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? NONE Diameter of posts? N/A

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8.0" Type CARBON STEEL

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

HOLE IN CASING FROM A PITLESS ADAPTER

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.58'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☒ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ? ☐ Brass Marker ☐ Both ☐ None

Other (describe) WELL SEAL COVERS TOP RIM OF CASING

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

DTW = 203.82 BELOW TOP OF WELL SEAL.

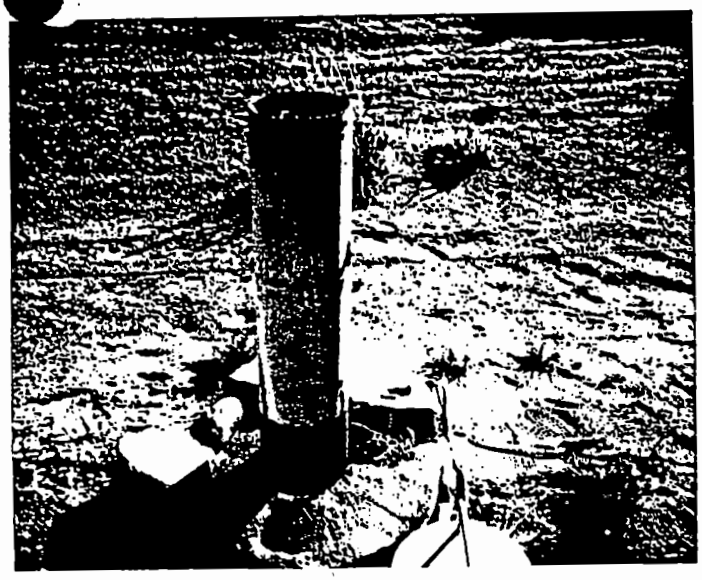
DTB = 220.76 " " " " "

No organic vapor detected by OVM

No radioactive contamination detected by HPT

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-18
-21-91 TL Hottell

Well Number 299-18-18 Date 2-21-91

Inspector (print) TL Hottell

Signature TL Hottell

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☒ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1 DITCH	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☒ 2 ft round Is it damaged? ☒ Yes ☐ No

Irregular/Damage (describe) Pad is Broken in 3 pieces

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" X 8 in Type Carbon Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

Bent TK 2-21-91

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.05 ft

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☒ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☒ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

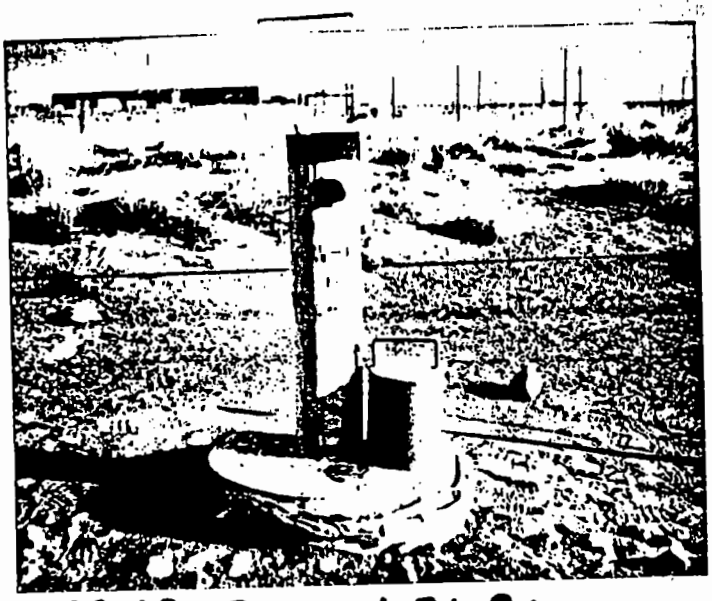
COMMENTS

DTW 201.34 E-Tape
DTB 201.64 (?) ?
No organic vapors detected by OVM
No radioactive contamination detected by HPT

A-6000-499R (03/90)

9 1 1 2 2 4 7 0 6 8 3

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-18-19 1-31-91
R Hotell

Well Number 299-W18-19 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	South of 234-5Z	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☒ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.513'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☒ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☒ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☒ Both ☐ None

Other (describe) nothing stamped into brass stamp

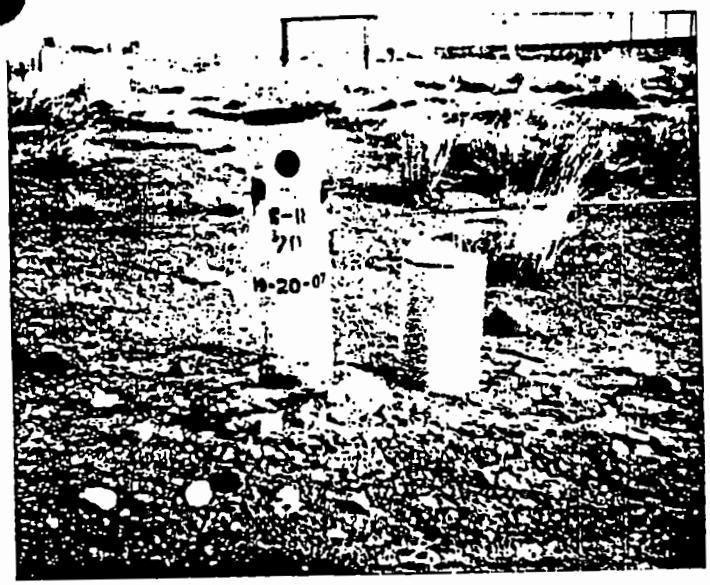
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

HNU detected no organic vapors
HPT detected no radioactive contamination

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18.20 1-31-91
TL Hittell

Well Number 299-W18-20 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	south of 234-5-Z	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☒ 2 ft round Is it damaged? ☒ Yes ☐ No

Irregular/Damage (describe) very badly crushed and chipped

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

hole in casing where pump system used to be

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.50'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☒ Brass Marker ☐ Both ☐ None

Other (describe) non stamped (well #) in brass marker

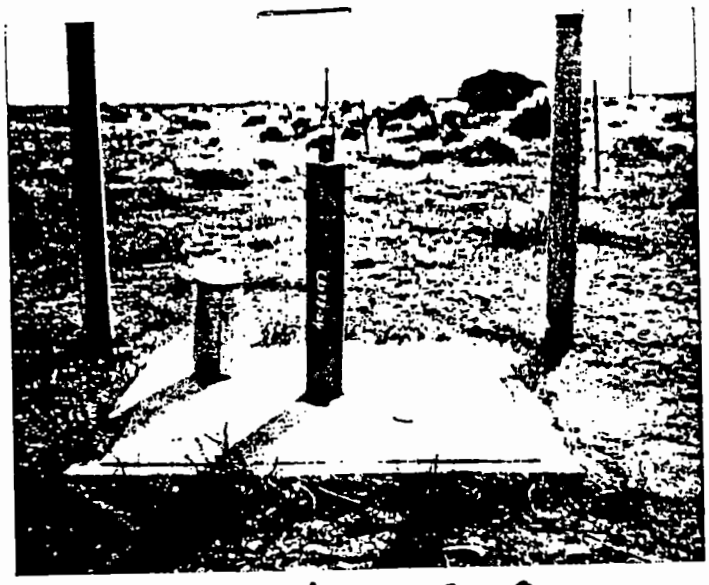
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

HNU detected no organic vapors
HPT detected no radioactive contamination
D-T-W - 199.78 E tape below top of casing
D-T-B 237.37 + 3.01 = 240.38 below top of casing
steel tape

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-24 1-31-91
TL Hottell

Well Number 299-W18-24 Date 1-31-91

Inspector (print) MM Baird Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☒ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	North west corner 216-Z-18 crib	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☐ None ☒ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

MMBS 1-31-91

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☒ Yes ☐ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☒ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 4" Type Stainless Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.24' top of pump plate / 2.19' to top of casing

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☒ Hydrostar ☐ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☒ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☒ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☒ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

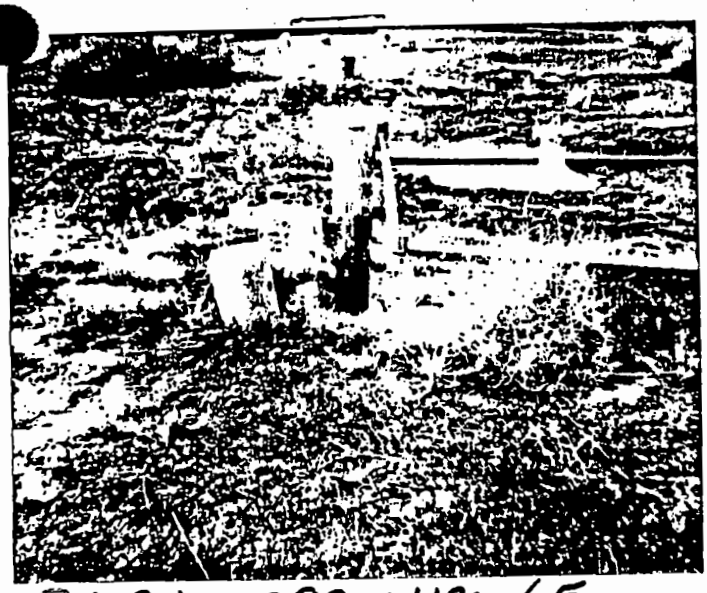
COMMENTS

1-31-91 HNU went off scale at 20 ppm. Immediately recapped well.
DTB 237.46' + 2.98' = 240.44' below Top of pump plate
DTW 216.34' with E tape from Top of pump plate.

Stock tank at the well

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W18-65
TR Hottel

Well Number 299-W18-65 Date 2-1-91

Inspector (print) M M Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	8 5/8" / 8"	Type	carbon steel
Inner casing:	OD/ID:	~ 4"	Type	stainless steel
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing unable to determine

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Near a cave in potential area in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Well is in a cave in potential area. Must stay a minimum of 10 feet away.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

Well Photo. Include appurtenance description of well site. Include additional photographs as needed to document unusual conditions. Label photograph(s) with well number and date. Sign photograph(s) then attach to field inspection report.

Well Number 299-W18-67 Date 2-7-91

Inspector (print) T L Hottell

Signature TL Hottell

N/A

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/repainted thus requiring relabeling?	☐ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☐ No	If yes, identify facility _____		
Is well located in a radiation zone?	☐ Yes	☐ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☐ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☐ No
Is the cap locked?	☐ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

See Comments On Back of This Form

A 6000 499 (03/90)

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☐ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: _____ Type _____

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

_____

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing _____

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

_____

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Near a Cave in potential area in 216-Z-1A tile field, locked Area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) Unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Well is in a Cave in potential area. Must stay a minimum of 10 feet away

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

Well Number 299-W18-68 Date 2-7-91

Inspector (print) T L Hottell

Signature T L Hottell

Well Photo. Include appurtenance description of well site. Include additional photographs as needed to document unusual conditions. Label photograph(s) with well number and date. Sign photograph(s) then attach to field inspection report.

See Comments On Back Of This Form

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☐ No	If yes, identify facility _____		
Is well located in a radiation zone?	☐ Yes	☐ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☐ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☐ No
Is the cap locked?	☐ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☐ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: _____ Type _____

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

_____

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing _____

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☐ None

_____

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Near a cave in potential area in 216-Z-1A tile field, locked area TH 8-20-91

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) Unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

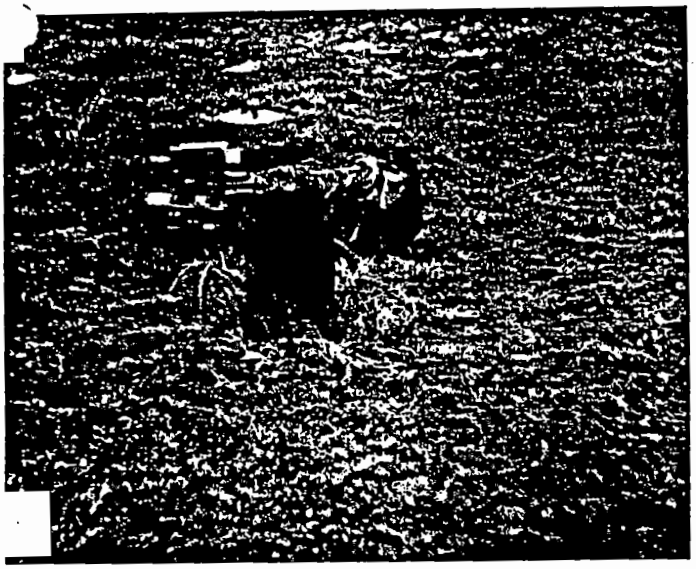
COMMENTS

Well is in a Cave in potential area, Must Stay a ~~maximum~~ minimum of 10 feet away

TH 8-20-91

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-76 | 2-1-91
92 Hottell

Well Number 299 W18-76 Date 2-1-91

Inspector (print) M M Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

rusted, tape around it

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? —

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☒ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

rusted

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing .84'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

down in 2-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

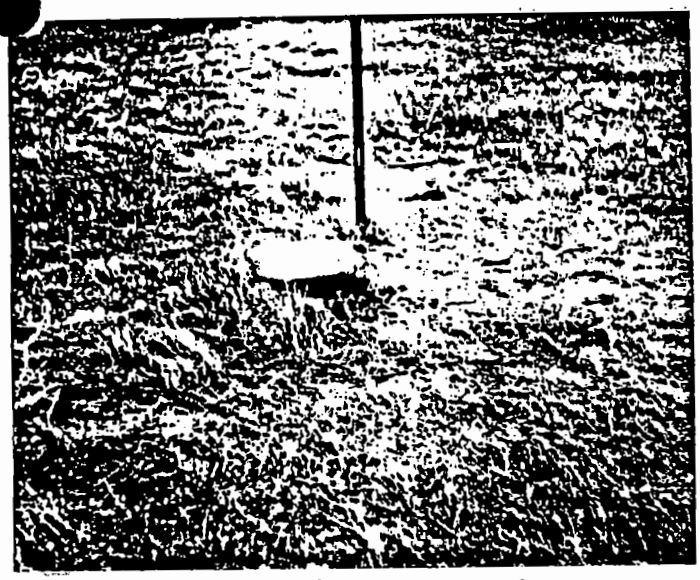
Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

OVM detected no organic vapors
DT-B 16.62 + 3.02 = 19.64' below top of casing
HPT found 21,000 dpm α. Deconed tape. Bagged & disposed of waste.

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-18-77 2-1-91
TR Hattell

Well Number 299-W18-77 Date 2-1

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-1A tile field		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type surface contamination		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

rusty and unable to be removed (in the ground possibly frozen)

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? 1 fence Diameter of posts? 1 1/2"

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine - couldn't remove cap

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

unable to determine close to the ground

Distance from: (check one) MMB-S 2-1-91

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing .37 foot

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Dam in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine - couldn't remove cap

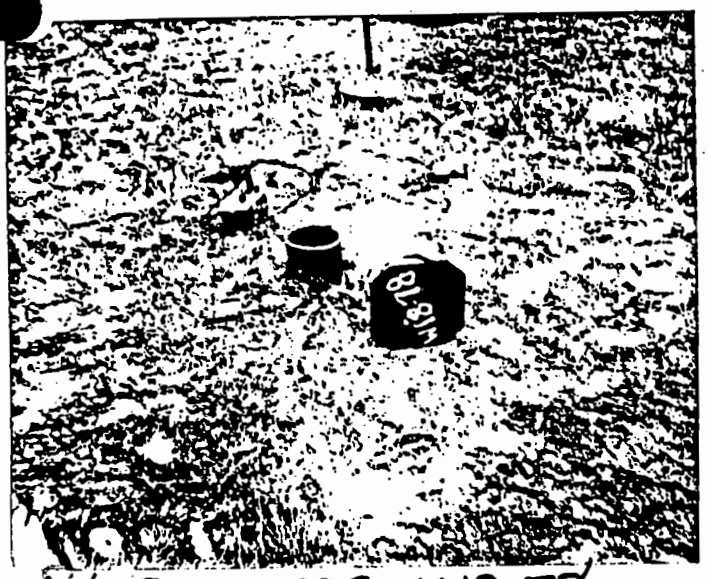
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Unable to remove cap

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W18-78
M M. Baird-Simmons

Well Number 299-W18-78 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tilefield	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

very rusty

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? —

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 6 5/8" / 6"	Type	carbon steel
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing: MMB-5-1-91

☐ Jagged ☐ Uneven ☒ Fairly Level ☒ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing .52'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

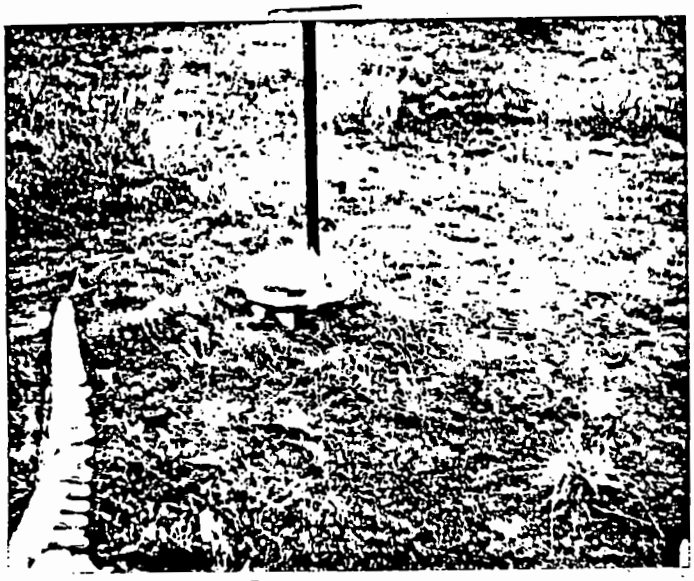
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

D-T-B 11.47' + 3.02' = 14.49' below top of casing
HNU + OVM detected no organic vapors.
HPT detected 700 dpm β. Bagged + disposed of smear.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2mW18-79 2-1-91
1L Hattell

Well Number ~~KW~~ 299-W18-79 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contaminatio	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

unable to remove - in ground (possibly frozen) rusted

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? 1 fence Diameter of posts? 1 1/2

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to see couldn't remove cap

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

rusty very close to ground

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing .24'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to see couldn't remove cap

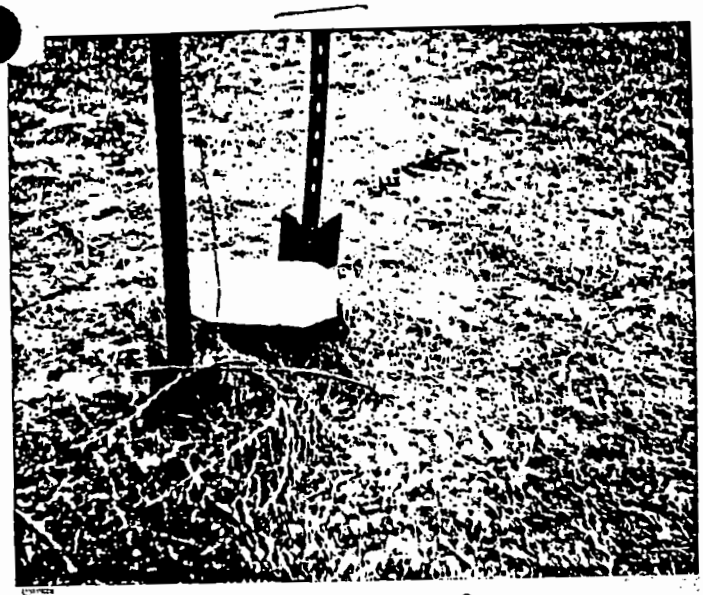
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Unable to remove cap

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-18-80 2-1-91
JL Hotteel

Well Number 299-W18-80 Date 2-1

Inspector (print) MM Baird-Simmons

Signature M.M. Baird Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	Surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

Unable to remove cap also very rusty + falling apart

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? 2 fence Diameter of posts? 1 1/2"

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 8 5/8" 8"	Type	carbon steel
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine – couldn't remove cap

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

unable to determine – couldn't remove cap

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing .38'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

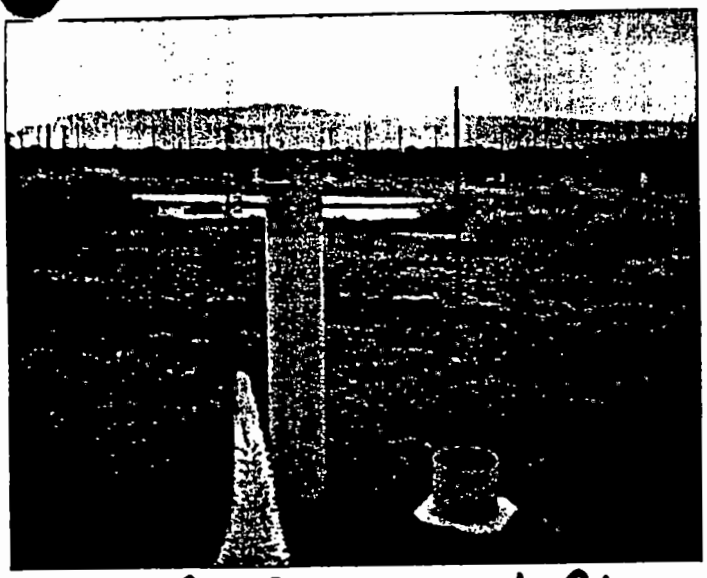
Other (describe) unable to determine – couldn't remove cap

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Unable to remove cap.

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-18-81 2-1-91
R Hottell

Well Number 299-18-81 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8' / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.20'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

down in Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

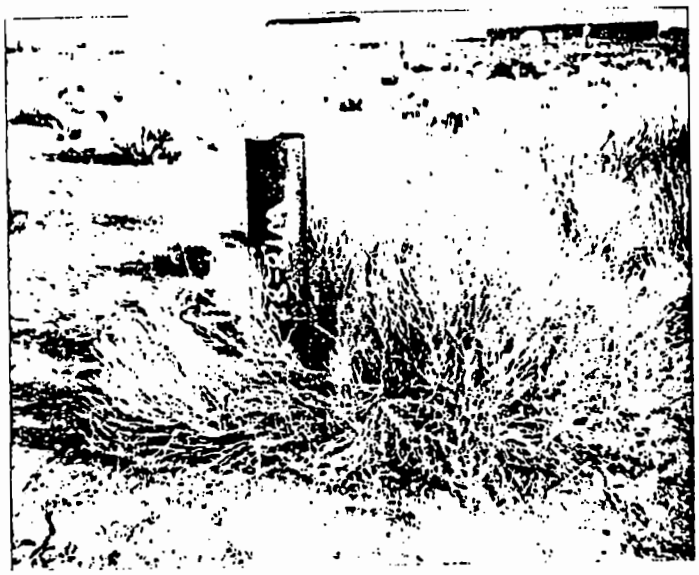
OVM detected ~ 2 ppm organic vapors 30.00 barometric pressure
D-T-B 37.85 + 3.02 = 40.87' below TOC and falling.

HPT detected no radioactive contamination

A-6000-499R (03/90)

9112271017

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-82 1-31-91
TL Hottel

Well Number 299-W18-82 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities No paint

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	south west corner of 216-Z-18 crib	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe)

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

steel rubber seal, plug type difficult to open

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe)

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8' / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☒ Jagged ☒ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.42'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

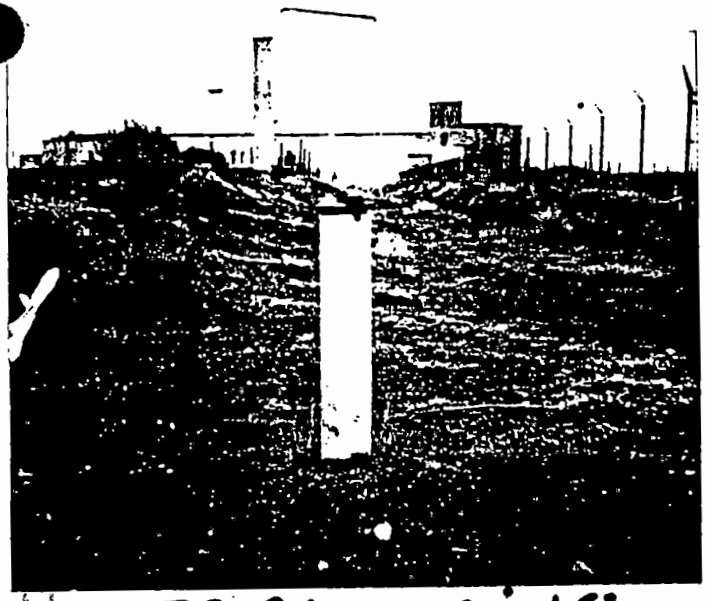
COMMENTS

D-7-B 147.68' + 3.02 = 150.70' below top of casing

HNU detected No organic vapors.
HPT detected no radioactive contamination.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 MM Baird-Simmons
299-W18-85

Well Number 299-W18-85 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

Rubber sealed type cap MMB-S 1-30-91 difficult to remove

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 6 5/8" / 6"	Type	carbon steel
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.92'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: mmB-5 1-28-91 ☒ None

old cable (quite a few feet)

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

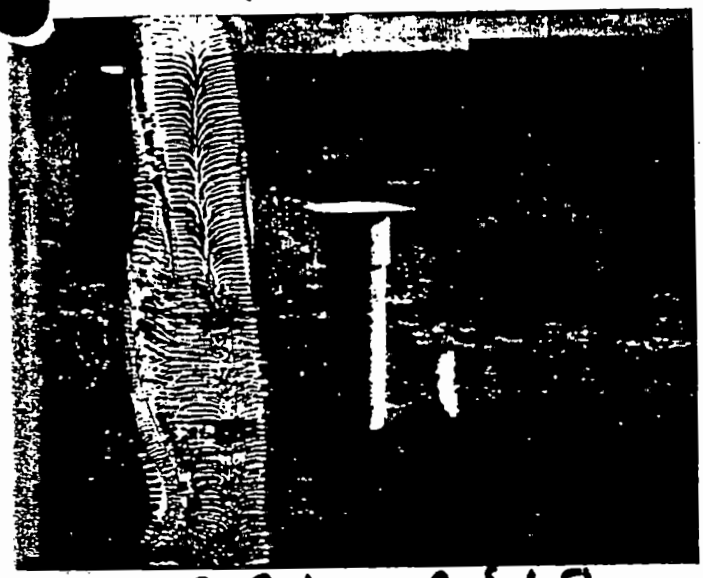
Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

149.92' + 2.96' DTB = 152.88' below top-of-casing.
No organic vapors detected by OVM.
No radioactive contamination detected by HPT.

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 MM Baird-Simmons
299-W18-86

Well Number 299-W18-86 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

1-28-91 MMB-S

Is the well labeled?	☒ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☐ No	If yes, identify facility	216-Z-1A tile field
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type	_____

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? —

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 1/2" / 6" Type carbon steel

Inner casing: OD/ID: Type

Other casing: OD/ID: Type

Other casing: OD/ID: Type

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe)

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.01'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe)

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe)

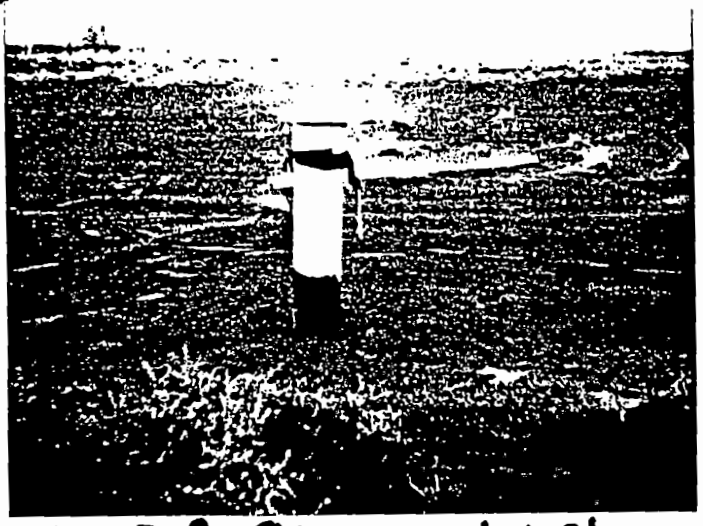
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

D-T-B 148.12' + 2.96' = 151.08' below top-of-casing
No organic vapors detected by OVM.
No radioactive contamination detected by HPT.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 MM Baird-Simmons
299-W18-87

Well Number 299-W18-87 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type Carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.37'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

OT-B 148.64' + 2.96' = 151.60'

1-28-91 No organic vapors detected by the OVM.

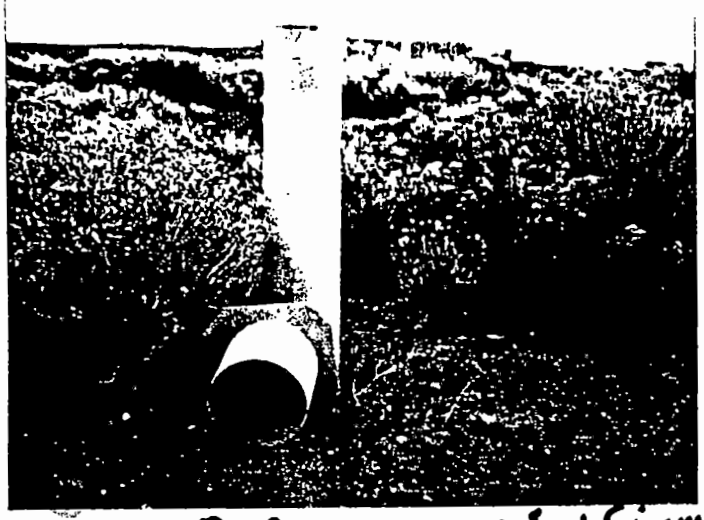
No radioactive contamination detected by HPT.

MMB-S 1-30-91 ~~1-29-91~~ A cloth swabbing of the well casing showed ~ 400

1-30-91 alpha contamination.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 | MM Baird Simmons
299-W18-88

Well Number 299-W18-88 Date 1-28-91

Inspector (print) MM Baird Simmons

Signature MM Baird Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A file field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.75'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Isregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

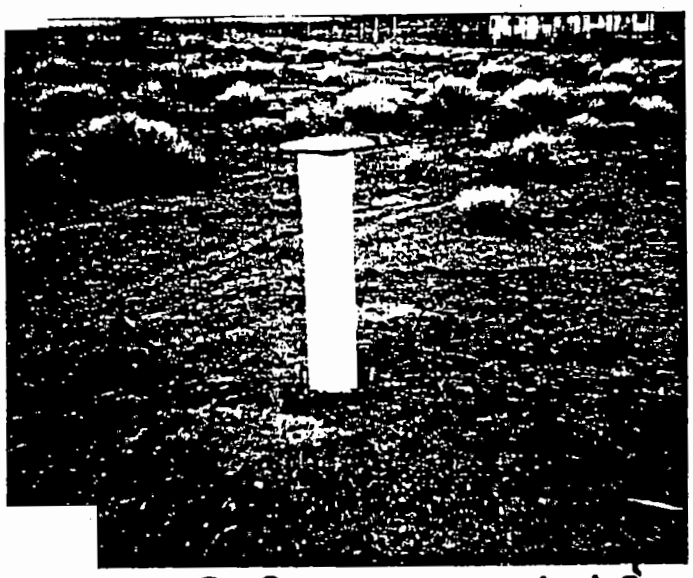
Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

D-T-B 146.48' + 2.96' = 149.44 MMB-S 1-28-91 below top of casing.
No organic vapors detected by HPT. OVM
No radioactive contamination detected by HPT.

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-28-91 mm Baird Simmons
299-W18-89

Well Number 299-W18-89 Date 1-28-91

Inspector (print) mm Baird-Simmons

Signature mm Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☒ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 10 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.82'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

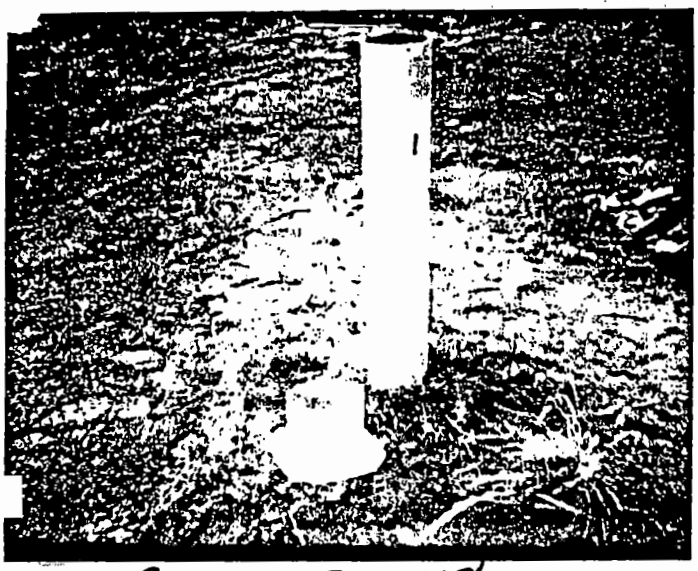
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

DTB 141.56' + 2.96' = 144.52' below top of casing.
No organic vapors detected by OVM.
No radioactive contamination detected by HPT

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 299-W18-93
MM Baird-Simmons

Well Number 299-W18-93 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	underground radioactive	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	6 5/8 / 6"	Type	Carbon steel
Inner casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.00'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

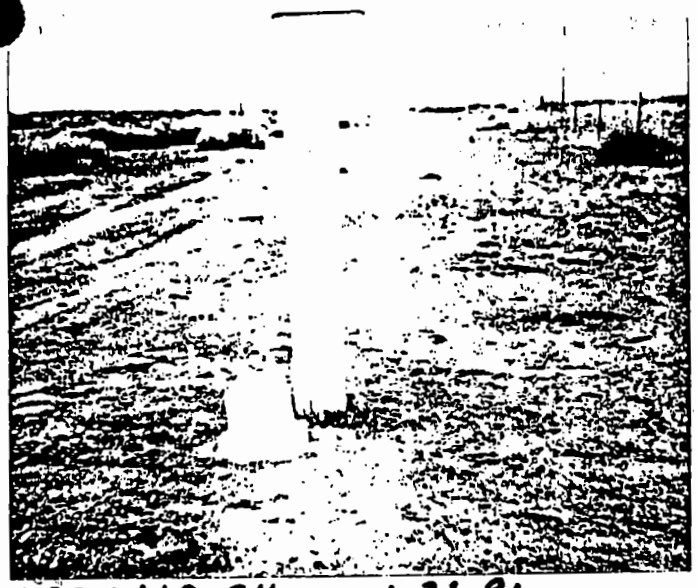
COMMENTS

D-T-B 139.70 + 3.01 = 142.71' below top of casing

HNU detected NO organic vapors
HPT detected NO radioactive contamination

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-94 1-31-91
T L Hotell

Well Number 299-W18-94 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8"/6" Type Carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.23'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None mmB-S 1-31-91

fence posts and cables

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

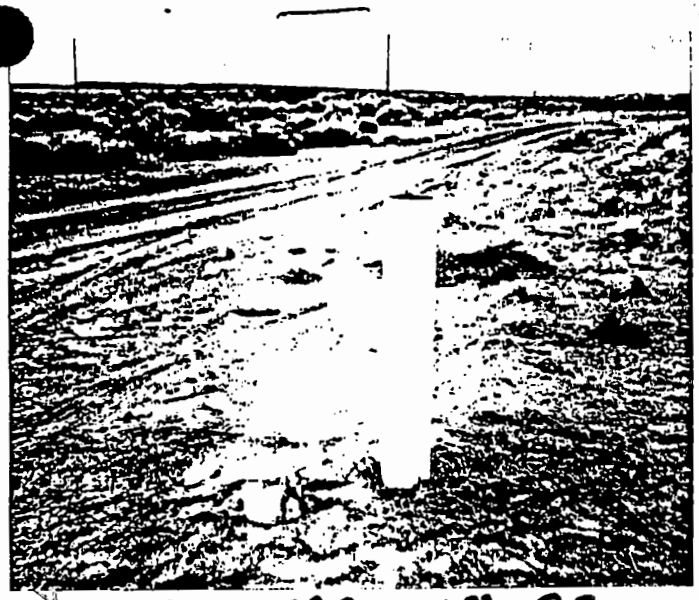
COMMENTS

D-T-B - 84.64 + 3.02 = 87.66

HNU detected no organic vapors.
HPT detected no radioactive contamination

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 299-W18-95
MM Baird-Simmons

Well Number 299-W18-95 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type Carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.02'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

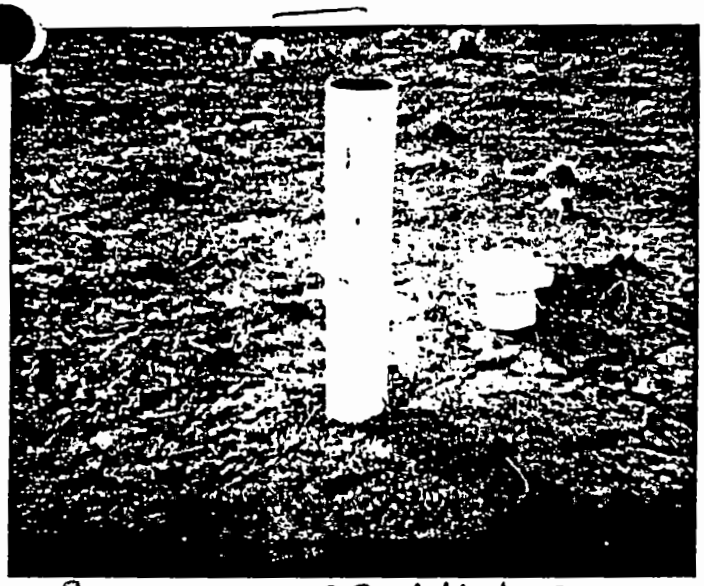
COMMENTS

D-T-B 78.18 + 3.02 = 81.20' below top of casing

HNU detected no organic vapors.
HPT detected no radioactive contamination

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 299-W18-96
MM Baird-Simmons

Well Number 299-W18-96 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	underground radioactive mtl	

Irregular/Damage (describe) none

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" x 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☒ Beveled MMB-5 1-31-91

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.98'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

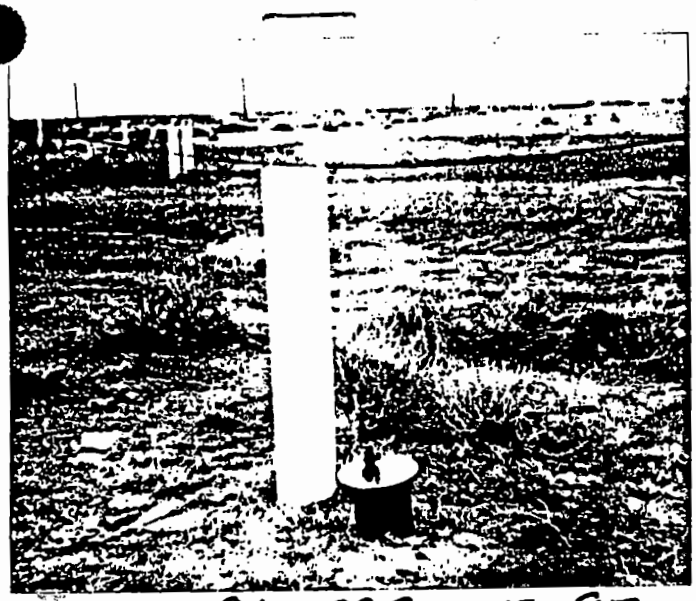
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

PTB - 78.13 + 3.01 = 81.14 below top of casing
HNU detected 2.2 ppm at top of casing 3.4 ppm inside ~ 6" down
HPT

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 299-W18-97
MM Baird-Simmons

Well Number 299-W18-97 Date 1-31-91
Inspector (print) MM Baird-Simmons
Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) none

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

steel rubber seal plug type difficult to remove

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.00'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

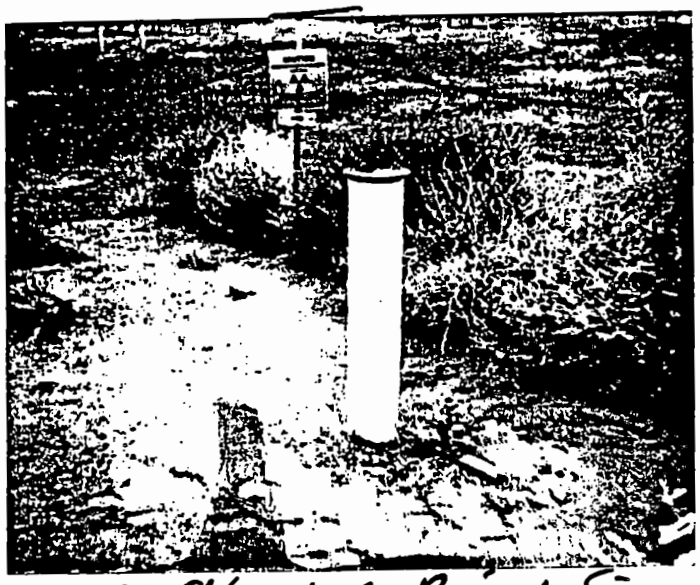
COMMENTS

DTB 83.21' + 3.00 = 86.23' below top of casing
HPT. Found 150 cpm & placed rad sticker on well. Decanned tape.
HNU detected a about ~2 ppm organic vapors.

A-6000-499R (03/90)

9 1 1 2 2 1 0 7 2 6

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 MM Baird Simmons
299-W18-98

Well Number 299-W18-98 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes ☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

steel rubber seal type cap difficult to remove

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type Carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.97'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

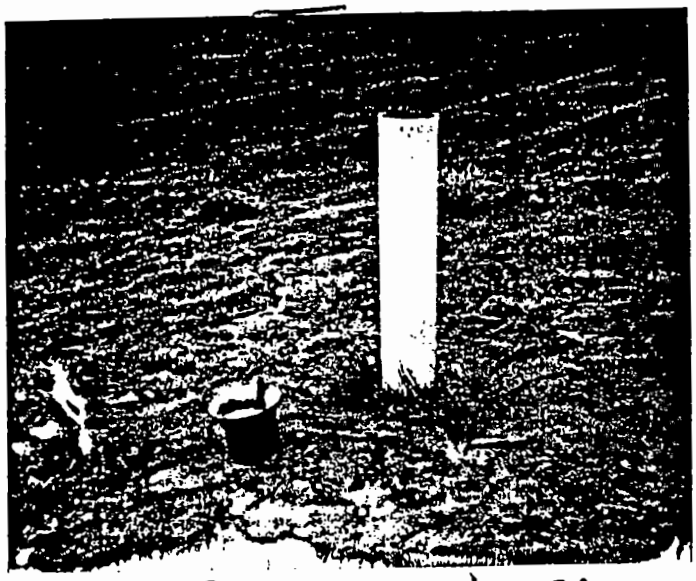
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

D-T-B 76.23' + 3.01' = ~~79.24~~ 79.24' below top of casing
ANU detected ~1.4 – 5.6 (down in the well) organic vapors
HPT detected no radioactive contamination.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-31-91 MM Baird-Simmons
299-W18-99

Well Number 299-W18-99 Date 1-31-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-18 crib	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

steel rubber seal type cap difficult to remove

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? None Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.87'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

DT-B 131.21' + 3.01 = 134.22' Below top of casing
HNU detected ~2 organic vapors
HPT detected No contamination

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

2-1-91 299-W18-149
MM Baird Simmons

Well Number 299-W18-149 Date 2-1-99

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, 8-Y Tank Farms, 8-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

PVC cap very snug

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) 6x6 ft concrete

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	10"	Type	carbon steel
Inner casing:	OD/ID:	6 5/8" / 6"	Type	PVC
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☒ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.0'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None MMB-S 1-31-91

Down in the 216-Z-1A locked area

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

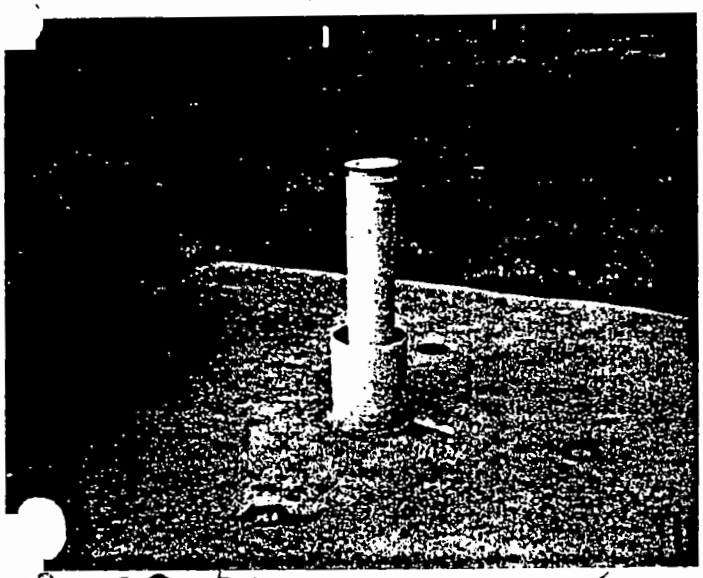
COMMENTS

D-T-B 23.72 + 3.02 = 26.74' below top of casing
OVM + HNO detected no organic vapors
HPT detected 7,000 dpm α decanned tape. Bagged + disposed of wipes.

A-6000-499R (03/90)

9112270735

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-29-91 MM Baird-Simmons
299-W18-150

Well Number 299-W18-150 Date 1-29-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination α	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☐ No
Is the cap locked?	☐ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☐ None

rubber seal plug type

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) 12 x 12

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

	OD/ID:	Type
Outer casing:	9 1/2" / 9"	Carbon steel
Inner casing:	~8 1/2 / ~8"	Carbon steel
Other casing:	6 13/16" / 6"	Carbon steel
Other casing:		

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: MMB-S 1-29-91 ☒ None

Quite rusty

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 2.96'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

In Z-1A crib area

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) _____

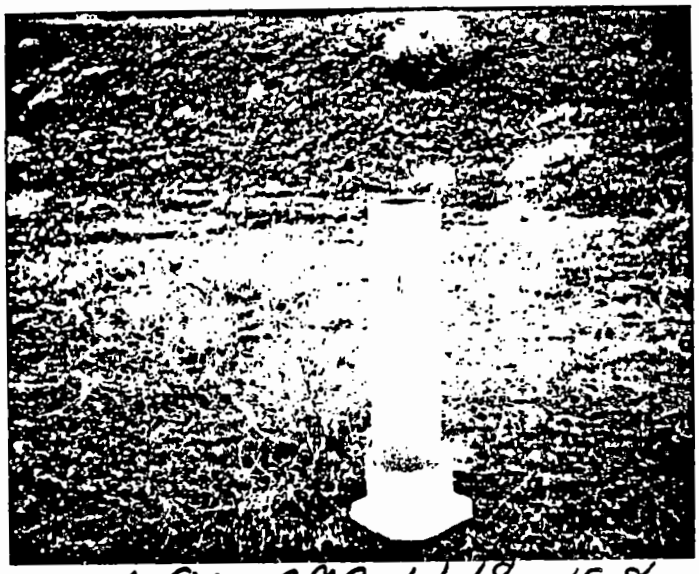
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

D-T-B 118.87'
No organic vapors detected by HNU.
No radioactive contamination detected by HPT.
Well swabbed with towels.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W-18-158
MM Baird-Simmons

Well Number 299-W18-158 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, 8-Y Tank Farms, 8-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: 6 5/8 / 6" Type carbon steel

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing (approx 2.7'); (2.64 exact meas.)

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine because of organic vapors

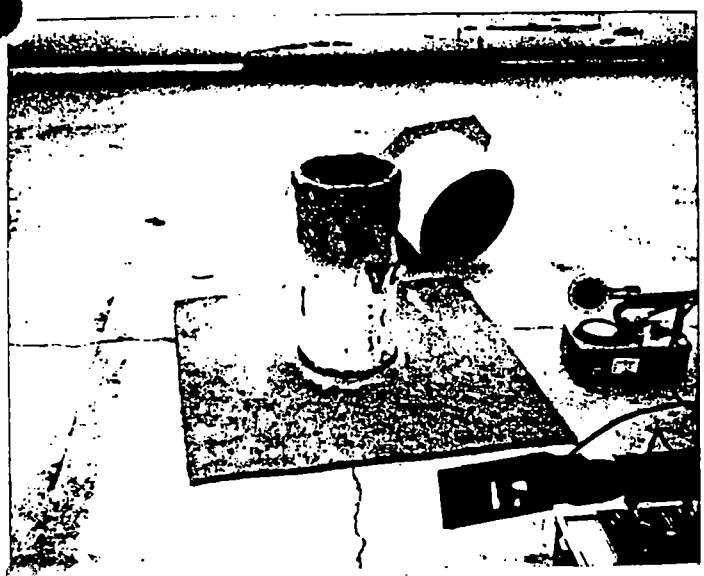
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

2-1-91 HNU, draeger tube and OVM detected organic vapors (carbon tet) Replaced cap immediately + delayed work. 56 ppm with OVM. at well 15 ppm draeger tube carbon tet. 60 ppm at edge w/ cap
DTB 125.24' + 2.98' = 128.22' below TOC 2-8-91

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-159 2-1-91
TL Hattell

Well Number 299-W18-159 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-1A tile field		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type surface contamination		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

CONCRETE PAD

☐ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☒ No

Irregular/Damage (describe) 20' x 30' concrete pad

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: ~~MMB-5 8 5/8 / 8"~~ 6 5/8"/6" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) taped up with duct tape

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 1.14' includes rubber mat

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine from tape placed on it

Is stamp clearly visible? ☐ Yes ☐ No No brass marker

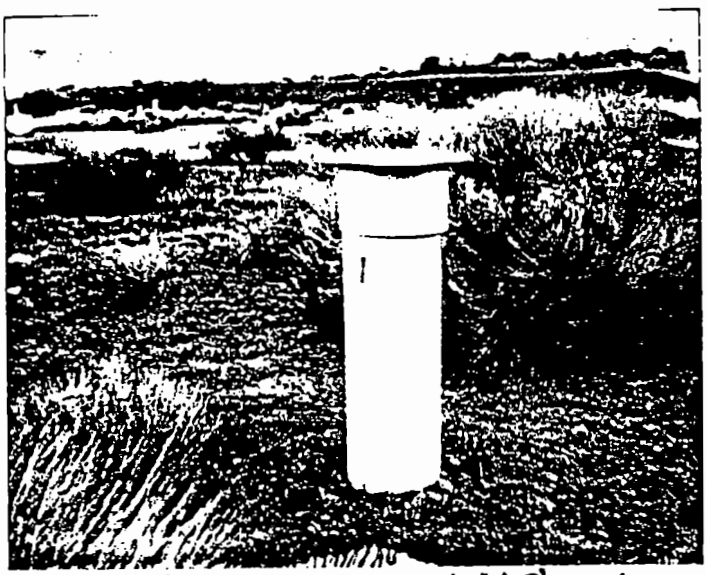
COMMENTS

OVM detected no organic vapors.
D-T-B 118.98 + 3.02 = 122.00' below top of casing
HPT detected no radioactive contamination.

2' square rubber matting placed around well casing (surface seal)

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W18-163
MMBaird-Simmons

Well Number 299-W18-163 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contaminat	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.50'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area.

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

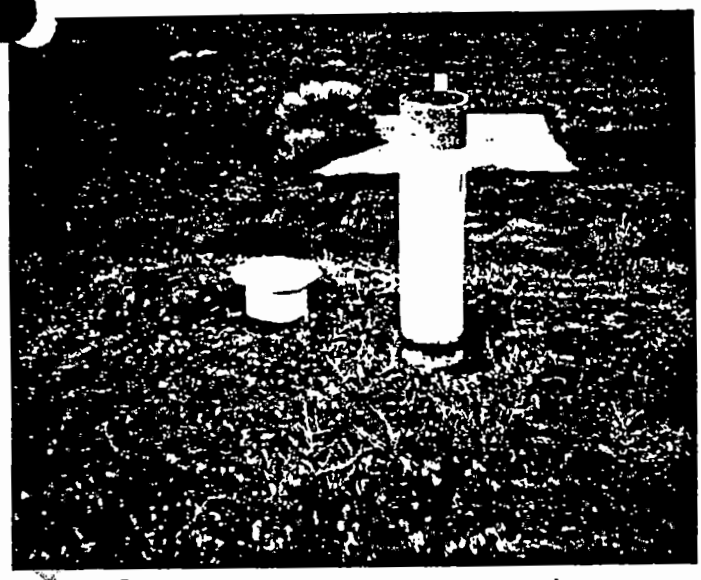
2-1-91
HNU detected ~ 3 ppm organic vapors. Recapped well and delayed work

2-8-91
DTB 129.78 + 2.98 = 132.76 below TOC

A-6000-499R (03/90)

9112907143

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-29-91 MM Baird-Simmons
299-W18-164

Well Number 299-W18-164 Date 1-29-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☐ No	If yes, identify facility	216-Z-1A	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination &	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	8 5/8" / 7 3/4"	Type	carbon steel
Inner casing:	OD/ID:	6 5/8" / 6"	Type	carbon steel
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) inner casing leaning to west side of outer casing

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.07'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: mmb 1-29-91 ☒ None

In the fenced 216-Z-1A tile field crib area

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) stamp not real clear

Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

DTB - 146.5' steel tape mmb 1-29-91

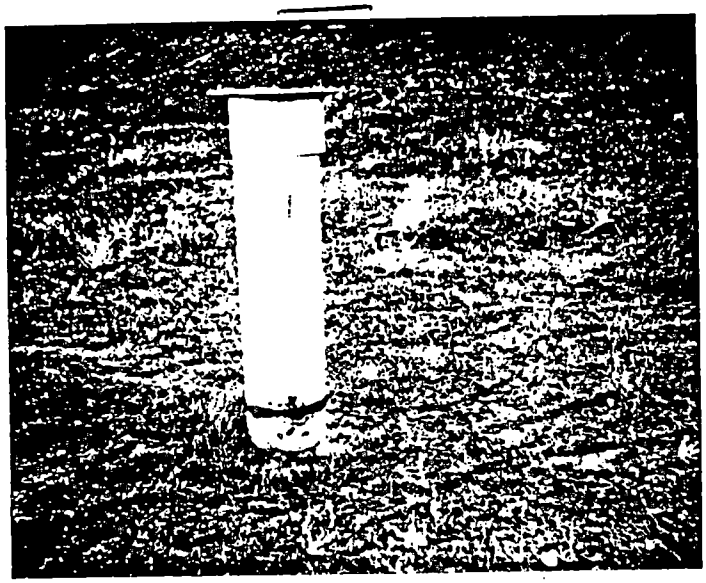
No Organic vapors detected by ~~HUNT~~ HILL

No radioactive contamination detected by RPT

Well swabbed with towels

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-165 2-1-91
1L Hotell

Well Number 299-W18-165 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-1A tile field		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type surface contamination		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID:	8 5/8" / 8"	Type	carbon steel
Inner casing:	OD/ID:	6 5/8 / 6"	Type	Carbon steel
Other casing:	OD/ID:		Type	
Other casing:	OD/ID:		Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.10'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

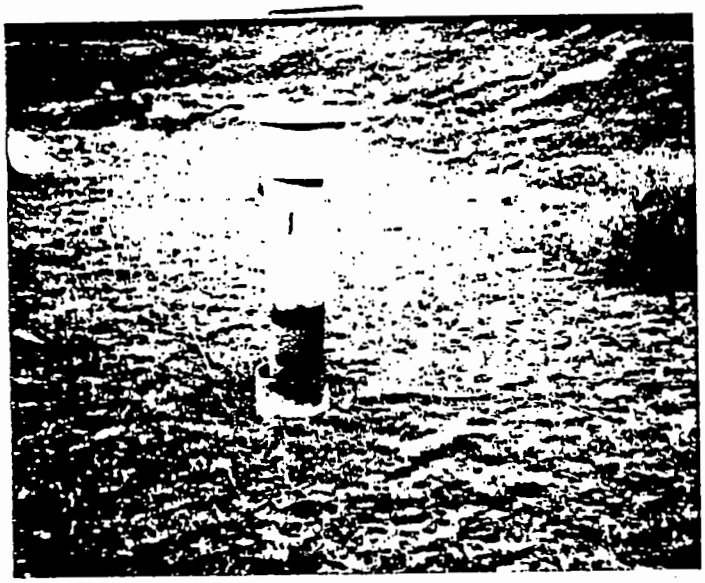
COMMENTS

2-1-91
HNU detected 2-3 ppm organic vapor. Recapped and delayed work.

2-8-91
DTB 125.47 + 2.988 = 128.45 below TOC

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-166 2-1-91
T L Hotell

Well Number 299-W18-166 Date 2-1-91

Inspector (print) M M Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: 6 5/8 / 6" Type carbon steel

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.75'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field, locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

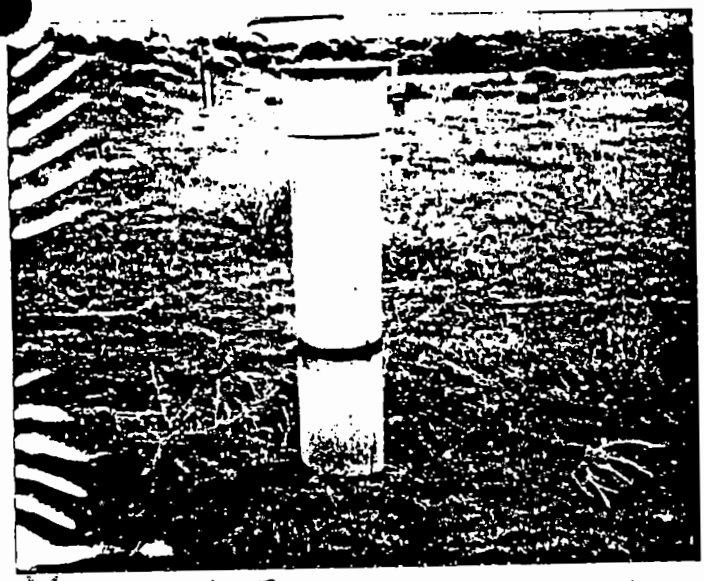
COMMENTS

2-1-91
HNU detected 20 p.p.m. organic vapors. Recapped and delayed further work

2-8-91
DTB 129.18 + 2.98 = 132.16 below TOC

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-18-167 2-1-91
T L Hottell

Well Number 299-W18-167 Date 2-1-91

Inspector (print) M M Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.32'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A crib (tile field) locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine - recapped well

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

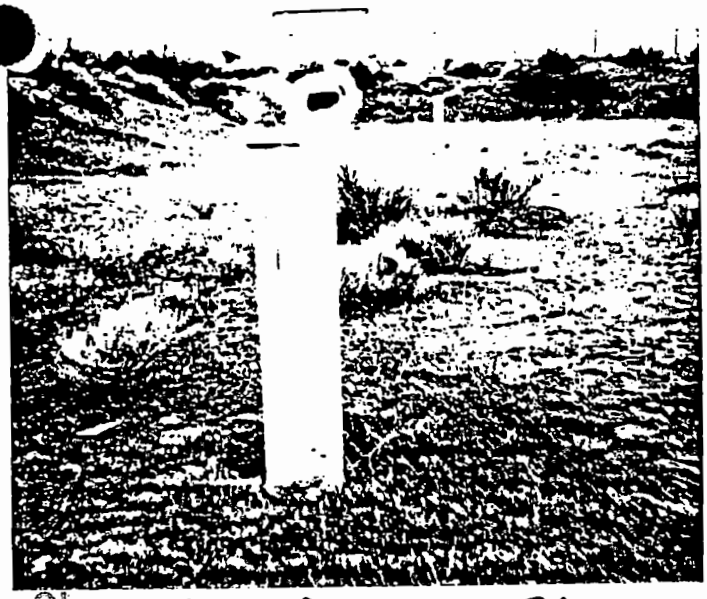
2-1-91 HNU detected 2 ppm organic vapors. Recapped and delayed work.

2-8-91

DTB 126.50' + 2.98' = 129.48' below TOC

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-168 2-1-91
TL Hottell

Well Number 299-W18-168 Date 2-1-91

Inspector (print) Mm Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing approx 3.32' 3.30 actual not measured.

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Sun in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine because of vapors

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

2-1-91

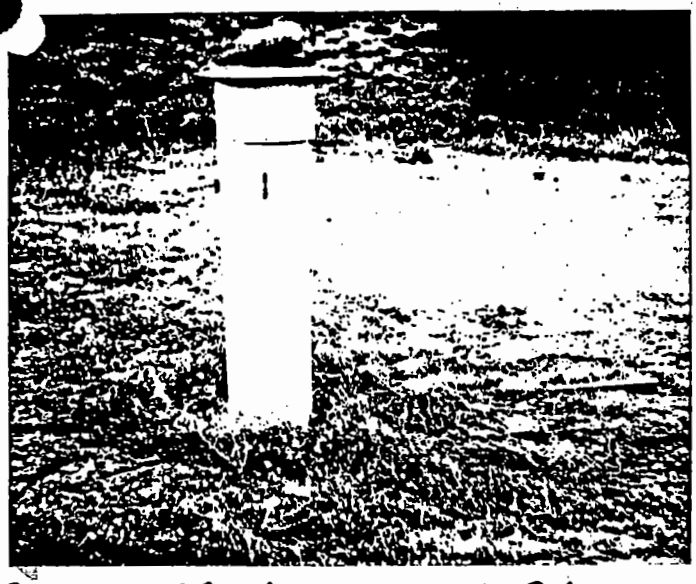
HNU "maxed" out on the 0-20 scale. Recapped well immediately and delayed work. 50 ppm on 0-200 scale

2-8-91

DTB 124.45' + 2.98' = 127.43' below TOC

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



299-W18-169 2-1-91
TL Hottell

Well Number 299-W18-169 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determine

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.06'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

2-1-91
HNU detected 5 ppm organic vapors. Recapped well and delayed work.

2-8-91
DTB 125.73' + 2.98' = 128.71' below TOC

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

299-W18-170 2-1-91
TL Hottell

Well Number 299-W18-170 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility 216-Z-1A tile field		
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type surface contamination		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts?

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe)

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 6 5/8" / 6" Type carbon steel

Inner casing: OD/ID: Type

Other casing: OD/ID: Type

Other casing: OD/ID: Type

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☒ Beveled flared

Other (describe) flared out

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.73'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe)

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe)

Is stamp clearly visible? ☒ Yes ☐ No

COMMENTS

HNU detected .5 ppm down inside
D-T-B 28.71' + 3.02' = 31.73' below top of casing
HPT detected no radioactive contamination

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

1-28-91 MM Baird-Simmons
299-W18-171

Well Number 299-W18-171 Date 1-28-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DOE/RL-91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) none

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8"/16"/8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.5'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

COMMENTS

DTB 128.21' + 2.96' below top-of-casing total 131.17'
No organic vapors detected by OVM
No radioactive contamination detected by HPT
1-29-91 Cloth swab of well casing was determined to be contamination free, also.

A-6000-499R (03/90)

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT

2-1-91 299-W18-172
TL Hallett

Well Number 299-W18-172 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature M.M. Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A-6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) unable to determin (cave-in potential)

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☐ Ground Surface ☐ Cement Pad To top edge of highest most casing unable to determine

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Near a cave in potential area inside 216-Z-1A tile field locked area.

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

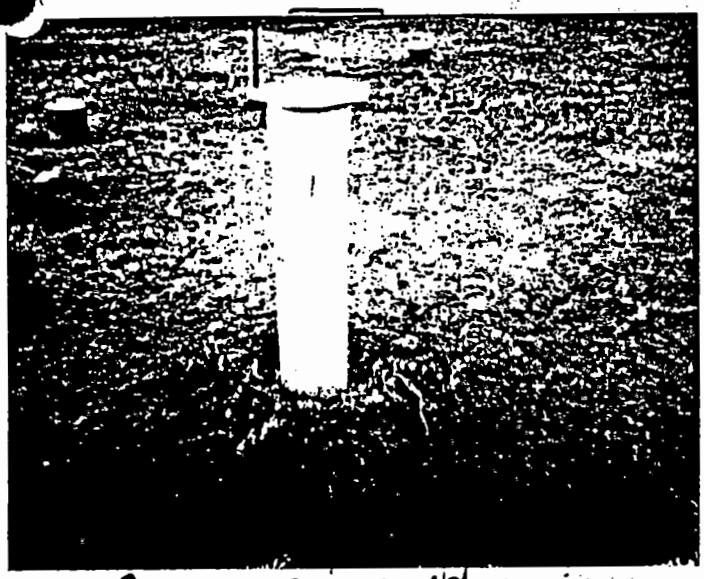
Other (describe) unable to determine

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

Well is in an area marked Cave-In potential. Must stay minimum of 10 feet away.

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W18-173
MM Baird-Simmons

Well Number 299-W18-173 Date 2-1-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000 499 (03/90)

DUL Draft 91-32
Draft B

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.29'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

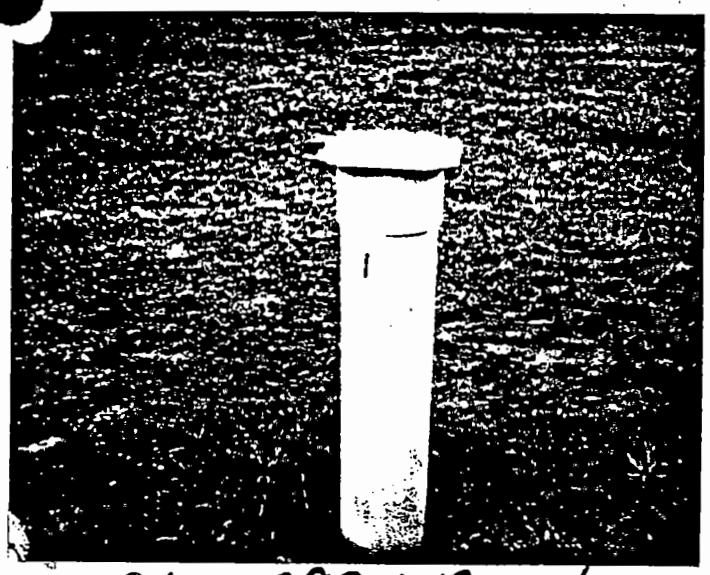
COMMENTS

OVM + HNU detected no organic vapors
D-T-B 44.84 + 3.02 = 47.86' below top of casing
HPT detected 100 dpm α. Bagged and disposed of smear.

A-6000-499R (03/90)

9112270763

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



2-1-91 299-W18 174
mm Baird-Simmons

Well Number 299-W18-174 Date 2-1-91

Inspector (print) M M Baird-Simmons

Signature M M Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A tile field	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? none Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" / 8" Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 3.36'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in 216-Z-1A tile field locked area

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) _____

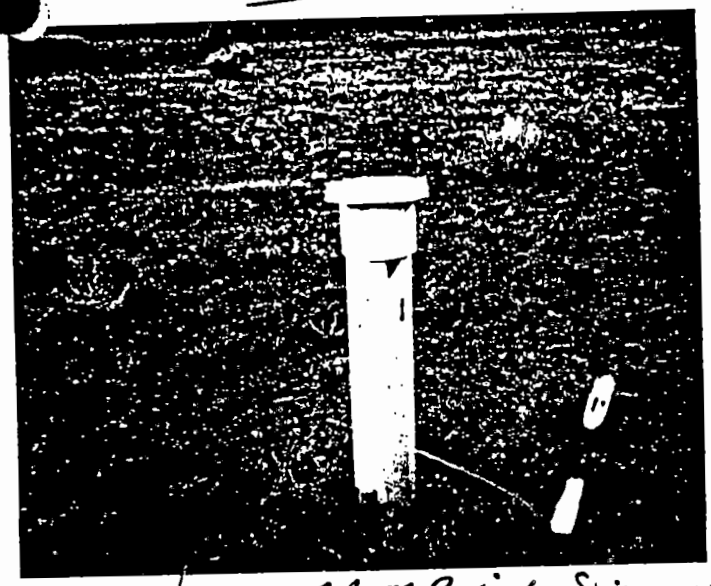
Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

2-1-91
HNU detected 17 ppm organic vapors. Recapped + work delayed
2-8-91
DTB 46.74' + 2.98 = 49.72' below TOC

150 - 175 71'

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



1-29-91 M M Baird-Simmons
299-W18-175

Well Number 299-W18-175 Date 1-29-91

Inspector (print) MM Baird-Simmons

Signature MM Baird-Simmons

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☐ Yes	☒ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☐ Yes	☒ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility	216-Z-1A Hilfield crib	
Is well located in a radiation zone?	☒ Yes	☐ No	If yes, describe zone type	surface contamination	

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☐ Yes	☒ No
Is the cap locked?	☐ Yes	☒ No

Describe existing problems with well cap, if any, or check none: ☐ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

A 6000-499 (03/90)

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 7 1/8" / 5 7/8" (including tape) Type carbon steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) top taped with duct tape thickly

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☒ None

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.93'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☐ Submersible ☐ Bladder ☒ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☐ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☐ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☐ None

Down in the 216-Z-1A tile field

SURVEY INFORMATION

Describe survey mark location:

☐ Top edge of highest most casing ☐ Brass Marker ☐ Both ☒ None

Other (describe) taped over the top edge

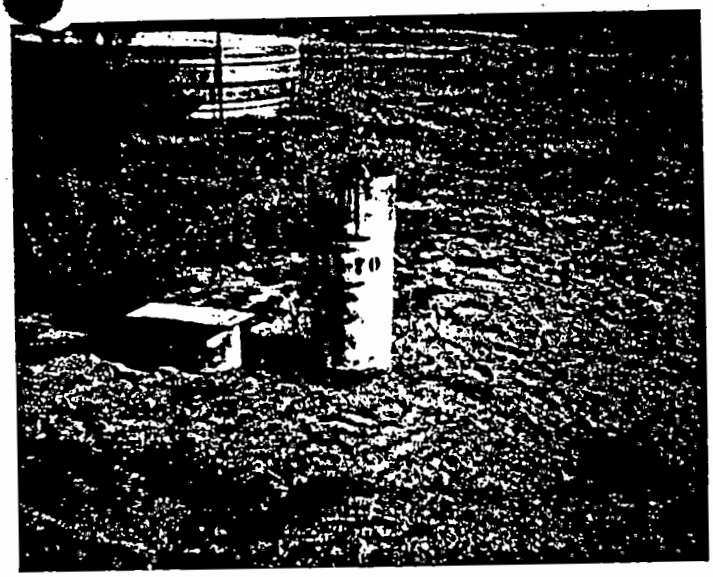
Is stamp clearly visible? ☐ Yes ☒ No

COMMENTS

D-T-B steel tape 121.35' below top of casing
No organic vapors detected by HNU.
No radioactive contamination detected by HPT. except ~ 100 cpm beta only on swab. No alpha

9112220757

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



699-38-70
2-21-91 RL Hottell

Well Number 699-38-70 Date 2/21/91

Inspector (print) RT COFFMAN

Signature RT Coffman

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☑ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☑ No
Does the well have a brass marker?	☐ Yes	☑ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☑ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☑ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☑ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☑ No	If yes, identify facility _____		
Is well located in a radiation zone?	☐ Yes	☑ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☑ Yes	☐ No
Is the cap able to be locked?	☑ Yes	☐ No
Is the cap locked?	☑ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☑ None

_____

CONCRETE PAD

☑ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? NONE Diameter of posts? N/A

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 8 5/8" / 8 1/4"	Type	CARBON STEEL
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

HOLE IN CASING FOR J-HOOK

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 1.80'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☒ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

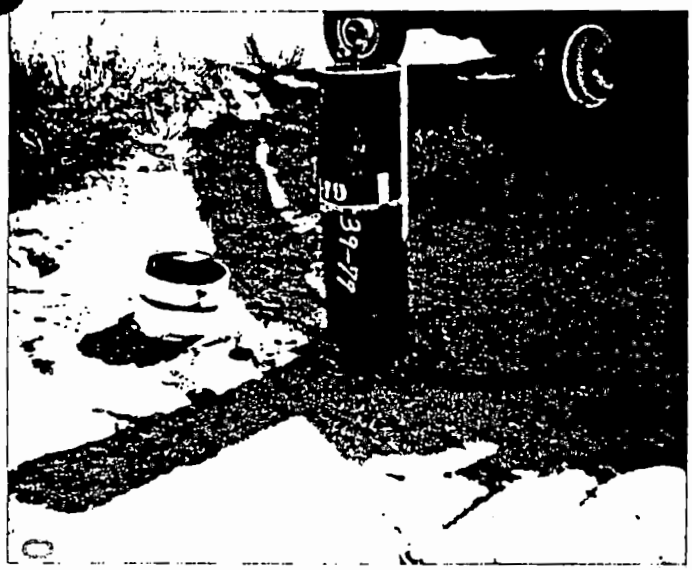
Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

COMMENTS

DTW = 258.10' BELOW TOC E-TAPE
DTB = 292.32' " " "

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



699-39-79
2-21-91 TL Hottell

Well Number 699-39-79 Date 2-21-91

Inspector (print) TL Hottell

Signature TL Hottell

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☒ Yes	☐ No
Does the well have a brass marker?	☐ Yes	☒ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☐ No
Does the casing need to be painted/repainted thus requiring relabeling?	☒ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☐ Yes	☒ No	If no, is one needed?	☒ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☐ Yes	☒ No	If no, is one needed?	☒ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☐ Yes	☒ No	If yes, identify facility _____		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☒ None ☐ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8" x 8" Type Carbon Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

Two holes, one for J-Hook

Distance from: (check one)

☒ Ground Surface ☐ Cement Pad To top edge of highest most casing 2.50 ft

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☒ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

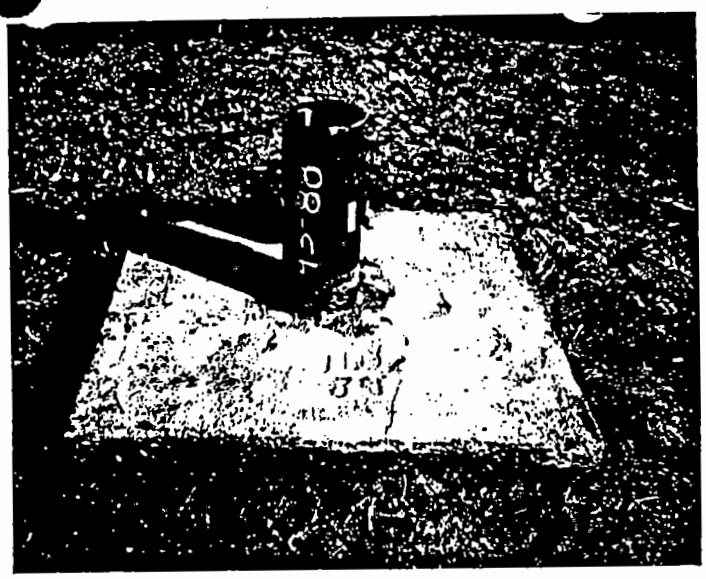
Other (describe) _____

Is stamp clearly visible? ☒ Yes ☐ No

COMMENTS

DTW - 206.80 E-Tape
DTB 236.34

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



699-43-88
2-21-91 RT Hatchell

Well Number 699-43-88 Date 2-21-91

Inspector (print) RT COFFMAN

Signature RT Coffman

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☑ Yes	☐ No
If yes, should the casing be relabeled?	☑ Yes	☐ No
Does the well have a brass marker?	☑ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☑ No
Does the casing need to be painted/repainted thus requiring relabeling?	☑ Yes	☐ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☑ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☑ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, B-Y Tank Farms, B-Pond, etc.)	☑ Yes	☐ No	If yes, identify facility OLD BWIP PIPEYARD		
Is well located in a radiation zone?	☐ Yes	☑ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☑ Yes	☐ No
Is the cap able to be locked?	☑ Yes	☐ No
Is the cap locked?	☑ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☑ None

_____

CONCRETE PAD

☐ None ☑ 4 ft x 4 ft ☐ 18 in. x 18 in. ☐ 2 ft round Is it damaged? ☐ Yes ☑ No

Irregular/Damage (describe) _____

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? NONE Diameter of posts? N/A

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing:	OD/ID: 8 5/8" / 8.0"	Type	CARBON STEEL
Inner casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	
Other casing:	OD/ID:	Type	

Describe condition of top edge of the highest most casing:

☒ Jagged ☐ Uneven ☐ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

PERF HOLE ABOVE CEMENT PAD

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 1.80'

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☒ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☐ Brass Marker ☐ Both ☐ None

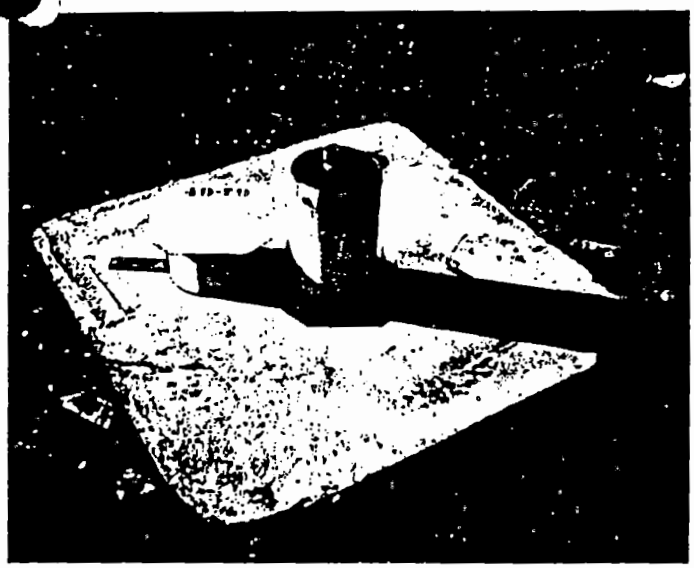
Other (describe) _____

Is stamp clearly visible? ☐ Yes ☐ No

COMMENTS

DTW – 177.42 BTOC E-TAPE
DTB – 193.08 BTOC "

RESOURCE PROTECTION GROUNDWATER WELL STRUCTURE FIELD INSPECTION REPORT



699-49-79
2-21-91 TL Hottell

Well Number 699-49-79 Date 2-21-91

Inspector (print) TL Hottell

Signature TL Hottell

WELL IDENTIFICATION ID MARKINGS

Is the well labeled?	☒ Yes	☐ No
If yes, should the casing be relabeled?	☐ Yes	☒ No
Does the well have a brass marker?	☒ Yes	☐ No
If yes, is the brass marker stamped with well ID?	☐ Yes	☒ No
Does the casing need to be painted/ repainted thus requiring relabeling?	☐ Yes	☒ No

Irregularities _____

WELL SITE IDENTIFICATION

Does well have a barber pole?	☒ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Does well have an identification sign posted at entrance to access route?	☒ Yes	☐ No	If no, is one needed?	☐ Yes	☐ No
Is well located in or around a particular facility? (e.g. 216-A-10 crib, 8-Y Tank Farms, 8-Pond, etc.)	☒ Yes	☐ No	If yes, identify facility NW of 200 W.		
Is well located in a radiation zone?	☐ Yes	☒ No	If yes, describe zone type _____		

Irregular/Damage (describe) _____

INSPECT WELL SURFACE PROTECTION MEASURES
WELL CAPS

Is the well capped?	☒ Yes	☐ No
Is the cap able to be locked?	☒ Yes	☐ No
Is the cap locked?	☒ Yes	☐ No

Describe existing problems with well cap, if any, or check none: ☒ None

_____

CONCRETE PAD

☐ None ☒ 4 ft x 4 ft ☐ 18 in x 18 in ☐ 2 ft round Is it damaged? ☐ Yes ☐ No

Irregular/Damage (describe) _____

BARRIER POSTS

Four posts, min. 3 in. ID, 1 removable? ☐ Yes ☒ No

If no, describe barrier posts: How many posts? _____ Diameter of posts? _____

Is there a removable post? ☐ Yes ☐ No

Irregular/Damage (describe) _____

CASING INFORMATION

CASING DIAMETERS: OUTER (SURFACE), INNER, AND OTHER – RECORD IN INCHES

Indicate diameter of casing. Describe type of casing (e.g. carbon steel, stainless steel, PVC, etc.)

Outer casing: OD/ID: 8 5/8 x 8 in Type Carbon Steel

Inner casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Other casing: OD/ID: _____ Type _____

Describe condition of top edge of the highest most casing:

☐ Jagged ☐ Uneven ☒ Fairly Level ☐ Beveled

Other (describe) _____

Describe protective casing damage, if any (e.g., hole in casing, bent, etc.), or check none: ☐ None

Hole in casing for J-Hook

Distance from: (check one)

☐ Ground Surface ☒ Cement Pad To top edge of highest most casing 1.10 ft

SAMPLING EQUIPMENT INSTALLATION

Describe type of pump system:

☐ Hydrostar ☒ Submersible ☐ Bladder ☐ None

Describe type of pump system support:

☐ Hydrostar Plate ☐ Well Seal ☒ J-Hook ☐ Steel Cable ☐ Pitless Adapter

Describe type of pump system:

☐ 3/4 in. Stainless Steel ☒ 1 1/2 in. ABS ☐ 1 in. PVC ☐ 1 1/2 in. galvanized

Irregular/Damage (describe) _____

WELL SITE

Describe debris present at well site, if any, or check none: ☒ None

Describe well site irregularities (e.g., down in pit, locked building, etc.) or check none: ☒ None

SURVEY INFORMATION

Describe survey mark location:

☒ Top edge of highest most casing ☒ Brass Marker TH 2-21-91 ☐ Both ☐ None

Other (describe) ~~No ID on~~ TH 2-21-91

Is stamp clearly visible? ☒ Yes ☐ No

COMMENTS

DTW - 232.44 E-Tape

DTB - 280.50

9112270775

APPENDIX C3

CAMERA SURVEYS

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FIELD ACTIVITY REPORT – BOREHOLE TELEVISION SURVEY

Page 1 of 1

Date	Well No.	Location	Report No.
1-29-91	299-W18-171	216-Z-1A Tile Field	91-046-01

Casing Size:	Type:	Set At:	Screened/Perf Interval	Construction Depth
8"	C/S	127'	NA	127'

Last Recorded Depth to Water: NA Date:

Top of Casing Elev (ft)

Ground Surface Elev (ft)

PURPOSE
Determine condition and status of casing, screens and/or perforations as applicable.

Start Time: 0935 End Time: 1020

Television System Used: EFSG

Personnel: D E Gostovich, H D Tomison, D L Mallory HPT

CAMERA/CABLE DECONTAMINATED PRIOR TO USE:

Date 1-29-91 By H D Tomison

INSTRUCTIONS:
Measurements are to be recorded in feet and referenced to a common datum of ground surface.
Entries may be YES, NO, NA = Not applicable, ND = Not determined or OTHER.
Explain entries of OTHER in COMMENTS Section.

1. **GROUND SURFACE DATUM**--Establish ground surface datum in feet below top of casing. The camera counter, (or display equivalent) is set to zero. DATUM (ft below top of casing: 2.40 from ground surface
2. **VADOSE ZONE CASING**--Examine vadose zone casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged ND Comments
   Corrosion/scale/rust ND Comments
3. **SUBMERGED CASING**--Examine submerged casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NA Comments
   Corrosion/scale/rust Comments
4. **PERFORATIONS** (If applicable)--Examine perforations for condition and interval.
   Depth Top NA Depth Bottom Cuts/rd/ft
   Condition, (clean/corroded, slots open, slots obscured, etc.)
5. **SCREEN** (if applicable)--Examine screen for condition and interval.
   Depth Top NA Depth Bottom Type
   Condition, (clean, corroded, slots open, slots obscured, etc.)
6. **TOP OF WATER**--Determine depth of water and interface condition.
   Depth NA Floating debris Surface appearance
   Comments
7. **WATER QUALITY**--Record water quality observed during survey.
   Clear NA Murky Dislodged Scale Suspended debris
   Comments
8. **HOLE BOTTOM**--Examine borehole bottom as observed during survey.
   Measured depth 128.10 Appearance, (debris, silt, etc.) Rocks and broken glass
   Comment and bottles
9. **COMMENTS** It looked like a cement scale on the sides of the casing

Report By D E Gostovich
Title Rig Tech
Signature

Reviewed By M. G. GARDNER
Title Team Leader Date 02-04-91
Signature M G Gardner

Distribution: White – Group File Custodian Yellow – Group Files Pink – Project Coordinator Goldenrod – Team Leader BC-6000-419 (03/90)

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FIELD ACTIVITY REPORT – BOREHOLE TELEVISION SURVEY

Page 1 of 1

Date	Well No.	Location	Report No.
2-8-91	299-W18-159	216-Z-1A crib	91-046-01

Casing Size:	Type:	Set At:	Screened/Perf Interval	Construction Depth
6"	C/S	126	NA	130'

Last Recorded Depth to Water:	Date:	Top of Casing Elev (ft)	Ground Surface Elev (ft)
NA		670.77	669.62

PURPOSE
Determine condition and status of casing, screens and/or perforations as applicable.

Start Time: 1000 End Time: 1030

Television System Used: EFS 6

CAMERA/CABLE DECONTAMINATED PRIOR TO USE:

Date 2-8-91 By HD Jamison

Personnel
D E Gostovich
H D Jamison
R Shay HPT

INSTRUCTIONS:
Measurements are to be recorded in feet and referenced to a common datum of ground surface.
Entries may be YES, NO, NA = Not applicable, ND = Not determined or OTHER.
Explain entries of OTHER in COMMENTS Section.

1. **GROUND SURFACE DATUM**--Establish ground surface datum in feet below top of casing. The camera counter, (or display equivalent) is set to zero. DATUM (ft below top of casing: 1.15 from Cement
2. **VADOSE ZONE CASING**--Examine vadose zone casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NO Comments
   Corrosion/scale/rust yes Comments cement from plugging the bottom
3. **SUBMERGED CASING**--Examine submerged casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NA Comments
   Corrosion/scale/rust Comments
4. **PERFORATIONS** (If applicable)--Examine perforations for condition and interval.
   Depth Top NA Depth Bottom Cuts/rd/ft
   Condition, (clean/corroded, slots open, slots obscured, etc.)
5. **SCREEN** (if applicable)--Examine screen for condition and interval.
   Depth Top NA Depth Bottom Type
   Condition, (clean, corroded, slots open, slots obscured, etc.)
6. **TOP OF WATER**--Determine depth of water and interface condition.
   Depth NA Floating debris Surface appearance
   Comments
7. **WATER QUALITY**--Record water quality observed during survey.
   Clear NA Murky Dislodged Scale Suspended debris
   Comments
8. **HOLE BOTTOM**--Examine borehole bottom as observed during survey.
   Measured depth ND Appearance, (debris, silt, etc.)
   Comment could tell because of a object in well The object is at 119'
9. **COMMENTS** There was a hole that had been patched from the outside at 102 ft. There was cement on the casing. The object on the bottom is some kind of radiation probe. The HPT didn't find any contamination on the camera equipment

Report By D E Gostovich
Title Eng Tech
Signature D E Gostovich

Reviewed By A.L. SCHATZ
Title Plant Eng. Date 2-19-91
Signature A.L. Schatz

Distribution: White – Group File Custodian Yellow – Group Files Pink – Project Coordinator Goldenrod – Team Leader BC-6000 419 (03/90)

9112270178

FIELD ACTIVITY REPORT – BOREHOLE TELEVISION SURVEY

Page 1 of 1

Date	Well No.	Location	Report No.
2-8-91	299-W18-150	216-Z-1A CribB	91-046-01

Casing Size:	Type:	Set At:	Screened/Perf Interval	Construction Depth
6"	C/S	128	NA	128'

Last Recorded Depth to Water:	Date:	Top of Casing Elev (ft)	Ground Surface Elev (ft)
NA		671.81	668.88

PURPOSE
Determine condition and status of casing, screens and/or perforations as applicable.

Start Time: 0920 End Time: 0950

Television System Used: EFSG

Personnel: DE Gostovich, HD Jamison, K Shay HPT

CAMERA/CABLE DECONTAMINATED PRIOR TO USE:

Date 2-8-91 By HD Jamison

INSTRUCTIONS:
Measurements are to be recorded in feet and referenced to a common datum of ground surface.
Entries may be YES, NO, NA = Not applicable, ND = Not determined or OTHER.
Explain entries of OTHER in COMMENTS Section.

1. **GROUND SURFACE DATUM**--Establish ground surface datum in feet below top of casing. The camera counter, (or display equivalent) is set to zero. DATUM (ft below top of casing: 2.93 from Cement
2. **VADOSE ZONE CASING**--Examine vadose zone casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NO Comments
   Corrosion/scale/rust yes Comments cement from when the bottom plug was put in
3. **SUBMERGED CASING**--Examine submerged casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NA Comments
   Corrosion/scale/rust NA Comments
4. **PERFORATIONS** (If applicable)--Examine perforations for condition and interval.
   Depth Top NA Depth Bottom Cuts/rd/ft
   Condition, (clean/corroded, slots open, slots obscured, etc.)
5. **SCREEN** (if applicable)--Examine screen for condition and interval.
   Depth Top NA Depth Bottom Type
   Condition, (clean, corroded, slots open, slots obscured, etc.)
6. **TOP OF WATER**--Determine depth of water and interface condition.
   Depth NA Floating debris Surface appearance
   Comments
7. **WATER QUALITY**--Record water quality observed during survey.
   Clear NA Murky Dislodged Scale Suspended debris
   Comments
8. **HOLE BOTTOM**--Examine borehole bottom as observed during survey.
   Measured depth 118.45 Appearance, (debris, silt, etc.) There looked like what appeared to
   Comment be rust and cement on the bottom
9. **COMMENTS** The casing has cement on most of it. It didn't look like it was very heavy. When we came out with the camera no contamination was found by the HPT

Report By DE Gostovich
Title Eng Tech
Signature DE Gostovich

Reviewed By A.L. SCHATZ
Title Plant Eng Date 2-19-91
Signature A.L. Schatz

Distribution: White – Group File Custodian Yellow – Group Files Pink – Project Coordinator Goldenrod – Team Leader BC-6000-419 (03/90)

FIELD ACTIVITY REPORT – BOREHOLE TELEVISION SURVEY

Page 1 of 1

Date	Well No.	Location	Report No.
2-8-91	299-W18-87	216-Z-1A CWB 200 W	91-046-01

Casing Size:	Type:	Set At:	Screened/Perf Interval	Construction Depth
6"	C/S	150'	NA	150'

Last Recorded Depth to Water:	Date:	Top of Casing Elev (ft)	Ground Surface Elev (ft)
NA		677.23	674.80

PURPOSE
Determine condition and status of casing, screens and/or perforations as applicable.

Start Time: 1130 End Time: 1200

Television System Used: EFSG

Personnel: D E Gostovich, H O Jamison, K Shay HPT

CAMERA/CABLE DECONTAMINATED PRIOR TO USE:

Date 2-8-91 By H O Jamison

INSTRUCTIONS:
Measurements are to be recorded in feet and referenced to a common datum of ground surface.
Entries may be YES, NO, NA = Not applicable, ND = Not determined or OTHER.
Explain entries of OTHER in COMMENTS Section.

1. **GROUND SURFACE DATUM**--Establish ground surface datum in feet below top of casing. The camera counter, (or display equivalent) is set to zero. DATUM (ft below top of casing: 2.43 from ground surface
2. **VADOSE ZONE CASING**--Examine vadose zone casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged NO Comments
   Corrosion/scale/rust some Comments casing is in fairly good shape
3. **SUBMERGED CASING**--Examine submerged casing for evidence of damage, corrosion, scale or rust.
   Casing parted/damaged ND NA Comments
   Corrosion/scale/rust ND NA Comments
4. **PERFORATIONS** (If applicable)--Examine perforations for condition and interval.
   Depth Top ND NA Depth Bottom Cuts/rd/ft
   Condition, (clean/corroded, slots open, slots obscured, etc.)
5. **SCREEN** (if applicable)--Examine screen for condition and interval.
   Depth Top ND NA Depth Bottom Type
   Condition, (clean, corroded, slots open, slots obscured, etc.)
6. **TOP OF WATER**--Determine depth of water and interface condition.
   Depth NA Floating debris Surface appearance
   Comments
7. **WATER QUALITY**--Record water quality observed during survey.
   Clear NA Murky Dislodged Scale Suspended debris
   Comments
8. **HOLE BOTTOM**--Examine borehole bottom as observed during survey.
   Measured depth 148.62 Appearance, (debris, silt, etc.) There was a spick and a small
   Comment amount of plastic on the bottom
9. **COMMENTS** there was a small amount of cement on the casing. at around 100 ft the casing was rough for about 20 or 30 ft.

Report By D E Gostovich	Reviewed By A. L. Schatz
Title Eng Tech	Title Plant Eng. Date 2-19-91
Signature D E Gostovich	Signature A. L. Schatz

Distribution: White – Group File Custodian Yellow – Group Files Pink – Project Coordinator Goldenrod – Team Leader BC-6000-419 (03/90)

APPENDIX C4

LITHOLOGIC AND WELL CONSTRUCTION DIAGRAMS

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EXPLANATION

DOMINANT GRAIN-SIZE SCALE

C/Z	=	Clay and Silt
S	=	Sand
P	=	Pebble Gravel
C/B	=	Cobble + Boulder Gravel
B	=	Basalt

ADDITIONAL LITHOLOGIC SYMBOLS

Clayey

Silty

Sandy

Gravely

Cobbly

Bouldery

Basalt

Ashy

Carbonate-rich (Caliche)

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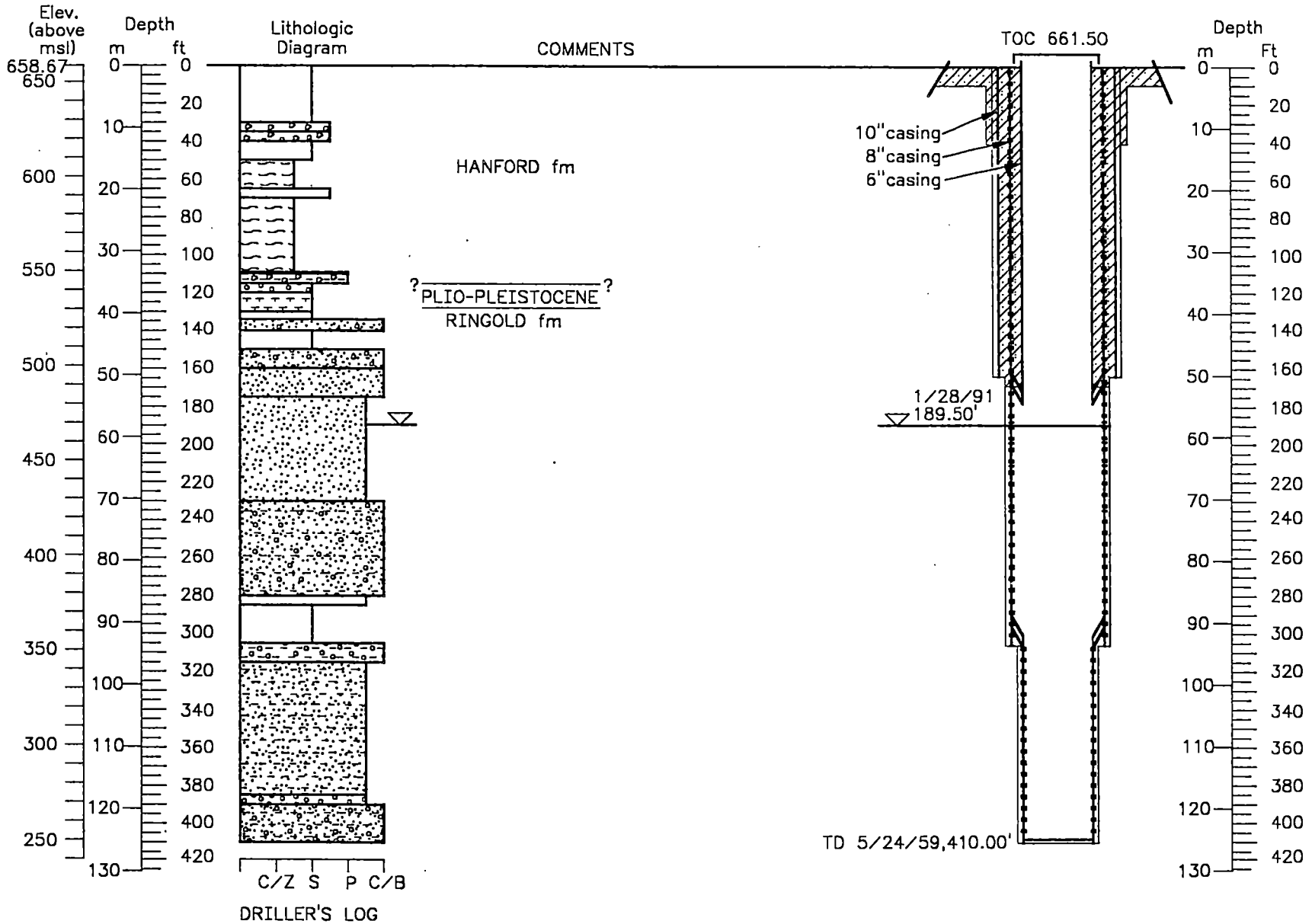
WELL 299-W15-6



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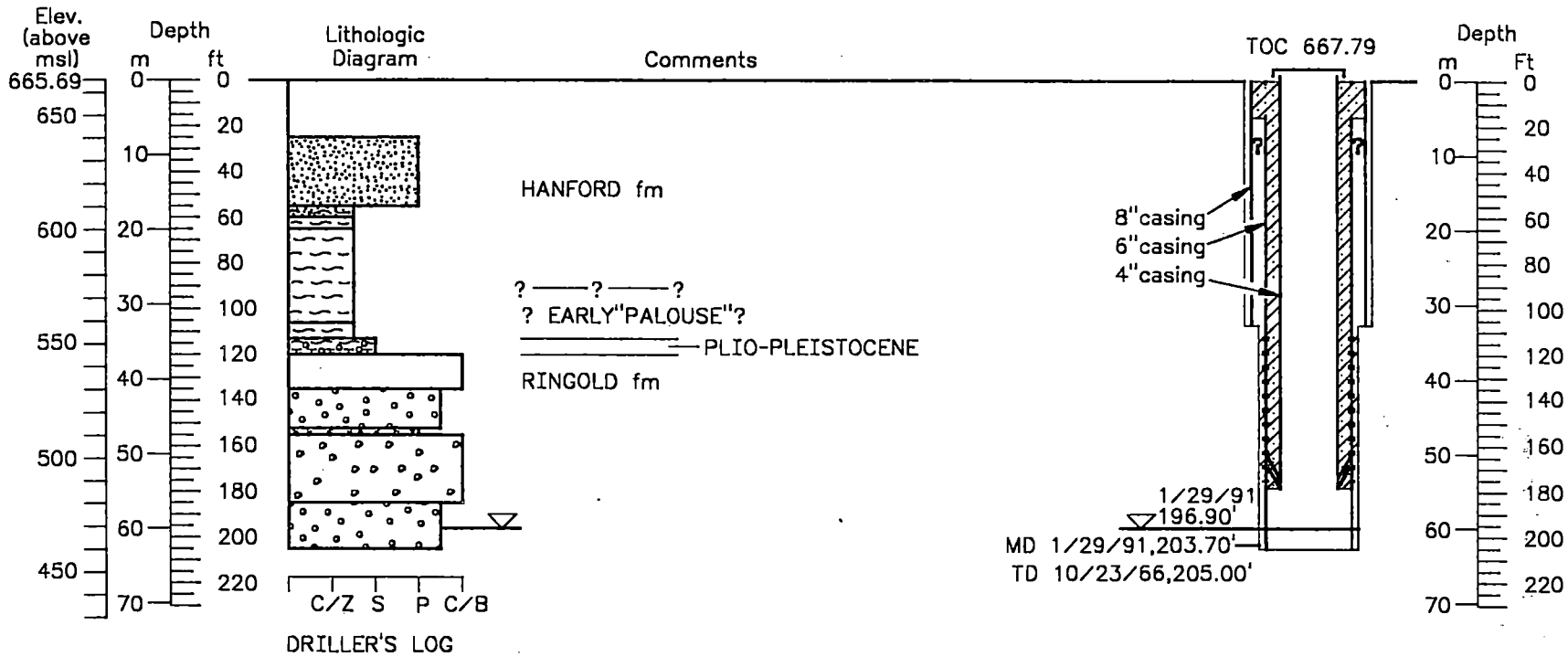

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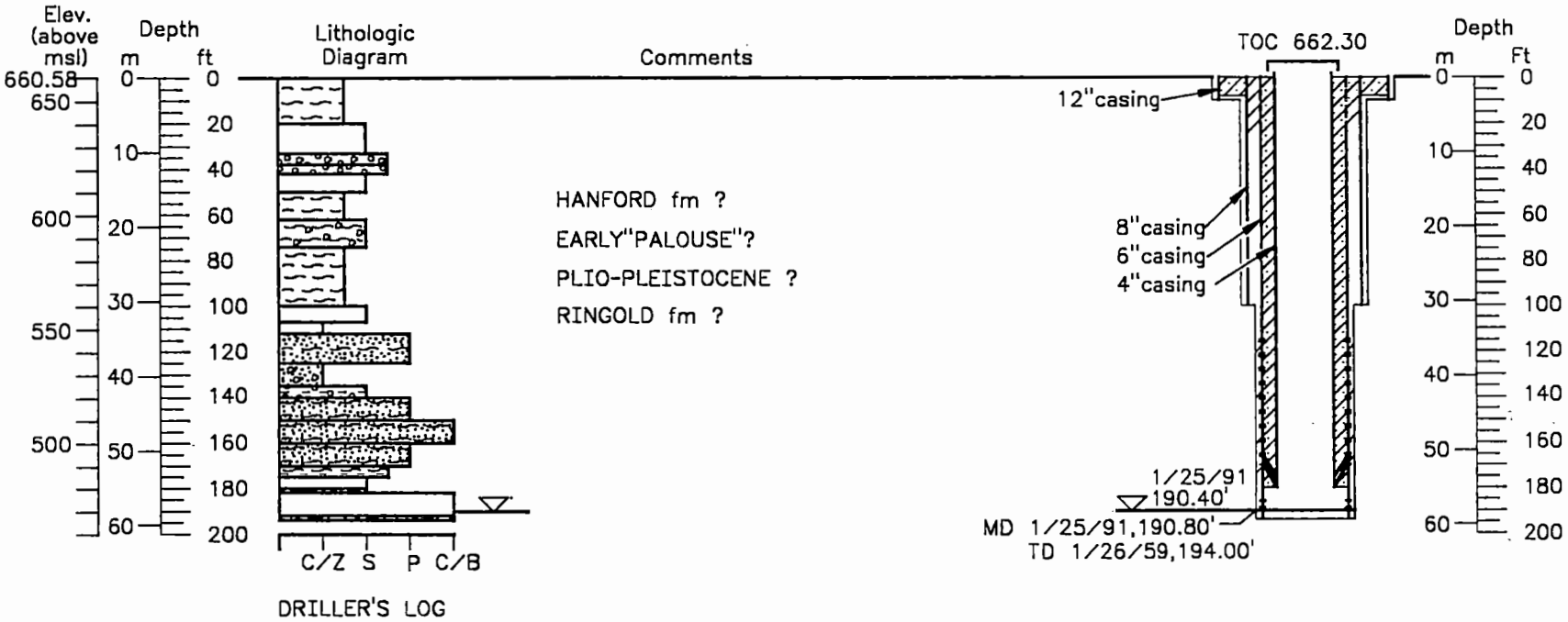

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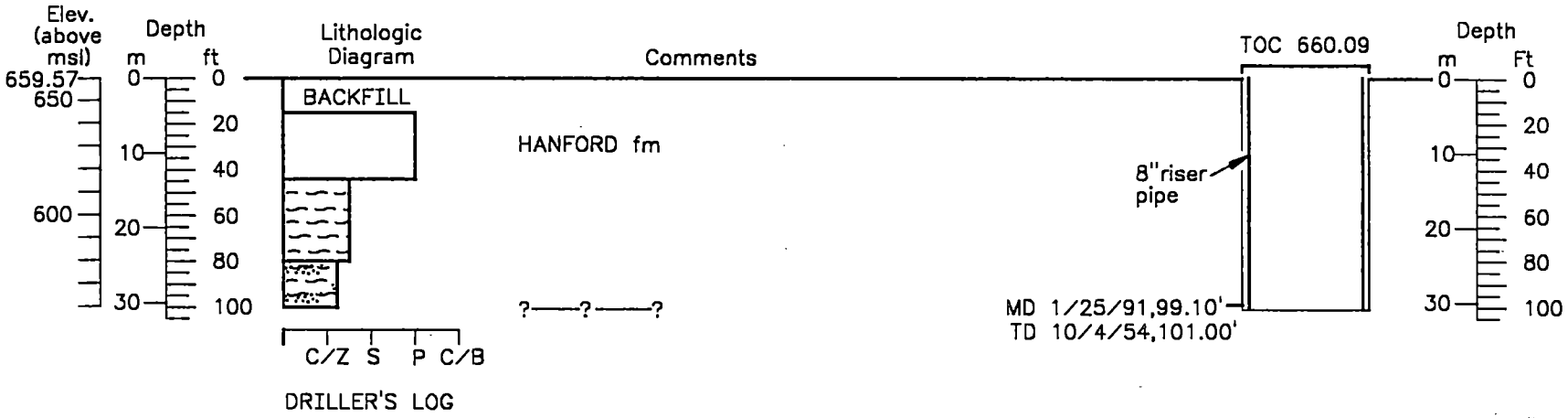

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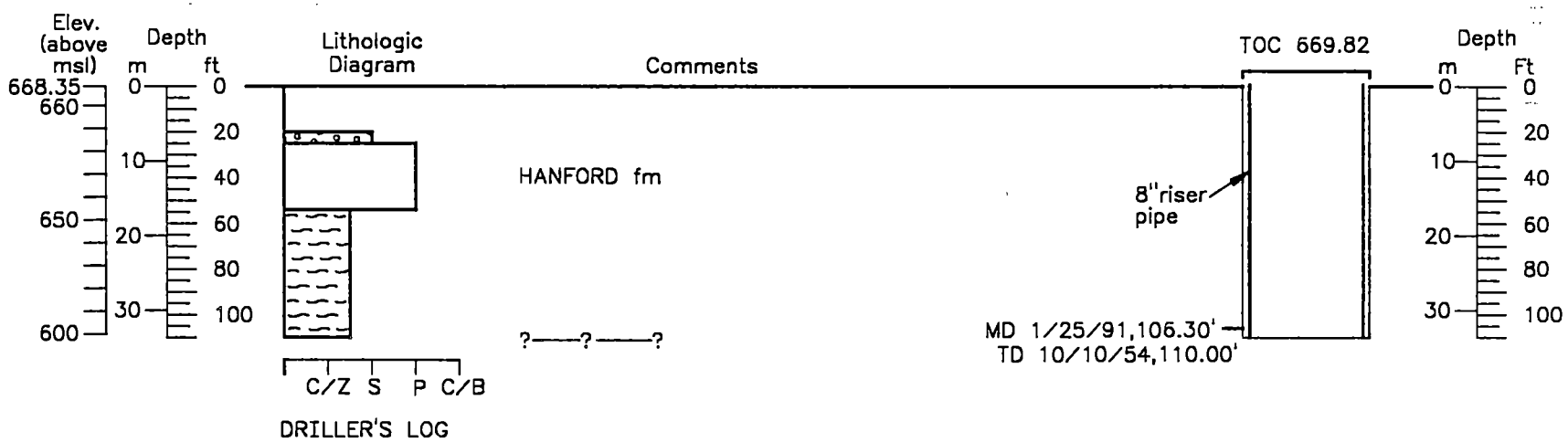

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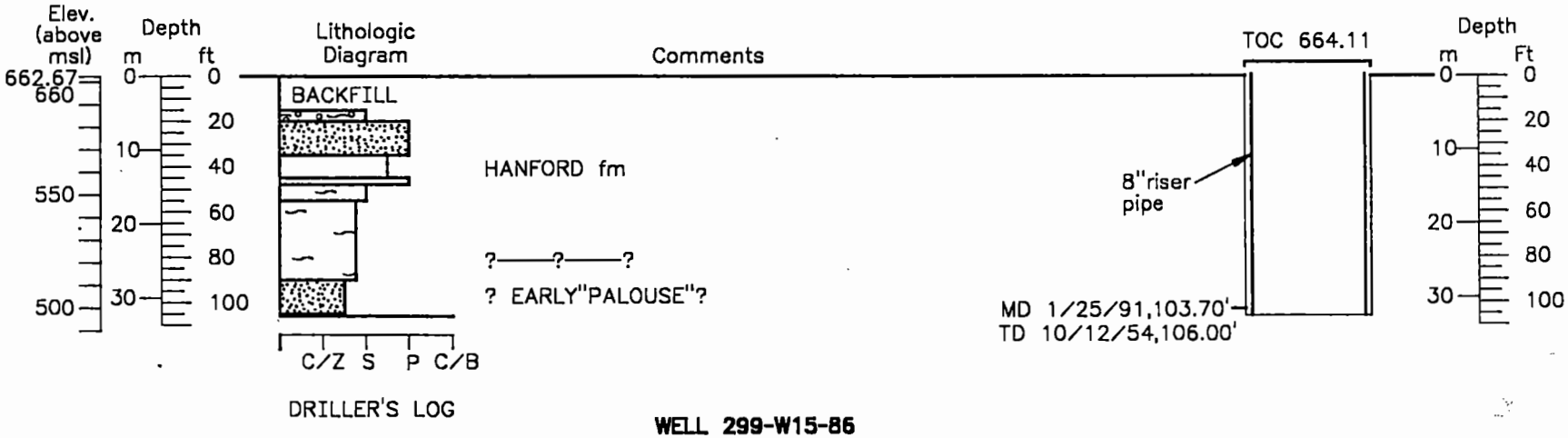

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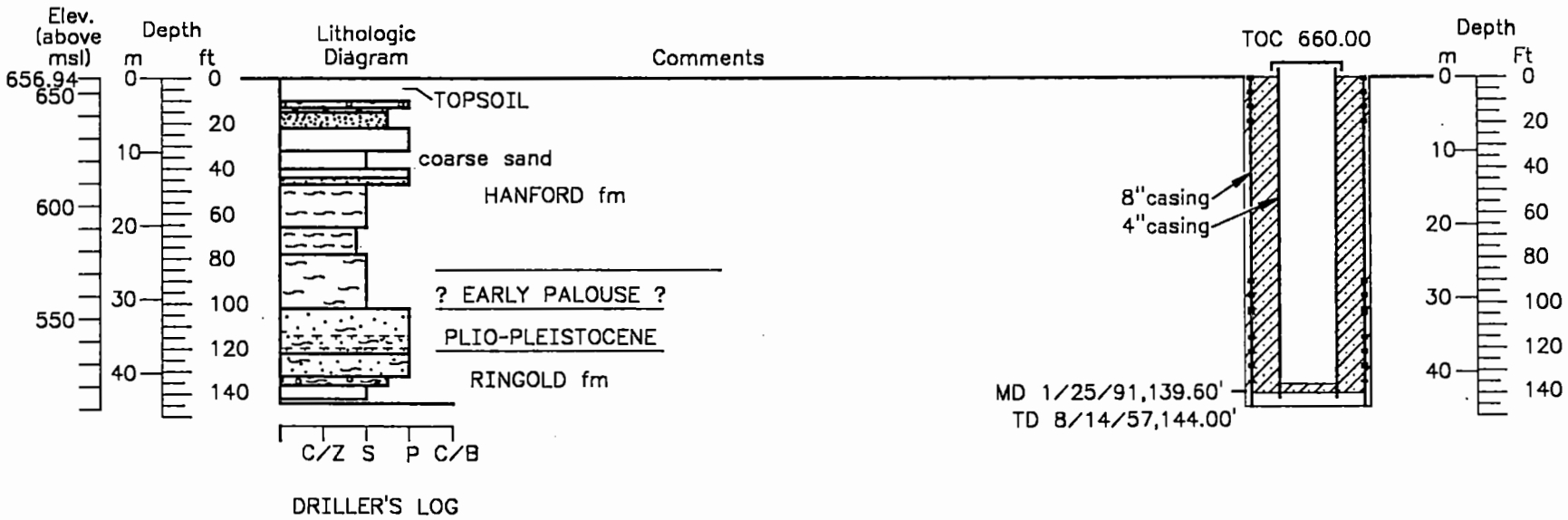

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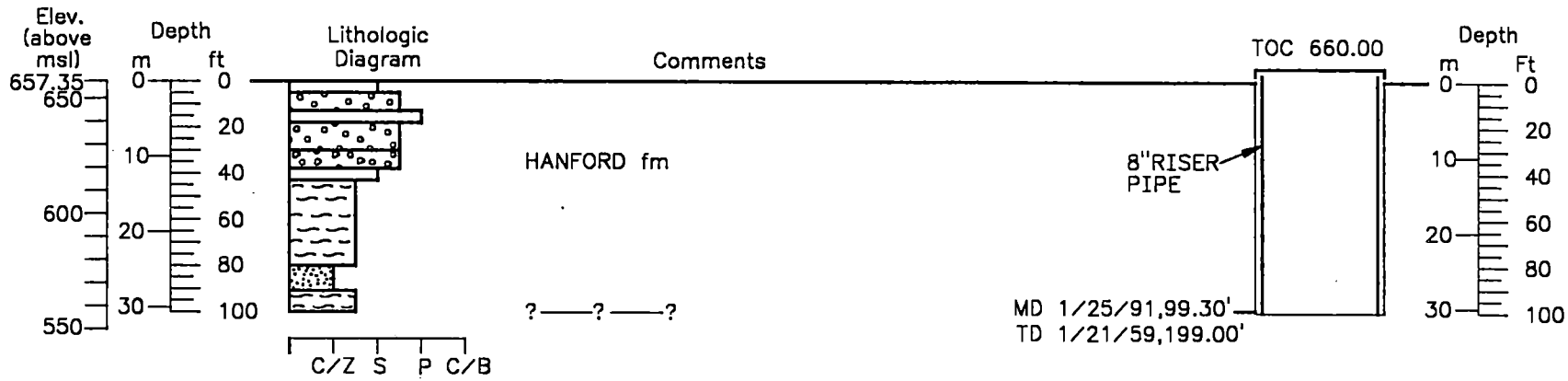

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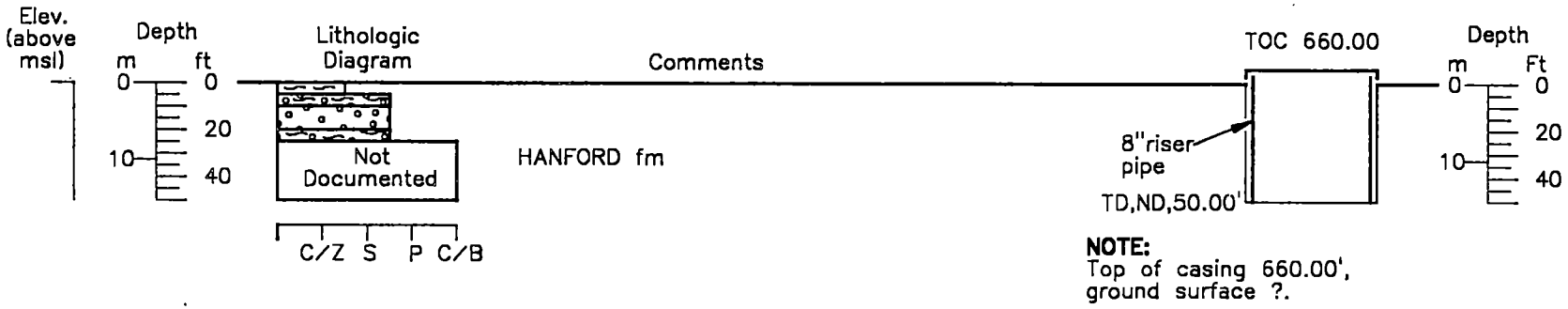
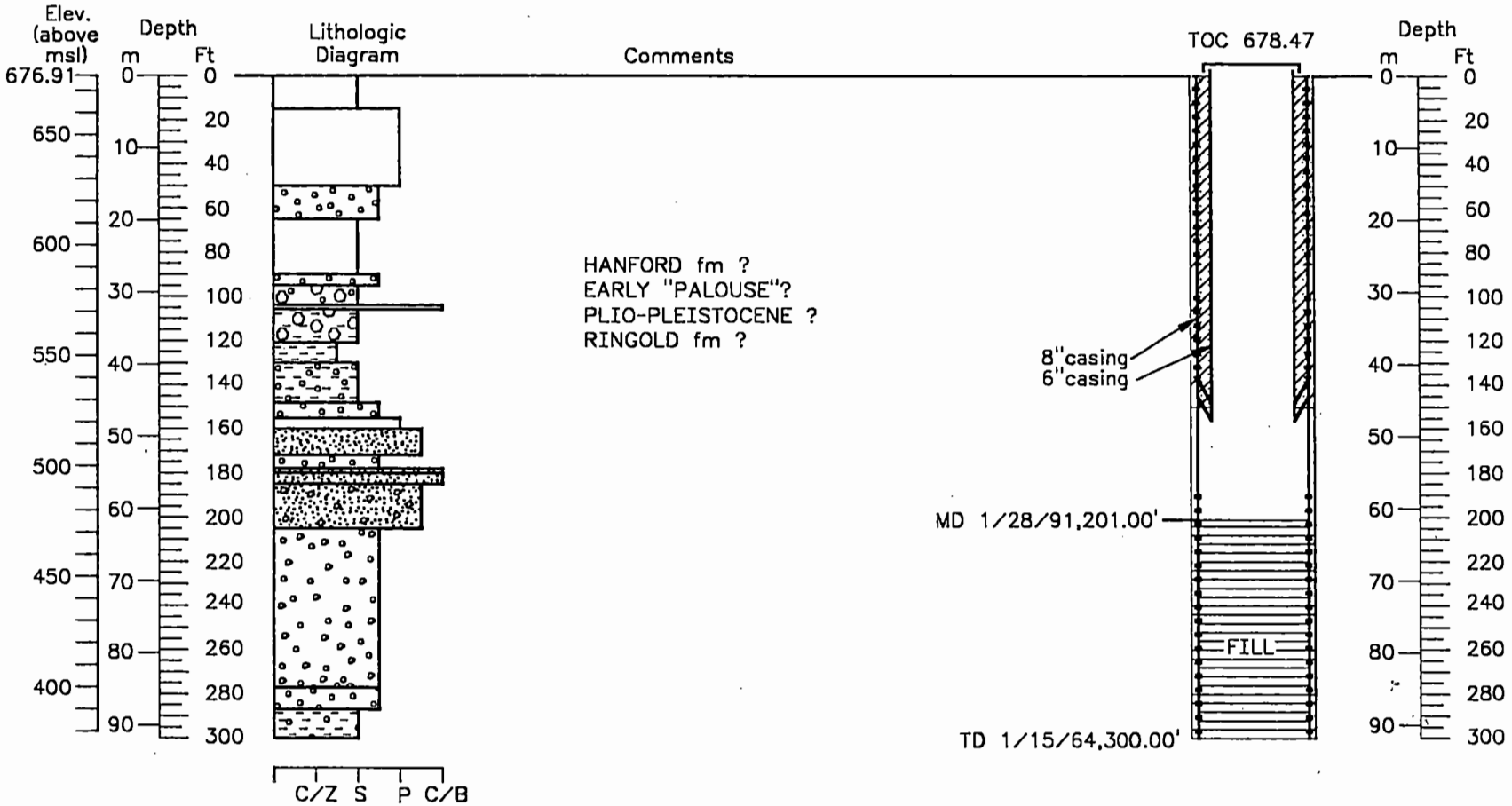


NOTE:
Top of casing 660.00', ground surface ?.

WELL 299-W18-6



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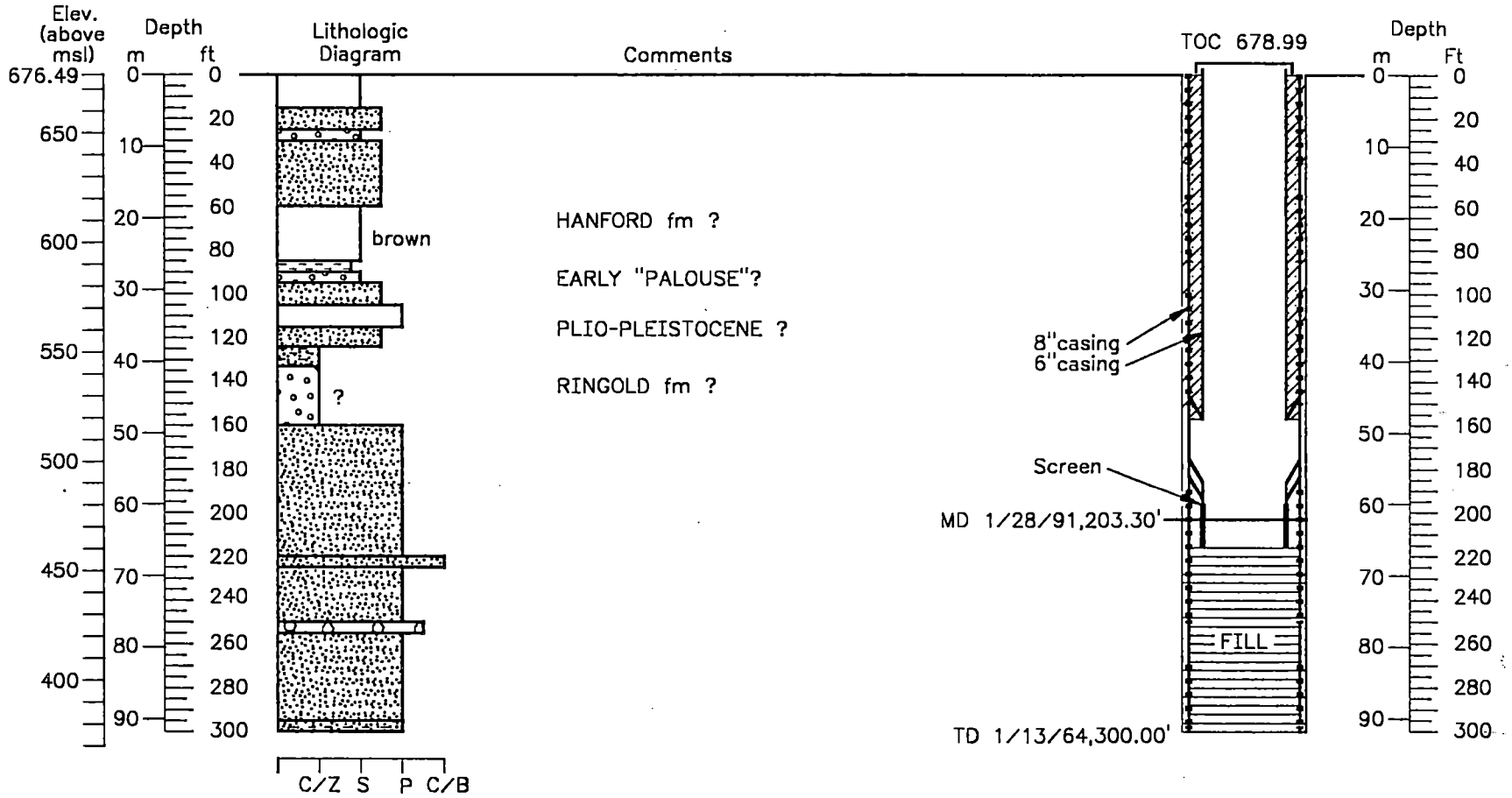
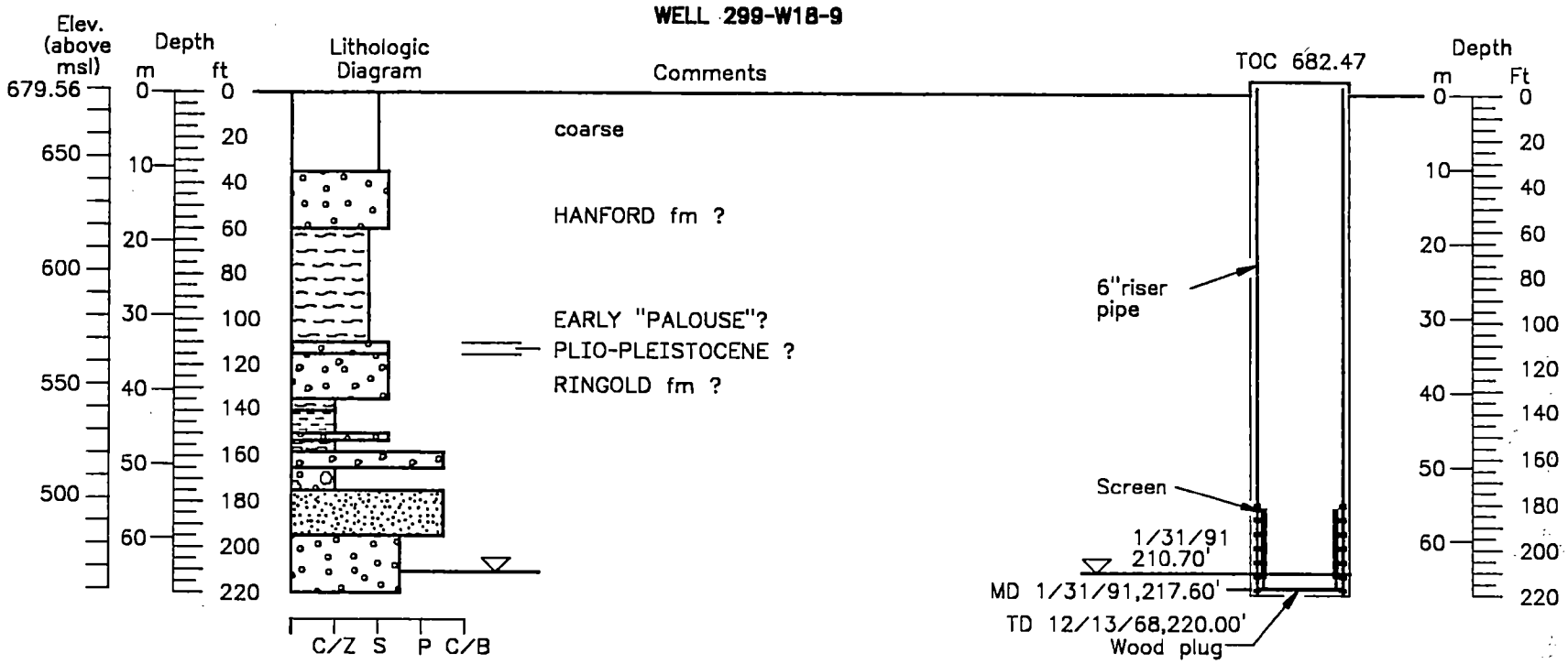
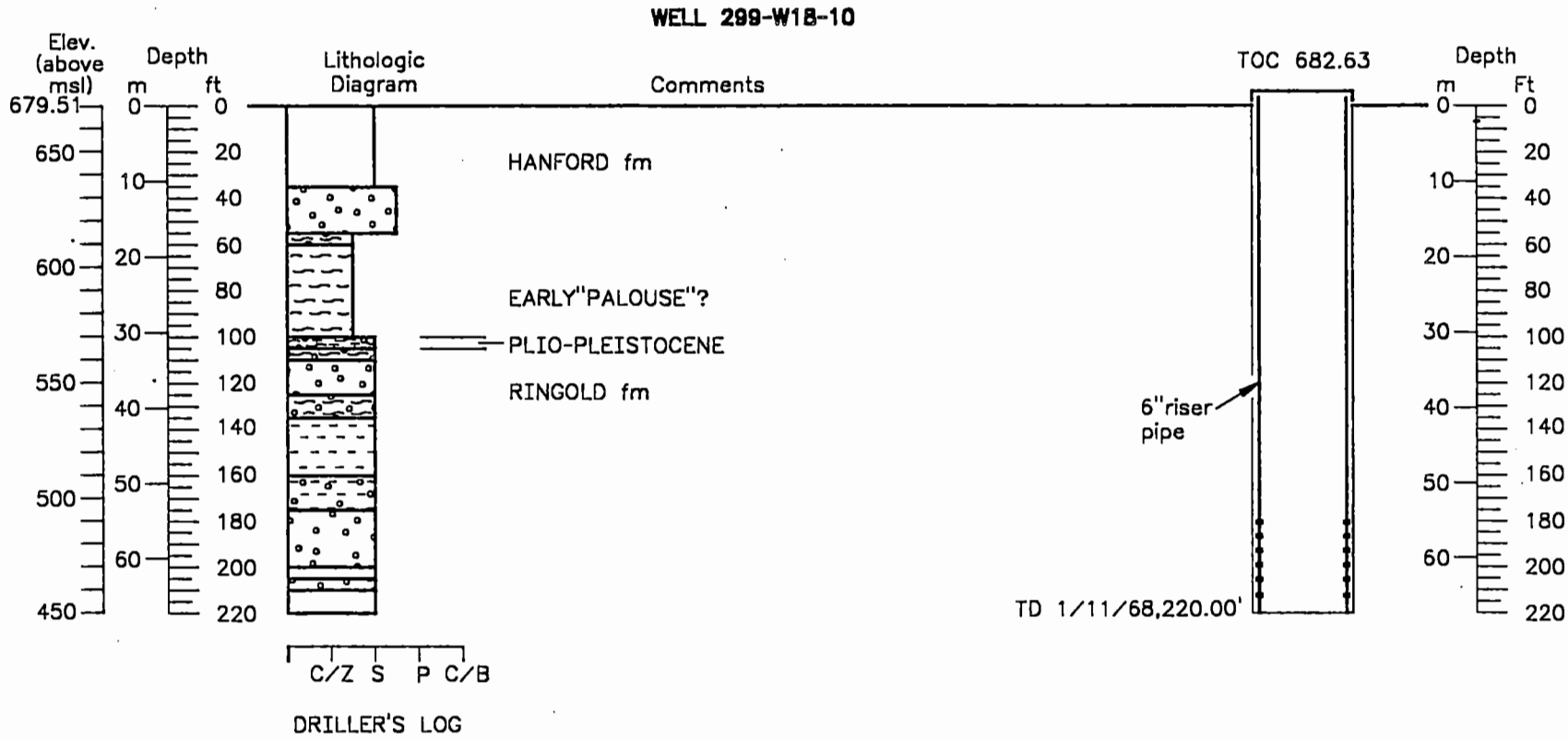



WELL 299-W18-9
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
679.56
650
600
550
500
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
200
220
coarse
HANFORD fm ?
EARLY "PALOUSE"?
PLIO-PLEISTOCENE ?
RINGOLD fm ?
C/Z S P C/B
TOC 682.47
6"riser pipe
Screen
1/31/91
210.70'
MD 1/31/91,217.60'
TD 12/13/68,220.00'
Wood plug
Depth
m
Ft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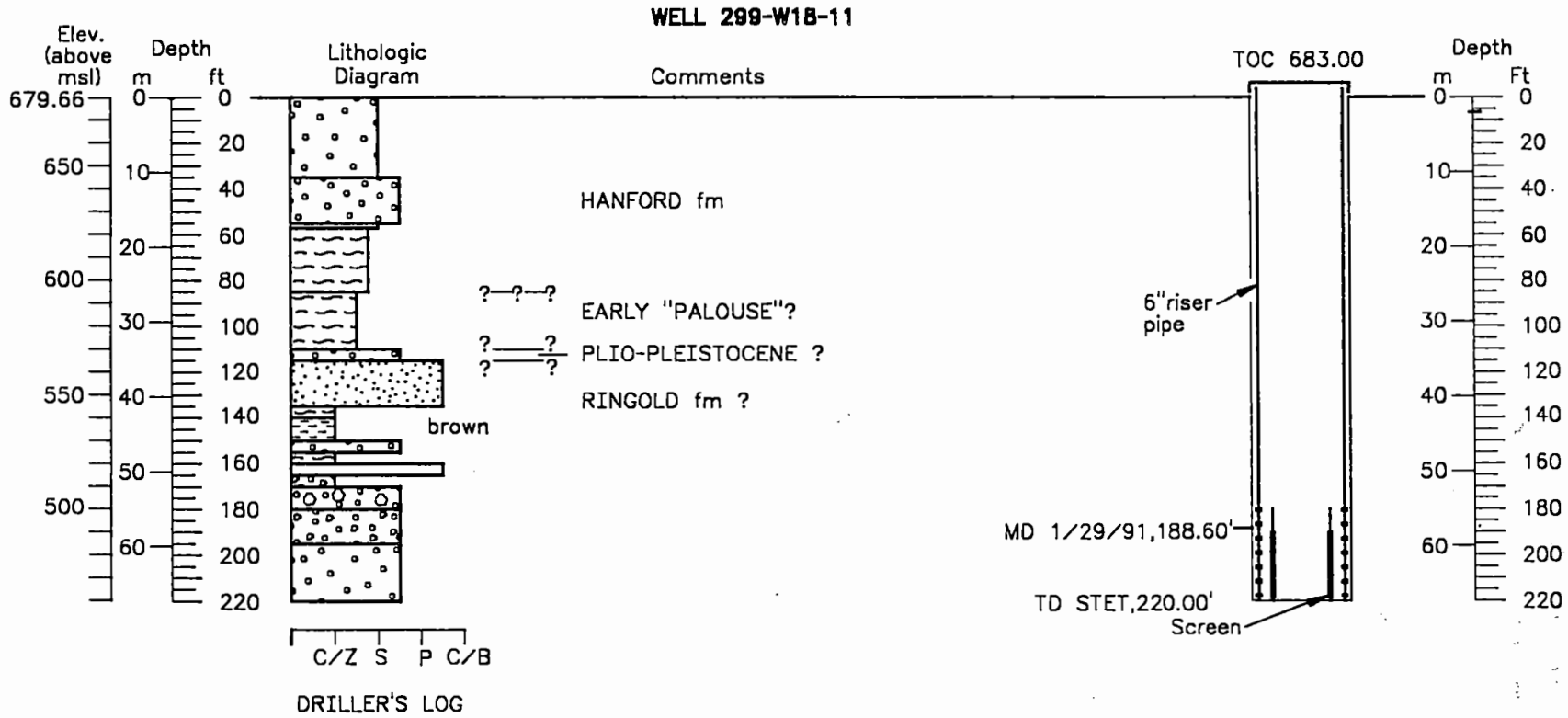
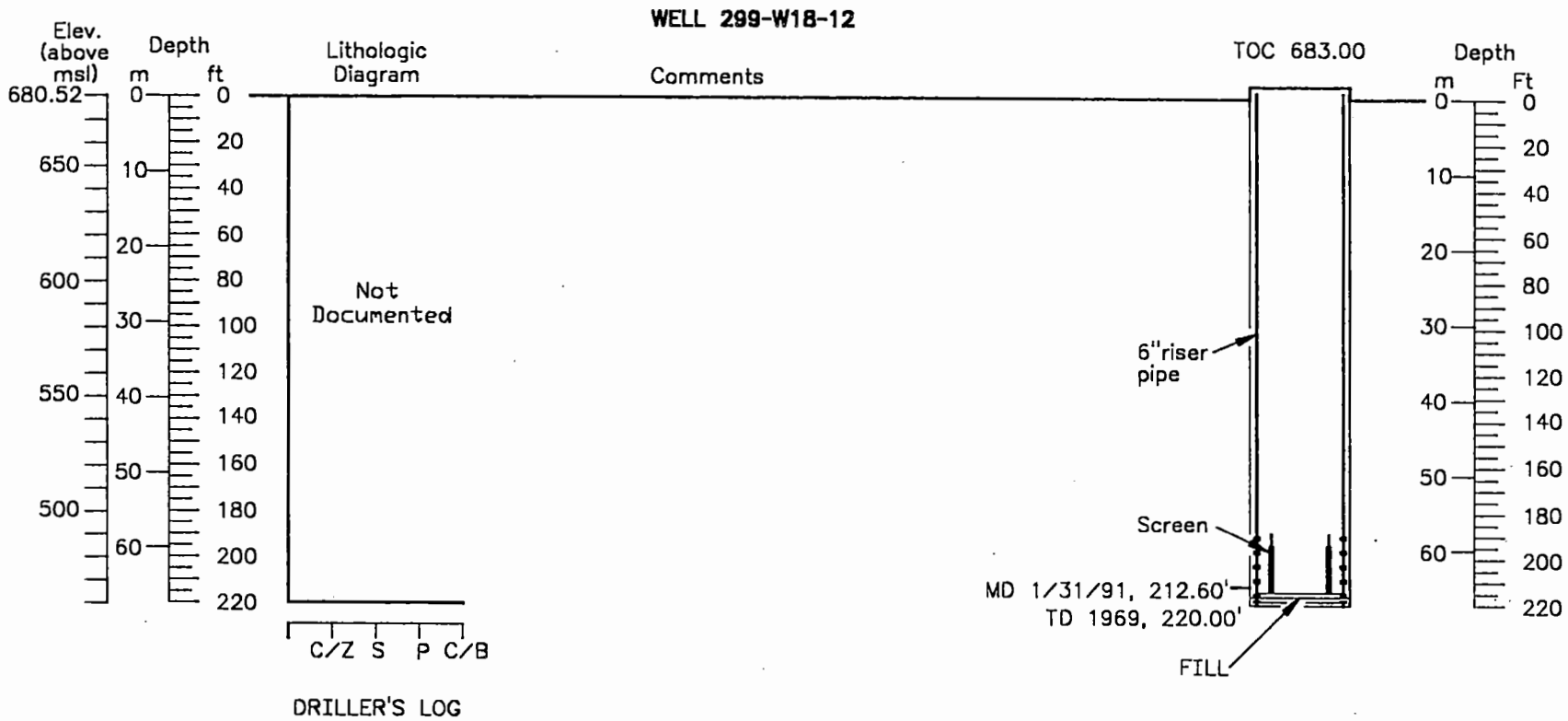
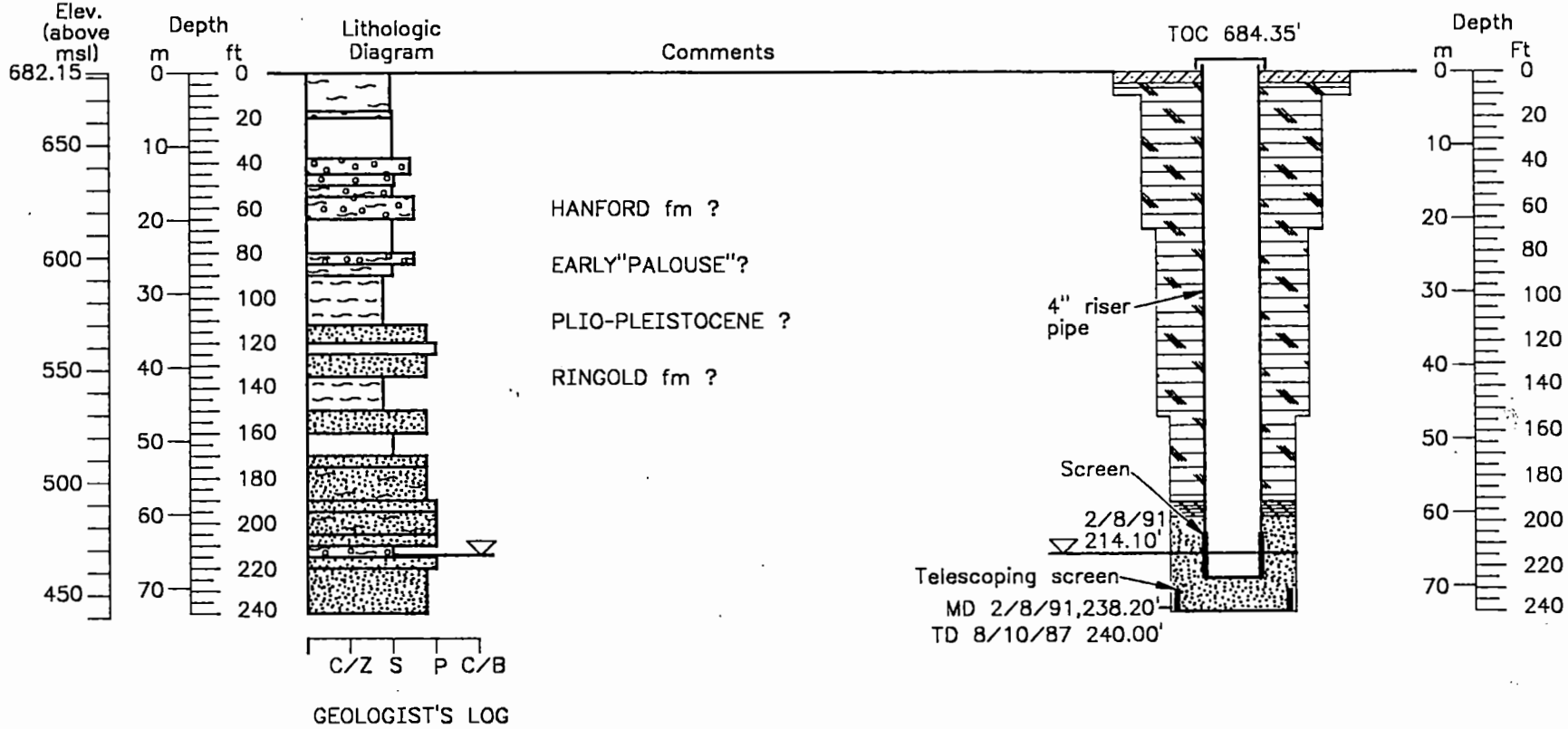
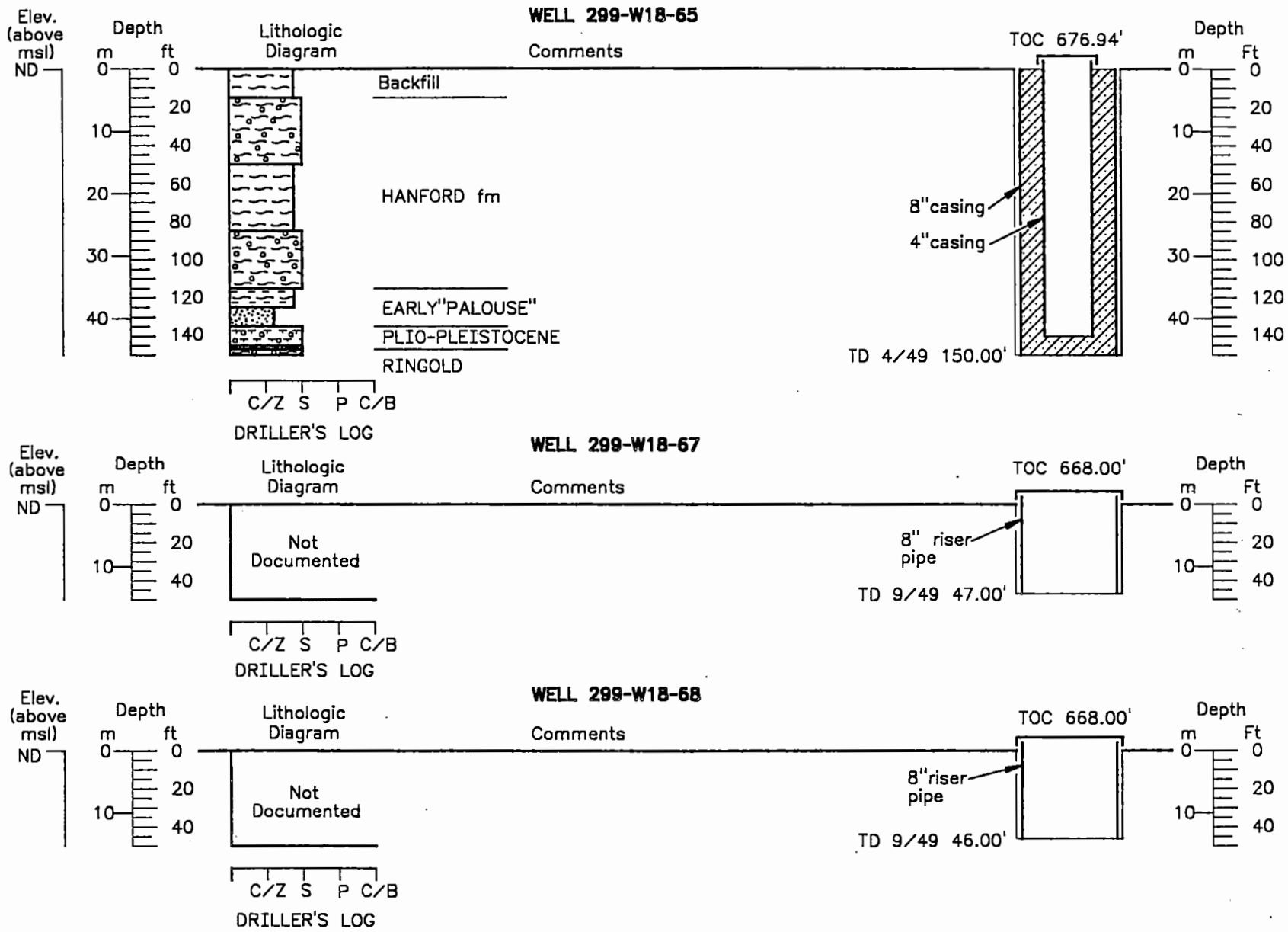
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 682.63
Depth
m
Ft
679.51
650
600
550
500
450
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
RINGOLD fm
6"riser pipe
TD 1/11/68,220.00'
C/Z S P C/B
DRILLER'S LOG

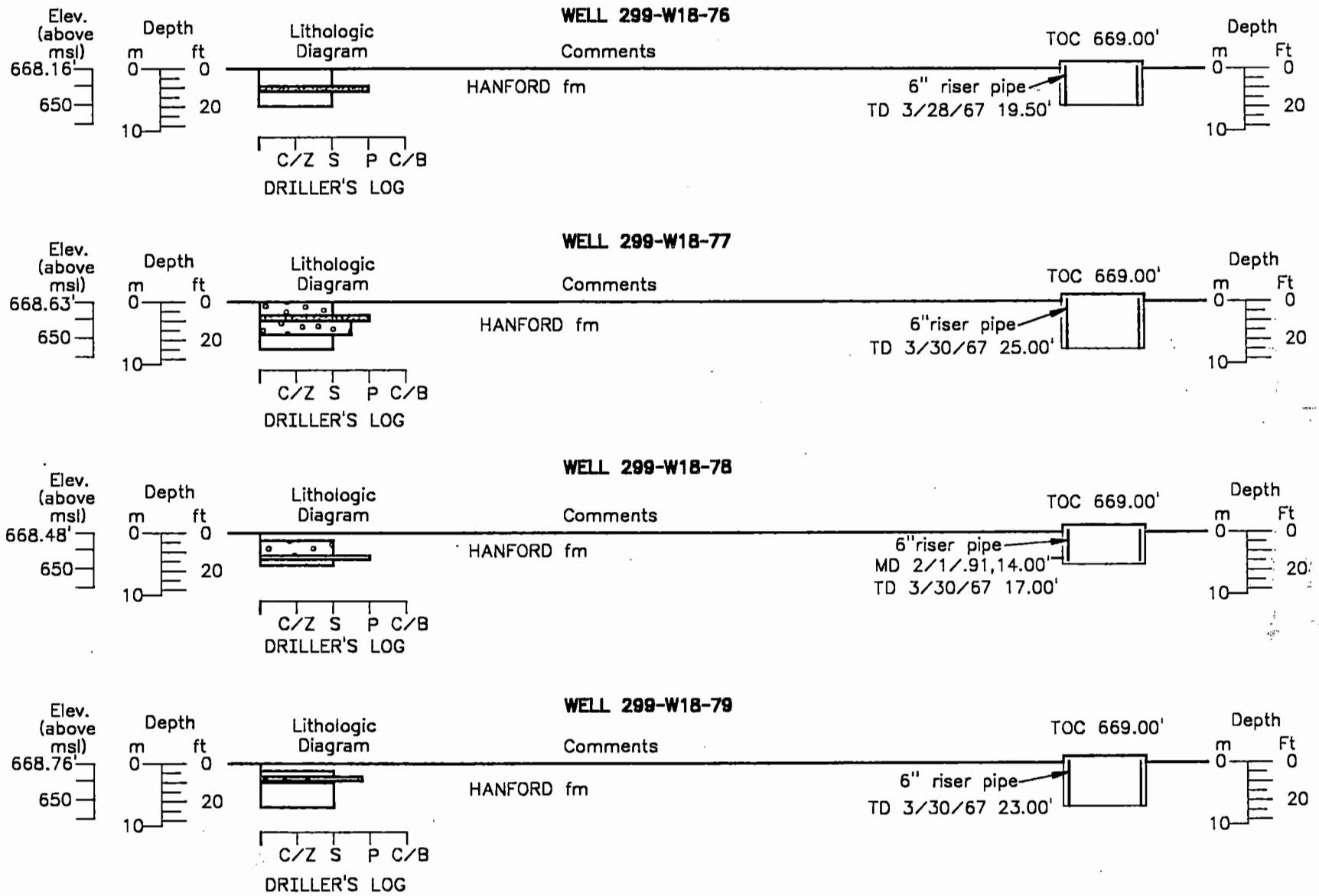

WELL 299-W18-11
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
679.66
650
600
550
500
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
200
220
HANFORD fm
EARLY "PALOUSE"?
PLIO-PLEISTOCENE ?
RINGOLD fm ?
brown
C/Z S P C/B
DRILLER'S LOG
TOC 683.00
6"riser pipe
MD 1/29/91,188.60'
TD STET,220.00'
Screen
Depth
m
Ft

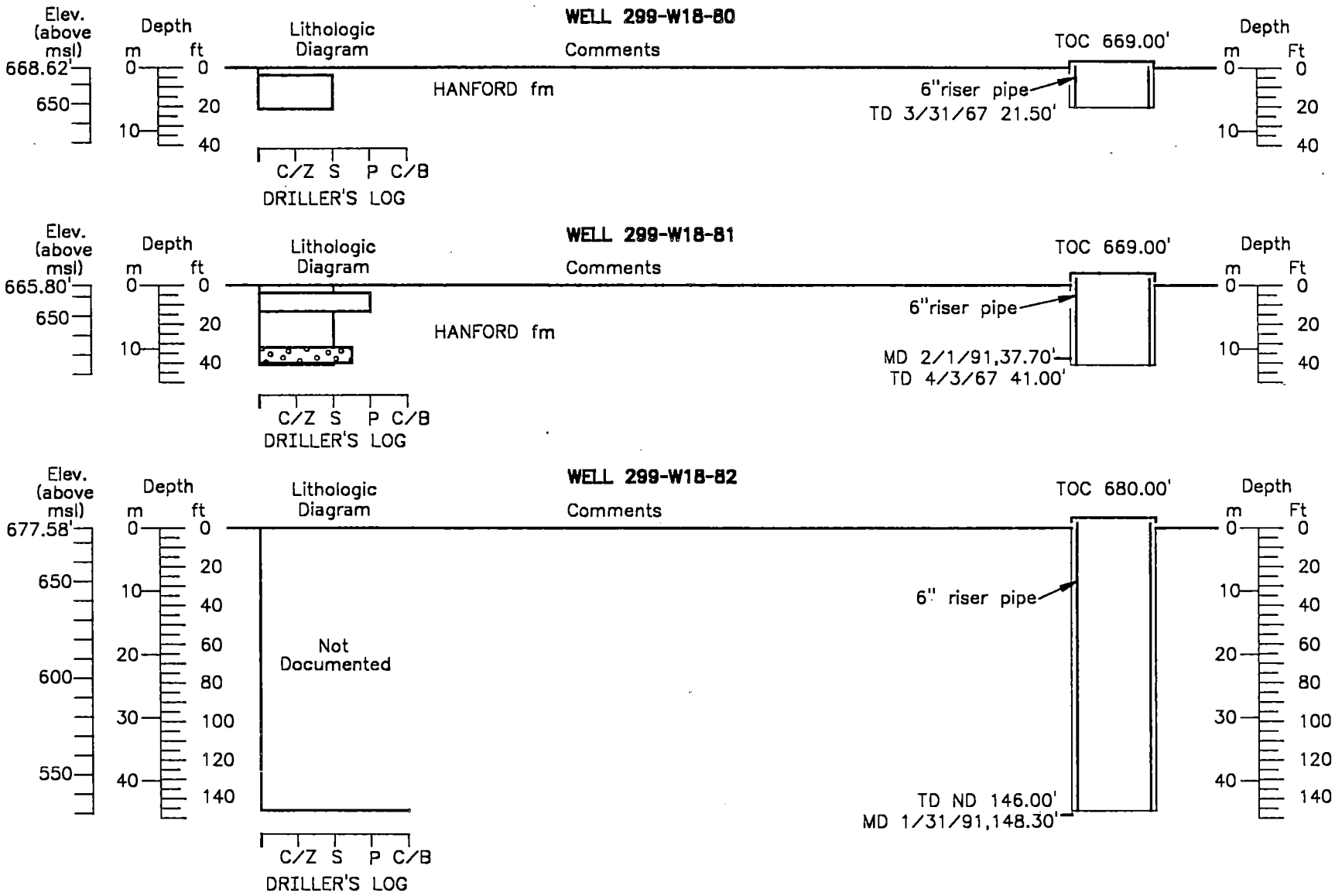

WELL 299-W18-12
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 683.00
Depth
m
Ft
680.52
650
600
550
500
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
200
220
Not Documented
C/Z S P C/B
DRILLER'S LOG
6"riser pipe
Screen
MD 1/31/91, 212.60'
TD 1969, 220.00'
FILL

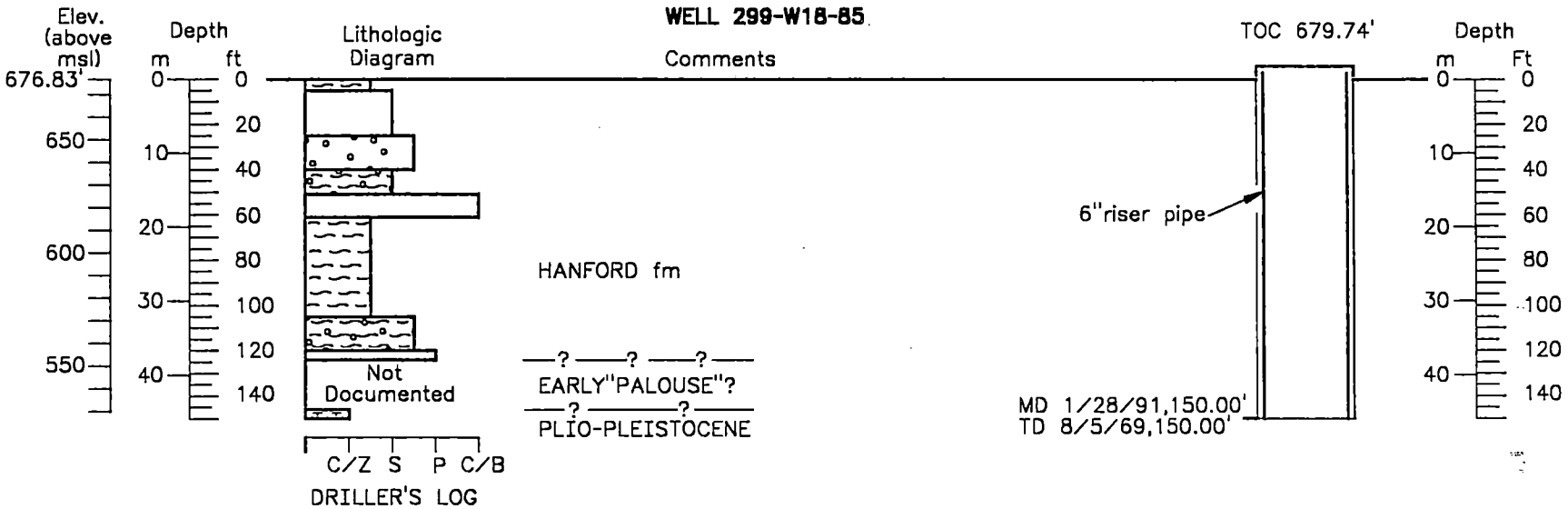
WELL 299-W18-24

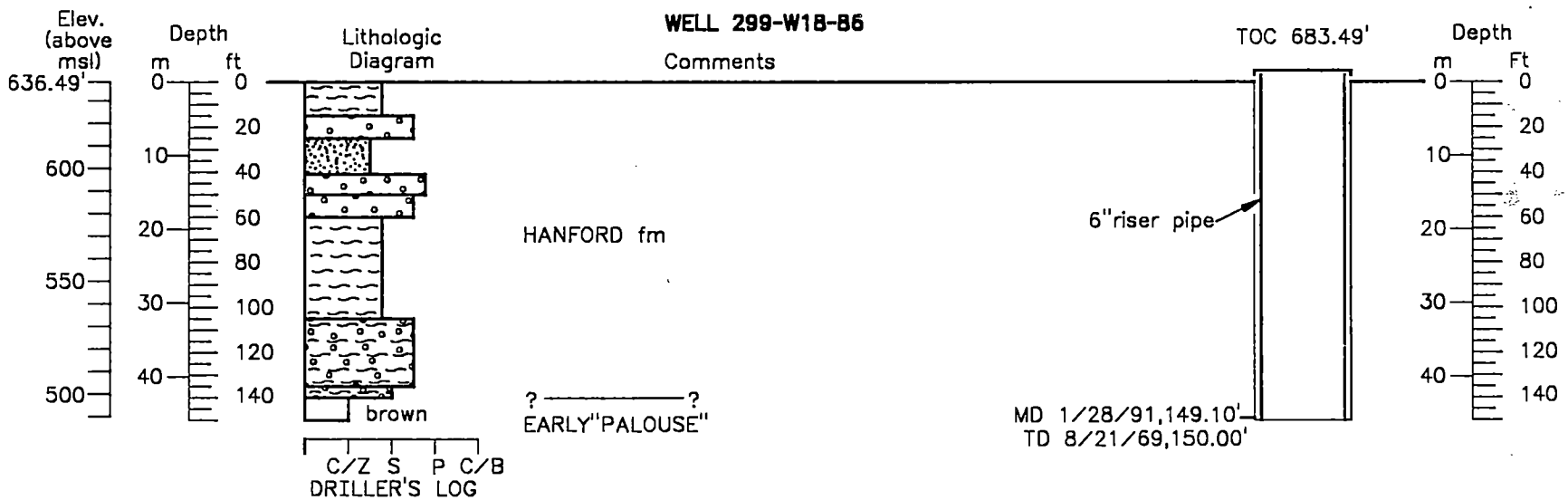



WELL 299-W18-65
Elev. (above msl) ND
Depth m ft
Lithologic Diagram
Comments
Backfill
HANFORD fm
EARLY "PALOUSE"
PLIO-PLEISTOCENE
RINGOLD
C/Z S P C/B
DRILLER'S LOG
TOC 676.94'
8" casing
4" casing
TD 4/49 150.00'
Depth m Ft
WELL 299-W18-67
Not Documented
TOC 668.00'
8" riser pipe
TD 9/49 47.00'
WELL 299-W18-68
Not Documented
TOC 668.00'
8" riser pipe
TD 9/49 46.00'

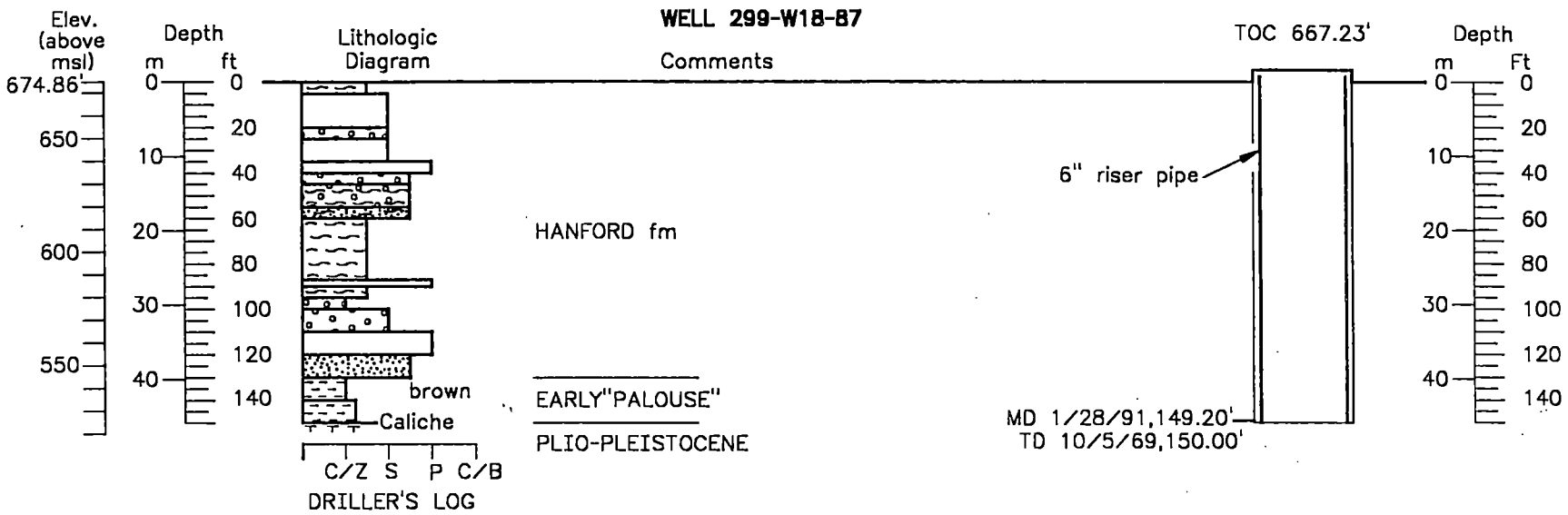

WELL 299-W18-76
Elev. (above msl)
668.16'
650
Depth
m
ft
0
20
10
Lithologic Diagram
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
TOC 669.00'
6" riser pipe
TD 3/28/67 19.50'
Depth
m
Ft
WELL 299-W18-77
668.63'
6"riser pipe
TD 3/30/67 25.00'
WELL 299-W18-78
668.48'
6"riser pipe
MD 2/1/.91,14.00'
TD 3/30/67 17.00'
WELL 299-W18-79
668.76'
6" riser pipe
TD 3/30/67 23.00'

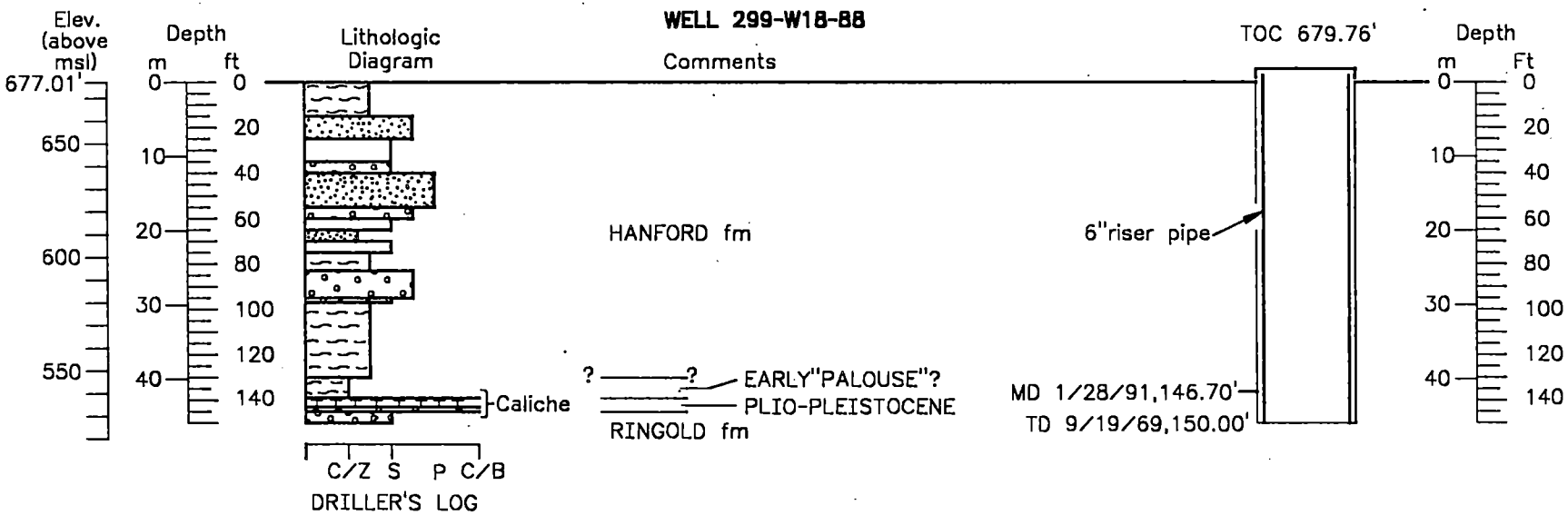

WELL 299-W18-80
Elev. (above msl)
668.62'
650
Depth
m
ft
Lithologic Diagram
Comments
HANFORD fm
TOC 669.00'
6"riser pipe
TD 3/31/67 21.50'
C/Z S P C/B
DRILLER'S LOG
WELL 299-W18-81
665.80'
HANFORD fm
TOC 669.00'
6"riser pipe
MD 2/1/91,37.70'
TD 4/3/67 41.00'
WELL 299-W18-82
677.58'
600
550
Not Documented
TOC 680.00'
6" riser pipe
TD ND 146.00'
MD 1/31/91,148.30'
Ft

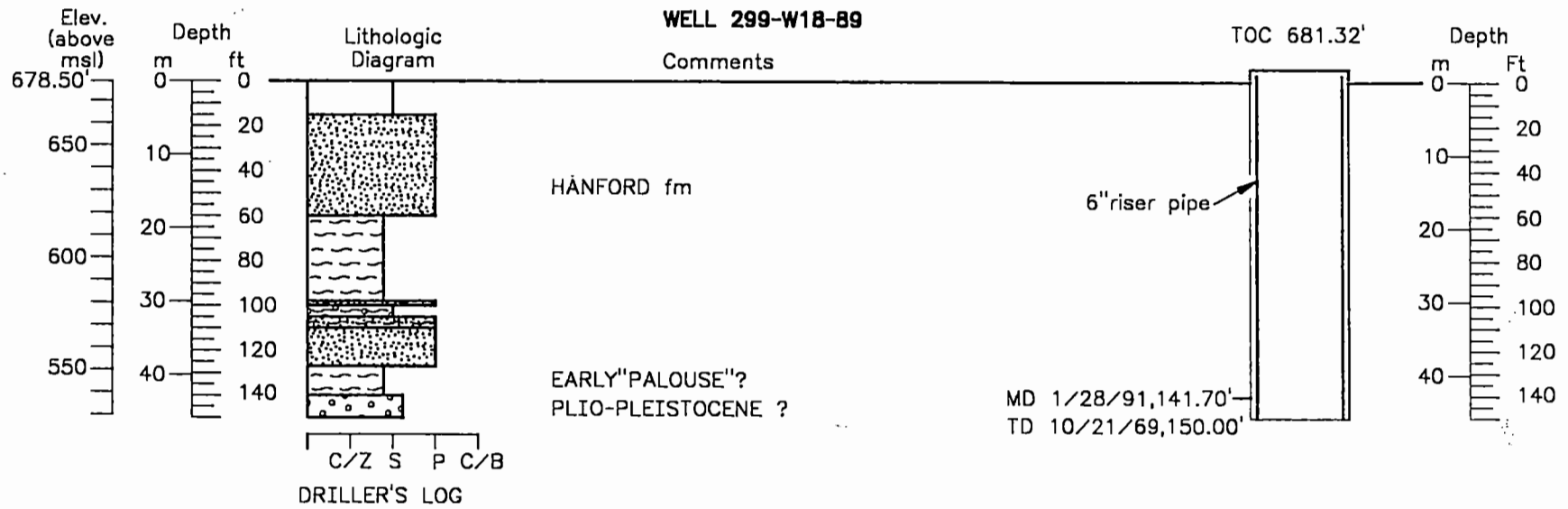

WELL 299-W18-85
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 679.74'
676.83'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
140
Not Documented
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
6"riser pipe
MD 1/28/91,150.00'
TD 8/5/69,150.00'
Ft
C/Z S P C/B
DRILLER'S LOG

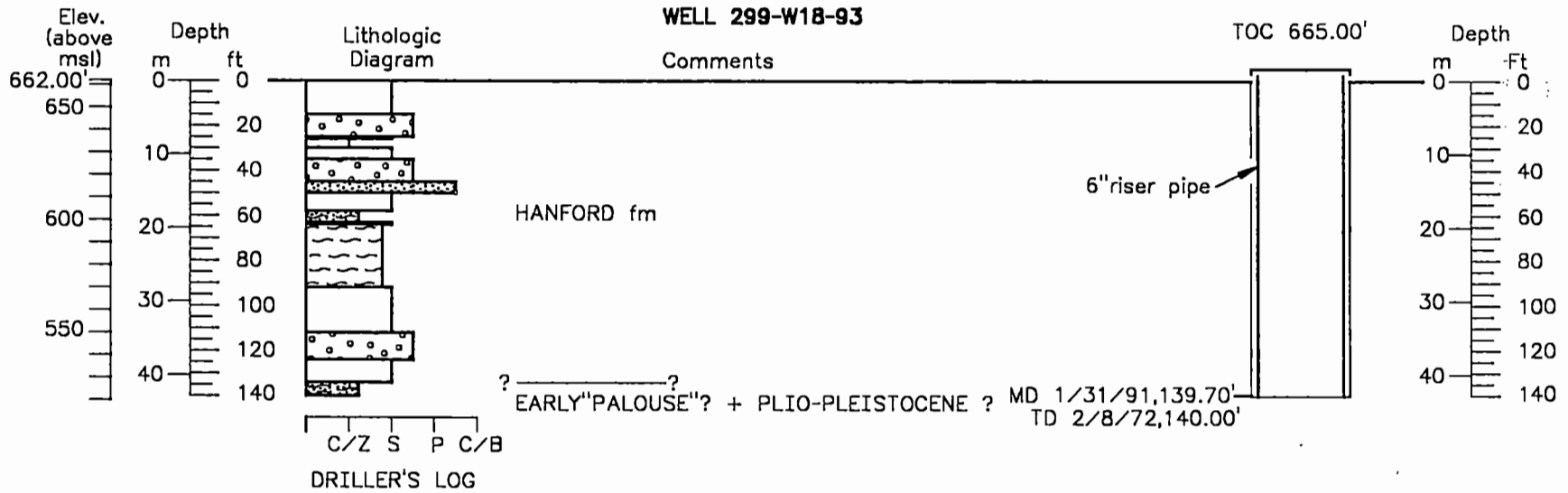

WELL 299-W18-86
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 683.49'
636.49'
600
550
500
0
10
20
30
40
0
20
40
60
80
100
120
140
brown
HANFORD fm
EARLY"PALOUSE"
6"riser pipe
MD 1/28/91,149.10'
TD 8/21/69,150.00'
Ft
C/Z S P C/B
DRILLER'S LOG

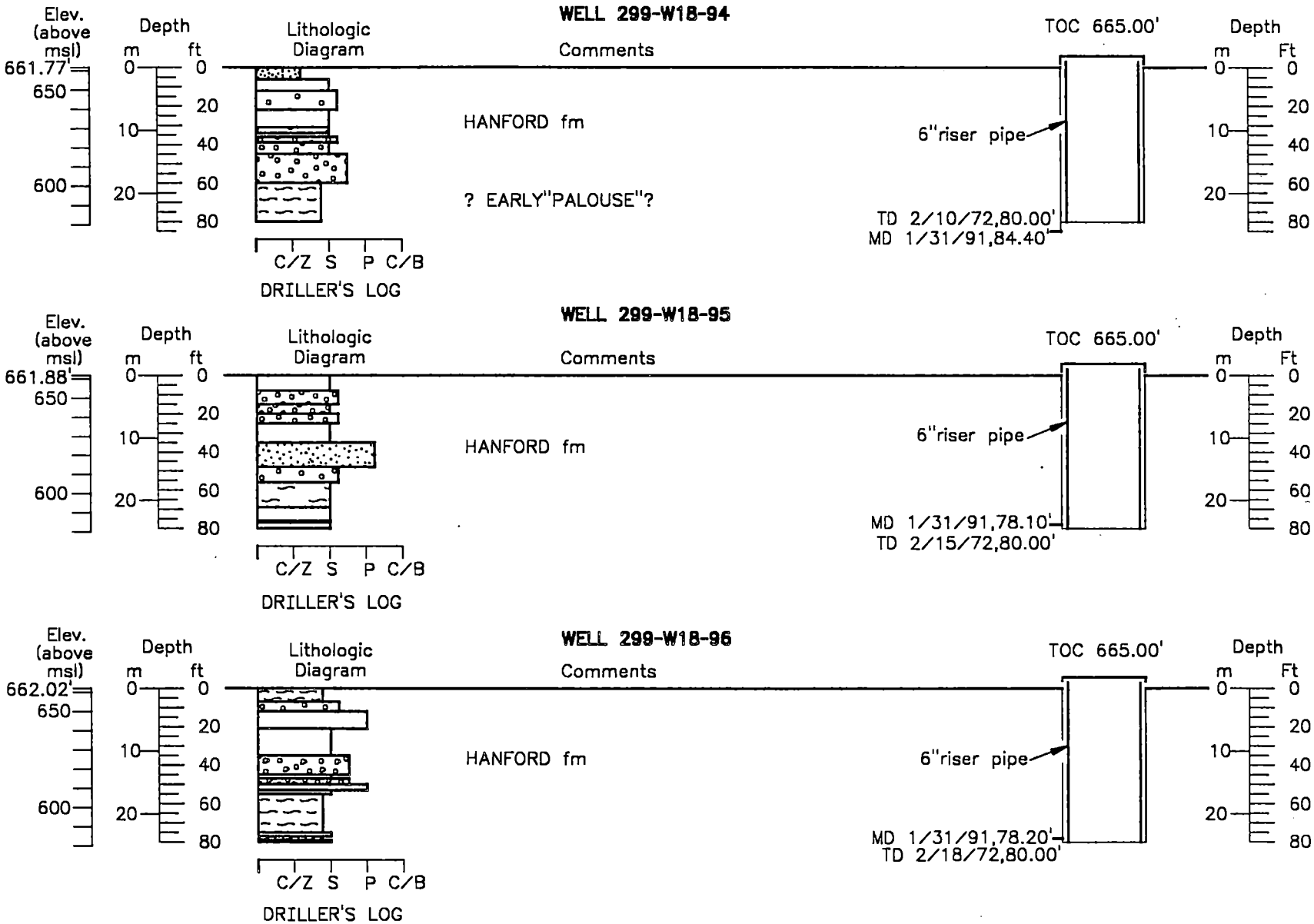
84-19

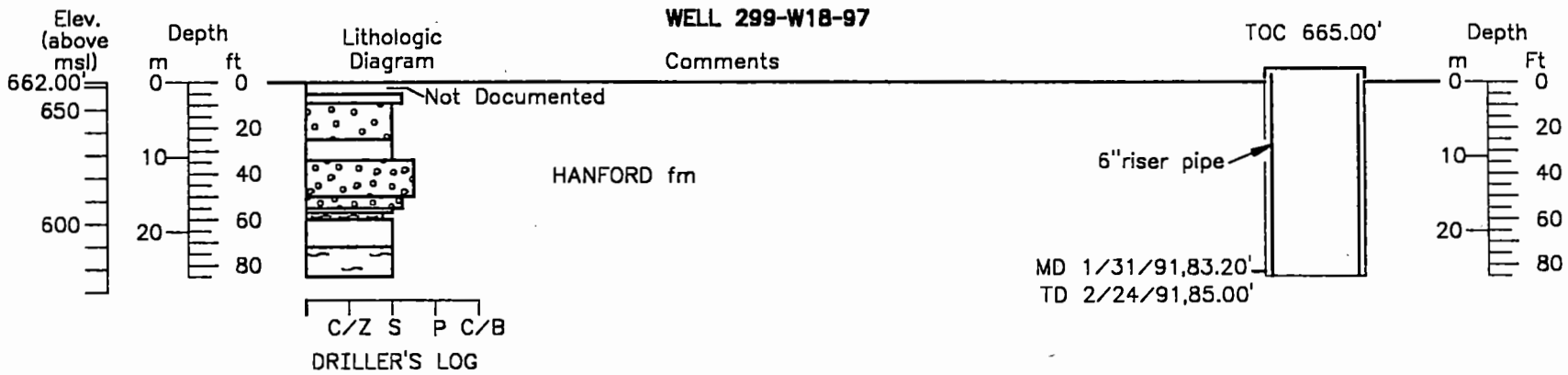

WELL 299-W18-87
Elev. (above msl)
674.86'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
140
Lithologic Diagram
brown
Caliche
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
EARLY"PALOUSE"
PLIO-PLEISTOCENE
TOC 667.23'
6" riser pipe
MD 1/28/91,149.20'
TD 10/5/69,150.00'
Depth
m
Ft

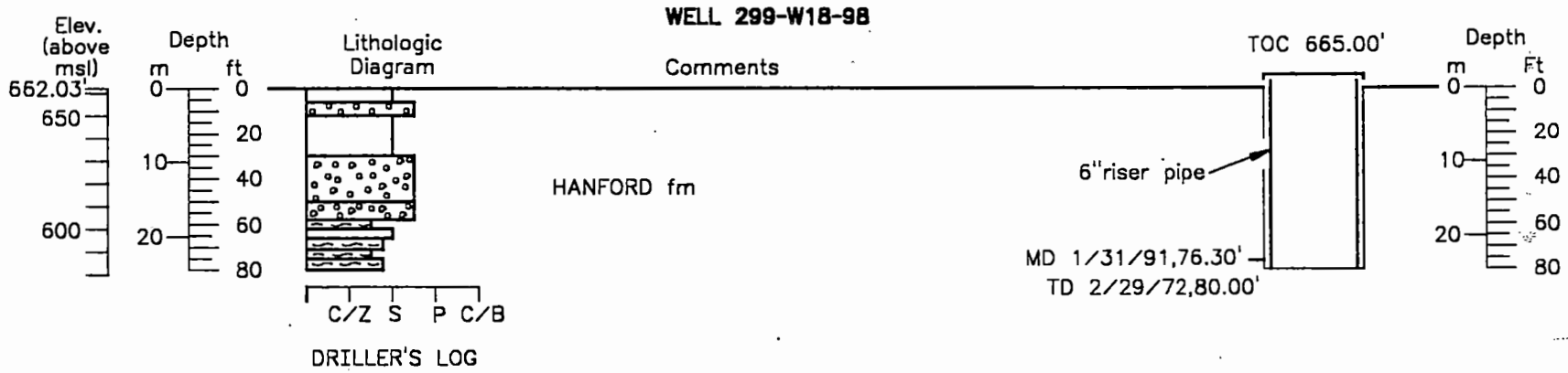

WELL 299-W18-88
Elev. (above msl)
677.01'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
140
Lithologic Diagram
Caliche
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
? ? EARLY"PALOUSE"?
PLIO-PLEISTOCENE
RINGOLD fm
TOC 679.76'
6"riser pipe
MD 1/28/91,146.70'
TD 9/19/69,150.00'
Depth
m
Ft

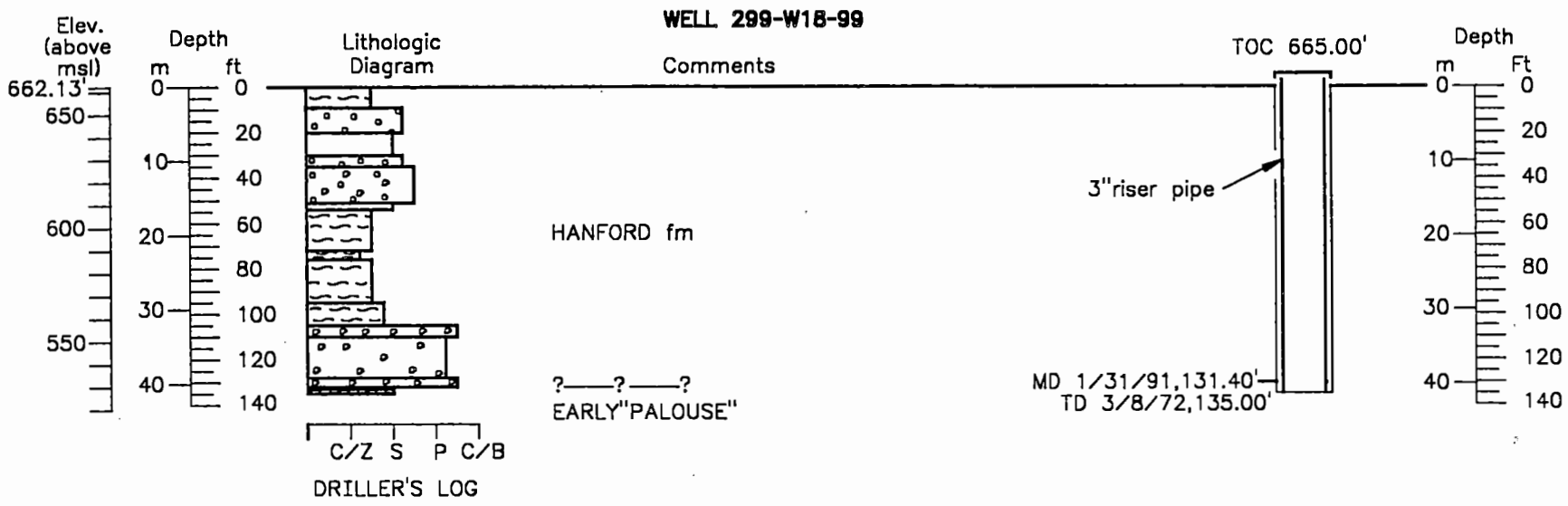

WELL 299-W18-89
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 681.32'
Depth
m
Ft
678.50'
650
600
550
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE ?
6"riser pipe
MD 1/28/91,141.70'
TD 10/21/69,150.00'
C/Z S P C/B
DRILLER'S LOG

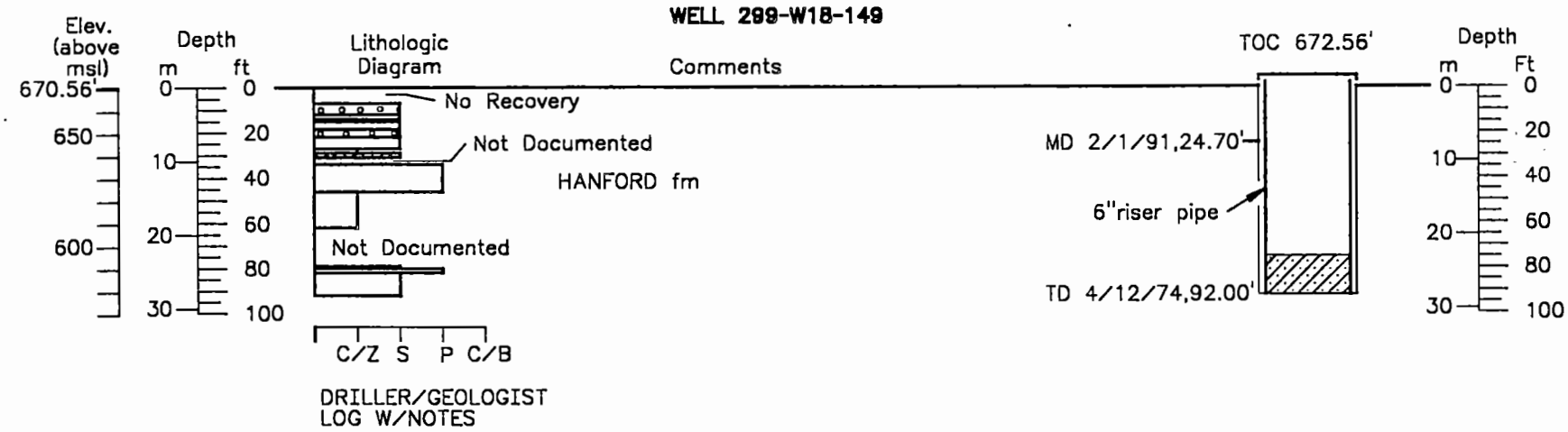

WELL 299-W18-93
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 665.00'
Depth
m
Ft
662.00'
650
600
550
HANFORD fm
? ? EARLY"PALOUSE"? + PLIO-PLEISTOCENE ?
6"riser pipe
MD 1/31/91,139.70'
TD 2/8/72,140.00'
C/Z S P C/B
DRILLER'S LOG

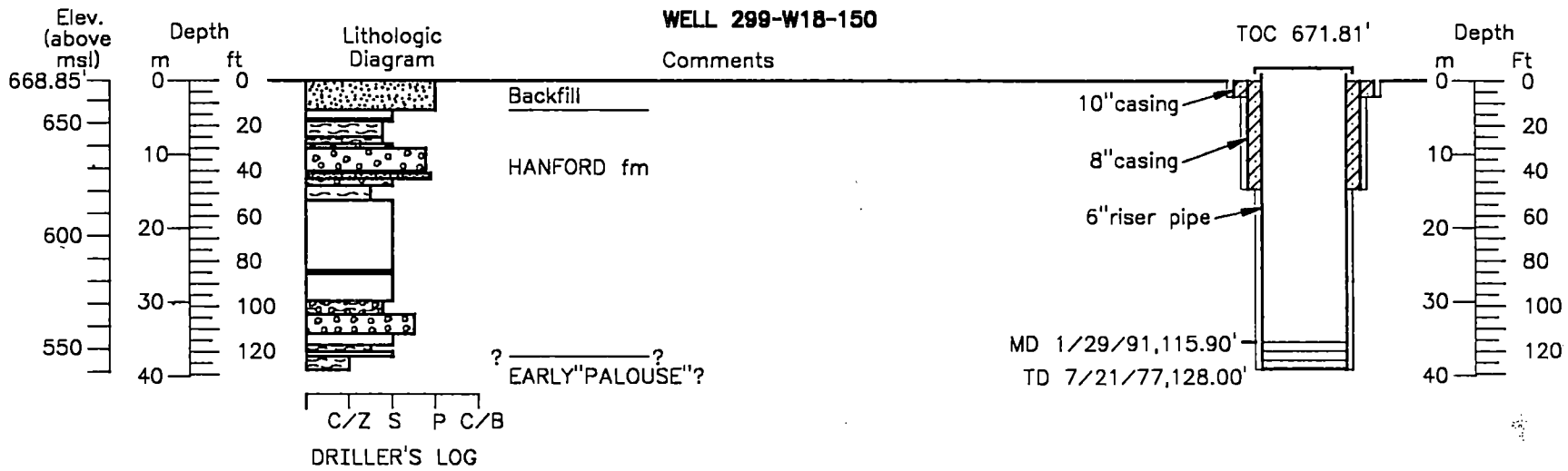

WELL 299-W18-94
Elev. (above msl)
661.77'
650
600
Depth
m
ft
0
10
20
0
20
40
60
80
Lithologic Diagram
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
? EARLY"PALOUSE"?
TOC 665.00'
6"riser pipe
TD 2/10/72,80.00'
MD 1/31/91,84.40'
Depth
m
Ft
WELL 299-W18-95
Elev. (above msl)
661.88'
650
600
Depth
m
ft
Lithologic Diagram
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
TOC 665.00'
6"riser pipe
MD 1/31/91,78.10'
TD 2/15/72,80.00'
Depth
m
Ft
WELL 299-W18-96
Elev. (above msl)
662.02'
650
600
Depth
m
ft
Lithologic Diagram
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm
TOC 665.00'
6"riser pipe
MD 1/31/91,78.20'
TD 2/18/72,80.00'
Depth
m
Ft

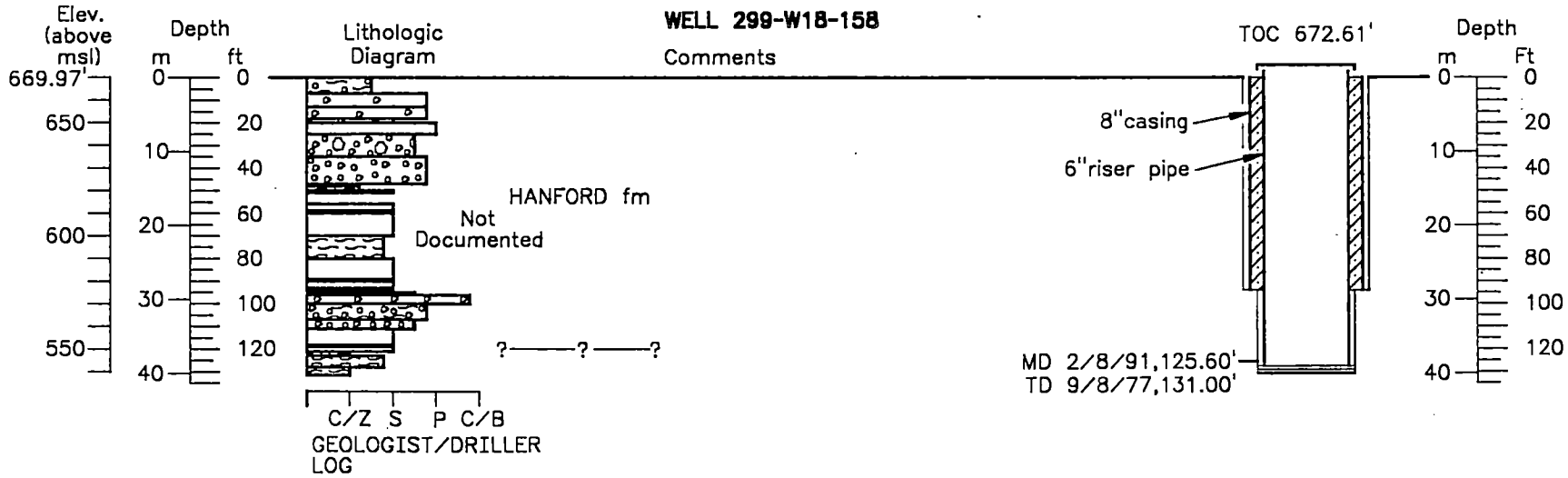

WELL 299-W18-97
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 665.00'
Depth
m
Ft
662.00'
650
600
0
10
20
0
20
40
60
80
Not Documented
HANFORD fm
6"riser pipe
MD 1/31/91,83.20'
TD 2/24/91,85.00'
C/Z S P C/B
DRILLER'S LOG

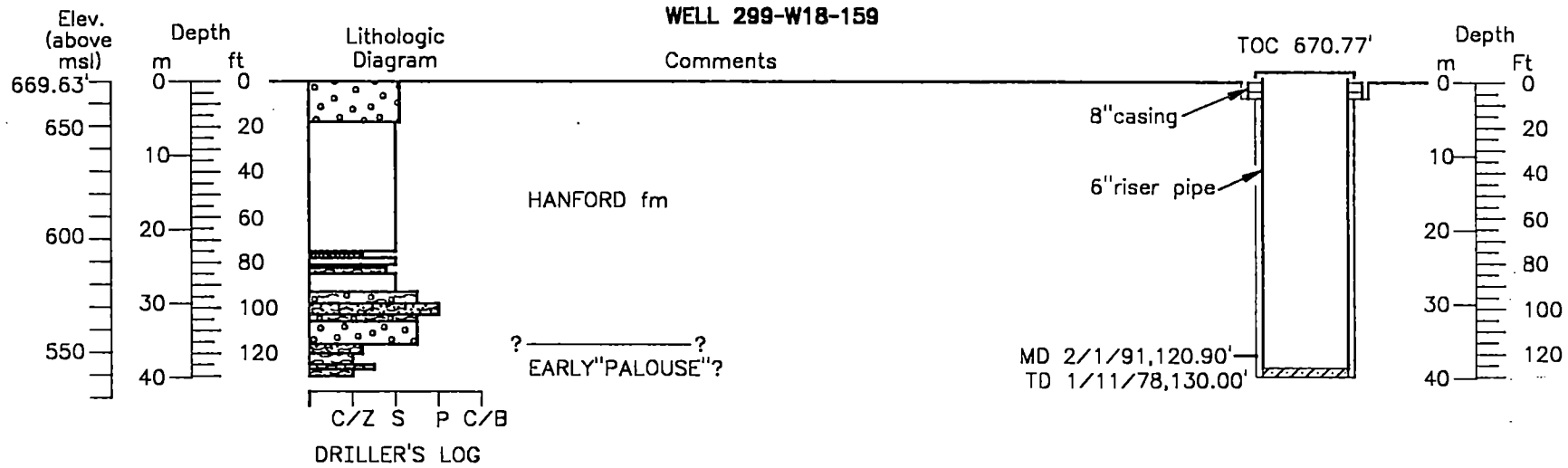

WELL 299-W18-98
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 665.00'
Depth
m
Ft
662.03'
650
600
0
10
20
0
20
40
60
80
HANFORD fm
6"riser pipe
MD 1/31/91,76.30'
TD 2/29/72,80.00'
C/Z S P C/B
DRILLER'S LOG

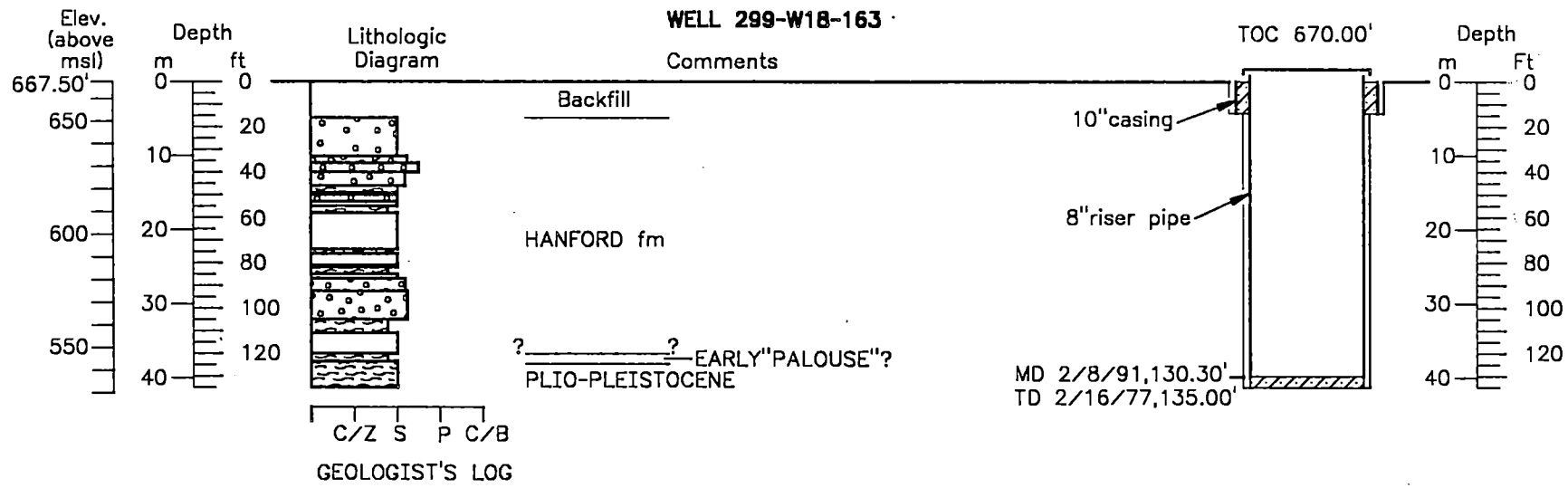

WELL 299-W18-99
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 665.00'
Depth
m
Ft
662.13'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
140
HANFORD fm
3"riser pipe
?——?——?
EARLY"PALOUSE"
MD 1/31/91,131.40'
TD 3/8/72,135.00'
C/Z S P C/B
DRILLER'S LOG

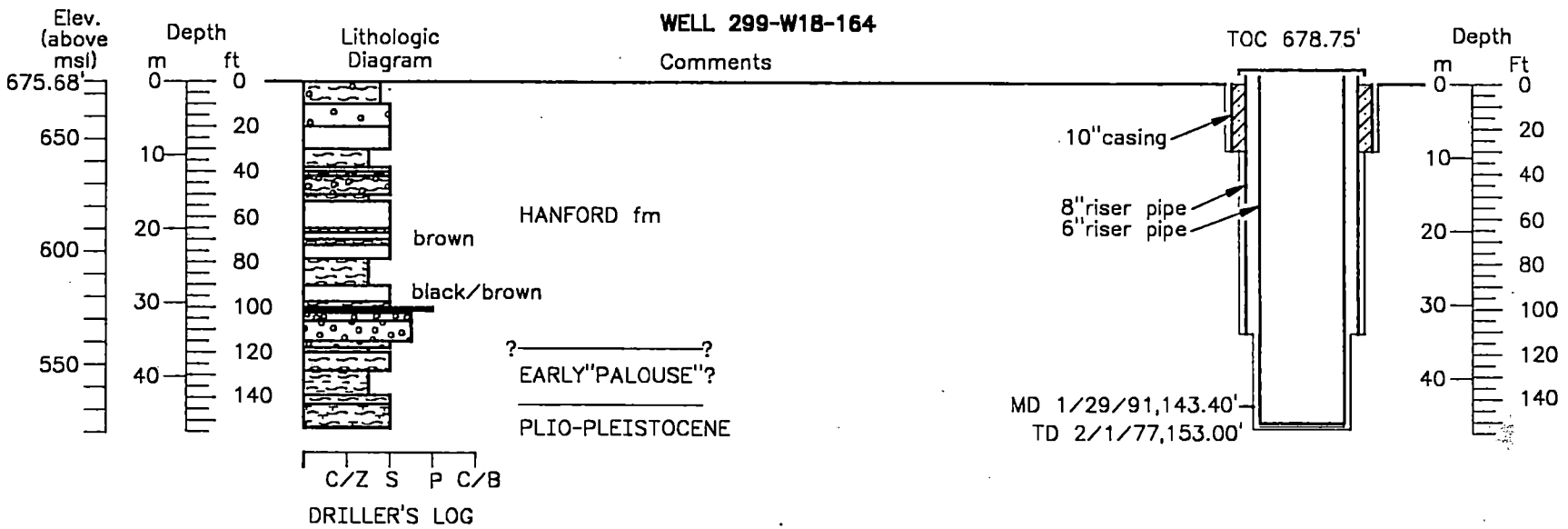

WELL 299-W18-149
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 672.56'
Depth
m
Ft
670.56'
650
600
0
10
20
30
0
20
40
60
80
100
No Recovery
Not Documented
HANFORD fm
Not Documented
MD 2/1/91,24.70'
6"riser pipe
TD 4/12/74,92.00'
C/Z S P C/B
DRILLER/GEOLOGIST LOG W/NOTES

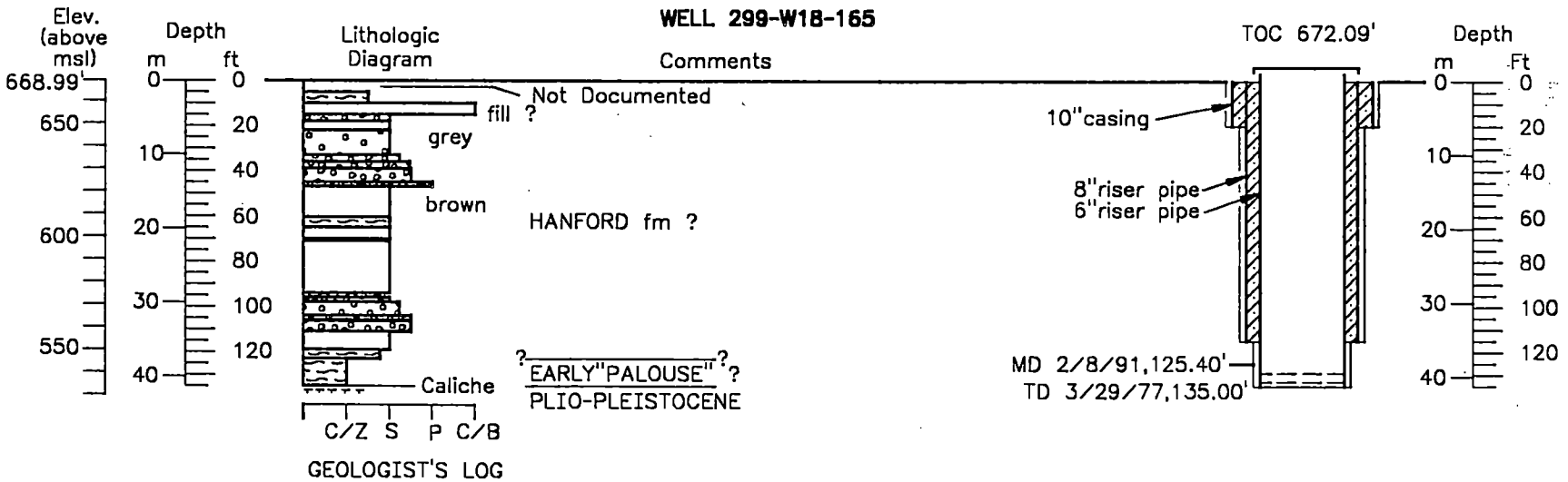

WELL 299-W18-150
Elev. (above msl)
668.85'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
Lithologic Diagram
Comments
Backfill
HANFORD fm
? ? EARLY"PALOUSE"?
C/Z S P C/B
DRILLER'S LOG
TOC 671.81'
10"casing
8"casing
6"riser pipe
MD 1/29/91,115.90'
TD 7/21/77,128.00'
Depth
m
Ft

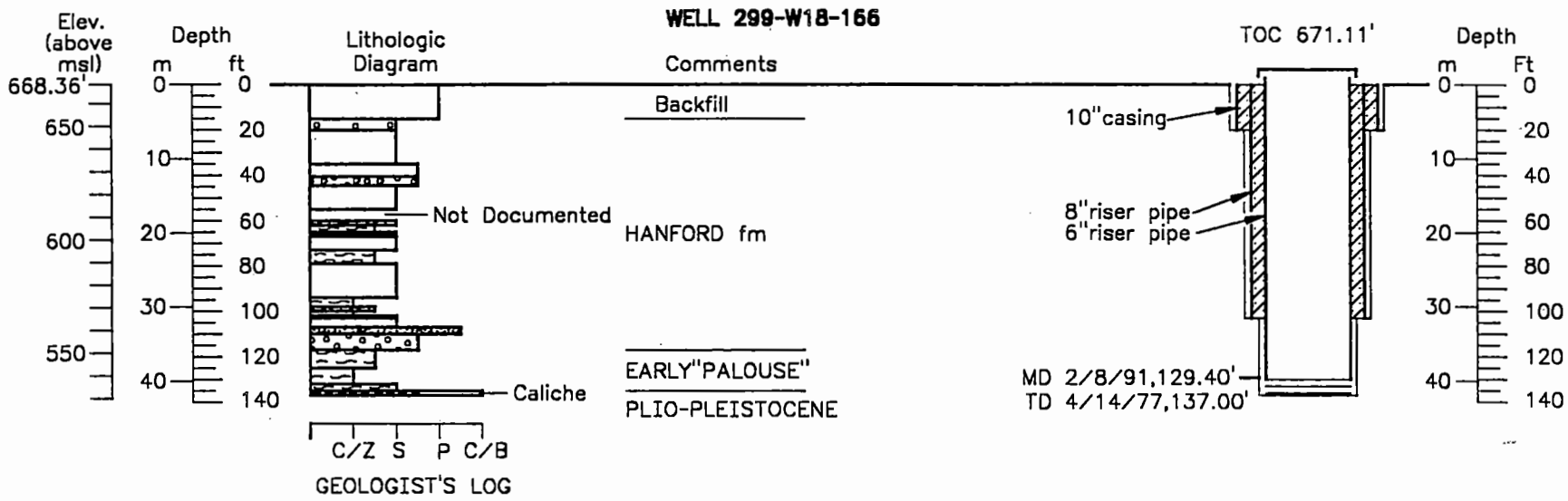

WELL 299-W18-158
Elev. (above msl)
669.97'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
Lithologic Diagram
Comments
HANFORD fm
Not Documented
? ? ?
C/Z S P C/B
GEOLOGIST/DRILLER LOG
TOC 672.61'
8"casing
6"riser pipe
MD 2/8/91,125.60'
TD 9/8/77,131.00'
Depth
m
Ft

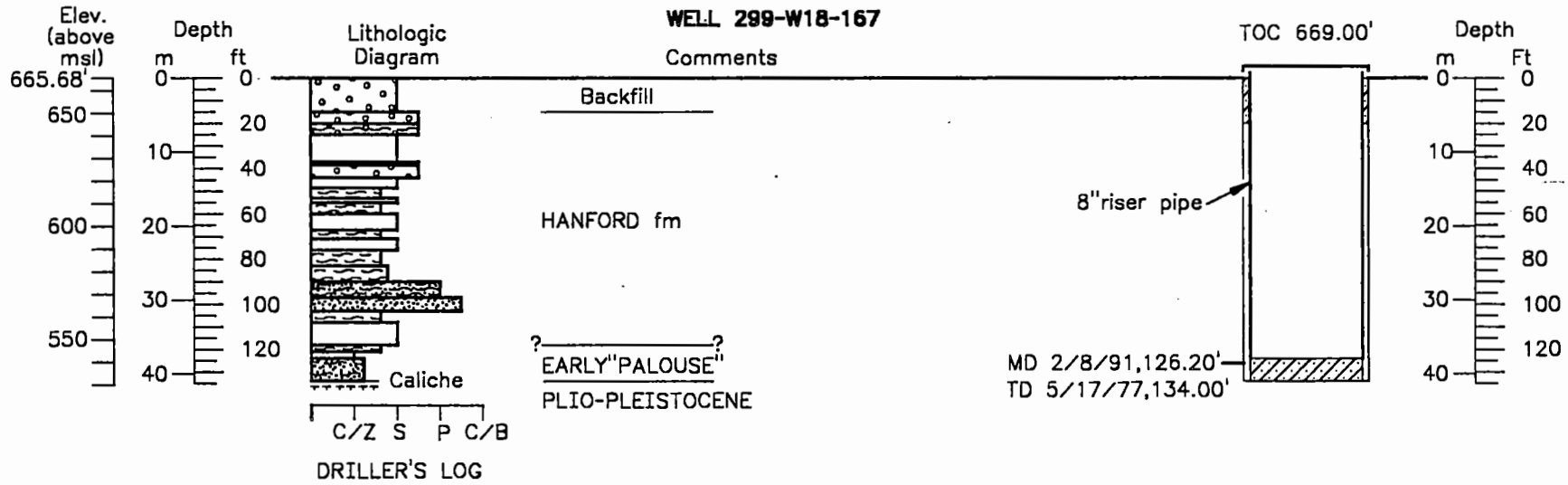

WELL 299-W18-159
Elev. (above msl)
669.63'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
Lithologic Diagram
Comments
HANFORD fm
? ? EARLY"PALOUSE"?
C/Z S P C/B
DRILLER'S LOG
TOC 670.77'
8"casing
6"riser pipe
MD 2/1/91,120.90'
TD 1/11/78,130.00'
Depth
m
Ft

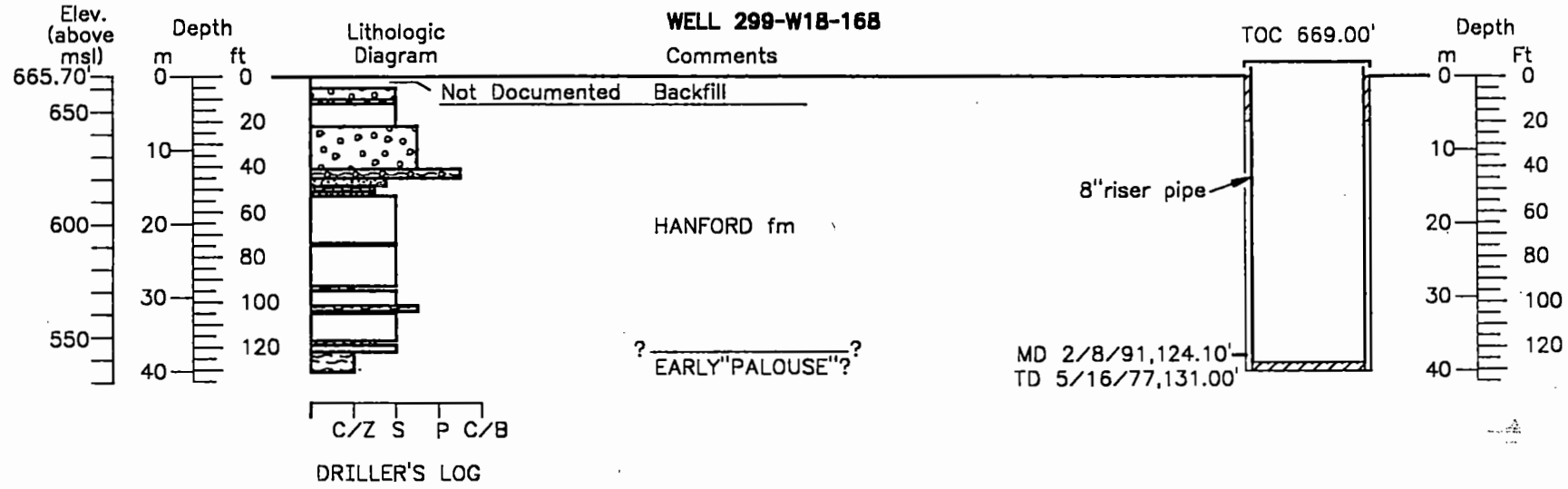

WELL 299-W18-163
Elev. (above msl)
667.50'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
Lithologic Diagram
Comments
Backfill
HANFORD fm
? ? EARLY"PALOUSE"?
PLIO-PLEISTOCENE
C/Z S P C/B
GEOLOGIST'S LOG
TOC 670.00'
10"casing
8"riser pipe
MD 2/8/91,130.30'
TD 2/16/77,135.00'
Depth
m
Ft

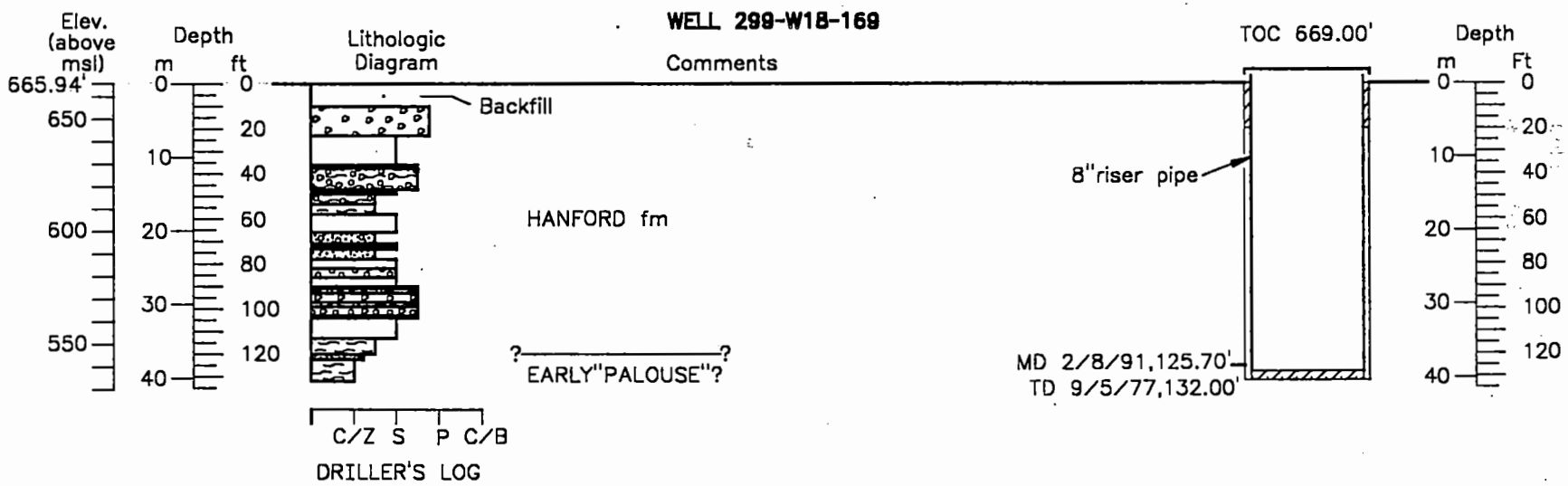

WELL 299-W18-164
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 678.75'
675.68'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
140
brown
black/brown
HANFORD fm
?
?
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
10"casing
8"riser pipe
6"riser pipe
MD 1/29/91,143.40'
TD 2/1/77,153.00'
C/Z S P C/B
DRILLER'S LOG

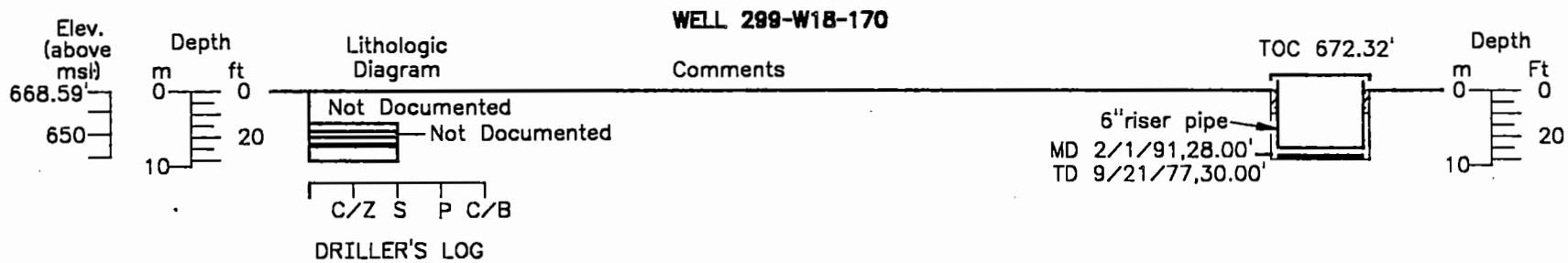

WELL 299-W18-165
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 672.09'
668.99'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
Not Documented
fill ?
grey
brown
HANFORD fm ?
Caliche
?
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
10"casing
8"riser pipe
6"riser pipe
MD 2/8/91,125.40'
TD 3/29/77,135.00'
C/Z S P C/B
GEOLOGIST'S LOG

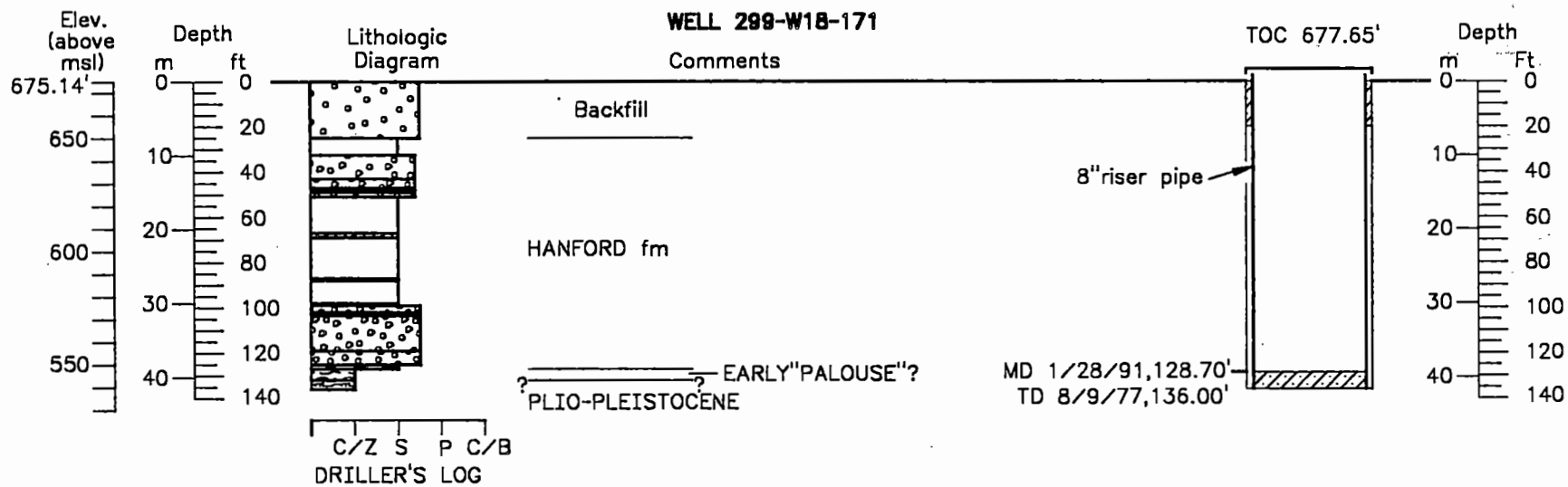

WELL 299-W18-166
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
668.36'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
140
Backfill
Not Documented
HANFORD fm
EARLY"PALOUSE"
PLIO-PLEISTOCENE
Caliche
C/Z S P C/B
GEOLOGIST'S LOG
TOC 671.11'
10"casing
8"riser pipe
6"riser pipe
MD 2/8/91,129.40'
TD 4/14/77,137.00'
Depth
m
Ft

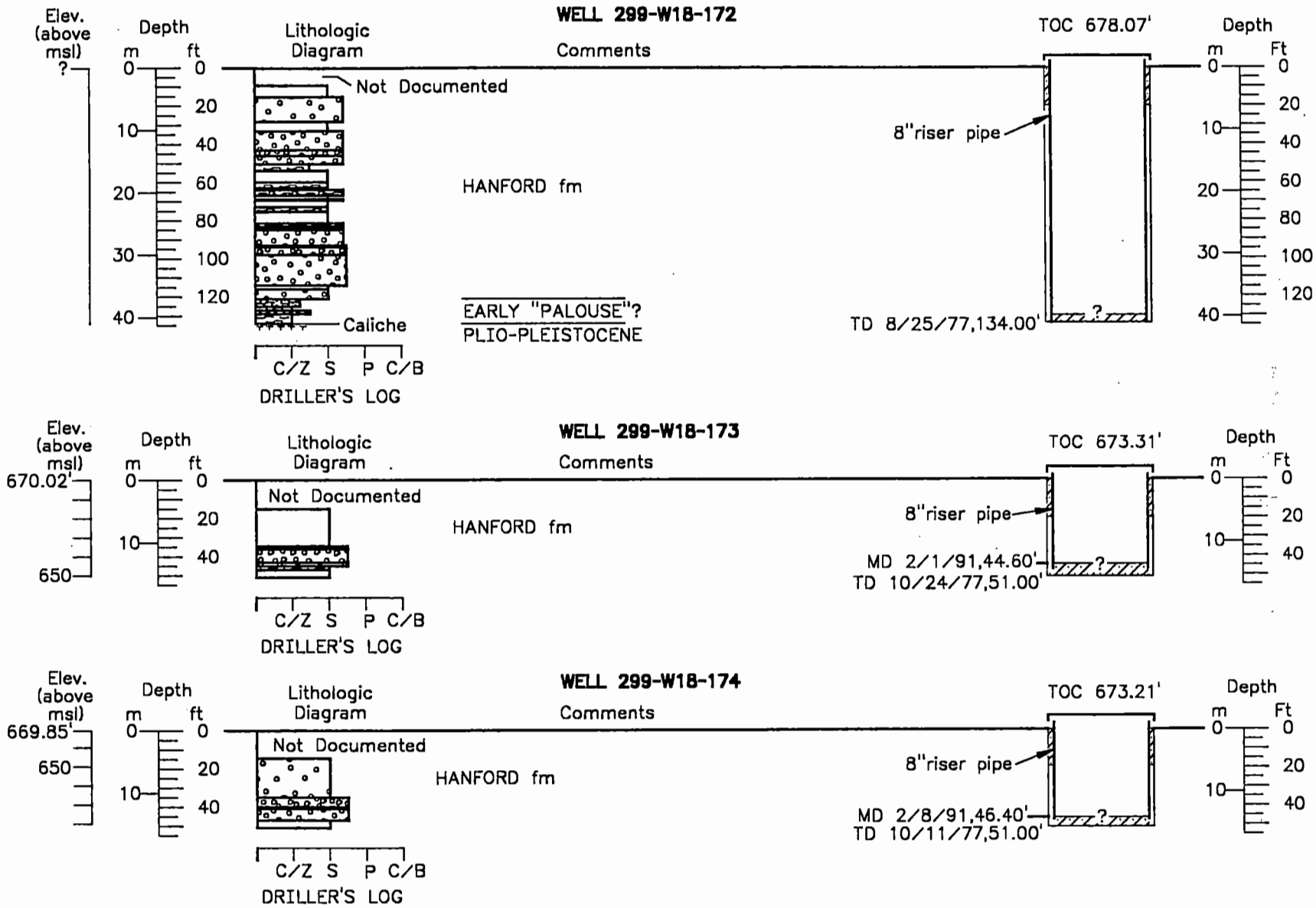

WELL 299-W18-167
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
665.68'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
Backfill
HANFORD fm
EARLY"PALOUSE"
PLIO-PLEISTOCENE
Caliche
C/Z S P C/B
DRILLER'S LOG
TOC 669.00'
8"riser pipe
MD 2/8/91,126.20'
TD 5/17/77,134.00'
Depth
m
Ft

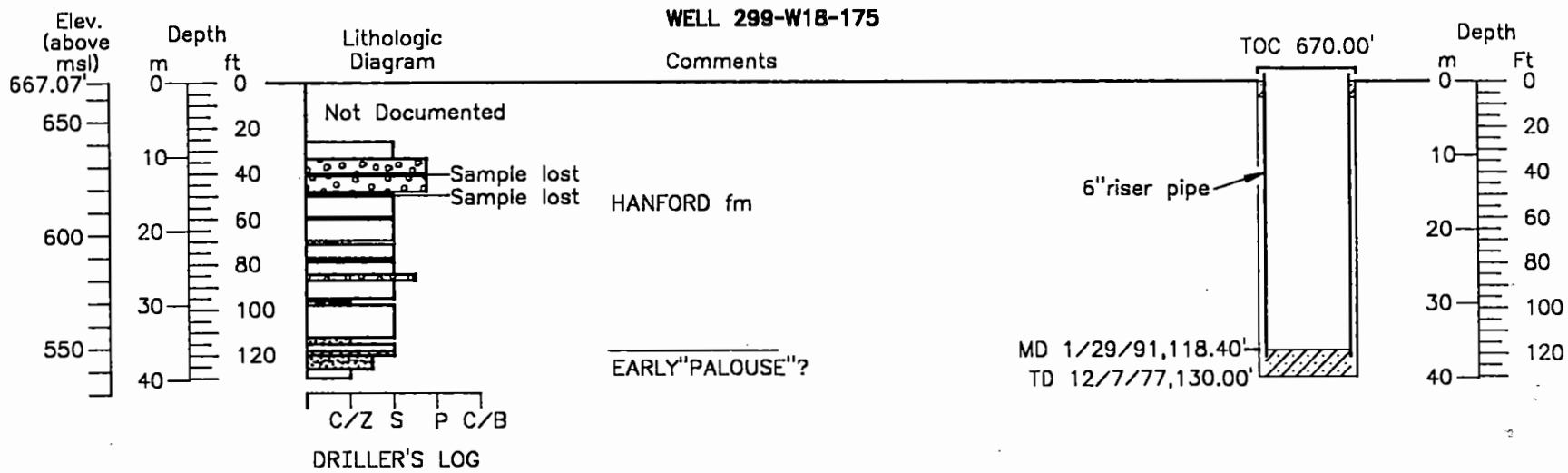

WELL 299-W18-168
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 669.00'
Depth
m
Ft
665.70'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
Not Documented
Backfill
HANFORD fm
8"riser pipe
? EARLY"PALOUSE"?
MD 2/8/91,124.10'
TD 5/16/77,131.00'
C/Z S P C/B
DRILLER'S LOG

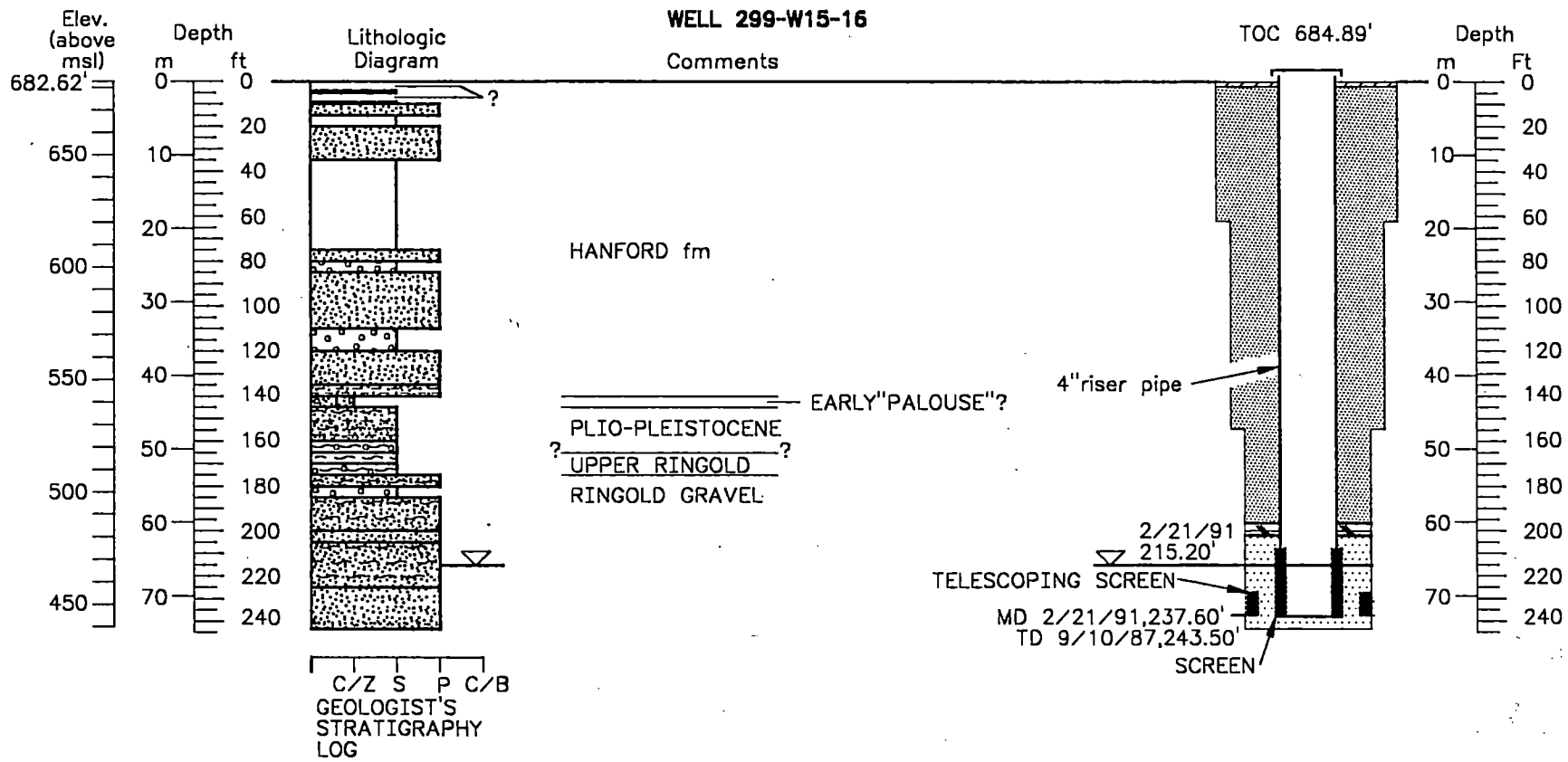

WELL 299-W18-169
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 669.00'
Depth
m
Ft
665.94'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
Backfill
HANFORD fm
8"riser pipe
? EARLY"PALOUSE"?
MD 2/8/91,125.70'
TD 9/5/77,132.00'
C/Z S P C/B
DRILLER'S LOG

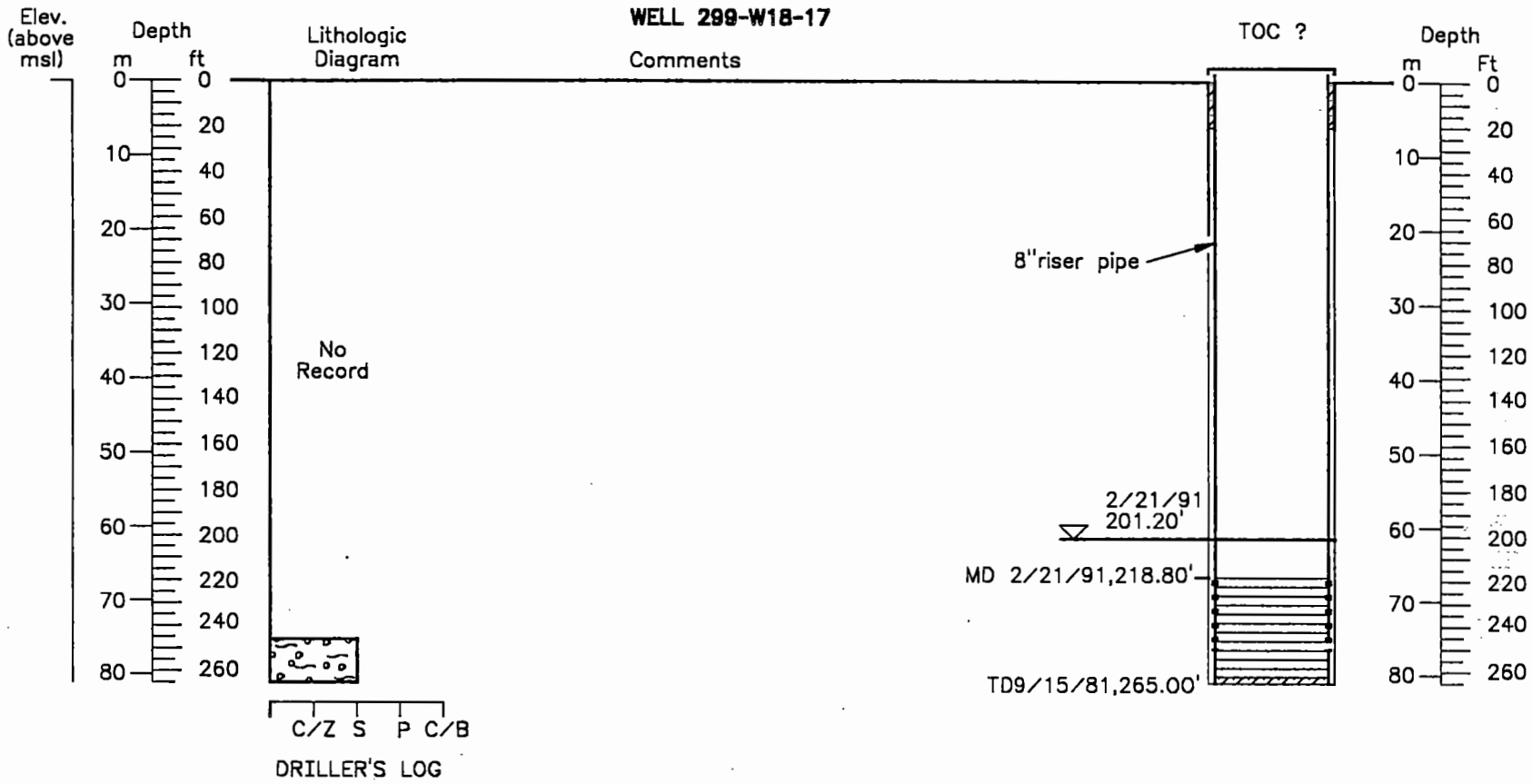

WELL 299-W18-170
Elev. (above msl)
668.59'
650
Depth
m
ft
0
10
0
20
Lithologic Diagram
Not Documented
Not Documented
C/Z S P C/B
DRILLER'S LOG
Comments
TOC 672.32'
6"riser pipe
MD 2/1/91,28.00'
TD 9/21/77,30.00'
Depth
m
Ft
0
10
0
20

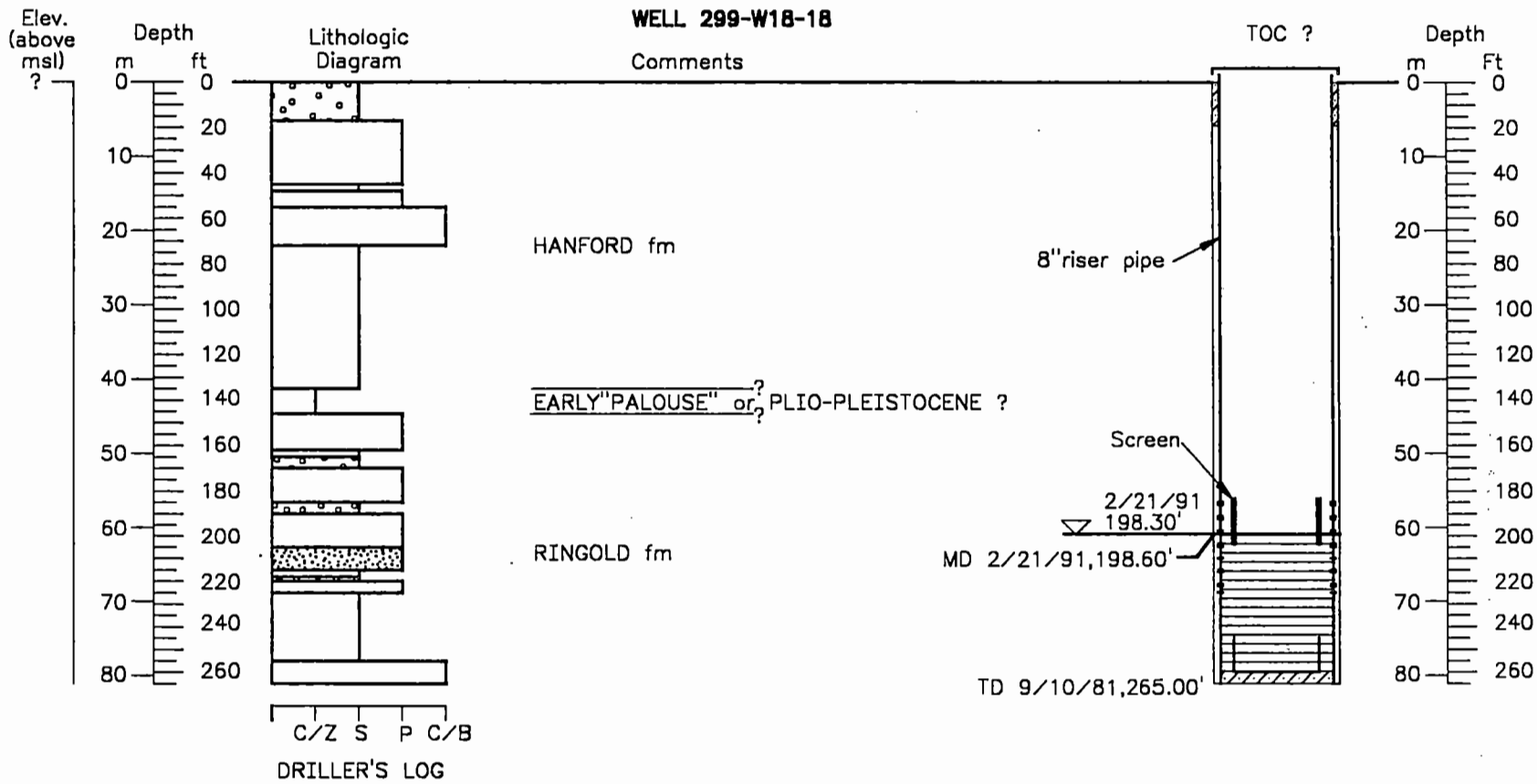

WELL 299-W18-171
Elev. (above msl)
675.14'
650
600
550
Depth
m
ft
0
10
20
30
40
0
20
40
60
80
100
120
140
Lithologic Diagram
C/Z S P C/B
DRILLER'S LOG
Comments
Backfill
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
TOC 677.65'
8"riser pipe
MD 1/28/91,128.70'
TD 8/9/77,136.00'
Depth
m
Ft
0
10
20
30
40
0
20
40
60
80
100
120
140

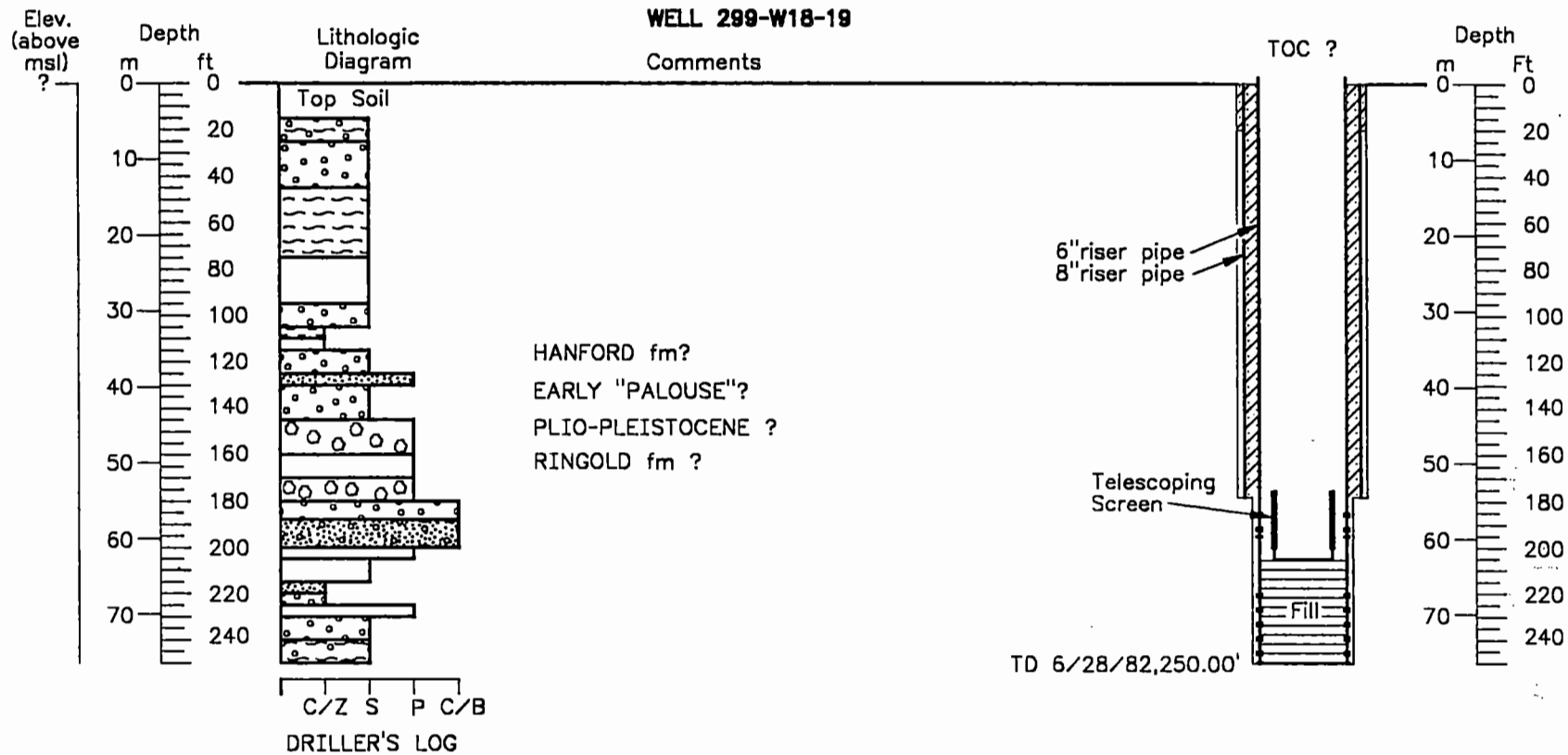

WELL 299-W18-172
Elev. (above msl)
?
Depth
m
ft
Lithologic Diagram
Comments
Not Documented
HANFORD fm
EARLY "PALOUSE"?
PLIO-PLEISTOCENE
Caliche
C/Z S P C/B
DRILLER'S LOG
TOC 678.07'
8"riser pipe
TD 8/25/77,134.00'
Depth
m
Ft
WELL 299-W18-173
Elev. (above msl)
670.02'
650
Not Documented
HANFORD fm
C/Z S P C/B
DRILLER'S LOG
TOC 673.31'
8"riser pipe
MD 2/1/91,44.60'
TD 10/24/77,51.00'
WELL 299-W18-174
Elev. (above msl)
669.85'
650
Not Documented
HANFORD fm
C/Z S P C/B
DRILLER'S LOG
TOC 673.21'
8"riser pipe
MD 2/8/91,46.40'
TD 10/11/77,51.00'

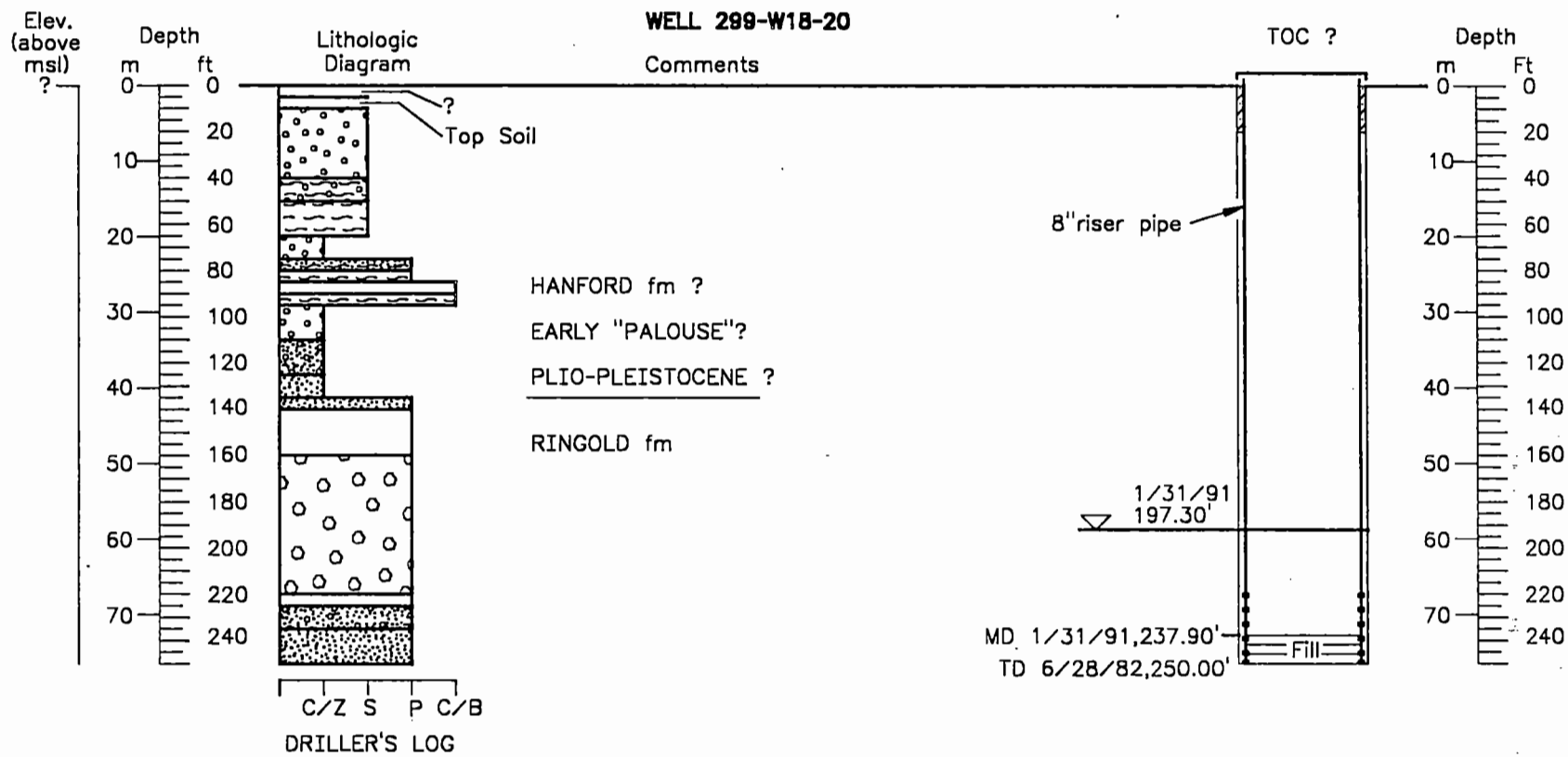

WELL 299-W18-175
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 670.00'
Depth
m
Ft
667.07'
650
600
550
0
10
20
30
40
0
20
40
60
80
100
120
Not Documented
Sample lost
Sample lost
HANFORD fm
EARLY"PALOUSE"?
6"riser pipe
MD 1/29/91,118.40'
TD 12/7/77,130.00'
C/Z S P C/B
DRILLER'S LOG

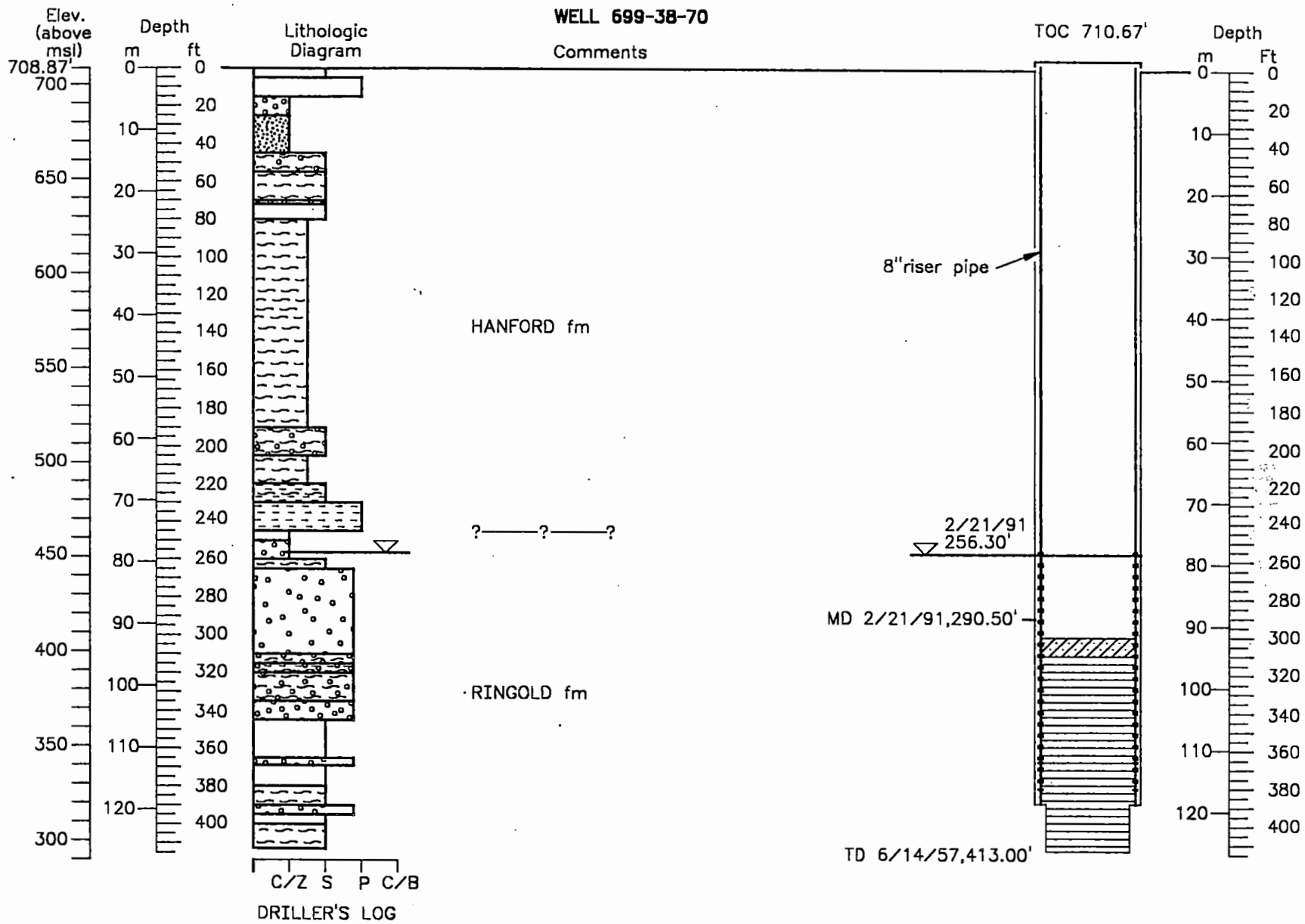

WELL 299-W15-16
Elev. (above msl)
682.62'
650
600
550
500
450
Depth
m
ft
0
10
20
30
40
50
60
70
0
20
40
60
80
100
120
140
160
180
200
220
240
Lithologic Diagram
Comments
?
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
?
?
UPPER RINGOLD
RINGOLD GRAVEL
C/Z S P C/B
GEOLOGIST'S STRATIGRAPHY LOG
TOC 684.89'
4"riser pipe
2/21/91
215.20'
TELESCOPING SCREEN
MD 2/21/91,237.60'
TD 9/10/87,243.50'
SCREEN
Depth
m
Ft

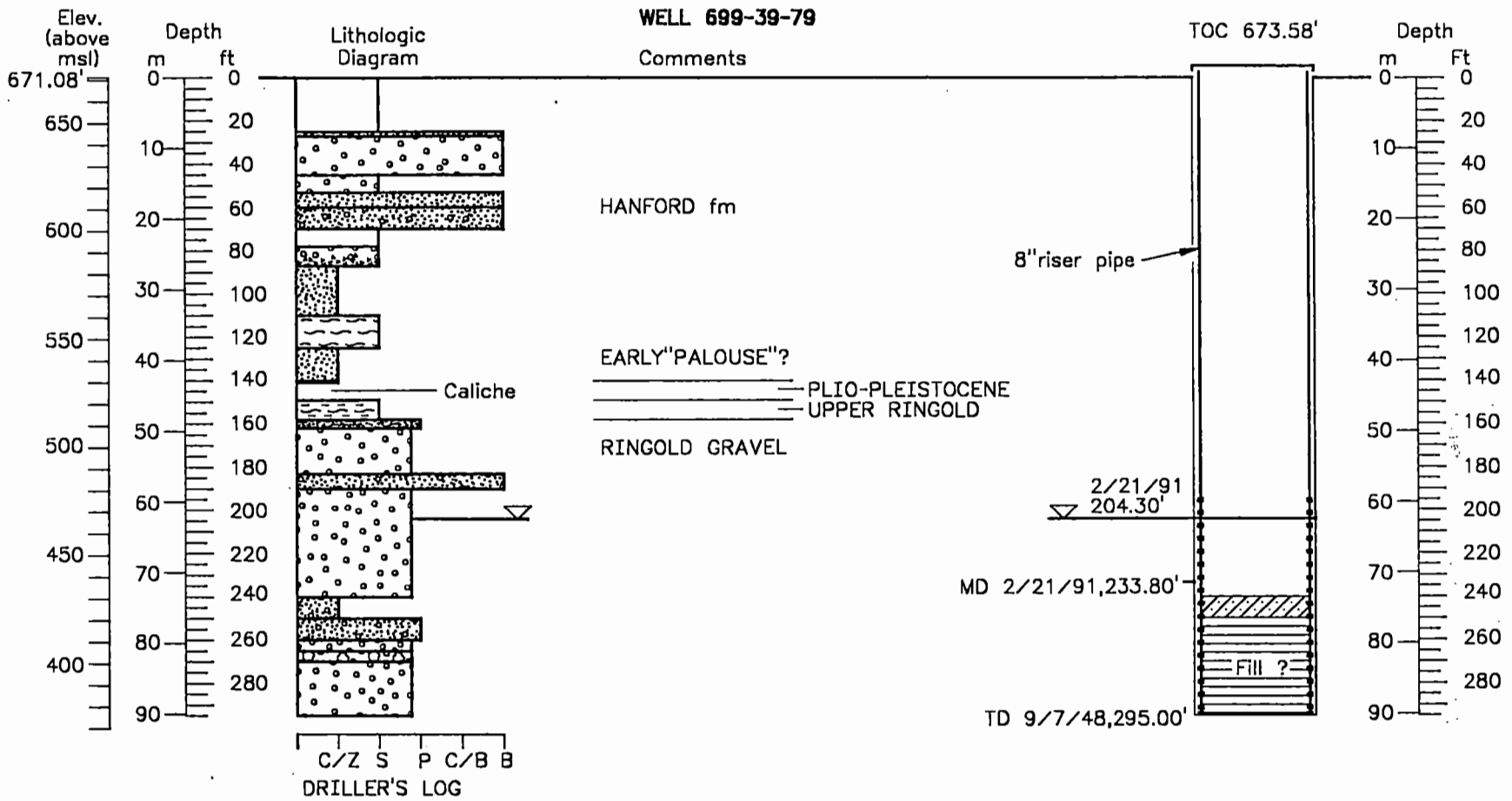

WELL 299-W18-17
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC ?
Depth
m
Ft
No Record
C/Z S P C/B
DRILLER'S LOG
8"riser pipe
2/21/91
201.20'
MD 2/21/91,218.80'
TD9/15/81,265.00'

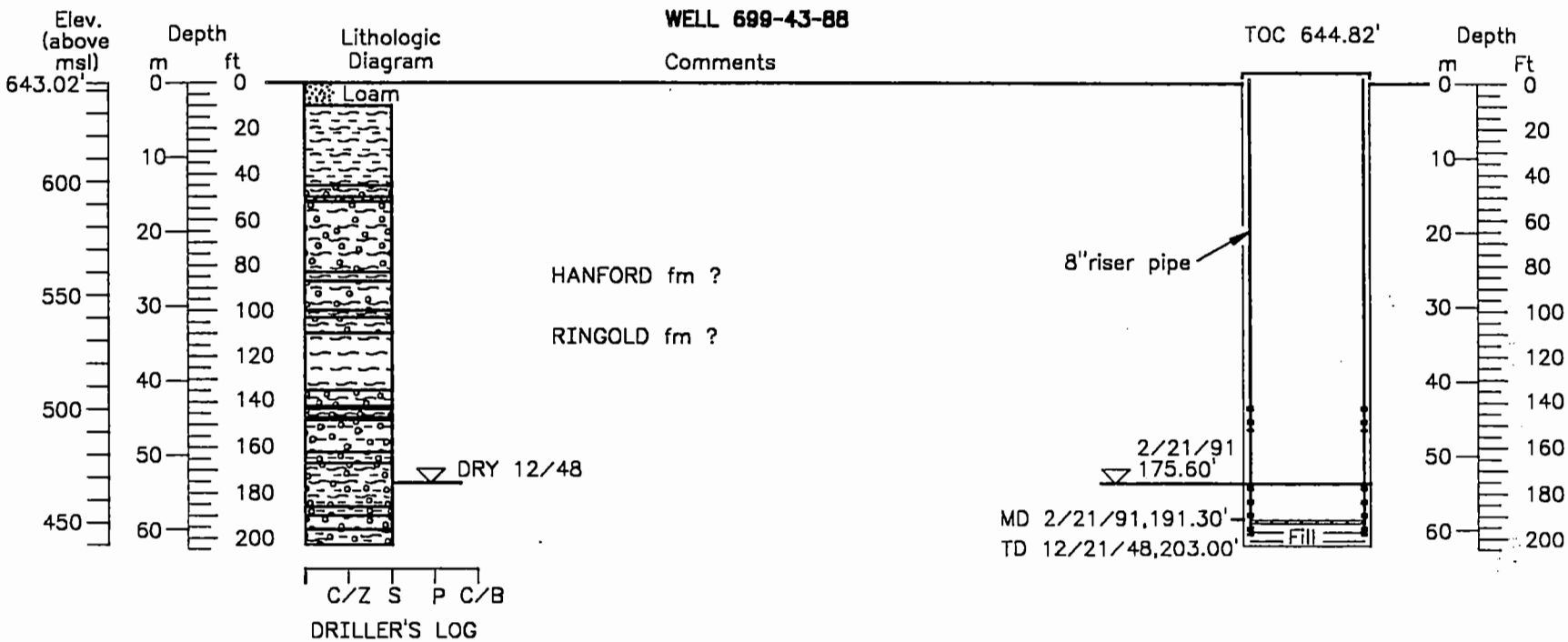

WELL 299-W18-18
Elev. (above msl) ?
Depth
m
ft
Lithologic Diagram
Comments
TOC ?
Depth
m
Ft
HANFORD fm
EARLY "PALOUSE" or PLIO-PLEISTOCENE ?
RINGOLD fm
8" riser pipe
Screen
2/21/91
198.30'
MD 2/21/91,198.60'
TD 9/10/81,265.00'
C/Z S P C/B
DRILLER'S LOG

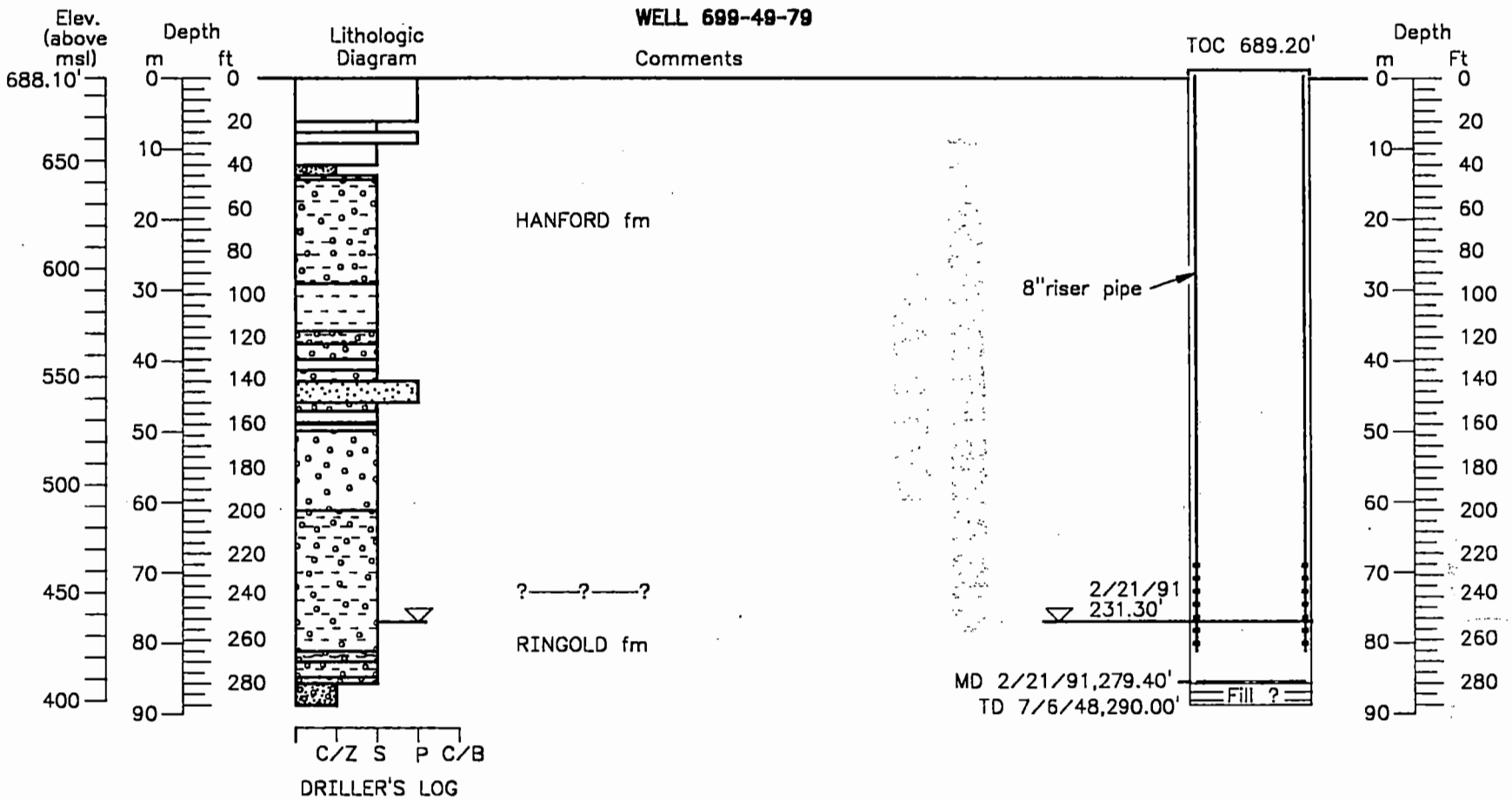

WELL 299-W18-19
Elev. (above msl) ?
Depth
m
ft
Lithologic Diagram
Comments
Top Soil
HANFORD fm?
EARLY "PALOUSE"?
PLIO-PLEISTOCENE ?
RINGOLD fm ?
C/Z S P C/B
DRILLER'S LOG
TOC ?
6"riser pipe
8"riser pipe
Telescoping Screen
Fill
TD 6/28/82,250.00'
Depth
m
Ft


WELL 299-W18-20
Elev. (above msl) ?
Depth
m
ft
Lithologic Diagram
Comments
?
Top Soil
HANFORD fm ?
EARLY "PALOUSE"?
PLIO-PLEISTOCENE ?
RINGOLD fm
C/Z S P C/B
DRILLER'S LOG
TOC ?
8"riser pipe
1/31/91
197.30'
MD 1/31/91,237.90'
TD 6/28/82,250.00'
Fill
Depth
m
Ft


WELL 699-38-70
Elev. (above msl)
Depth
m
ft
Lithologic Diagram
Comments
TOC 710.67'
Depth
m
Ft
708.87'
HANFORD fm
?——?——?
RINGOLD fm
8"riser pipe
2/21/91
256.30'
MD 2/21/91,290.50'
TD 6/14/57,413.00'
C/Z S P C/B
DRILLER'S LOG


WELL 699-39-79
Elev. (above msl)
671.08'
650
600
550
500
450
400
Depth
m
ft
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Lithologic Diagram
Caliche
C/Z S P C/B B
DRILLER'S LOG
Comments
HANFORD fm
EARLY"PALOUSE"?
PLIO-PLEISTOCENE
UPPER RINGOLD
RINGOLD GRAVEL
TOC 673.58'
8"riser pipe
2/21/91
204.30'
MD 2/21/91,233.80'
Fill ?
TD 9/7/48,295.00'
Depth
m
Ft


WELL 699-43-88
Elev. (above msl)
643.02'
600
550
500
450
Depth
m
ft
0
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
200
Lithologic Diagram
Loam
DRY 12/48
C/Z S P C/B
DRILLER'S LOG
Comments
HANFORD fm ?
RINGOLD fm ?
TOC 644.82'
8"riser pipe
2/21/91
175.60'
MD 2/21/91,191.30'
TD 12/21/48,203.00'
Fill
Depth
m
Ft


WELL 699-49-79
Elev. (above msl)
688.10'
650
600
550
500
450
400
Depth
m
ft
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
Lithologic Diagram
Comments
HANFORD fm
?——?——?
RINGOLD fm
C/Z S P C/B
DRILLER'S LOG
TOC 689.20'
8"riser pipe
2/21/91
231.30'
MD 2/21/91,279.40'
TD 7/6/48,290.00'
Fill ?
Depth
m
Ft

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APPENDIX C5

BOREHOLE GEOPHYSICAL LOGGING RESULTS

9 1 1 2 2 2 0 8 2 2

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Westinghouse Hanford Company

Internal Memo

From: Geosciences Group 81232-91-021
Phone: 6-9148, G6-50
Date: May 7, 1991
Subject: BOREHOLE LOGGING ACTIVITY REPORT FOR INTERIM RESPONSE ACTION: CARBON-TETRACHLORIDE VAPOR EXTRACTION

To: V. J. Rohay H4-56

cc: J. W. Fassett G6-50
M. C. Hagood H4-55
D. G. Horton H4-56
V. G. Johnson H4-56
W. L. Johnson H4-55
JRB:CJK:RKP File/LB

OBJECTIVE OF LOGGING ACTIVITY

The objective of geophysical logging with the high resolution passive spectral gamma ray detector in borehole number 299-W18-171 was to identify depth intervals with potential plutonium contamination. This will allow the contaminated intervals to be excluded from perforating activities in which carbon tetrachloride vapors will be extracted.

HISTORICAL DATA

Two sources of borehole-specific historical data were identified prior to initiating logging activities. Representative samples of both sources are included in this report for completeness and comparison. The gross gamma-ray geophysical borehole logs for the four prospective boreholes to be perforated were examined prior to selecting the well which would primarily be used for vapor extraction. The gross-gamma logs for the boreholes are reproduced in Figures 1 through 4. The borehole numbers are:

299-W18-87
299-W18-150
299-W18-164
299-W18-171.

Results of laboratory analysis from several drill cutting samples were reported in document RHO-ST-17, "Distribution of Plutonium and Americium beneath the 216-Z-1A Crib, Status Report," February 1979. The sample analysis data for plutonium and americium from drill cuttings for three of the four selected boreholes are reproduced in Figures 5 through 7. The borehole not included is 299-W18-87, which existed prior to the publication of the study.

Hanford Operations and Engineering Contractor for the US Department of Energy

CONFIGURATION OF LOGGING INSTRUMENTATION

The spectral borehole logging equipment is undergoing development that will continue for several more months. This report is an interim action to document field data acquisition activities and summarize findings. Final quantification of radionuclide concentrations can be reported at a later date after more studies of the equipment and analysis techniques are complete.

The Radionuclide Logging System (RLS) high purity germanium logging system was first calibrated in November 1990 at the DOE calibration center in Grand Junction, Colorado. The equipment appeared stable prior to the calibration trip. However, its operation during the calibration studies was compromised by elevated noise from electrical ground loops between three system components. The ground loops appeared after repeated vibrations due to highway travel. The equipment was repaired upon return from the calibration trip. Measurement during repairs indicated that the calibration, although compromised, could still be considered valid. Since December 20, 1990 the equipment has been very stable. The equipment performance and stability will be reported in an internal memorandum when scheduling permits.

Configuration of the equipment hardware, computer software, and interpretation technique is subject to change as additional calibrations, geophysical studies, and other types of borehole measurements are completed and implemented. The current equipment configuration, although not mature, is adequate to satisfy the stated objective of this logging activity. The equipment configuration at the time of this logging activity is identified as VERSION A.0. The equipment configuration used for this borehole logging activity is identical to the configuration used for the November 1990 calibration trip to DOE Grand Junction, Colorado. The equipment configuration will be reported in an internal memorandum, when scheduling permits.

ACQUISITION STANDARDS

In situ borehole measurements were acquired in accordance with procedure WHC-CM-7-7 Environmental Investigation and Site Characterization Manual, Section EII 11.1 Geophysical Logging, Appendix B: Spectral Gamma-ray Logging, Rev 1, March 5, 1991. Relevant supportive details about the field activities are included in this report for historical purposes and to confirm the quality of recorded data.

A portable field reference source serves to check equipment efficiency, repeatability, resolution, and voltage gain of signal pulses. The logging procedure indicates that a field reference source must be used and how the measurement must be taken. The source is not specifically identified in the procedure, but is described as follows.

Field reference source identification: 79B40
Radionuclides in source: Ba-133, Cs-137, Co-60, Ra-226, Th-232
Photo-peaks used for two-point energy calibration in Maestro II:
661.6 keV of Cs-137 and 1332.5 keV of Co-60

The field reference source spectrum is recorded with the tool suspended above the ground with the truck stationary. Immediately following this measurement a second measurement must also be recorded with the source removed, this permits the ambient, or background, gamma-ray signature present from local sources to be quantified. The background response is subtracted from the previous measurement of combined field reference source and background. The difference yields the net contribution from the reference source. The tool responses to the field reference before and after the borehole logging are compared to the tool responses that were observed when the equipment was calibrated.

The field reference source becomes the connecting link which permits the calibration coefficients to be applied for computing the radionuclide concentrations. Nuclide concentrations in the subsurface can be computed for gamma energies within the November 1990 DOE Grand Junction, Colorado calibration limits of 350 keV to 2615 keV. The energy range for which the calibration measurements and calibrated detector efficiency are valid cannot be extended below 350 keV until additional studies are completed. The lower gamma-ray energy limit of 350 keV is imposed by at least three nonlinear and nontrivial phenomena.

1. The calibration for man-made gamma-ray emitters depends on the determination of an efficiency function which relates a measured count rate in a gamma-ray peak to the corresponding gamma-ray intensity in the surrounding medium. Using calibration data for three gamma rays from the uranium decay chain, three gamma rays from the thorium decay chain, and the potassium-40 gamma ray, seven values for the efficiency function have been determined over a gamma-ray energy range from 351 keV to 2615 keV. For gamma-ray energies of about 350 keV and higher, increases in gamma-ray energy are accompanied by a log-linear decrease in the efficiency function because the detector efficiency is dominated by Compton scattering. Because the efficiency function is well behaved above 350 keV, calibration factors for man-made radionuclides can be found by interpolation. However, as the gamma-ray energy

decreases below about 350 keV, the role of photoelectric absorption in the detector efficiency becomes more and more pronounced. The November 1990 calibration measurements were not designed to map the complex changes in detector efficiency that occur below 350 keV.

2. Gamma-ray attenuation from borehole materials, such as casing, changes rapidly with gamma-ray energy at energies below 350 keV.

3. The presence of high-atomic-number atoms, such as americium-241 (Z = 95), in the formation selectively reduces the low-energy gamma-ray fluxes. If the high-Z elements exist in low concentrations, the nonlinear flux reduction is confined to energies below about 300 keV, but the nonlinear region approaches 1000 keV as the concentrations of high-Z elements increase toward levels that, although high, can still occur naturally. Some features of this so-called "Z-effect" were characterized by work for the DOE's National Uranium Resource Evaluation project.

Computer interface with a depth encoder is required to control the detector position within the borehole. A problem has been identified in the depth measuring system and a solution is being investigated. The problem is that the logging cable diameter is not constant and infrequently exceeds the groove diameter machined into the depth encoding sheave wheel. This causes the cable to ride above the engineered position on the sheave wheel and permits the radius to the wheel center to increase.

During the logging runs, the encoder conversion factor was 793.0 pulses per foot.

SPECIFICATIONS

Data acquisition required three days of logging. Many daily log specifications were common to the entire logging period while others were unique for each day. The specifications common to all three acquisition sessions are given below.

Detector
    EG&G Ortec HPGe Pop-Top, 18%
Logging mode
    move-stop-acquire
Depth increment between measurements
    0.5 feet
Depth reference
    ground level = 0.0 feet
Count time per depth increment
    180 sec (live time)

Tool movement
detector moving down hole, except last day when changed due to time restrictions

File control
spectra for each depth increment recorded under computer control, spectral files transferred to non-erasable optical disk (WORM) upon completion of daily logging activities

File format
EG&G Ortec PHA integer data files (.CHN) recorded in IBM-PC DOS compatible format, filename prefixes limited to 8 characters with last 3 positions reserved for sequence number

Spectra format
gamma-ray energy spectra subdivided into 4000 MCA channels, gamma-ray spectra recorded over energy range of about 50 to 2850 keV

Logging specifications unique to each day of field acquisition are given below. Possibly some entries may not be immediately obvious; their explanations follow.

- The filename prefix is the first four characters for all saved spectra files. The fifth character indicates which detector, either number 1 for HPGe or number 2 for NaI was used.
- The file sequence number and data acquisition point represent a one-to-one correlation. Only the start and stop depth and file sequence number are presented below.
- The difference between encoder depth and tool position is measured when the tool is returned to the zero depth, generally at the end of the daily logging activities.

Date	Depth	Feet	File seq. no.	
6FEB91	- -	- -	- -	Filename prefix = A022
	Start	0.0	000	
	Stop	2.5	005	
	- -	- -	- -	attempt to activate printer, skipped 2 numbers
	Start	3.0	008	
	Stop	47.0	096	
	- -	- -	- -	depth error tool 0.9 in. high at return to ref. depth

7FEB91	- -	- -	- -	filename prefix = A023
	Start	45.0	001	
	Stop	92.5	096	
	- -	- -	- -	depth error tool 3.5 in. low at return to ref. depth
13FEB91	- -	- -	- -	filename prefix = E334
	Start	90.0	000	
	Stop	99.0	018	
	- -	- -	- -	time constraints prevented continuous log
	Start	124.0	019	
	Stop	115.5	036	
	- -	- -	- -	depth error tool 14. in. high at return to ref. depth

DATA ANALYSIS

Data analysis algorithms for high-resolution gamma-ray spectra are not complete at the time of this report. The borehole data have been preserved and can be reevaluated when the algorithms are implemented. At this time the analysis will be limited to reporting the potassium concentrations with two-sigma uncertainty (95% confidence interval) and the total gamma profile with two-sigma uncertainty. The tabular and plotted results are presented in table 1 and Figure 8 below, respectively.

The only depth interval where man-made gamma-ray emitters were encountered was from 83.0 to 84.0 feet. The man-made elements were americium and plutonium. The spectral plots for these three depth intervals and the adjacent interval containing only natural radionuclides are presented in Figures 9 through 13. An expanded spectral plot of the 84.0-foot depth is shown in Figure 14. Note that the vertical scale of this plot is linear instead of logarithmic to demonstrate the net counting activity in the individual peaks.

Analyses of the spectral gamma-ray log data accounted for the following borehole parameters:

Hole diameter	8-inch ID
Casing thickness	0.31 inch
Water depth	not applicable, hole air filled
Grout	assumed no grout between casing and formation

The potassium concentrations and concentration uncertainties were calculated by the following steps.

1. In each spectrum the peak corresponding to the 1460.75-keV gamma ray was identified. For each peak, the number of gamma-ray counts and the counting uncertainty was calculated. These calculations were performed by the EG&G Ortec MAESTRO II spectrum analysis program.

   Explanation of the term "peak" may be warranted. When a gamma ray enters the germanium crystal, the detector system generates a voltage pulse with amplitude proportional to the energy absorbed by the crystal. A count is then tallied in one of 4000 channels in a multichannel analyzer (MCA); the number of the channel that receives the count is proportional to the amplitude of the voltage pulse. Since the amplitude of the voltage pulse is proportional to the absorbed gamma-ray energy, the MCA channel number is also proportional to the absorbed energy.

   After many pulses are processed, a graph of counts in a channel versus channel number is a histogram as depicted in Figure 9. (The horizontal axis in Figure 9 has been converted from channel number to energy.) At energies near 1460 keV there is a group of channels that all contain numbers of counts that are significantly higher than background. This feature is a peak. It is, in fact, a measure of the number of 1460.75-keV gamma rays from potassium-40 that deposited their energies in the germanium crystal.

   MAESTRO II calculates the net count in a peak by adding the counts in all the MCA channels that span the peak, then subtracting the background. Background is determined from an average of the counts in several MCA channels that lie on either side of the group of channels that contains the peak.

2. The number of counts in each peak was divided by the counting time (system live time) in seconds. This yielded a count rate, or peak area, for each peak. The counting uncertainty for each peak was also divided by the counting time, producing a count rate uncertainty. MAESTRO II performed these calculations.

3. Each count rate and count rate uncertainty was multiplied by 1.61. This corrected the count rates and count rate uncertainties for attenuation by the 0.31-inch steel casing.

4. The potassium concentration and concentration uncertainty, both in picocuries per gram (pCi/g), were found using the following relationships:

- K = A*P + B,

where K is the concentration of K-40 in pCi/g,
P is the casing-corrected net count rate of the 1460.75-keV gamma-ray peak,
A = 11.03 ± 0.46, and
B = -2.38 ± 1.24;

- UncK = SQRT (0.215*P**2 + 121.661*UncP**2 + 1.538),

where UncK is the uncertainty in K, and
UncP is the uncertainty in P.

CONCLUSIONS

High resolution spectral gamma-ray borehole logging of well 299-W18-171 was conducted on three days in February 1991. The data acquisition time was 180 seconds for each 0.5 foot increment. The logging depth interval was 0.0 to 124.0 feet. The depth interval of 83.0 to 84.0 is the only location where man-made radionuclides were encountered. The man-made radionuclides were americium and plutonium. This information was verbally transmitted to the Technical Leader for the purpose of excluding the contaminated zone from well perforation activities. The concentrations of potassium-40, a natural radionuclide, were calculated and are presented in tabular and graphic form in this report. The concentrations of the other natural radionuclides, uranium and thorium, are not presented.

Equipment development is in progress and the additional capabilities will be forthcoming.

J. R. Brodeur	C. J. Koizumi	C. J. Koizumi for R. K. Price
Engineer	Scientist	Scientist

dyl

Attachments

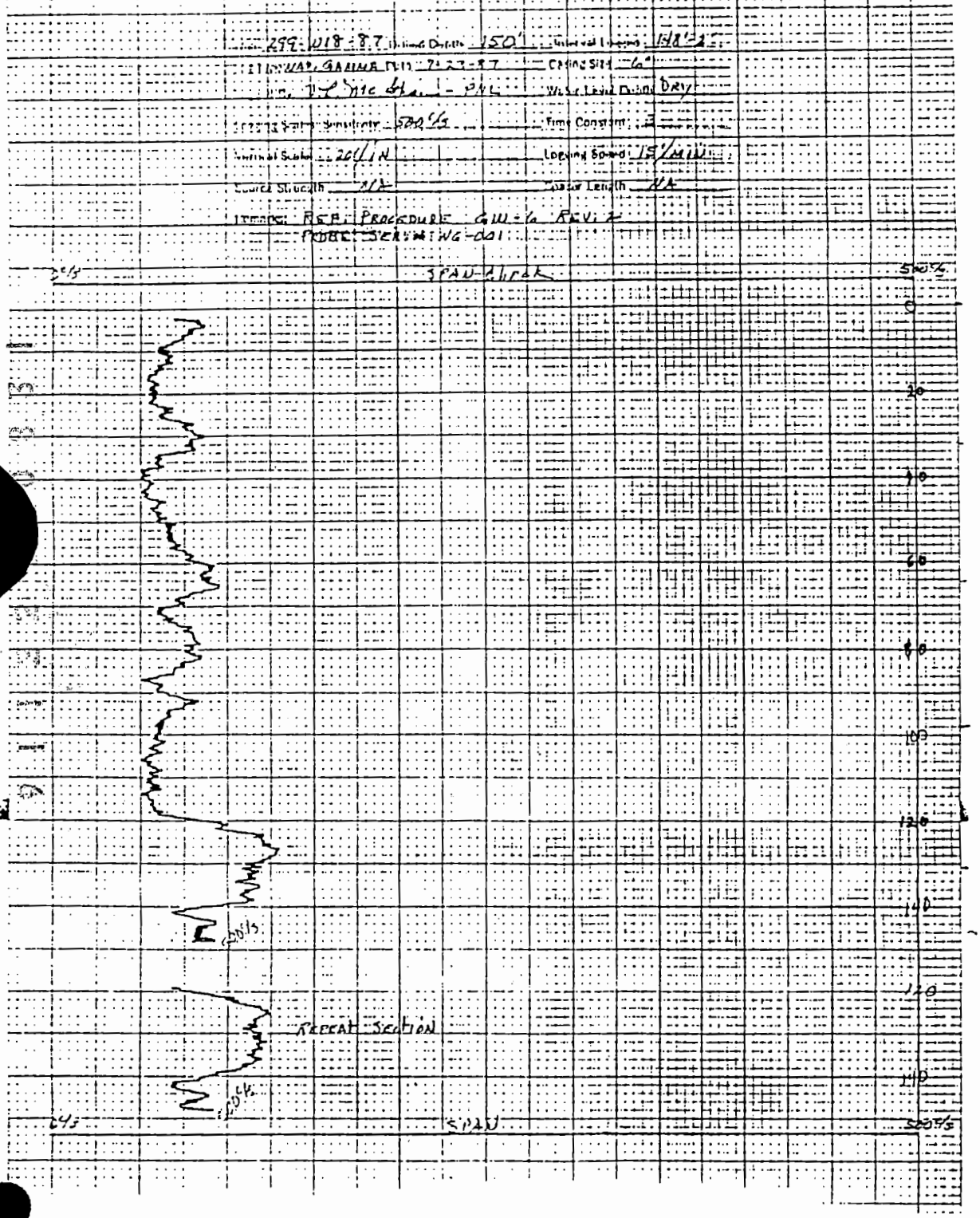

Figure 1. Gross Gamma Ray borehole log for 299-W18-87

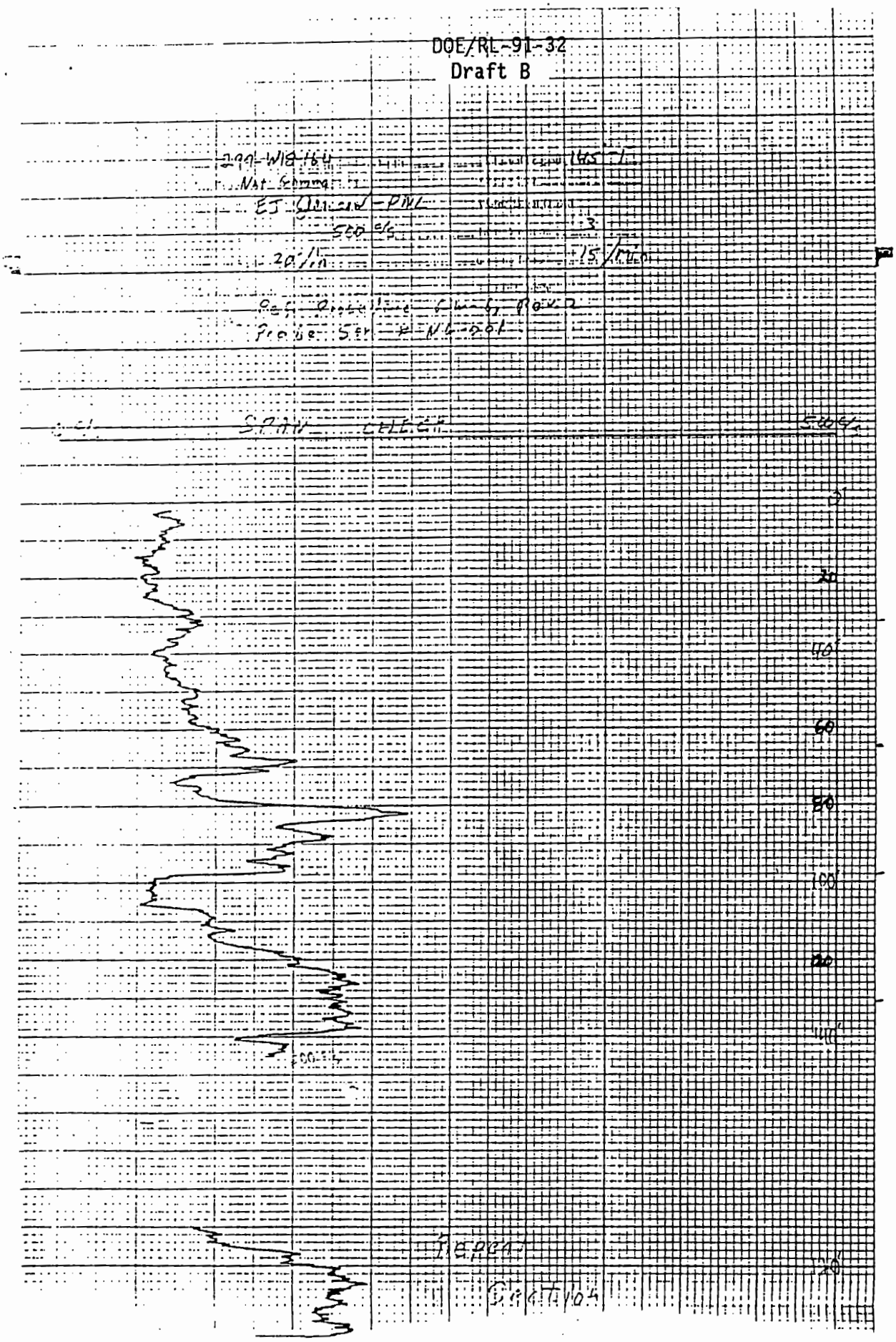

Figure 3. Gross Gamma Ray borehole log for 299-W18-164

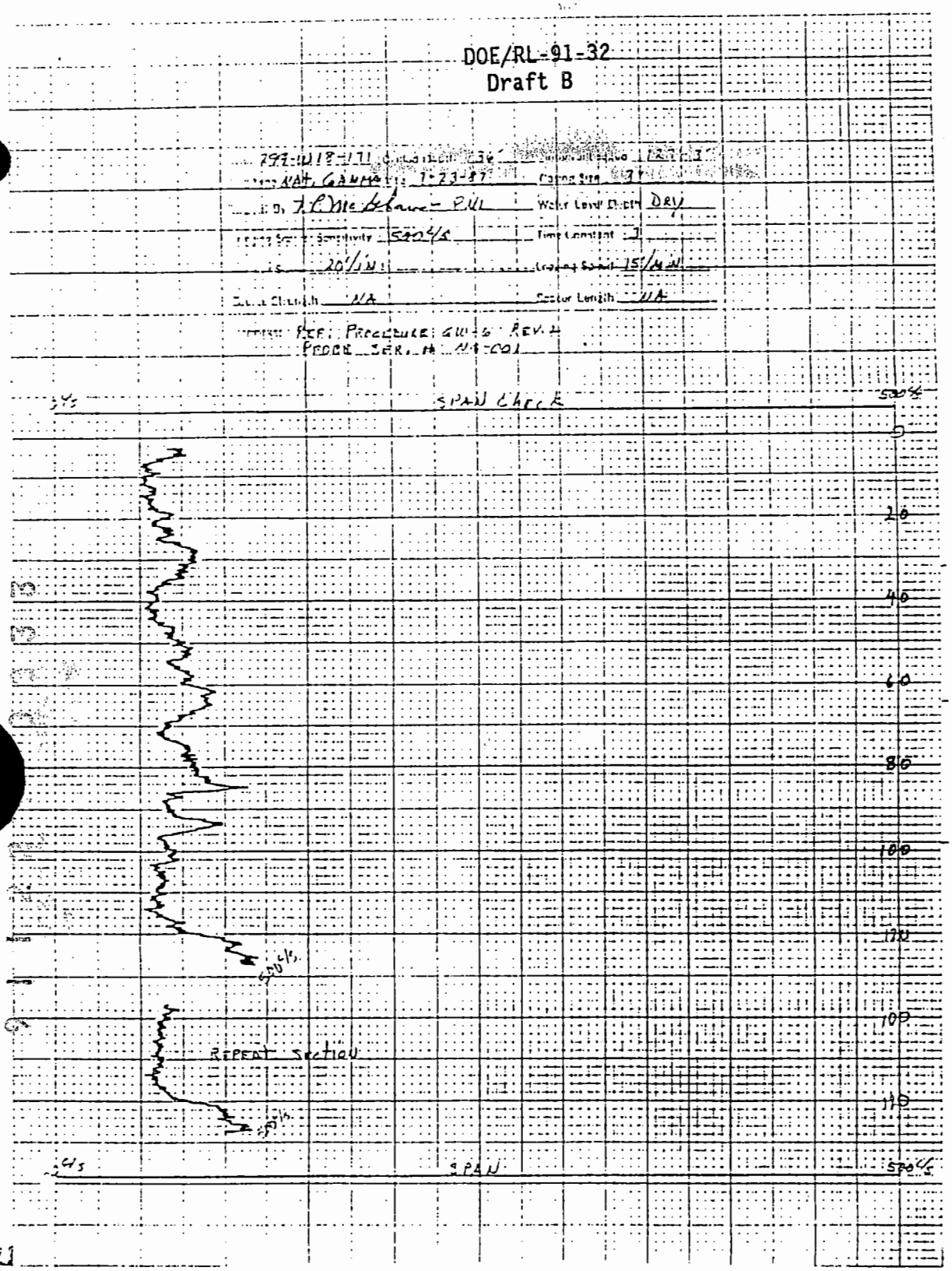

Figure 4. Gross Gamma Ray borehole log for 299-W18-171

WELL 299-W18-150

ELEVATION (METERS ABOVE MSL): 204.8

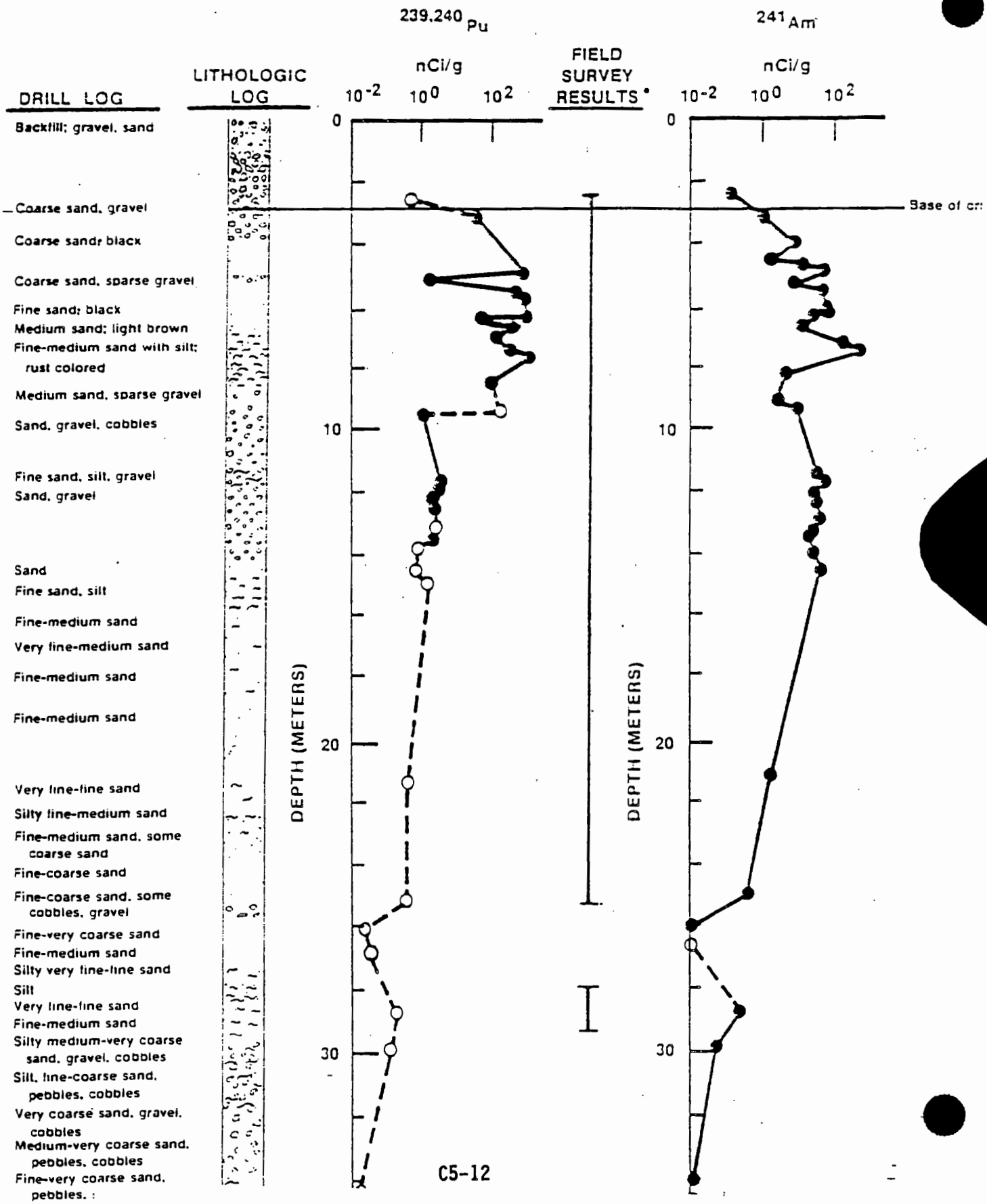

Figure 5. Laboratory analysis of drill cuttings from borehole 299-W18-150

WELL 299-W18-164

ELEVATION (METERS ABOVE MSL): 206.7

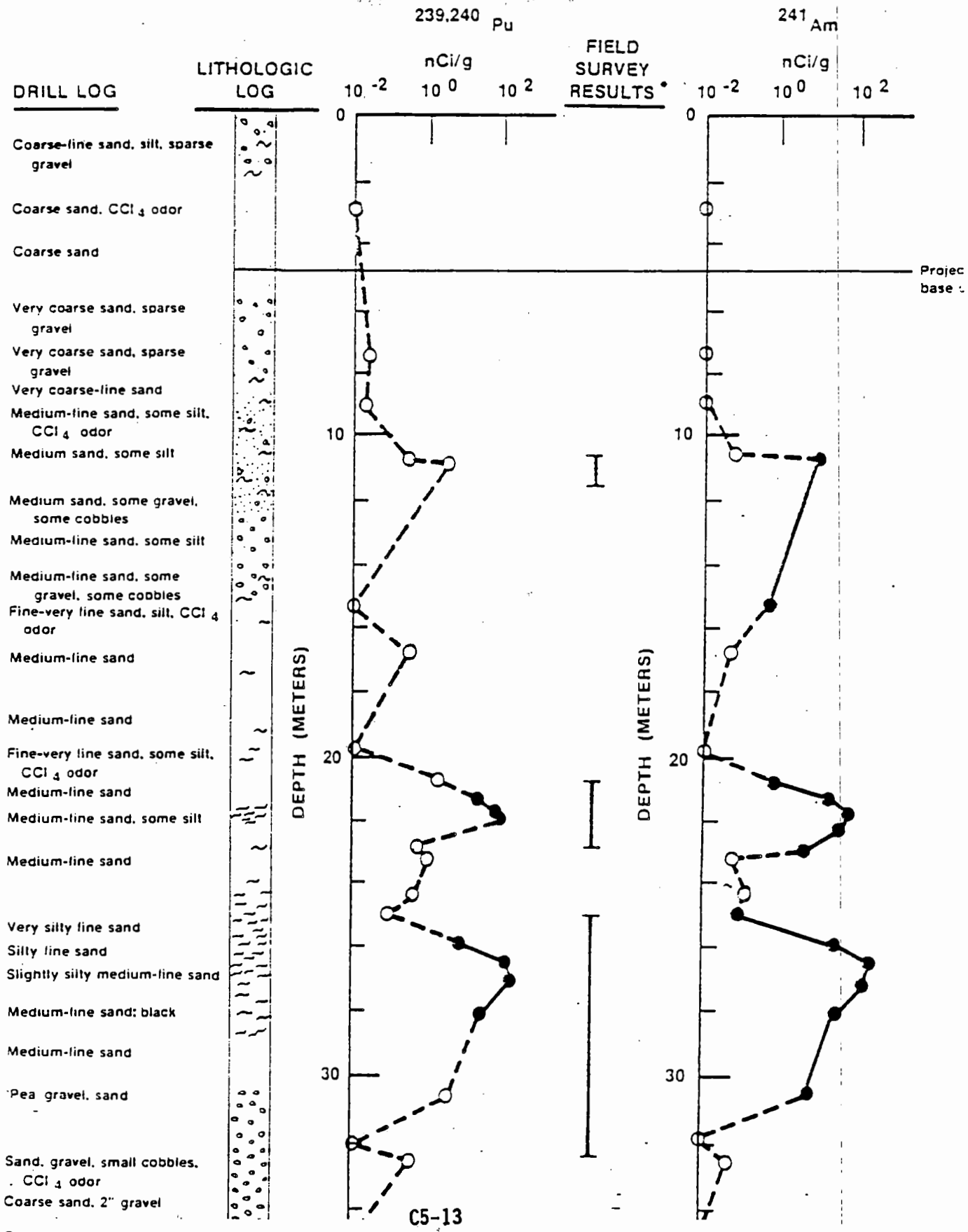

Figure 6. Laboratory analysis of drill cuttings from borehole 299-W18-164

ELEVATION (METERS ABOVE MSL): 206.5

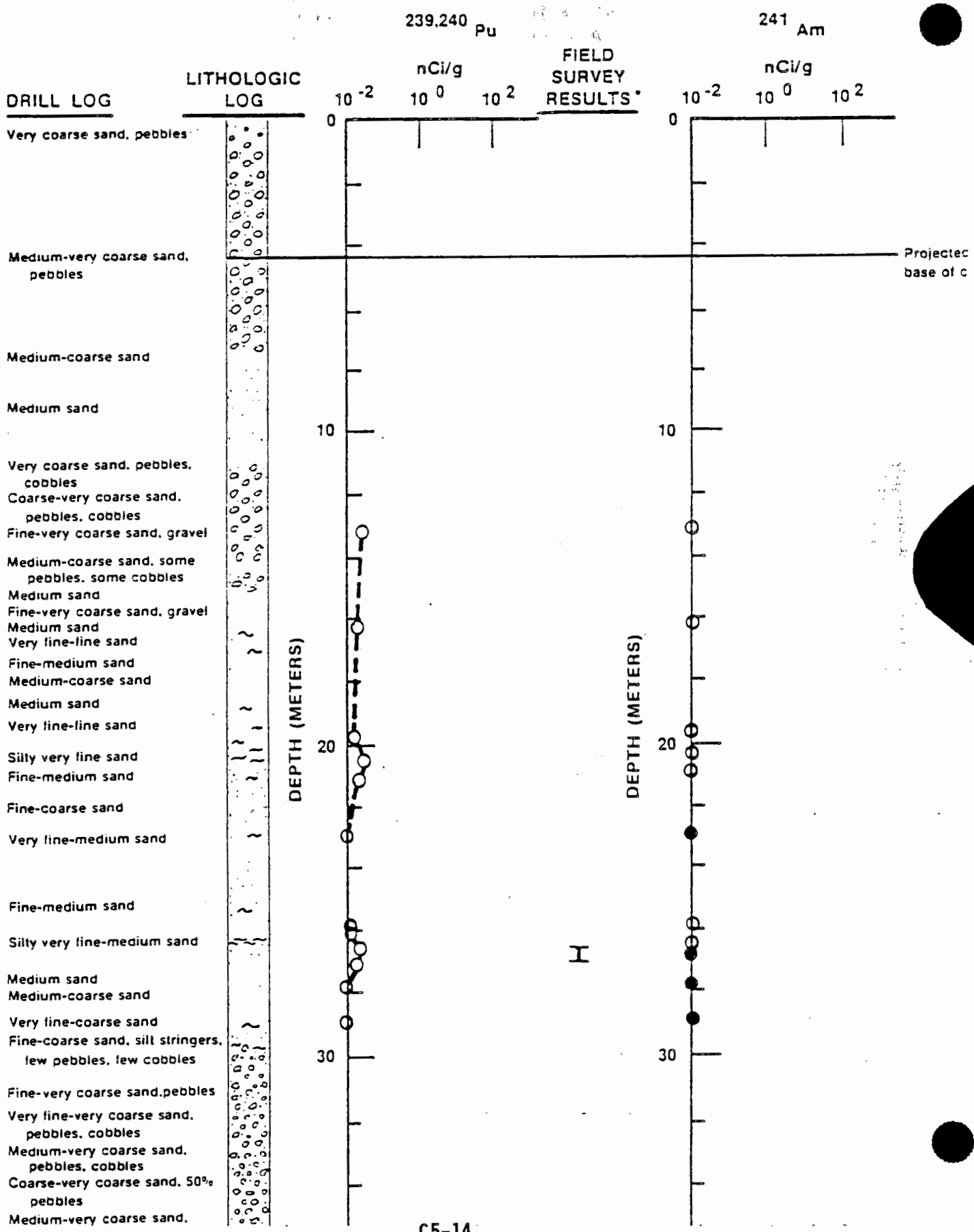

Figure 7. Laboratory analysis of drill cuttings from borehole 299-W18-171

Table 1. Potassium concentration and gross gamma activity
Well 299-W18-171 February 1991

Depth feet	Gross cps	Uncer 2-sigma	K-40 pCi/g	Uncer 2-sigma
0.0	56.2	1.12	5.64	3.16
0.5	69.2	1.24	9.53	3.48
1.0	75.3	1.29	10.85	3.59
1.5	78.6	1.32	9.56	3.48
2.0	78.2	1.32	7.68	3.33
2.5	76.5	1.30	8.21	3.37
3.0	73.4	1.28	7.29	3.30
3.5	73.9	1.28	7.48	3.30
4.0	71.1	1.26	8.27	3.38
4.5	68.9	1.24	8.69	3.39
5.0	65.4	1.21	4.74	3.08
5.5	60.9	1.16	3.83	3.01
6.0	60.6	1.16	4.45	3.04
6.5	64.6	1.20	5.04	3.11
7.0	65.0	1.20	5.74	3.17
7.5	65.9	1.21	5.46	3.13
8.0	65.8	1.21	5.54	3.14
8.5	65.1	1.20	5.54	3.14
9.0	65.3	1.20	4.13	3.04
9.5	64.0	1.19	7.94	3.34
10.0	64.6	1.20	6.69	3.24
10.5	62.7	1.18	5.93	3.17
11.0	63.4	1.19	6.22	3.20
11.5	65.1	1.20	4.97	3.10
12.0	63.1	1.18	6.79	3.23
12.5	63.3	1.19	4.57	3.08
13.0	63.5	1.19	7.16	3.25
13.5	63.6	1.19	5.31	3.13
14.0	62.1	1.17	6.13	3.20
14.5	60.9	1.16	5.27	3.13
15.0	60.5	1.16	4.28	3.03
15.5	59.5	1.15	4.19	3.04
16.0	59.7	1.15	2.77	2.93
16.5	61.9	1.17	6.18	3.20
17.0	65.9	1.21	7.15	3.25
17.5	67.5	1.22	8.60	3.40
18.0	68.9	1.24	7.88	3.34
18.5	71.0	1.26	10.26	3.51
19.0	70.0	1.25	10.99	3.59
19.5	71.2	1.26	10.00	3.51
20.0	70.4	1.25	10.03	3.51
20.5	70.7	1.25	8.54	3.40
21.0	71.2	1.26	8.67	3.40
21.5	70.6	1.25	9.91	3.50
22.0	72.0	1.26	11.37	3.60
22.5	73.0	1.27	10.57	3.55
23.0	70.3	1.25	11.13	3.60
23.5	70.1	1.25	11.59	3.64
24.0	71.4	1.26	9.57	3.49
24.5	72.1	1.27	9.81	3.49
25.0	77.5	1.31	12.04	3.67
25.5	86.7	1.39	12.44	3.71
26.0	94.2	1.45	12.80	3.73
26.5	100.1	1.49	12.96	3.74
27.0	100.5	1.49	14.73	3.91
27.5	102.2	1.51	12.83	3.74
28.0	102.3	1.51	12.83	3.73
28.5	102.1	1.51	13.20	3.77
29.0	101.3	1.50	13.61	3.82
29.5	101.4	1.50	14.05	3.83
30.0	97.9	1.47	11.50	3.64
30.5	96.8	1.47	13.49	3.80
31.0	95.7	1.46	14.79	3.90
31.5	95.8	1.46	16.98	4.10
32.0	97.2	1.47	14.78	3.89
32.5	94.9	1.45	12.86	3.75
33.0	94.2	1.45	14.47	3.89
33.5	91.9	1.43	13.30	3.77
34.0	90.4	1.42	10.00	3.54
34.5	86.7	1.39	11.93	3.67
35.0	80.6	1.34	12.12	3.69
35.5	76.7	1.31	12.26	3.70
36.0	75.0	1.29	10.74	3.56
36.5	74.6	1.29	10.21	3.53
37.0	73.4	1.28	11.05	3.58
37.5	74.4	1.29	11.06	3.60
38.0	73.5	1.28	11.35	3.62
38.5	72.0	1.27	11.61	3.65
39.0	72.1	1.27	8.97	3.43
39.5	72.9	1.27	9.43	3.46
40.0	70.8	1.25	9.52	3.47
40.5	71.9	1.26	10.35	3.54
41.0	73.6	1.28	8.19	3.34
41.5	72.1	1.27	9.83	3.49
42.0	75.3	1.29	11.60	3.62
42.5	76.8	1.31	10.17	3.53
43.0	77.3	1.31	9.98	3.50
43.5	76.6	1.30	9.97	3.50
44.0	75.4	1.29	10.41	3.56
44.5	78.4	1.32	10.77	3.57
45.0	81.3	1.34	10.90	3.58
45.5	81.4	1.35	8.89	3.42
46.0	81.4	1.34	10.11	3.52
46.5	81.4	1.34	11.34	3.63
47.0	80.4	1.34	10.25	3.54
45.0	81.2	1.34	12.69	3.75
45.5	82.5	1.35	11.60	3.67
46.0	83.5	1.36	11.81	3.64
46.5	82.0	1.35	12.07	3.69
47.0	82.1	1.35	11.36	3.62
47.5	81.6	1.35	12.49	3.72
48.0	80.8	1.34	10.52	3.55
48.5	82.8	1.36	11.43	3.63
49.0	82.1	1.35	13.13	3.77
49.5	86.3	1.38	12.56	3.74
50.0	93.6	1.44	13.31	3.77
50.5	98.2	1.48	13.54	3.83
51.0	100.3	1.49	13.87	3.84
51.5	97.5	1.47	13.07	3.79
52.0	95.3	1.46	15.83	3.98
52.5	92.8	1.44	12.26	3.70
53.0	90.9	1.42	12.71	3.74
53.5	91.8	1.43	14.32	3.87

Table 1 continued. Well 299-W18-171 February 1991

Depth feet	Gross cps	Uncer 2-sigma	K-40 pCi/g	Uncer 2-sigma
54.0	90.6	1.42	15.69	4.00
54.5	88.4	1.40	13.60	3.81
55.0	92.5	1.43	15.50	3.95
55.5	97.6	1.47	14.72	3.90
56.0	100.0	1.49	16.99	4.08
56.5	98.6	1.48	13.32	3.79
57.0	98.6	1.48	13.46	3.79
57.5	98.8	1.48	14.15	3.88
58.0	96.6	1.47	16.38	4.02
58.5	98.0	1.48	14.80	3.91
59.0	100.0	1.49	16.53	4.05
59.5	103.0	1.51	16.74	4.08
60.0	104.2	1.52	15.06	3.93
60.5	104.8	1.53	17.69	4.16
61.0	106.3	1.54	15.51	3.96
61.5	109.8	1.56	14.85	3.93
62.0	113.1	1.59	14.21	3.85
62.5	113.1	1.59	13.69	3.84
63.0	113.8	1.59	15.88	4.00
63.5	114.0	1.59	14.05	3.86
64.0	113.8	1.59	13.49	3.79
64.5	114.0	1.59	16.31	4.05
65.0	109.4	1.56	14.04	3.86
65.5	102.2	1.51	14.15	3.88
66.0	97.4	1.47	14.87	3.92
66.5	97.1	1.47	17.20	4.12
67.0	96.9	1.47	14.79	3.90
67.5	94.1	1.45	14.08	3.86
68.0	90.9	1.42	15.56	3.97
68.5	88.9	1.41	14.61	3.88
69.0	83.3	1.36	11.06	3.62
69.5	79.5	1.33	12.83	3.73
70.0	74.6	1.29	9.73	3.50
70.5	73.7	1.28	10.33	3.54
71.0	74.9	1.29	11.80	3.66
71.5	75.3	1.29	10.57	3.55
72.0	74.2	1.28	10.86	3.58
72.5	81.3	1.34	12.31	3.68
73.0	89.5	1.41	12.86	3.76
73.5	96.4	1.46	15.23	3.95
74.0	99.8	1.49	13.08	3.77
74.5	101.3	1.50	15.62	3.99
75.0	101.1	1.50	15.31	3.94
75.5	98.9	1.48	13.63	3.81
76.0	96.1	1.46	12.90	3.74
76.5	96.4	1.46	14.29	3.86
77.0	98.0	1.48	13.20	3.77
77.5	99.6	1.49	19.27	4.28
78.0	99.7	1.49	15.68	3.99
78.5	100.3	1.49	16.84	4.08
79.0	98.4	1.48	13.45	3.81
79.5	98.2	1.48	13.29	3.79
80.0	99.4	1.49	13.19	3.79
80.5	102.6	1.51	13.23	3.80
81.0	108.1	1.55	16.92	4.07
81.5	108.0	1.55	15.64	3.98
82.0	108.3	1.55	15.65	4.00
82.5	108.4	1.55	13.71	3.84
83.0	128.5	1.69	12.07	3.70
83.5	149.4	1.82	14.59	3.89
84.0	143.4	1.79	13.43	3.72
84.5	96.5	1.46	12.37	3.69
85.0	82.8	1.36	12.74	3.76
85.5	79.2	1.33	13.15	3.78
86.0	78.4	1.32	12.57	3.72
86.5	78.2	1.32	11.86	3.66
87.0	78.3	1.32	13.60	3.80
87.5	76.8	1.31	13.76	3.79
88.0	75.1	1.29	11.16	3.60
88.5	76.7	1.31	11.71	3.66
89.0	75.0	1.29	12.28	3.69
89.5	78.0	1.32	12.21	3.68
90.0	80.8	1.34	12.89	3.75
90.5	88.5	1.40	14.07	3.85
91.0	101.2	1.50	15.33	3.96
91.5	109.2	1.56	17.04	4.09
92.0	112.5	1.58	18.56	4.21
92.5	113.3	1.59	16.85	4.06
90.0	93.5	1.44	11.34	3.67
90.5	106.2	1.54	13.61	3.85
91.0	113.3	1.59	13.84	3.83
91.5	114.6	1.60	15.25	3.97
92.0	113.3	1.59	17.55	4.16
92.5	110.5	1.57	15.35	3.98
93.0	104.7	1.53	15.93	4.02
93.5	93.6	1.44	12.30	3.71
94.0	82.3	1.35	11.84	3.68
94.5	78.0	1.32	11.18	3.63
95.0	78.5	1.32	10.80	3.57
95.5	76.3	1.30	9.70	3.52
96.0	76.2	1.30	9.37	3.49
96.5	75.1	1.29	11.18	3.62
97.0	75.7	1.30	11.74	3.67
97.5	76.1	1.30	10.05	3.55
98.0	75.6	1.30	10.55	3.58
98.5	73.3	1.28	8.95	3.43
99.0	73.5	1.28	10.66	3.57
115.6	73.6	1.28	9.63	3.49
116.1	76.9	1.31	10.10	3.52
116.6	84.6	1.37	12.57	3.74
117.1	99.0	1.48	13.48	3.81
117.6	107.9	1.55	15.29	3.95
118.1	115.1	1.60	17.25	4.10
118.6	118.7	1.62	16.89	4.10
119.1	120.7	1.64	12.23	3.73
119.6	121.1	1.64	14.06	3.88
120.1	119.5	1.63	15.54	3.96
120.6	116.5	1.61	13.23	3.78
121.1	115.0	1.60	16.19	4.02
121.6	120.1	1.63	17.13	4.14
122.1	126.2	1.67	16.48	4.05
122.6	130.3	1.70	16.93	4.10
123.1	134.8	1.73	15.48	3.99
123.6	140.1	1.76	16.12	4.01
124.1	133.9	1.72	15.98	4.02

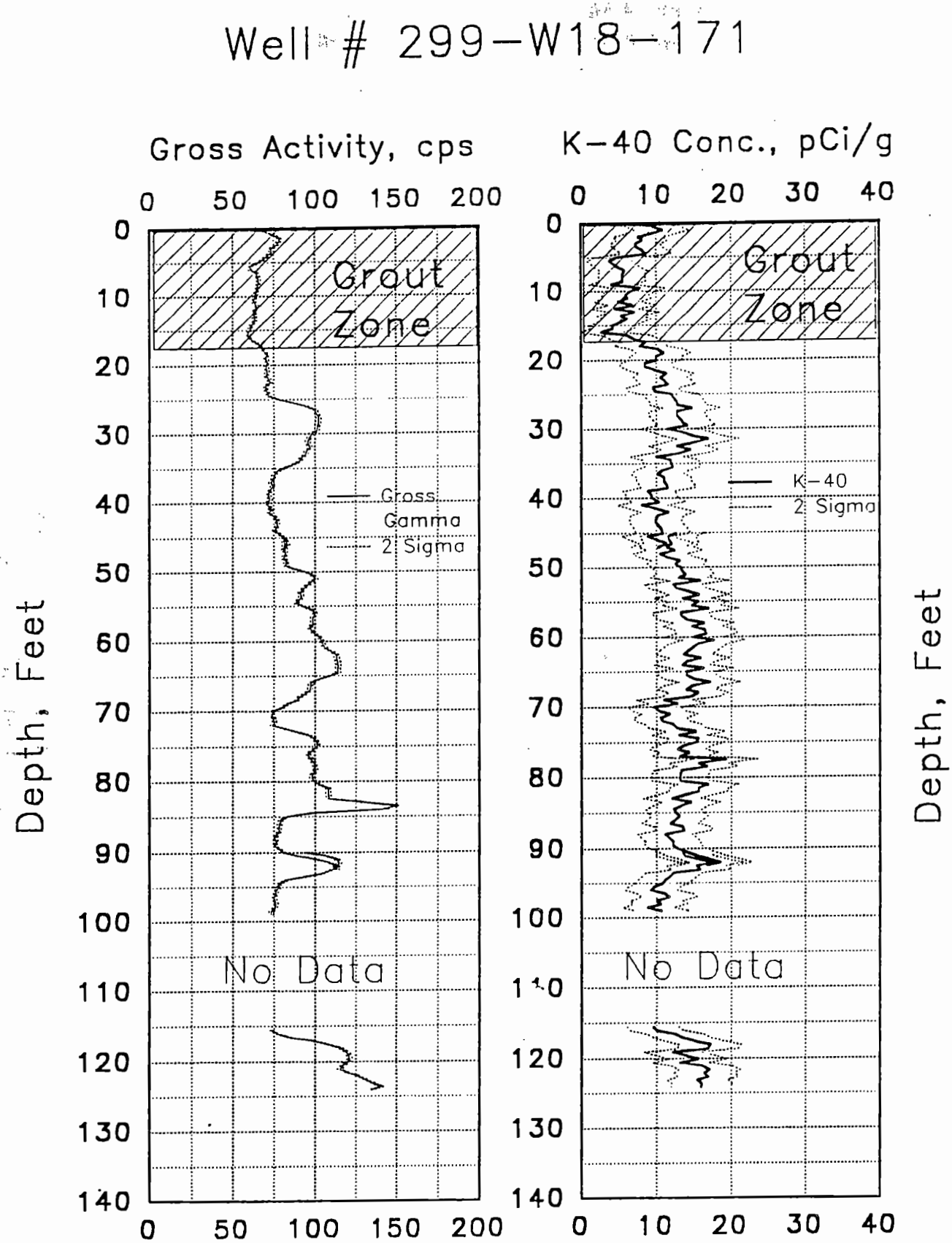

Figure 8. Potassium concentration and gross gamma activity for 299-W18-171

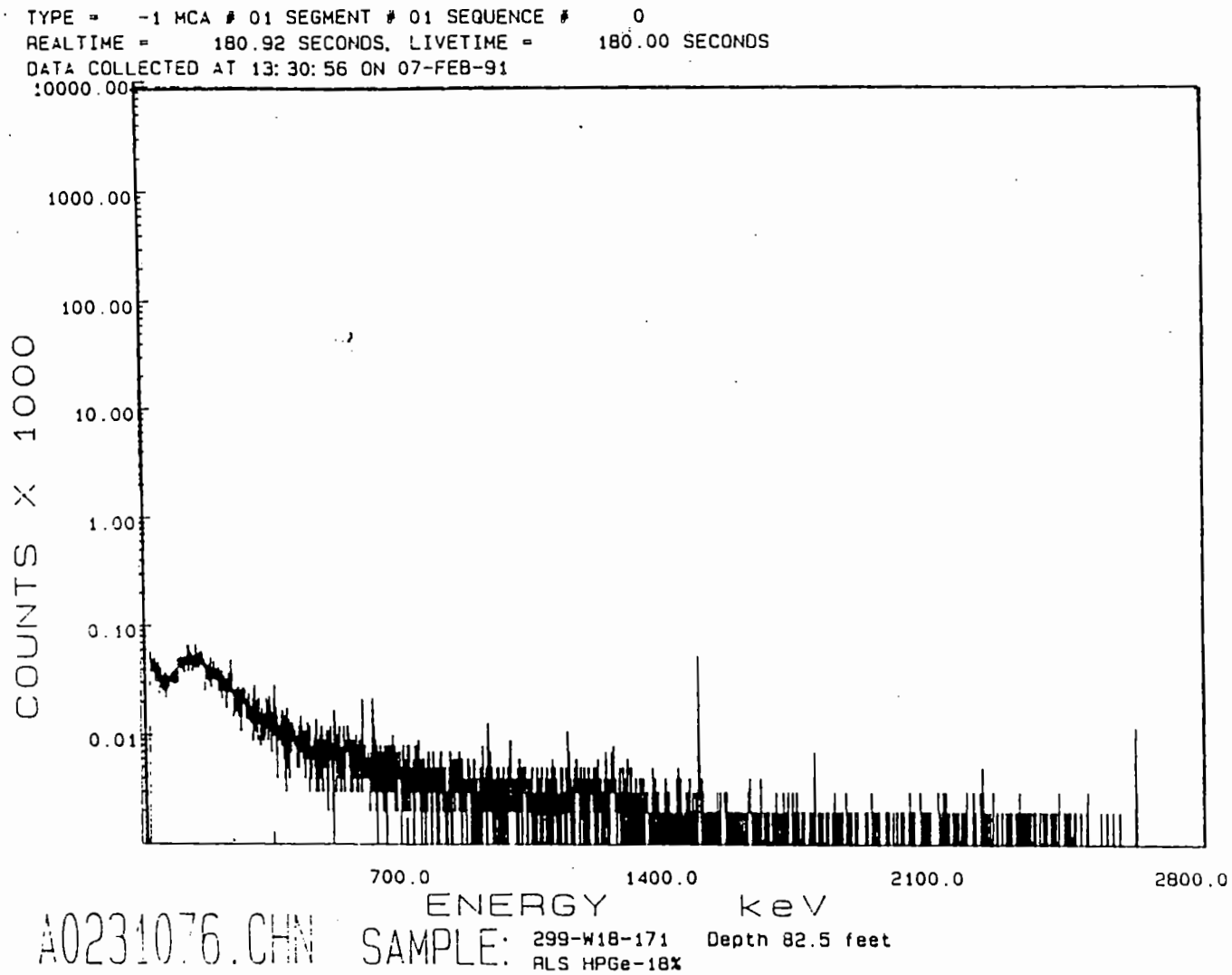

Figure 9. Gamma Ray spectra for borehole 299-W18-171 at depth 82.5 feet

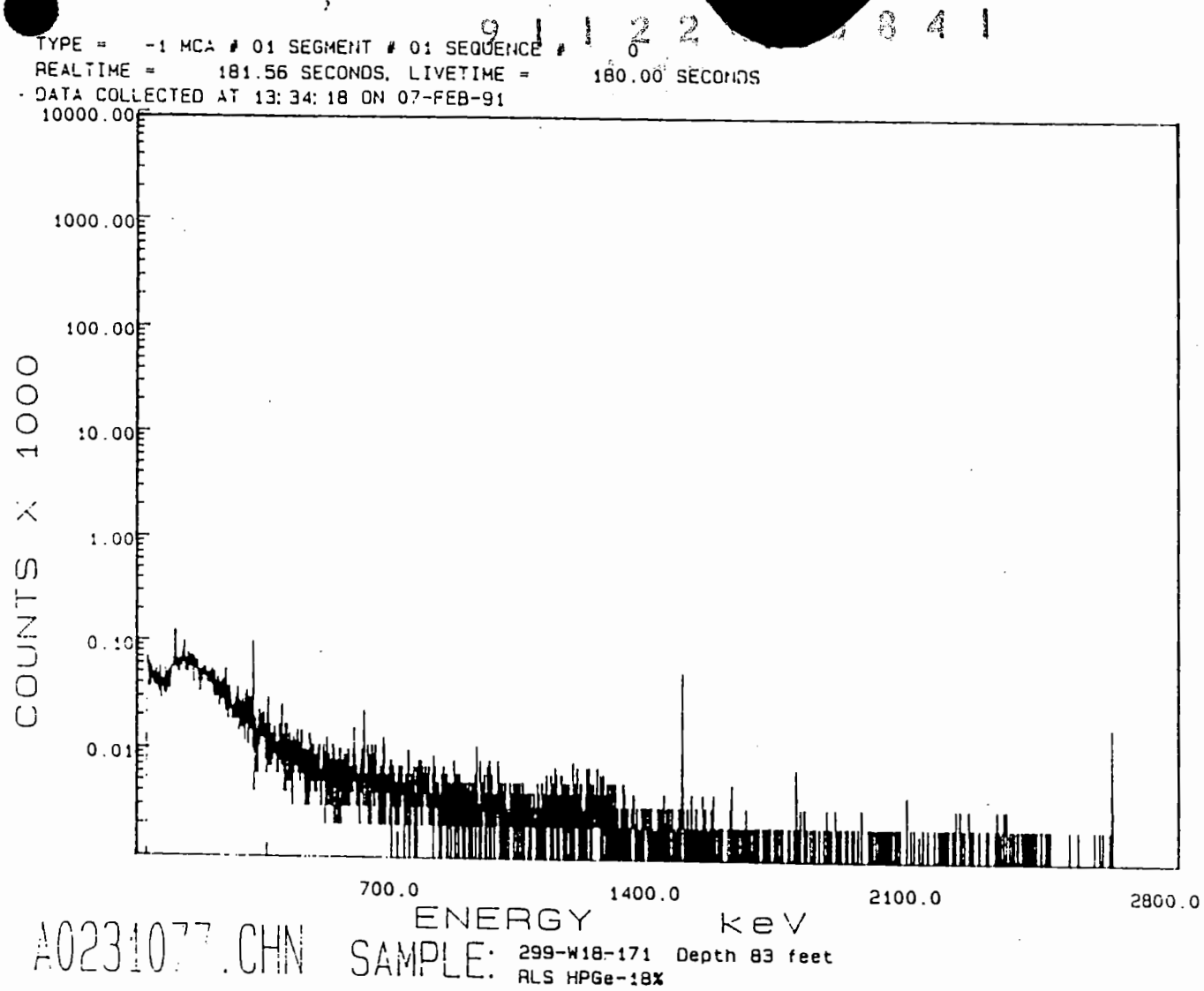

Figure 10. Gamma Ray spectra for borehole 299-W18-171 at depth 83.0 feet

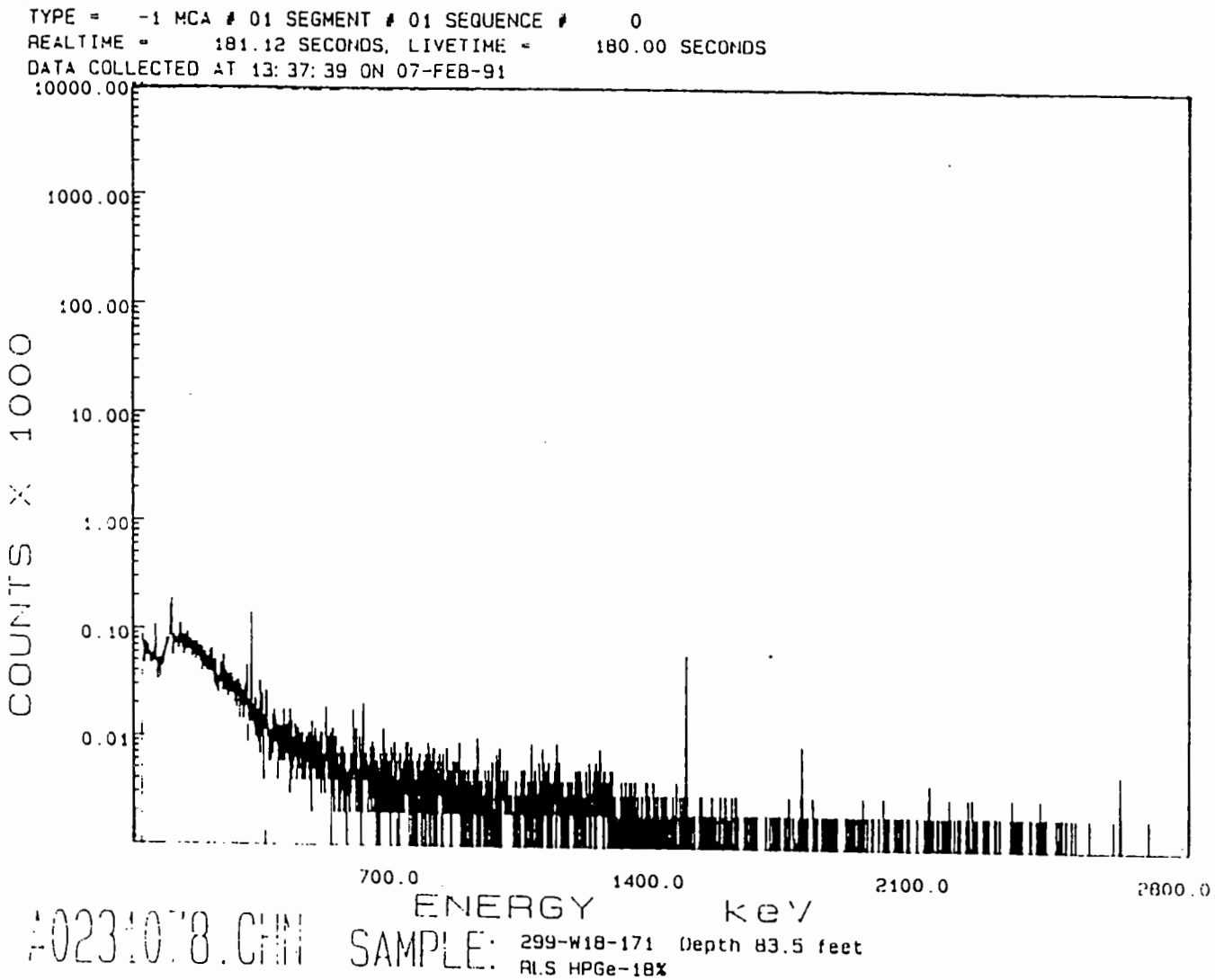

Figure 11. Gamma Ray spectra for borehole 299-W18-171 at depth 83.5 feet

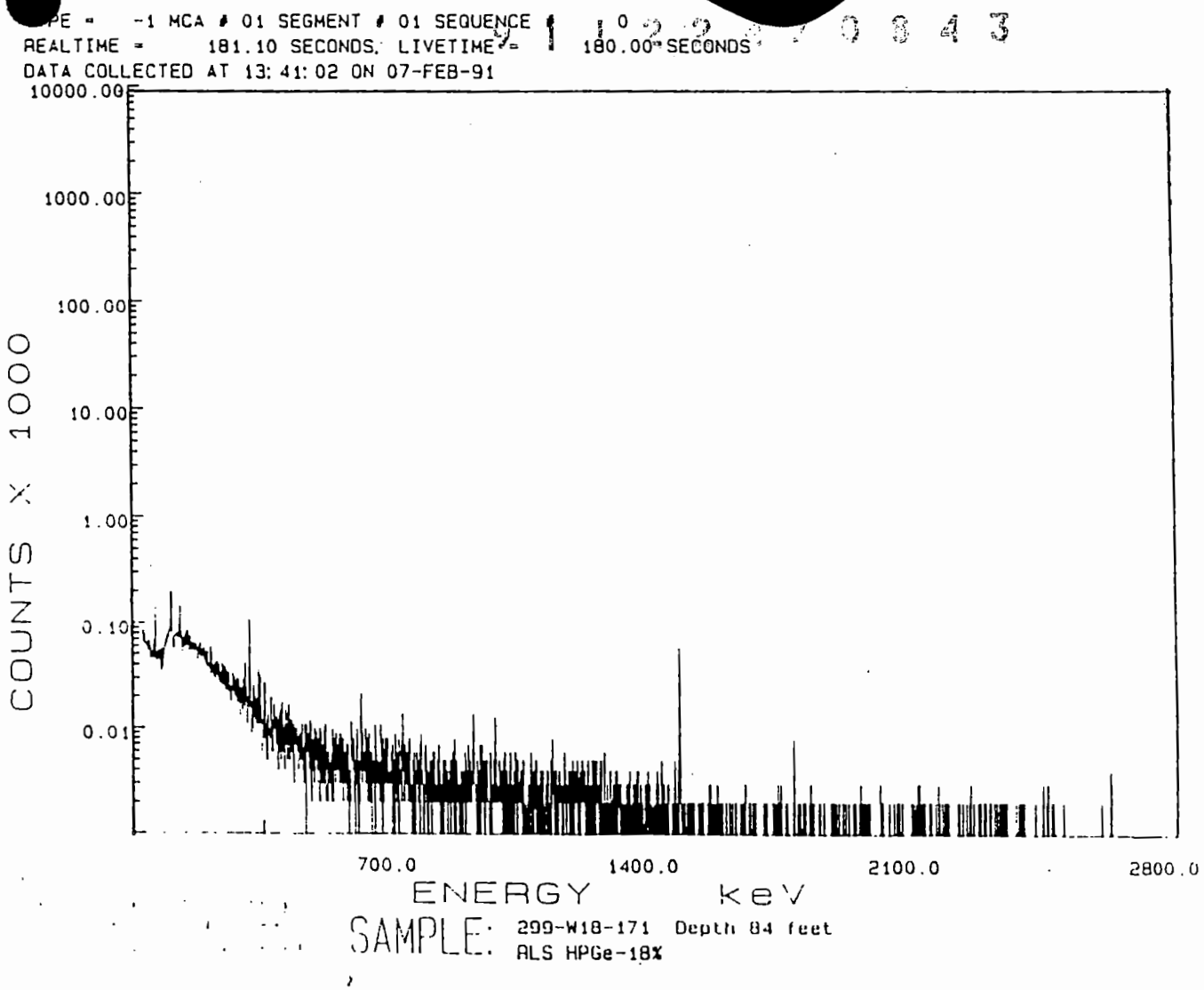

Figure 12. Gamma Ray spectra for borehole 299-W18-171 at depth 84.0 feet

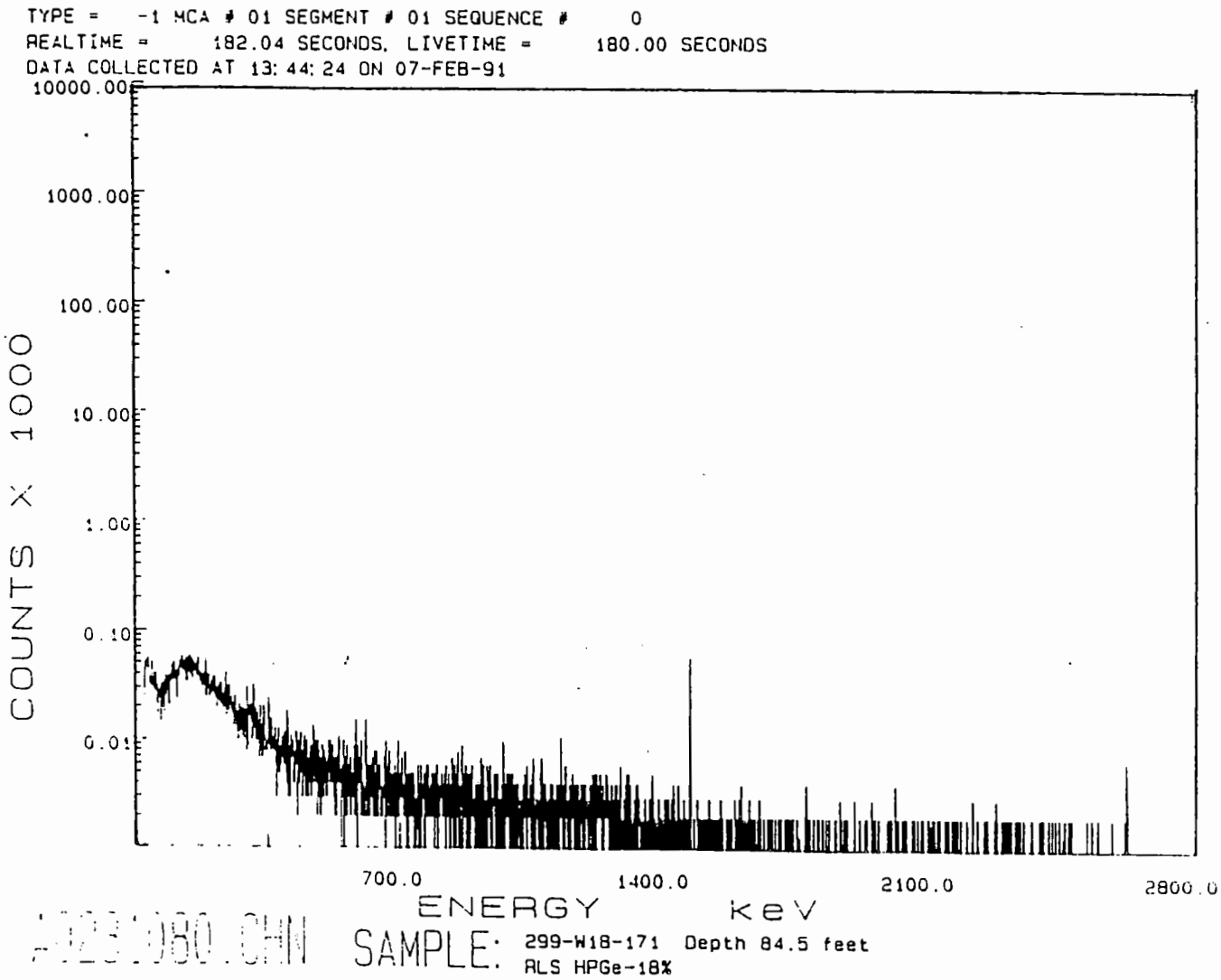

Figure 13. Gamma Ray spectra for borehole 299-W18-171 at depth 84.5 feet

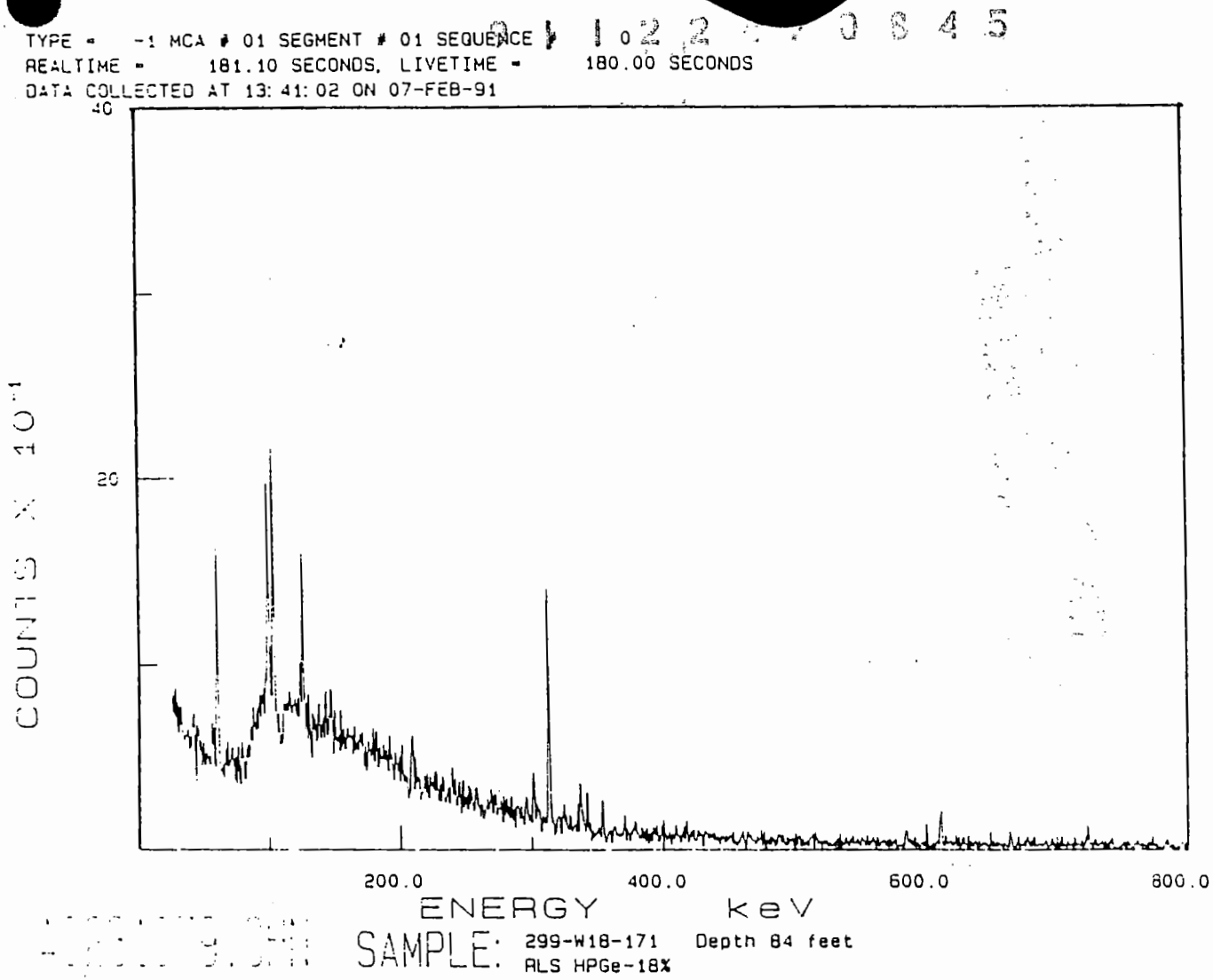

Figure 14. Expanded Gamma Ray Spectra for 299-W18-171 at depth 84.0 feet

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RESULTS OF GROSS GAMMA RAY GEOPHYSICAL LOGGING OF WELL 299-W18-171

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Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-5056

March 19, 1991

Ms. V. H. Rohay
Westinghouse Hanford Company
P.O. Box 1970/H4-56
Richland, WA 99352

Dear Ms. Rohay:

RESULTS FROM GROSS-GAMMA RAY LOGGING OF WELL 299-W18-171 IN SUPPORT OF 200 WEST AREA CARBON TETRACHLORIDE EXPEDITED RESPONSE ACTION - ED1397

Enclosed are the results from the gross gamma ray geophysical logging activities performed on February 21, 1991. I hope you find this information useful, and will consider using our services in the future. If similar work is anticipated, $1000 should be budgeted per well. This additional funding will cover the cost of preparing the report. Please feel free to make any suggestions as to logging/plotting scales, or to the contents of the report.

If you have any questions, please feel free to contact either Steven P. Airhart (376-0117) or me.

Very truly yours,

Michael A. Neely

Michael A. Neely, Manager
Ground Water and Compliance Monitoring
OFFICE OF ENVIRONMENTAL TECHNOLOGY

MAN/AWP/dla

Enclosure

cc: WHC w/enc
KR Fecht H4-56
RL Jackson
AJ Knepp

Twenty-five years of science for DOE and the Northwest

Attachment
March 19, 1991

RESULTS OF GROSS GAMMA RAY GEOPHYSICAL LOGGING OF WELL 299-W18-171

This work was performed on February 21, 1991 in accordance with the gross gamma logging procedure PNL-MA-567 GL-7A Rev. 0. The original analog copy of the log was given to Kent Reynolds at the site upon completion of the activity. Logs presented in this report were recorded digitally and later plotted. The "GAMMA DIRECT" log is a plot of the raw signal data which contains some statistical noise. The "GAMMA FILTERED" log is a plot of the same data after a seven point averaging filter has been applied. This filter suppresses the statistical noise, while preserving the character of the log.

The accompanying lithologic column was compiled from the drill log enclosed in the SOW. This column shows major lithologic changes which is useful for interpreting the gross gamma log.

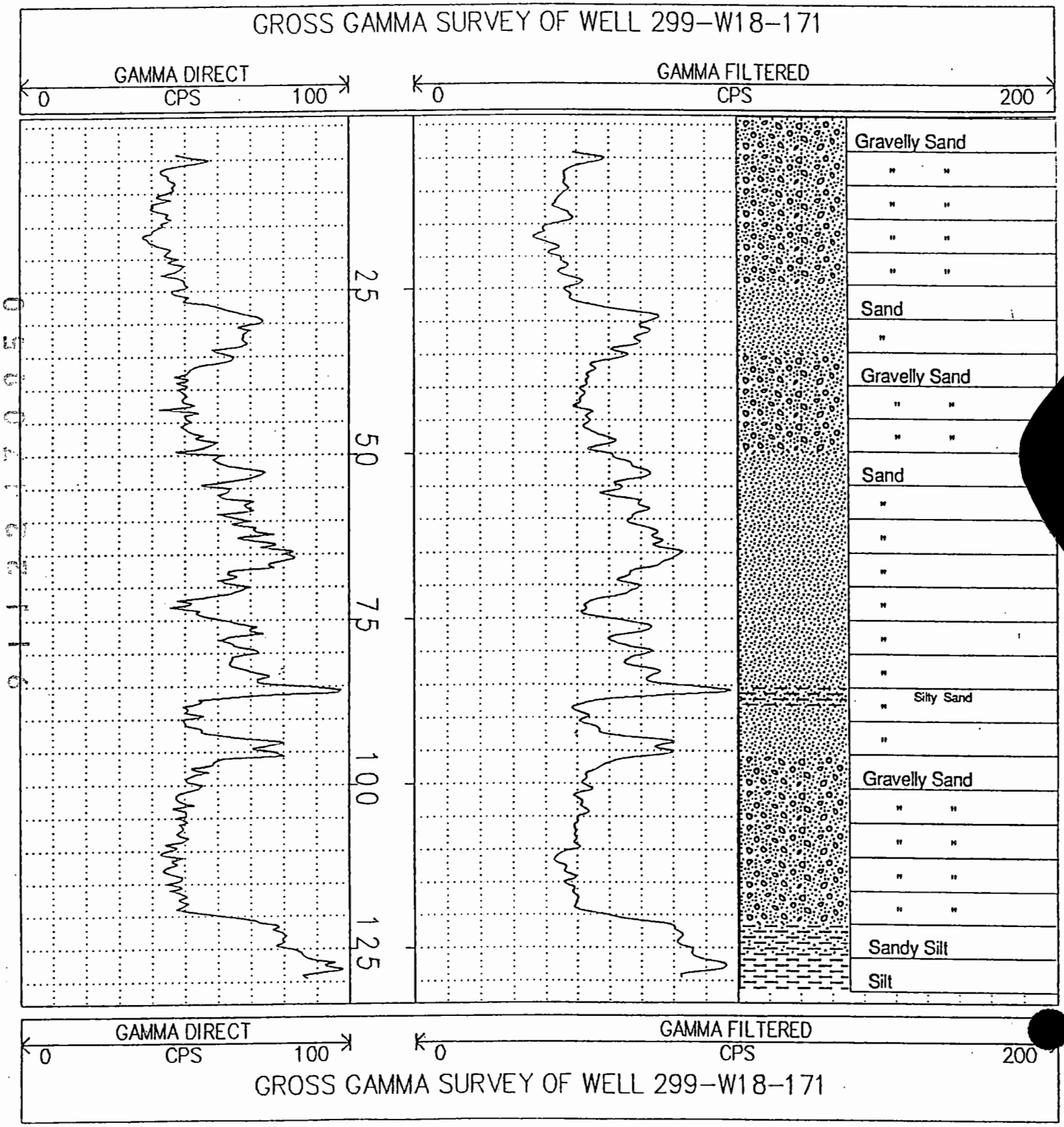
In general, gross-gamma geophysical logging is used to correlate and interpret subsurface stratigraphy between boreholes. Specifically, the gross gamma log is useful for providing an indication of the clay content of the formation. In many cases, the fine-grained sedimentary layers produce a higher gamma activity than coarse-grained sediments. Another use is to identify zones of suspected contamination by gamma-ray-emitting radionuclides.

Additional factors which may influence gross-gamma ray data include casing, the presence of voids behind the casing, and annular seal material. Bentonite normally contains potassium, thus producing a higher count rate. Cement grout produces a lower count rate and tends to shield the borehole. The same is true for silica sand. In this case it is difficult to tell what effects these factors have on the log. It was noted in the drill log that 108 gallons of cement grout was placed as a surface seal. This normally would be placed in the annulus between 20 feet of starter casing and the 8 inch permanent casing. The starter casing would have then been pulled out exposing the cement grout to the formation, thus forming a surface seal. If this was

the case then the lower count rate exhibited in the top 25 feet of the log is a direct result.

The spike at 86 ft appears to correspond to the 20,000 dpm contamination encountered at this depth while drilling. It is our experience that count rates as high as 150 cps can occur at some silt/clay lenses at the Hanford Site. However, when we have encountered radiological contamination in the past it has often exhibited this same well defined sharp spike characteristic. It is difficult to determine if contamination is still present. My recommendation would be to avoid perforating between 80 and 90 ft.

Attachment
March 19, 1991



APPENDIX C6

STRATIGRAPHIC DATA TABLE

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Stratigraphic Data for the 200 West Area (1 of 4)

Coordinates West	Coordinates North	Well	Top of Hanford Formation	Thickness of Hanford Formation	Top of Early Palouse	Thickness of Early Palouse	Top of Plio-Pleistocene Unit	Thickness of Plio-Pleistocene Unit	Top of Upper Ringold Unit	Thickness of Upper Ringold Unit	Top of FSE Gravel Unit Ringold Formation	Water Table Elevation	Thickness of FSE Gravel Unit, Ringold Formation	Top of Lower Mud Sequence, Ringold Formation	Thickness of Lower Mud Sequence, Ringold Formation	Top of FSA Gravel Unit Ringold Formation	Thickness of FSA Gravel Unit, Ringold Formation	Top of Elephant Mt Basalt
75920	43783	W10-10	674	83	591	7	584	13	571	21	550	465						
75908	43771	W10-11	674	83	591	12	579	28	551	10	541	465						
75906	43755	W10-12	673	70	603	12	591	28	563	20	543	465						
78297	43137	W10-13	697	112	585	8	577	15	562	0	562	465						
78330	43143	W10-14	697	130		0	567	7	560	0	560	465						
75858	43791	W10-15	676									465						
75825	43130	W10-16	673									465						
76183	43154	W10-2	674	80	594	16	578	19	559	17	542	465						
75980	43348	W10-3	671	84	587	9	578	17	561	20	541	465						
76489	42669	W10-5	671	95	576	10	566	10	556	15	541	466						
75600	43799	W10-8	680	83	597	10	587	34	553	16	537	465						
71500	43150	W11-10	729	113	616	10	606	8	598	0	598	457						
75340	43098	W11-12	680	96	584	10	574	25	549	0	549	465						
73000	44000	W11-14	715	125	590	10	580	15	565	5	560	461						
75416	43716	W11-24	685	94	591	8	583	33	550	0	550	465						
74959	42986	W11-26	694	90	604	16	588	24	564	11	553		271	282	17	265	74	191
73525	42750	W11-6	716	120	596	25	571	0	571	10	561	461						
74251	43350	W11-7	709	105	604	27	577	13	564	20	544	463						
72542	43319	W11-9	723	111	612	20	592	5	587	50	537	459						
70733	45083	W12-1	726									452						
75262	42159	W14-1	666									460						
75002	40003	W14-7	677	113	564	15	549	2	547	0	547		294	253	51	211	53	158
71795	40098	W14-8	695	164	531	14	517	6	511	0	511		226	285	8	269	81	188
76920	41080	W15-10	676									466						
76095	42350	W15-12	671									467						
78089	39990	W15-14	698	140	558	17	541	12	529	11	518		278	240	48	192	58	134
78103	40330	W15-15	696	145	551	5	546	23	523	0	523	467						
77387	40269	W15-16	683	131	552	11	541	13	528	15	513	468						
77387	40221	W15-17	683				547	34	513	5	508	467						
77383	39705	W15-18	684	126	558	12	546	8	538	25	513	468						

Stratigraphic Data for the 200 West Area (2 of 4)

Coordinates West	Coordinates North	Well	Top of Hanford Formation	Thickness of Hanford Formation	Top of Early Palouse	Thickness of Early Palouse	Top of Plio-Pleistocene Unit	Thickness of Plio-Pleistocene Unit	Top of Upper Ringold Unit	Thickness of Upper Ringold Unit	Top of FSE Gravel Unit Ringold Formation	Water Table Elevation	Thickness of FSE Gravel Unit, Ringold Formation	Top of Lower Mud Sequence, Ringold Formation	Thickness of Lower Mud Sequence, Ringold Formation	Top of FSA Gravel Unit Ringold Formation	Thickness of FSA Gravel Unit, Ringold Formation	Top of Elephant Mt Basalt
77772	41041	W15-19	692	146		0	545	17			528	467						
78120	41028	W15-20	698	141		0	557	5			552	467						
75700	41200	W15-4	662									467						
75984	39537	W15-5	671	111	560	10	550	25	525	0	525	469	285	240	55	185	40	145
75765	40005	W15-6			571	9	562	17	545	0	545							
77013	39388	W18-1	680	120	560	5	555	25	530	20	510							
77152	36990	W18-15	661	121	540	20	520	25	495	0	495	469						
78109	37831	W18-22	666	118	548	20	528	7	521	0	521	467						
78120	38987	W18-23	695	143	552	15	537	20	517	0	517	467						
77180	38998	W18-24	682	128	554	12	542	16	526	0	526	468						
78097	39477	W18-26	699	163		0	536	15		0	521	467						
75491	37613	W19-1	674	126	548	25	523	10	513	0	513	470						
75000	37201	W19-10	682	135	547	24	523	10	513	0	513		288	225	28	197	74	123
74240	37300	W19-14	693									464						
74285	37775	W19-15	693									465						
73000	36849	W19-2	694	158	536	27	509	18	491	37	454	460						
72252	37525	W19-20	691	176		0	515	20		0	495	459						
75273	37462	W19-21	679									469						
72588	37613	W19-24	697	182		0	515	25		0	490	460						
75072	37629	W19-27	684									468						
73184	37823	W19-28	701	165	526	20	516	8	508	20	488	462						
72940	37849	W19-29	700	167	533	22	511	6	506	52	453	461						
71999	39000	W19-4	715									460						
71382	35868	W21-1	699									456						
75082	35534	W22-17	672									464						
73099	34508	W22-19	681	155	526	38	488	2	486	0	486	458						
74600	34600	W22-21	670									460						
73098	36094	W22-22	690	160	530	30	500	40	460	22	438	459						
74450	36100	W22-26	680									463						
73770	36150	W22-28	689									460						

Stratigraphic Data for the 200 West Area (3 of 4)

Coordinates West	Coordinates North	Well	Top of Hanford Formation	Thickness of Hanford Formation	Top of Early Palouse	Thickness of Early Palouse	Top of Plio-Pleistocene Unit	Thickness of Plio-Pleistocene Unit	Top of Upper Ringold Unit	Thickness of Upper Ringold Unit	Top of FSE Gravel Unit Ringold Formation	Water Table Elevation	Thickness of FSE Gravel Unit, Ringold Formation	Top of Lower Mud Sequence, Ringold Formation	Thickness of Lower Mud Sequence, Ringold Formation	Top of FSA Gravel Unit Ringold Formation	Thickness of FSA Gravel Unit, Ringold Formation	Top of Elephant Mt Basalt
73630	35337	W22-7	687									460						
76725	35560	W23-11	664									465						
76335	35861	W23-4	663									467						
75550	35010	W23-6	667									463						
74396	46090	W6-1	703	40		0	663	59	604	0	604	459	366	238	0	238	0	238
75302	45571	W6-2	690	57	633	9	624	29	595	0	595	461						
78601	46551	W7-1	688	58	630	13	617	35	582	35	547	461						
77385	46519	W7-2			642	17	625	35	590	13	577	460						
77420	46520	W7-3	673	27	646	10	636	38	598	22	576	459	375	201	0	201	0	201
77040	45435	W7-4	669	50		0	619	20	599	35	564	462						
76816	46509	W7-5	673	24	649	11	638	41	597	0	597	460						
76219	46509	W7-6	679	19			660	58	602	0	602	459						
76519	46509	W7-7	675	38			637				622	460						
75880	46510	W7-8	687	54			633				594	458						
78889	46549	W7-9	735									461						
79200	46551	W8-1	701	72	629	15	614	32	582	33	549	461						
79507	44508	W9-1	738	150	588	10	578	25	553	9	544	464						
77727	29379	6-29-72	647	165		0		0	482	62	420		213	207	55	152	95	57
65357	30536	6-31-65	683	210		0	473	0	473	0	473	440						
83724	31265	6-31-84B																
61980	31974	6-32-62	707	224		0	483	0	483	0	483	429	180	303				
70338	32077	6-32-70B	667	185		0	482	0	482	0	482	452						
72039	32477	6-32-72	668	242		0	0	0		0	426	454	169	257	39	218	122	96
88207	34404	6-34-88				0	543	0	543	28	515							
65758	34860	6-35-66	726									439						
69988	34523	6-35-70	694									452						
78190	35478	6-35-78B	661	107	554	55	499	0	499	0	499	467	258	241	72	169	90	79
60704	36365	6-36-61B	748	309		0	439	0	439	0	439	408	90	349	104	245	41	204
81988	37018	6-37-82A	637	126		0	511	0	511	0	511	467						
64978	37965	6-38-65	753	282		0	471	0	471	0	471	430	110	361	57	304	66	238

Stratigraphic Data for the 200 West Area (4 of 4)

Coordinates		Well	Top of Hanford Formation	Thickness of Hanford Formation	Top of Early Palouse	Thickness of Early Palouse	Top of Plio-Pleistocene Unit	Thickness of Plio-Pleistocene Unit	Top of Upper Ringold Unit	Thickness of Upper Ringold Unit	Top of FSE Gravel Unit Ringold Formation	Water Table Elevation	Thickness of FSE Gravel Unit, Ringold Formation	Top of Lower Mud Sequence, Ringold Formation	Thickness of Lower Mud Sequence, Ringold Formation	Top of FSA Gravel Unit Ringold Formation	Thickness of FSA Gravel Unit, Ringold Formation	Top of Elephant Mt Basalt
West	North																	
70226	38142	6-38-70	711									453						
78751	39198	6-39-79	674	126	548	16	532	10	522	8	514	467						
61500	40300	6-40-62	748	313		0	435	0	435	0	435	406						
79978	39665	6-40-80	655	89	566	23	543	38	505	0	505		288	217	52	165	57	108
84146	40345	6-40-84					550	12	538	18	520		291	229	196	33	0	33
84341	43315	6-43-84					556	19	537	13	524		327	197	129	68	0	68
88500	43200	6-43-89										467						
90776	43369	6-43-91AP										442						
63751	44053	6-44-64	720	260		0	460	0	460	0	460	407	103	357	12	345	25	320
69428	45003	6-45-69A										448						
78294	44575	6-45-78			599	10	589	20	569	25	544		296	248	44	204	22	182
60286	47137	6-47-60	650	225	425	0	425	0	425	0	425	403	58	367	0	367	0	367
70660	47838	6-48-71	688	90		0		0		0	598	446						
79122	48600	6-49-79	688			0		0	641	71	570	457						
84503	49919	6-50-85	739	65		0	674	55	619	85	534	456	267	267	48	219	66	153
63060	51449	6-51-63										406						
75151	50667	6-51-75	641							0	429	450		376	5	371	105	266

APPENDIX D

SOIL GAS MEASUREMENTS

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APPENDIX D1

DOWNHOLE SOIL GAS MEASUREMENTS

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TO: V.J. Rohay

cc: M.C. Hagood
R.G. McCain

FROM: K.D. Reynolds

DATE: 3/7/91

SUBJECT: 200-West Carbon Tetrachloride Plume:
Gas Sampling in Existing Wells in the Z-1-A Tile Field
and Z-18 Crib Areas

SCOPE:

This field study was undertaken to determine the presence or absence of carbon tetrachloride vapor in both vadose and ground water monitoring wells in the Z-1-A tile field and Z-18 crib areas of 200W. For this study field methods were devised and used to first indicate the presence or absence of CCl4 vapor, and secondly to provide qualitative data as to relative amounts of the compound present in the sampled well bores.

EQUIPMENT:

The sampling was done with the use of hand held field portable instruments and a down hole sampling device designed by R. G. McCain of Environmental Engineering. Positive presence of carbon tetrachloride vapor was determined by the use of drager tubes in conjunction with an SIP 1000 PID type total organic vapor analyzer. The SIP was fitted with an 11.7 eV lamp to allow for detection of compounds with energies of ionization in the carbon tetrachloride range(11.25 eV), and was calibrated with 100 PPM isobutylene. The SIP 1000 was used because of it's relative accuracy (reliable to the .5-1 PPM range for detectability), and ease of operation and reliability. The downhole sampling device consisted of a 4" stainless steel sphere with ball valves and fittings on opposite sides, and an explosion proof solenoid valve connected to electric cable.

METHODOLOGY:

Sampling was conducted according to the following methodology.

(1) The cap of the selected well was removed and the E.F.S. personnel assigned would sample the well bore with an HNU total organic analyzer. If the readings were above allowable levels (5 PPM) the well cap was replaced and no down hole sampling was attempted. The HNU readings

were checked with the SIP 1000 and carbon tetrachloride presence proven with the use of drager tubes. Overall the SIP proved to be more sensitive to CCL4 vapors, and gave consistently higher readings than the HNU. Prevailing wind directions were taken into consideration for personnel safety when opening the well bores. If the surface readings were below safety levels the down hole sampling device was used. Prior to use the SIP was calibrated each morning and after lunch break each afternoon. In addition the instrument was recalibrated whenever the readings on the instrument changed with out apparent reason. This drift was most evident when there were noticeable temperature changes.

(2) The stainless steel sphere was flushed with air at least twice and a reading with the SIP taken before each use. The sampling device was evacuated by use of a small hand drive vacuum pump and opened to the air to flush it. This process was repeated until the sphere was clean and produced no readings on the SIP. The clean sphere was evacuated again, attached to the electric cable and lowered into the well bore.

(3) The device was lowered to the bottom of the hole, or in the case of a groundwater monitoring well to the water table. The selenoid valve was then activated by means of a switch at the surface , thus allowing the sphere to draw in a sample of the vapors present at that level in the bore hole. Sufficient time (one minute) was allowed for the sphere to reach equilibrium and the device was brought back to the surface.

(4) The sphere was then removed from the electric cable and a sample was drawn from it using the vacuum pump on the SIP. The total response of the SIP was observed and recorded. A second sample was then drawn from the sphere into a drager tube with the use of a hand pump to prove the presence of CCl4.

(5) In most cases a second sampling run was done to provide backup data for the first run. Second runs were not performed on well bores that produced radioactive contamination on the sample cable, and at those times when the well was being sampled to check on data gathered on prior sampling days.

PERSONNEL:

Field support for this project were supplied by Environmental Field Services, Health Physics and Geosciences. The field team was composed of three people on any given day, one from each of the three supporting groups. Personnel involved in the project were as follows:

Keith Shea	Health Physics
Pete Parrish	E.F.S.
Tim Hottell	E.F.S.
Randy Coffman	E.F.S.
Kent Reynolds	Geosciences/Geology

Bruce Tuttle — E.F.S./Safety-Prejob site safety instructions and field supplies (drager tubes and HNU total organic vapor monitor)

DATA GATHERED DURING STUDY

Z-18 CRIB AREA

WELL #	DEPTH	DATE & TIME	RESULTS	REMARKS
		NOTE: Field days 2/7,8,11 & 12/91		
W18-98	80'	2/7 10:30 2949	No surface det 38 PPM w/ HNU	Positive drager tube
		2/12 9:16 2924	15 PPM at surface	
W18-99		2/7 11:00 2949	No surf. det. 50 PPM w/HNU	Positive drager tube
		12:30 2947	Resample w/SIP 140 PPM Single run	*Relatively low press.
		2/12 9:30 2925	64 PPM " "	
W18-94	80'	2/7 13:20 2945	No surf. det. 16 PPM 1st run 7 PPM 2nd run	Positive drager tube
W 18-95	80'	2/7 13:40 2945	No surf. det. 15 PPM 1st run 13 PPM 2nd run	Positive drager tube
W 18-82	146'	2/7 14:20 2943	No surf. det. No det. 1st run 18 PPM 2nd run	Positive drager tube
W 18-11	208'	2/8 14:00 2943	No surf. det. .6 PPM 1st run .7 PPM 2nd run	*Relatively high barometric pressure 29.43.
		2/11 10:15 2926	No surf. det. .9 PPM single run	*Rel. low pressure 29.26
W 18-93	140'	2/8 14:30 2942½	No surf. det.	*Rel. high

				press.
		2/11 2926½ 10:30	.8 PPM 1 run No surf. det. 1.4 PPM	Positive drager tube
W 18-96	80'	2/11 2926½ 10:40	51 PPM at surf.	*Rel. low press. Pos drager tube
Z-1-A Tile Field				
W 18-167	134'	2/11 2923 13:00	2.8 PPM at surf. 1.9 PPM 1st run 2.2 PPM 2nd run	
W18-81	41'	2/11 2922 13:18	+14 PPM at surf.	*Rel. low press.
W 18-166	137'	2/11 2922 13:24	2.8 PPM at surf. 7.8 PPM 1st run 6.5 PPM 2nd run	Positive drager tube
W 18-150	128'	2/11 2920½ 13:50	.4 PPM at surf. 16.2 PPM 1st run	No second run-low level rad. cont.
W 18-6	200'	2/12 2926 10:20	170 PPM at surf. No sample run	Positive drager tube
W 18-89	150'	2/12 2926 10:25	8-11 PPM at surf.	No samples
W 18-86	150'	2/12 2926 10:35	53 PPM at surf.	No samples
W 18-85	150'	2/12 2926 10:38	105 PPM at surf.	No samples
W 18-171		2/12 2926 11:00	2.5 PPM at surf. 9.3 PPM 1st run 3.7 PPM 2nd run	Positive drager tube
W 18-7	204'	2/12 2926 11:15	16 PPM at surf.	No samples

W 18-88	150'	24x	2/12	11:25	No surf. det. No det. 1st run 1.7 PPM 2nd run

* Note= Relative high and low pressure days determined as follows:
HIGH 30.03 and rising LOW 30.03 and falling
2/7 &8/91 relative high pressure days
2/11 & 12/91 relative low pressure days

WELLS NOT SAMPLED

Five wells in the study area were not sampled. W 18-80, W 18-77, and W 18-79 were not sampled because the well caps were rusted on and could not be removed. W 18-76 and W 18-78 were not sampled because of known radiation contamination. In addition several wells were not sampled because of obstructions in the well bore, i.e. pumps and tubing in place would not allow for the sampler to be lowered into the well bore.

RESULTS:

Data collected during the study indicate that carbon tetrachloride is present in nearly all of the well bores in the vicinity of the Z cribs and tile field, and is present even in wells that have cement plugs in place. For these wells either the bottom plug does not form a complete seal, or the casing is no longer intact for the entirety of the well bore.

The most consistent high readings were found on the west side of the Z 1-A tile field, and on the north-northeast side and corner of the Z-18 crib. These wells either were venting high levels of CCL4 on low pressure days or gave consistent high levels of detection with the down hole sampler. During the field study it became apparent that high barometric pressure caused very large effects in the venting of vapors from the well bore. On low pressure days (30.00 and falling) consistently higher readings were recorded from surface, and from bottom hole. This phenomena is documented in regard to water level fluctuations in ground water monitoring wells, and in recorded vapor concentrations at the well head during drilling processes.

For the purpose of vapor extraction the most viable wells for consideration in the program would be:

W 18-96	51 PPM surface
W 18-98	38 PPM surface
W 18-99	140 PPM downhole
W 18-85	105 PPM surface
W 18-86	53 PPM surface
W 18-6	170 PPM surface

DON'T SAY IT --- Write It!

Date: February 3, 1991

TO: V.J. Rohay
M.C. Hagood

cc: R.P. Henckel
W.L. Johnson

FROM: R.G. McCain
H4-55, 6-0777

SUBJECT: 200-West Carbon Tetrachloride Plume: Gas Sampling in Existing Vadose Holes

As of Feb 1, 1991, we have obtained gas samples from the bottom of four vadose holes in the vicinity of Z-Plant. Given below are the holes sampled to date and the CCl_4 level.

Hole No.	Depth	Date Sampled	Results	Remarks
W15-95	100± ft	Jan 25, 1991 9:20 → 10:30 2400	2.3 ppm	Scentex GC indicates 5-6 ppm, but peaks are offscale. Retention time matched CCl_4 standard.
W15-84	110± ft	Jan 25, 1991 10:40 2960	106 ppm	SIP reads "HI" OVM 580-A reads 106 ppm Draeger tube gave positive indication of CCl_4 on first pump compression.
W15-82	100± ft	Jan 25, 1991 1:45 2458	6 ppm	SIP reads 6± ppm OVM reads 5± ppm
W18-87	150± ft	Jan 30, 1991 10:10 2160	3.6-3.7 ppm	SIP reads 2.8 ppm at top of casing,

The above data are interesting in that the first three holes are within 150 ft of each other. Given the relatively close proximity of the holes, one would not expect to see such a large variation in CCl_4 content. All three appear to have been completed in more or less the same way, with 8-inch diameter casing installed to total depth, with no perforations.

The relatively high concentrations of CCl_4 have led to a change in analytical strategy. Experience with the Scentex in ECD mode indicates a much greater sensitivity than is necessary. However, the GC is not set up for direct injection, and we have no way of performing reliable dilution in the field. Hence, only those samples with concentrations below a few ppm can be analyzed using the Scentex GC. Samples with higher concentrations will produce truncated peaks.

Both the SIP and the OVM are capable of detecting CCl_4 in the low ppm range in the field. These are both photoionization devices. An 11.7 eV lamp is used to ionize the CCl_4. (ionization potential is 11.28 eV). Therefore, in the future we will depend on the use of the SIP in the field to determine CCl_4 concentrations. If the SIP indicates high concentrations, Draeger tubes can be used to confirm the identity. If necessary, a second sample can be obtained for GC analysis.

I understand that several vadose holes in the vicinity of the Z-1A tile field have indicated high ambient levels of CCl_4 in the vicinity of the well casing at the surface. When high concentrations exist at the surface, it may not be advisable to obtain downhole samples, since the presence of significant levels of CCl_4 at the surface can be taken as an indication of similar or greater concentrations at depth. There are also operational considerations associated with working in level "B" and in dealing with possible radiological contamination of the sampling equipment.

I will be away from the office during the week of Feb 4-8 and Feb 11-15. During this period, Kent Reynolds will assist in collecting vadose zone samples.

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APPENDIX D2

SOIL GAS SURVEY

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DON'T SAY IT --- Write It! **Date:** July 22, 1991

TO: V.J. Rohay

cc: M.C. Hagood
R.P. Henckel

FROM: R.G. McCain
H4-55, 6-0777

SUBJECT: Soil Gas Monitoring - Carbon Tetrachloride Plume

The purpose of this DSI is to provide a summary of the data obtained when the soil gas points at the Z-18 crib were re-sampled in March, 1991.

Soil gas points were installed Feb 20-23, 1991 by SAIC personnel under the direction of K.D.Reynolds. Expendable stainless gas vapor points supplied by AMS were driven to a depth of 4-5 ft. A 3/16-inch ID Teflon tubing extends from the gas vapor probe to the surface. A map of soil gas points is shown in Figure 1.

The initial re-sampling of CCl_4 concentrations was made on March 14, 1991 by K.D. Reynolds and R.G. McCain. The organic vapor analyzer manufactured by Summit Interests (SIP-1000) equipped with an 11.7 eV lamp was used for this analysis. This instrument provides a total vapor reading in terms of equivalent concentration (in ppm) relative to the calibration gas.

Two SIP's were used. One (SIP#1) was set up for relatively low sensitivity. The second (SIP#2) was set up for higher sensitivity, and a sample dryer probe containing a dessicant was used to eliminate moisture. Both SIP's were calibrated to 100 ppm isobutylene in air immediately prior to soil gas sampling. To measure soil gas concentration, each unit was connected directly to the soil gas point and pumped for a period of 1- 2 minutes. The value recorded is the maximum reading of the instrument during this period. The maximum reading is obtained by depressing the [SET] button while in measurement mode.

The results obtained are indicated on Figure 1 and tabulated in Table 1. In general, the two instruments gave relatively consistent responses. However, both appear to have experienced significant drift, as indicated by the change in calibtation constants. We are presently evaluating various methods to deal with instrument drift.

The measurements reported in Table 1 were collected during a period of falling barometric pressure. Barometric pressure values reported by the Hanford Weather Station were as follows:

10:00 am	29.061
11:00 am	29.058
12:00 noon	29.042

Table 1

Z-18 Crib Soil Gas Data
R.G. McCain / K.D. Reynolds
Mar 14, 1991

	SIP #1		SIP #2	
DIP =	3		2	
B =	58		120	
S =	915		1608	
C =	100		100	
point	ambient soil gas		ambient soil gas	
E-3	0.5	2.7	0.5	2.7
E-2	0.25	2.6	1.1	1.6
E-1	0.02	1.956	1.1	1.902
S-1	"LO"	3.901	1.1	3.339
W-1	"LO"	3.683	0.9	4.633
W-2	"LO"	3.628	0.8	3.973
W-3	"LO"	3.978	0.8	6.05
N-4	"LO"	3.049	0.7	3.065
N-1	"LO"	3.42	0.8	3.519
N-2	"LO"	2.36	0.6	2.661
N-5	"LO"	1.431	0.6	1.679
N-6	"LO"	0.601	0.6	1.492
N-11	"LO"	6	0.6	6.082
N-7	"LO"	6.622	0.5	7.46
N-3	"LO"	1.726	0.4	1.716
N-8	"LO"	14.62	0.5	14.95
W-5	"LO"	4.677	0.5	5.093
N-9	"LO"	5.234	0.4	7.319
N-10	"LO"	1.18	0.4	5.883
N-10	"LO"	1.114	0.4	5.149
N-12	"LO"	1.245	0.4	2.68
W-4	"LO"	3.278	0.3	6.529
9 PPM CCl4	-	9.6	-	8.8
RECALIBRATE INSTRUMENTS				
DIP =	3		2	
B =	42		114	
S =	562		1250	
C =	100		100	
9 PPM CCl4	-	10.4	-	10.6

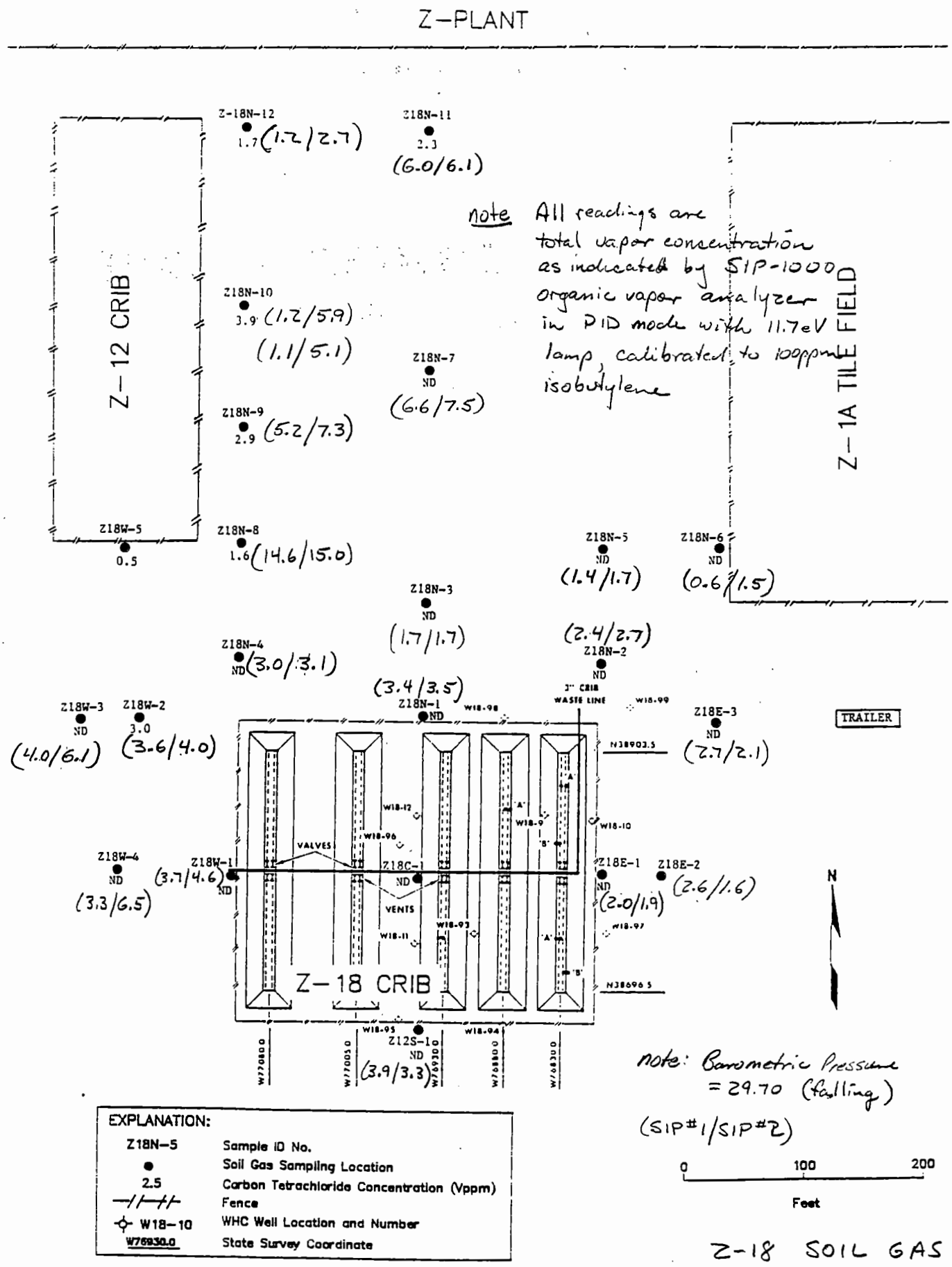

Figure 1. Soil Gas Sampling Locations and Carbon Tetrachloride Concentrations, 200 West Area, Hanford Reservation, Washington

Z-18 SOIL GAS
March 14, 1991
RG McCain / K.D. Reynolds

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APPENDIX E

GROUND WATER CHARACTERIZATION DATA

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APPENDIX E

GROUND WATER CHARACTERIZATION DATA

This appendix summarizes: (1) new analytical data acquired for Task 6 of the *200 West Area Carbon Tetrachloride Expedited Response Action Project Plan* (WHC 1991) and (2) existing data, used with new data, to evaluate the nature and extent of volatile organic contaminants in ground water and to address related health and safety concerns. The primary focus is on data quality aspects of the analytical results.

SAMPLING AND ANALYSIS

Sample Collection

All ground water sampling activities for this study were conducted under full procedural controls required by the Westinghouse Hanford statement of work (SOW) for Resource Conservation and Recovery Act (RCRA) of 1976 ground water monitoring projects (WHC 1990; PNL 1989). These are the same procedures and the same organization used to collect samples in the past, thus contributing to the comparability between previous or existing data and the present.

The general sampling procedure involved purging three bore volumes and stabilization of temperature, conductivity, and pH prior to sample collection (PNL 1989). Sample vials used for volatile organic analysis (VOA) were 40-mL amber glass vials with septum caps. Sample vials are carefully filled to eliminate air bubbles (i.e., "zero head space"). Field data and sampling conditions, including cross reference to sample chain of custody, were recorded on Pacific Northwest Laboratory (PNL) ground water sample field record sheets. Copies of all such records are maintained in the project files for this study as well as by PNL under the provisions of the aforementioned SOW (Task 16).

Monitoring Well Conditions

In accordance with the project plan (WHC 1991), only existing wells were sampled for this reconnaissance phase of ground water characterization. Monitoring wells in the primary areas of interest (near the 216-Z-1A Tile Field, 216-Z-18 Crib, and 216-Z-9 Trench), are primarily old wells of uncertain integrity. Following preliminary inspection, and initial attempts to obtain water samples, minimal remediation was requested on several of the wells. This consisted of attempting to install a pump and or removal of sand to deepen the well so that a pump could be installed. These efforts were largely unsuccessful and only a few wells met minimally acceptable conditions for acquiring representative ground water samples. A well status summary of these conditions is shown in Table E-1. In some cases, the limited water depth in a well allowed only a bailed sample to be obtained (i.e., no purging was possible prior to sampling). Such samples were submitted for analysis, but were used only to screen for the presence of volatile organic constituents. Results from bailed samples were not used to construct the near field distribu- tion map of carbon tetrachloride because they may not be representative of the aquifer.

Table E-1. Z Cribs Monitoring Well Status Summary.

Well	Purpose/Location	Able to collect sample	Type	Usable	Comment
299-W18-6	216-Z-1A Tile Field	No	None	No	Cannot deepen
299-W18-7	216-Z-1A Tile Field	No	None	No	Cannot deepen
299-W18-9	216-Z-18 Crib	Yes	Bailed	Marginal	May support a pump
299-W18-10	216-Z-18 Crib	No	None	Marginal	
299-W18-11	216-Z-18 Crib	No	None	No	
299-W18-12	216-Z-18 Crib	No	None	No	
299-W15-6[a]	216-Z-9 Trench	Yes	Submersible	Yes	Long perforated interval[b]
299-W15-8	216-Z-9 Trench	No	No	Marginal	May support a pump
299-W15-9	216-Z-9 Trench	Yes	Bailed	No	Too shallow
299-W15-16	Maximum observed concentrations	Yes	Hydrostar	Yes	
699-39-79	Increasing concentrations near maximum of plume	Yes	P	Yes	
699-38-70	Eastern perimeter of plume	Yes	P	Yes	
699-49-79	Northern perimeter of plume	Yes	P	Yes	
699-43-88	Western perimeter of plume	Yes	P	Yes	
299-W18-20	Southern perimeter of plume	Yes	P	Conditional; needs work	Needs perforated interval modified
299-W18-17	Southern perimeter of plume	Yes	P	Yes	
299-W18-2	Near Z-18 Crib	Yes	Hydrostar	Yes	
299-W10-17	Northern 200 W maximum	Yes	Hydrostar	Yes	
299-W10-18	Northern 200 W maximum	Yes	Hydrostar	Yes	
299-W15-22	Northern 200 W maximum	Yes	Hydrostar	Yes	
299-W7-4	Northern boundary of 200 W	Yes	Hydrostar	Yes	
299-W7-5	Northern boundary of 200 W	Yes	Hydrostar	Yes	

[a]Sampled by bailer at top and bottom of perforated interval after removing pump. Sampled at bottom with packer set 10 ft off the bottom.
[b]Long perforated interval; but needs to be sampled at various depth intervals before converting to 'standardized' sampling interval and sample pump.

Another major uncertainty about the older wells involves the possibility of "preferential pathways" along the outside of the casing that could have allowed vapor and/or liquid phase solvent to migrate downward through the unsaturated zone to the water table and even deeper into the saturated zone. This possibility cannot be evaluated for any of the older wells with currently available data. The closer the well is to a potential source (216-Z-9 Trench, 216-Z-1A Tile Field, or 216-Z-18 Crib), the more likely such a condition may have existed. Thus, the data from the older wells must be considered with this uncertainty in mind. The existence of such a source would be manifest as a random or anomalous occurrence. That is, if areal distribution of ground water concentrations occur in a somewhat regular manner, this may be circumstantial evidence that preferential pathways do not currently have a significant effect on observed ground water concentrations. Additionally, such contamination would tend to be more localized in the vicinity of the borehole. Extended (large volume withdrawals) pumping with time series sampling for VOAs may allow some inferences to be drawn in such cases. Widespread aquifer contamination would yield only slight changes in concentration with time or volume removed, whereas localized contamination would be expected to yield a declining contaminant concentration with volume removed.

In addition to the above, a mix of submersible pumps and Hydrostar (tradename of Instrumentation Northwest, Redmond, Washington) (positive displacement piston pumps) sample pumps, as indicated in Table E-1, were installed in the monitoring wells sampled. While the Hydrostar sample pump is in principle superior to the submersible pump for obtaining volatile organic samples, some Hydrostar pumps have been observed to cause significant "aeration" in the discharge water line during well purging. This apparent aeration has not been observed with submersible pumps. This is a generic problem that has been noted in several audits and for which a site-wide corrective action is needed. (A schedule has been worked out to check all Hydrostar pumps for "leaks" during June 1991 and to replace any defective parts or units).

A third uncertainty concerns the general practice of placement of the pump intake for most Hanford monitoring wells at 1.5 m below the static water level. If a dense, settling vapor is the primary pathway for contaminating ground water, the expectation would be for the highest concentrations to occur near the surface of the aquifer. Depth distribution data are needed to resolve this potential uncertainty and or to devise an alternative sampling strategy to obtain both types of samples from existing wells. (NOTE: an initial attempt was made to sample at the very top of the water in well W15-6 after removal of the sample pump but with inconclusive results. A concerted effort is necessary to assess the need for adjustment or modification of the depth of withdrawal for VOA sampling at a site where vapor transport is the primary suspected mechanism of ground water contamination).

Sampling for Vertical Distribution

Well W15-6 was sampled at three depths over its 52-m-long, perforated interval within the aquifer. The W15-6 well was originally equipped with a submersible pump set approximately 2.4 m below the water level. The well was sampled twice for this study with the pump in place. The pump was then removed, and a surface and bottom depth sample recovered with a flow-through bailer. A packer was then placed 3 m above the bottom of the perforated interval (52 m below the water table) to isolate the bottom section of the perforated interval. The packer was set on 5-cm riser pipe and a Hydrostar pump used for purging and sampling. The interval isolated by the packer was pumped at 4 L/min for 2 h. The calculated dead volume of the isolated interval was 57 L with 95 L in the 5-cm-diameter riser pipe above the packer. VOA samples were taken at the end of the pumping period after stabilization of standard indicator parameters and organic vapor monitor (OVM) (11.8-eV lamp) headspace readings that were made on 500 mL samples drawn at 15-min intervals.

Sampling results are also available from two different depths in well W18-17. This well was originally sampled in 1990 with a pump set at 6 m below the water level, with an additional 15 m of perforated interval below the pump. (There were no well casing perforations above the pump intake position.) While the exact depth zone sampled is uncertain, it is likely representative of 6 to 9 m below the water table. The same well was remediated by filling with sand (to approximately 6 m below the water level) and perforating the section of casing from 5 m below the water level to 1.5 m above the water level. The pump was then set 1.5 m below the water and a sample was taken.

Analytical Laboratory Results

Ground water samples in the vicinity of the study area are collected for RCRA, Operational Monitoring and Site-Wide Surveillance programs. Integration of ERA sampling with these activities minimized the number of new or additonal analyses. Laboratories, analytes, instrumentation, quality control data and results are discussed as follows.

Laboratories and Analytes of Interest. The target compounds or primary constituents for this study were carbon tetrachloride and chloroform. Carbon tetrachloride was expected to be the most significant contaminant based on abundance and ground water quality standards (e.g., 0.3 and 7 p/b for carbon tetrachloride and chloroform, respectively). However, several other volatile organics have been identified in soils of the 200 West Area and associated with past solvent extraction operations and testing. Thus, it was deemed important to include the broad spectrum screen available by gas chromatography/mass spectrometry (GC-MS) as well as analysis by standard GC methods more commonly available. Three laboratories were used for this purpose: (1) the GC-MS laboratory in the 325 Building in the 300 Area of Hanford Site operated by PNL, (2) an offsite Contract Laboratory Program (CLP) laboratory for Level IV analysis of laboratory splits (DATACHEM, Salt Lake City, Utah), and (3) the GC laboratory located in the Sigma 5 Building in the 1100 Area of the Hanford Site, operated by PNL.

The constituent lists for which results were routinely reported are as shown in Tables E-2 and E-3 for the GC and GC-MS methods, respectively. Also included are the results for one set of blanks. The GC laboratory results consistently yielded lower levels of detection than either of the GC-MS laboratories. This was especially true when the GC-MS laboratory diluted the samples to avoid contamination of the instrument from the samples with high concentrations of carbon tetrachloride. In these cases, the detectiom limit is 10 to 100 times higher than the levels indicated in Table E-2. The GC laboratory reported and quantified any additional significant peaks in the chromatograph not accounted for by the standard list shown in Table E-3. (The standard list shown in Table E-3 is a close match to the list of known volatile organics identified with an asterisk in Table E-2). Of the 34 compounds listed, only seven were reported above detection limits in the samples analyzed during the period of this study:

- carbon tetrachloride
- chloroform
- methylene chloride
- trichloroethylene
- tetrachlorotheylene (or perchloroethylene)
- methyl ethyl ketone, or 2-butanone
- toluene.

Only results for the above constituents are listed in the summary data table (Table E-4). All other constituents listed in Table E-2 or E-3 were below detection limits.

In addition to the volatile organics, some results for inorganic anions were available that have been included. Additionally, not all results were received in time for inclusion in this report. They should eventually be available from the Hanford Environmental Information System (HEIS) data base. Other major co-contaminants in the carbon tetrachloride solvent waste included TBP, DBP, and DBBP. These constituents were not analyzed in the ground water samples collected for this study. However, TBP and DBP results for several wells within and adjacent to the study area are available from the Hanford Ground Water Data Base (HGWDB). These data are included in the existing data summary that follows.

Quality Control Samples. Blanks, duplicates, and laboratory splits were used for quality control purposes. Blank results were as shown in Tables E-2 and E-3. Duplicates and laboratory splits are indicated in Table E-4. It should also be noted that the three laboratory split results (one additional laboratory split result has not been received), as well as samples from two other wells, were processed as Level IV data and received Westinghouse Handford Level B validation (summary sheets attached). No problems were identified with any of the validation checks.

Generally, there is good agreement for laboratory splits and duplicates for carbon tetrachloride and less so for chloroform. Other constituents are not consistently detected often enough to make any meaningful observation.

Table E-2. Constituent List and Blank Results for Gas Chromatography (GC) Method.

Compound (ppb)	Photo-ionization detector	Electron capture detector
Methylene Chloride		<5
trans-1,2-Dichloroethylene	<0.5	<3
1,1-Dichloroethane		<3
cis-1,2-Dichloroethylene	<0.5	<2
Chloroform		<2
1,1,1-Trichloroethane		<2
Carbon Tetrachloride		<2
1,2,-Dichloroethane		<2
Benzene	<0.5	
Trichloroethylene	<0.5	<2
Toluene	<0.5	
Tetrachloroethylene	<0.5	<2
Ethylbenzene	<0.5	
M + P - Xylene	<0.5	
O-Xylene	<0.5	
Other species		

Table E-3. Constituent List and Blank Levels for Gas Chromatography-Mass Spectrometry (GS-MS) Method.

Cas Number	Compound	Concentration units (µg/L or µg/Kg)	
		Data Chem	PNL 325
74-87-3	Chloromethane	10	10
74-83-9	Bromomethane	10	10
75-01-4	Vinyl Chloride	10	10
75-00-3	Chloroethane	10	10
75-09-2	Methylene Chloride[a]	5	5
67-64-1	Acetone[a]	10	10
75-15-0	Carbon Disulfide	5	5
75-35-4	1,1-Dichloroethene[a]	5	5
75-35-3	1,1-Dichloroethane	5	5
540-59-0	1,2-Dichloroethene[a] (total)	5	5
67-66-3	Chloroform	5	5
107-06-2	1,2-Dichloroethane[a]	5	5
78-93-3	2-Butanone[a,b]	10	10
71-55-6	1,1,1-Trichloroethane[a]	5	5
56-23-5	Carbon Tetrachloride[a]	5	5
108-05-4	Vinyl Acetate	10	10
75-27-4	Bromodichloromethane	5	5
78-87-5	1,2-Dichloropropane	5	5
10061-01-5	cis-1,3-Dichloropropene	5	5
79-01-6	Trichloroethene[a]	5	5
124-48-1	Dibromochloromethane	5	5
79-00-5	1,1,2-Trichloroethane	5	5
71-43-2	Benzene[a]	5	5
10061-02-6	Trans-1,3-Dichloropropene	5	5
75-25-2	Bromoform	5	5
108-10-1	4-Methyl-2-Pentanone	10	10
591-78-6	2-Hexanone,[a,c]	10	10
127-18-4	Tetrachloroethene[a]	5	5
79-34-5	1,1,2,2-Tetrachloroethane	5	5
108-88-3	Toluene[a]	5	5
108-90-7	Chlorobenzene[a]	5	5
100-41-4	Ethylbenzene[a]	5	5
100-42-5	Styrene	5	5
1330-20-7	Total Xylenes[a]	5	5

[a]Previously reported in 200 West soils and/or known to have been used in processes associated with the Z Cribs.
[b]Also known as methyl ethyl ketone (MEK).
[c]Also known as butyl methyl ketone.

A summary comparison between laboratory splits for this study and between results of this study and existing data is shown in Figure E-1. This plot indicates good agreement between CLP Level IV results and onsite GC data (Sigma 5 laboratory) as well as reasonable agreement with existing data. This provides confidence in the data necessary to combine all available carbon tetrachloride results for the far-field areal distribution maps. Thus, for the purposes of this study, there appears to be concordance between existing or nonvalidated data and current validated results.

Existing Analytical Data

All available 200 Area carbon tetrachloride results from the Hanford Ground Water Data Base (HGWDB) were combined with current results from Table E-4 to form an integrated data base for estimating far-field distribution patterns of carbon tetrachloride (Table E-5 and corresponding plots shown in Section 2.4.2). Data for constituent code A61 in the vicinity of 200 West Area were extracted from the HGWDB using the Westinghouse Hanford Geosciences Group's Paradox software on 4/30/91. The data cover the period of 1988 to the present. Where there were multiple results, the average was used for the entries shown in Table E-5. An "average" collection date is listed in each case where multiple analytical results were averaged. The table also provides information about the well and sampling system used. In most cases, the plume appears to be moving slowly enough that combining the time periods of sample collection should not significantly distort the distribution pattern obtained. Otherwise, there is insufficient areal distribution data on a year-by-year basis.

The time variability of existing carbon tetrachloride data is illustrated in Figure E-2 at well W15-16, the well with the highest ground water carbon tetrachloride concentrations. The plot also illustrates the effect of averaging multiple results from 1988 to present and that results from the previous analytical vendor are in reasonable agreement with present results.

Existing data for TBP and DBP for the period 1/88 to 5/91 are provided in the HGWDB. All values from the HGWDB were listed as less than the detection limits (10 µg/L for TBP and 10,000 µg/L for DBP). One value of 20 µg/L appears for TBP in Table E-7 that was the apparent detection limit for that analysis (i.e., listed as <20 µg/L in the HGWDB).

Table E-4. Summary of Ground Water Analytical Results. (sheet 1 of 2)

Well number	HEIS Sample ID	Collection Date	Time	pH	Temp. °C	Conductivity µS	Carbon Tetrachloride	Chloro-form	Methylene Chloride	Trichloro-ethylene	Tetrachloro-ethylene	Methyl ethyl ketone	Fluoride	Chloride	Phosphate	Sulfate	Nitrate	Lab	Chain of Custody
2-W15-22	B00JD2	4/18/91	1010	NA	NA	NA	1204	63	<5	7.9	1	NA	0.7	14.6	<0.2	33.1	63.4	A	38207
2-W18-20	H0007167	2/6/91	953	7.5	23.3	205	193	14	<5	1	<0.5	7	NA	NA	NA	NA	NA	B(A)	38044 (22815)
2-W18-20-0	(E)	2/6/91	953	7.5	23.3	205	181	13	<5	0.9	<0.5	6.5	NA	NA	NA	NA	NA	A	38044
2-W18-20-1	(E)	2/6/91	953	7.5	23.3	205	179	14	<5	0.9	<0.5	6.6	NA	NA	NA	NA	NA	A	38044
2-W18-20	H0007305	3/20/91	NA	NA	NA	NA	173	15	<5	0.9	<0.5	1.7	NA	NA	NA	NA	NA	A	38075
LAB SPLIT	H0007305	3/20/91	NA	NA	NA	NA	150	21	<5	<5	<5	<10	NA	NA	NA	NA	NA	C	38072
2-W18-9(b)	E	2/6/91	1250	6.8	17.9	263	61	5.5	<5	<0.5	<0.5	1347	NA	NA	NA	NA	NA	A	38037
2-W18-2	H0007302	3/20/91	NA	NA	NA	NA	929	654	<5	1.7	1.1	NR	NA	NA	NA	NA	NA	A	38074
LAB SPLIT	H0007302	3/20/91	NA	NA	NA	NA	920	1100	<50	<50	<50	<100	NA	NA	NA	NA	NA	C	38067
2-W18-17(P)		1/29/91	952	7.8	20.3	246	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	B(A)	38041 (22814)
2-W18-17	H0007303	3/20/91					1004	45	<5	9.4	0.7		NA	NA	NA	NA	NA	A	38100
LAB SPLIT	H0007303	3/20/91					1200	<50	<50	<50	<50	<100	NA	NA	NA	NA	NA	C	38072
2-W18-17(DUP)	H0007304												NA	NA	NA	NA	NA	C	NO RECORD
W7-4	H0007326						230	<5	<5	<5	<5	<10	NA	NA	NA	NA	NA	C	38127
W7-5	H0007329						28	<5	<5	<5	<5	<10	NA	NA	NA	NA	NA	C	38128
699-43-88(P)		1/29/91	1226	7.7	17.2	291	<10	<10	<10	<10	<5	<20	NA	NA	NA	NA	NA	B	38047
699-39-79(P)		1/29/91	852	8	14.3	280	340	<10	<20	<20	<20	<40	NA	NA	NA	NA	NA	A(B)	22817 (38046)
699-49-79(P)		1/29/91	1130	7.8	17.8	419	<5	<5	<5	<5	<5	<10	NA	NA	NA	NA	NA	A(B)	22818 (38048)
BLANK							<5	<5	<5	<5	<5	<10	NA	NA	NA	NA	NA	B	NA
699-38-70		1/29/91	1040	7.2	19	1083	38	<5	<5	<5	<5	<10	NA	NA	NA	NA	NA	A(B)	22816 (38045)
W15-16(H)		1/30/91	910	7.6	17.7	642	6200	<500	<500	<500	<500	<1000	NA	NA	NA	NA	NA	B	38035
W15-16(DUP)							5000	45	<5	8	<5	<10						B	38035
15-9(B)		1/31/91	845	6.5	14.5	643	1600	1500	<500	<500	210J	700J	NA	NA	NA	NA	NA	B	38034
DUP(B)		1/31/91	845	6.5	14.5	643	1600	2400	<500	<500	<500	<1000	NA	NA	NA	NA	NA	B	38034
2-W10-17(H)	B00JF3	5/8/91	NA	NA	NA	NA	1162	37	<5	15	1	NA	2.2	25.5	<0.2	65.4	121	A	38210
2-W10-18(H)	B00JF4	5/8/91	NA	NA	NA	NA	705	18	<5	5.9	<0.5	NA	1.3	27.1	<0.2	62.2	54.1	A	38211

Table E-4. Summary of Ground Water Analytical Results. (sheet 2 of 2)

Well number	HEIS Sample ID	Collection Date	Time	pH	Temp. °C	Conductivity µS	Carbon Tetrachloride	Chloro-form	Methylene Chloride	Trichloro-ethylene	Tetrachloro-ethylene	Methyl ethyl ketone	Fluoride	Chloride	Phosphate	Sulfate	Nitrate	Lab	Chain of Custody
2-W15-6(H)	B00JF5	5/8/91	NA	NA	NA	NA	2651	64	<5	1.3	1.2	NA	0.8	19.4	<0.2	33	4.7	A	38212
2-W15-6-0(P)	E	2/6/91	1105	7.4	17.4	326	4851	23	<5	1.5	1.8	NA	NA	NA	NA	NA	NA	A	38049
2-W15-6-1(DUP)	E	2/6/91	1105	7.4	17.4	326	4638	23	<5	1.5	1.8	NA	NA	NA	NA	NA	NA	A	38049
2-W15-6(B-top)	B00JD0	4/9/91		6.5	17.5	375	5770	43	<5	2.1	3	NA	NA	NA	NA	NA	NA	A	38205A
2-W15-6(B-bott)	B00JD1	4/9/91					3784	22	<5	1.6	1.4	NA	NA	NA	NA	NA	NA	A	38205A
2-W15-16(H)	H0007165	1/30/91	910	7.6	17.7	642	7429	38	<5	7.8	1.7	NA	NA	NA	NA	NA	NA	B(A)	38035 (22813)
2-W15-6(P)		1/30/91	1020	7.6	16.4	322	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	38032
2-W15-6(SPLIT COL)		4/9/91							<5				NA	NA	NA	NA	NA	NA	38204

A = PNL SIGMA 5 LAB
B = PNL 325 LAB
C = DATACHEM, INC
E = EXCEEDED HOLDING TIME
P = SUBMERSIBLE PUMP
H = HYDROSTAR
B = BAILED
DUP = DUPLICATE

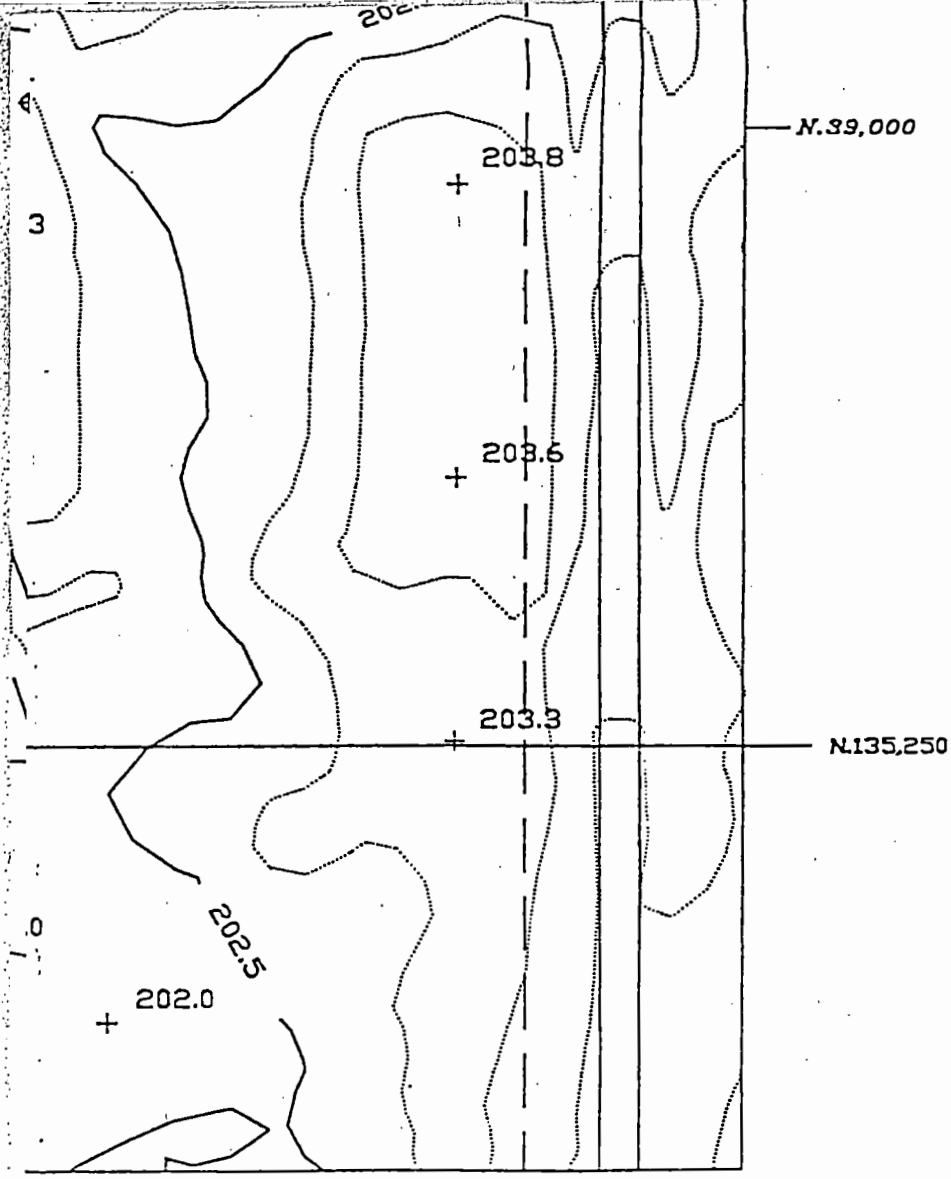

PLATE 1

DRAWN J.V. VOSAHLO	4/19/91	
CHECKED G.D. TILLEY	6-13-91	
DFTG APVD D. COWEN	6-13-91	
COG ENGR M.C. HAGOOD	6-13-91	
QA		
OTHER		
OTHER		
OTHER		
APVD FOR IMPLEMENTATION		
BY		
FOR	DATE	

EDT 145784

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
Westinghouse Hanford Company

TOPOGRAPHIC MAP
Z CRIBS WELLS

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	216Z	0500	H-13-000005	1

SCALE 1:750 SHEET 1 OF 1

CHK PRINT ☒ DATE 6/11/91 COMMENT PRINT ☐ DATE

DWG NO H-13-000005 SH 1 OF 1 REV 1

Horizontal Scale
500 ft

Vertical Scale
100 ft

Vertical Exaggeration
2.1 X

ation
Approximate)

well numbers
299–)

rt to metric, multiply
by 0.3048 to obtain
s)

Plate 2

Geologic Cross Sections in the Vicinity of Z Plant

GEOSCI\042691–C

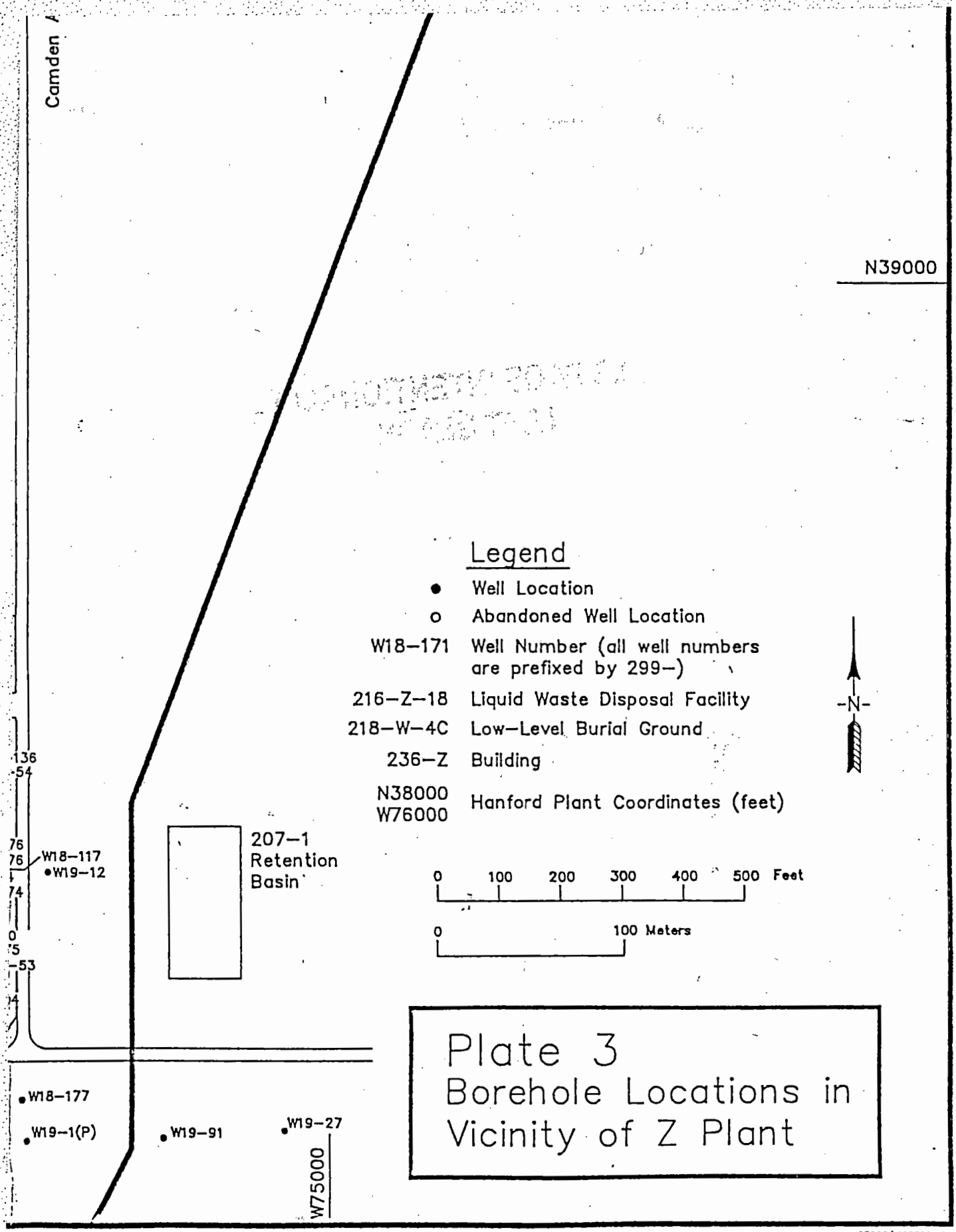

Plate 3
Borehole Locations in Vicinity of Z Plant

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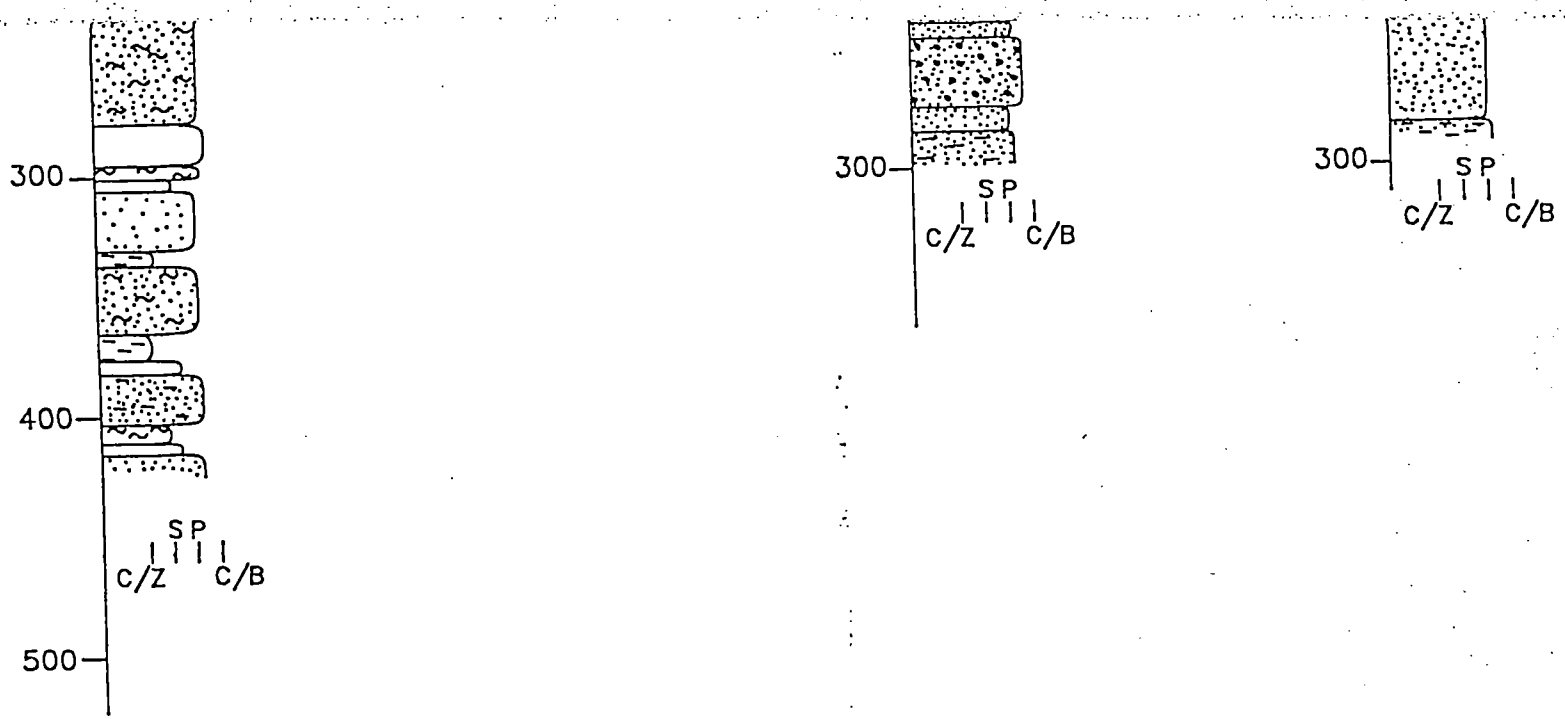

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Vertical
Exaggeration
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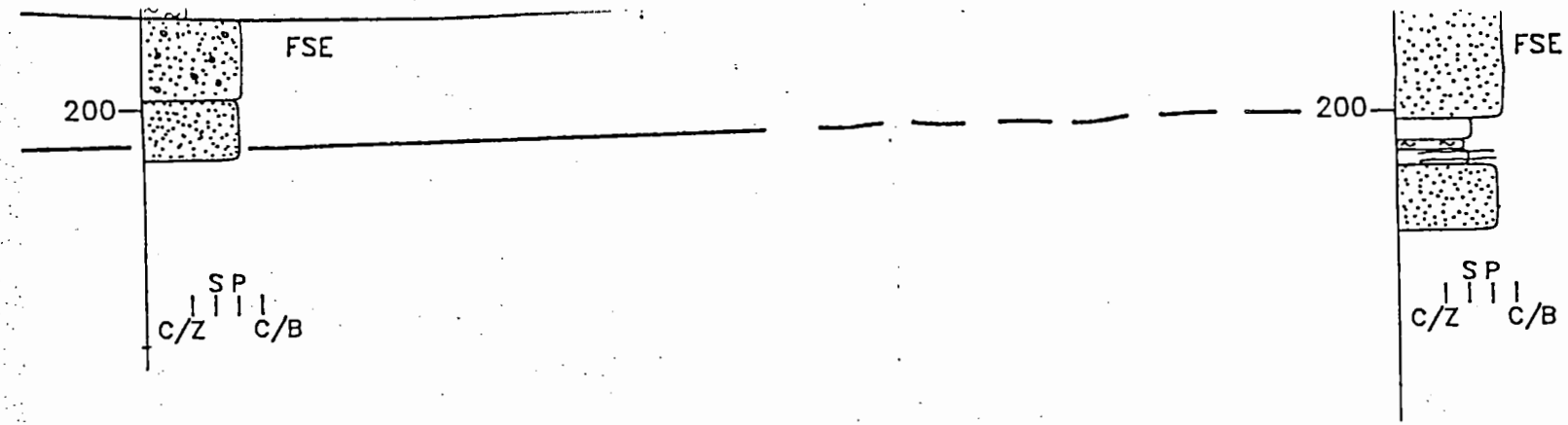

Horizontal Scale
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Vertical Scale
100 ft

Vertical
Exaggeration
2.1 X

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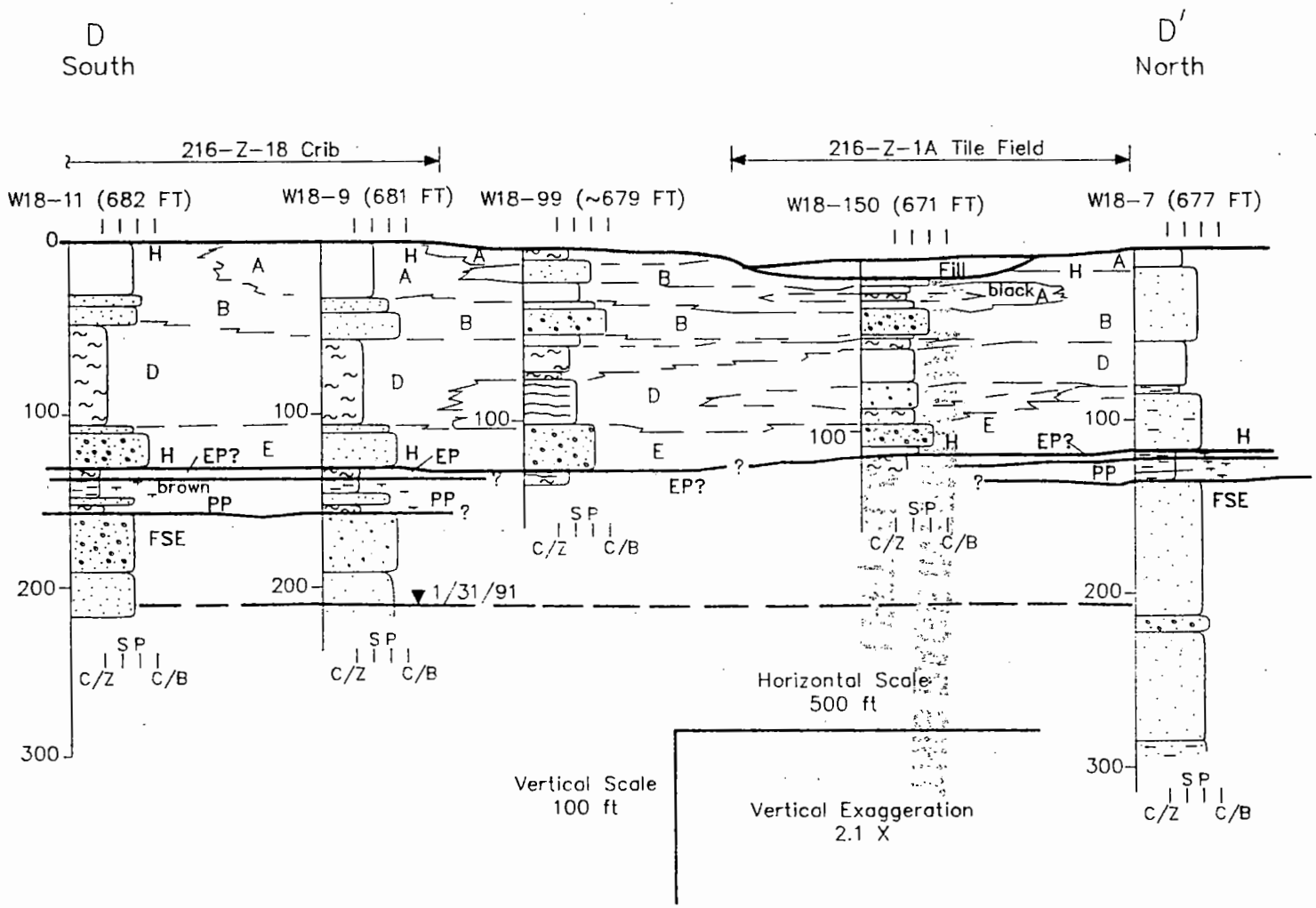

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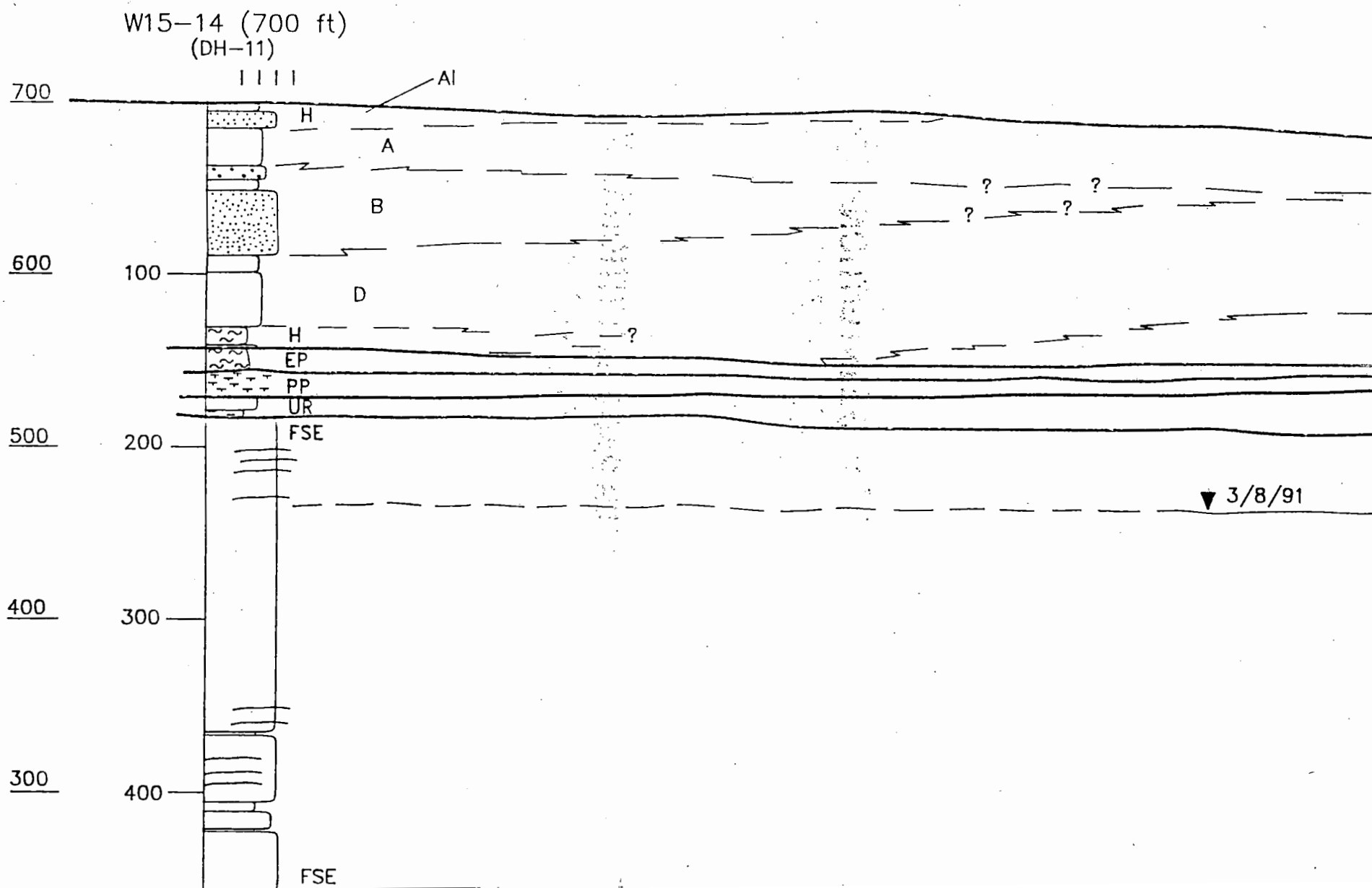
B
West



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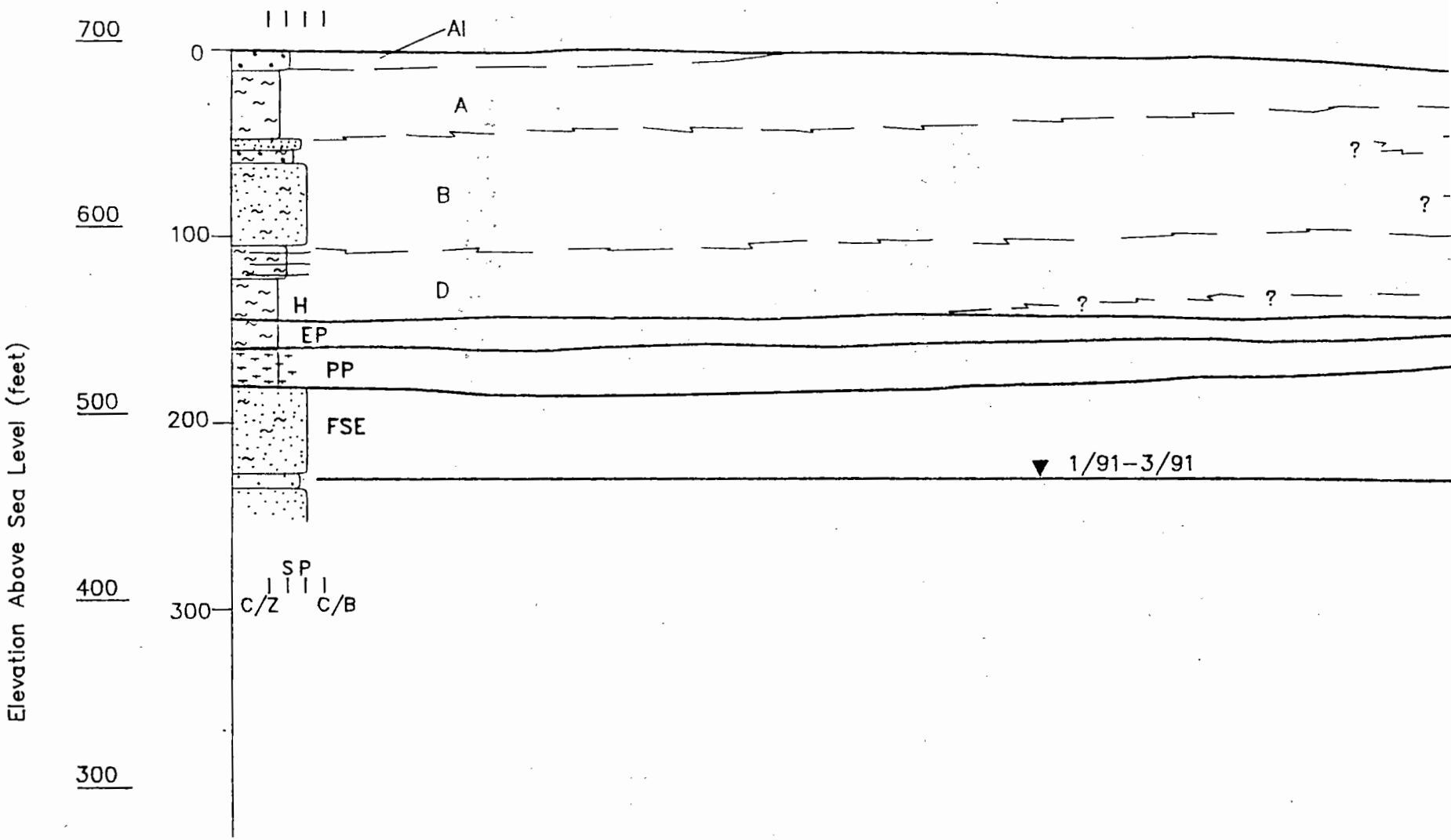
C

WEST

W18-23 (695 ft)



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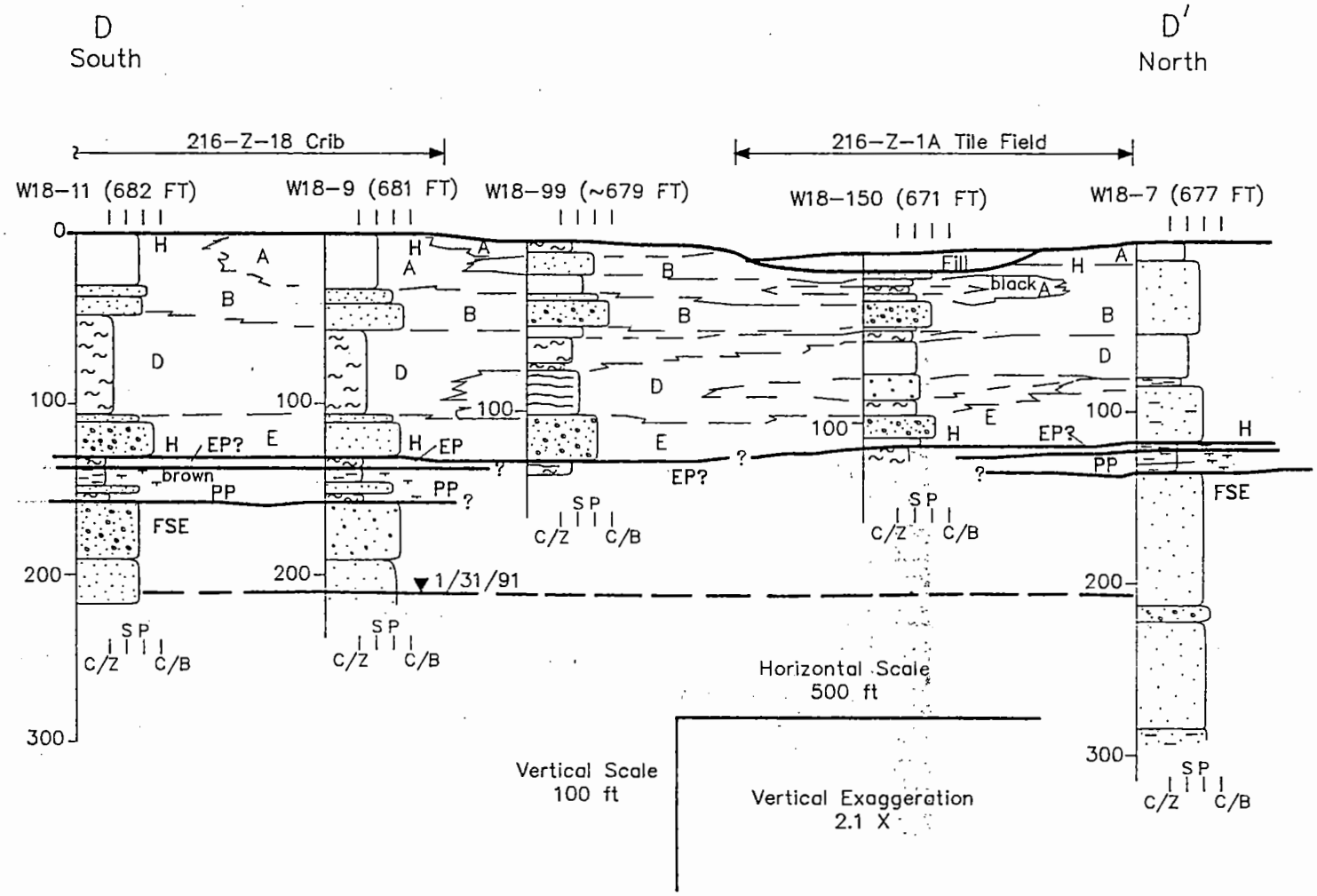

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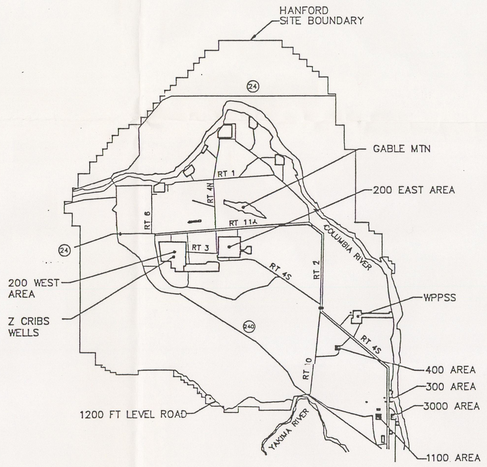
LEGEND

W.47,000 N.43,000	HANFORD PLANT COORDINATES (FEET)
E.576,250 N.136,000	WASHINGTON STATE COORDINATES (METERS)
	INTERMEDIATE CONTOUR
215.0	INDEX CONTOUR (METERS)
	EDGE OF PAVEMENT
	FENCE
	POST & CHAIN FENCE
+199.9	SPOT ELEVATION (METERS)
216-Z-18	CRIBS
241-Z	BUILDING
2-W18-12	WELL 299-W18-12
(2-W18-60)	ABANDONED WELL (299-W18-60)
	DIRT ROAD OR TRAIL
	PAVED ROAD
	BUILDINGS
4" SW	SANITARY WATER LINE



KEY PLAN
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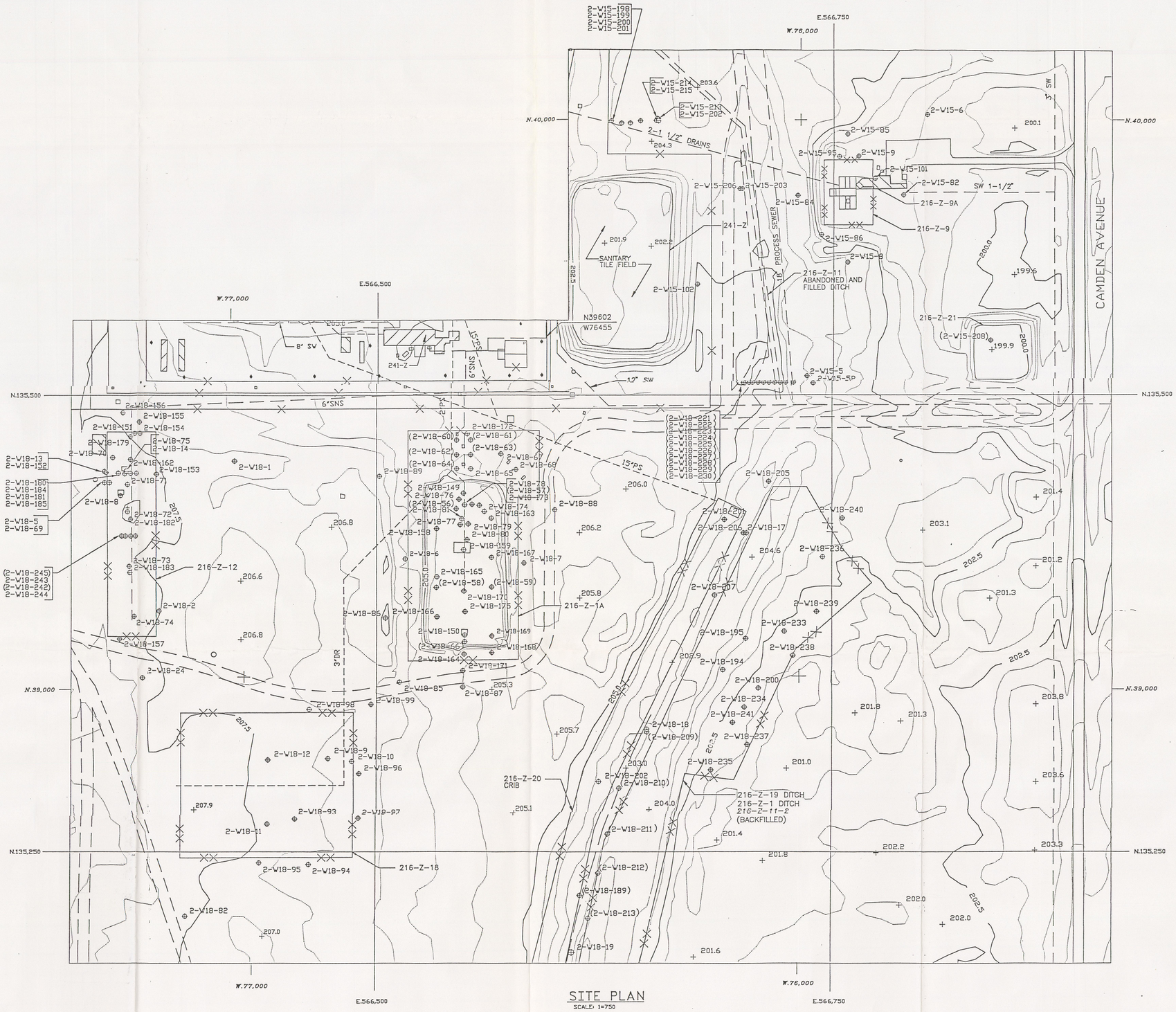


SITE PLAN
SCALE: 1=750

0 7.5 15 30 45 60 METERS

1 cm = 7.5 meters
PHOTO DATE: 6-24-89
CONTOUR INTERVAL: 0.5 meter

PLATE 1

DRAWN	J.V. VOSAHLO	4/19/91
CHECKED	G.D. TILLEY	6-13-91
DFTG APVD	D. COVEN	6-13-91
COG ENGR	M.C. HAGOOD	6-13-91
QA		
OTHER		
OTHER		
OTHER		
APVD FOR IMPLEMENTATION		

EDT 145784

U.S. DEPARTMENT OF ENERGY
Richland Operations Office
Westinghouse Hanford Company

TOPOGRAPHIC MAP Z CRIBS WELLS

SIZE	BLDG NO	INDEX NO	DWG NO	REV
F	216Z	0500	H-13-000005	1

SCALE 1:750 SHEET 1 OF 1

REV NO	DESCRIPTION	REV BY DATE	CHK BY DATE	DFTG APVD DATE	COG ENGR	OTHER	OTHER
1	PER ECN 145780 DIRECT DRAWING CHANGE	PAN 7/91	7/8/91				

REVISIONS — APPROVALS BY/DATE

DWG NO	TITLE	REFERENCES
H-6-10118	TOPOGRAPHICAL MAP 200 E/200 W AREA	
REF NUMBER	TITLE	

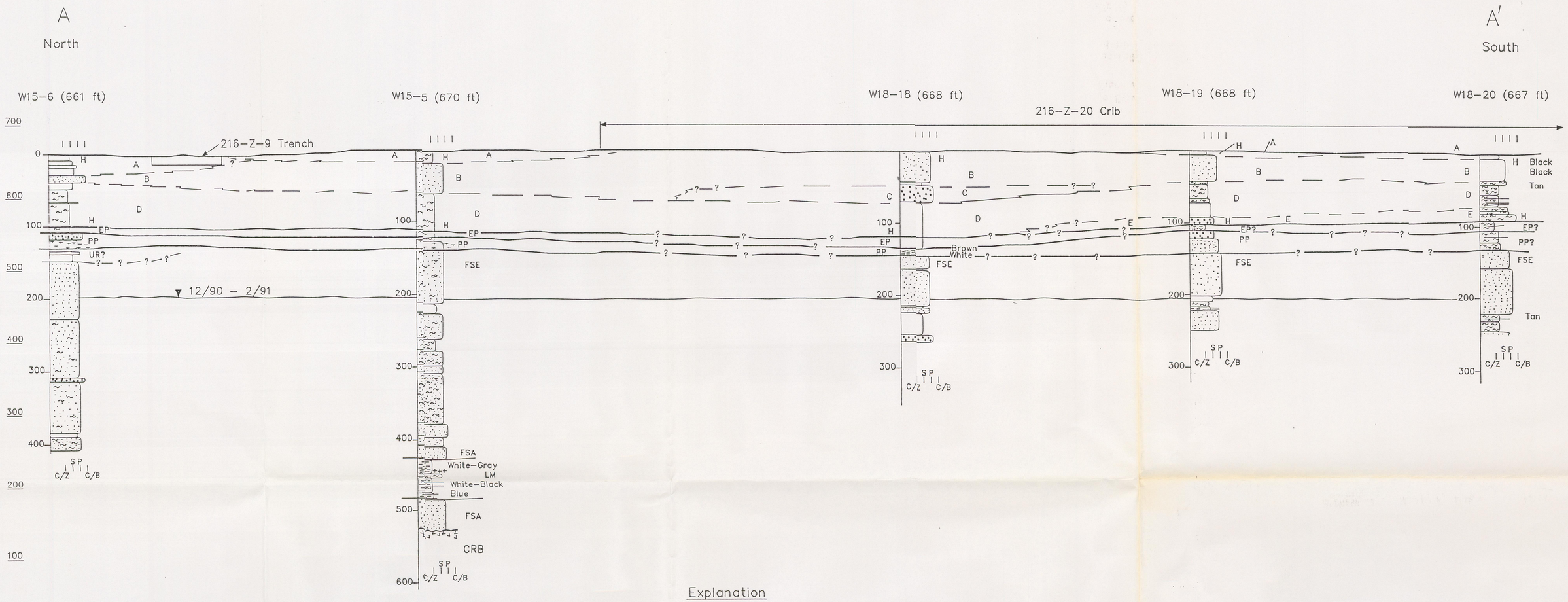
DRAWING TRACEABLILITY LIST — NEXT USED ON H-13-000001

CADFILE N0000054 CADCODE 1X:IBMJACD2:10.0:h

CHK PRINT ☒ DATE 6/11/91 COMMENT PRINT ☐ DATE

54-6000-027(5/89)

H-13-000005 REV 1 SHT 1 of 1



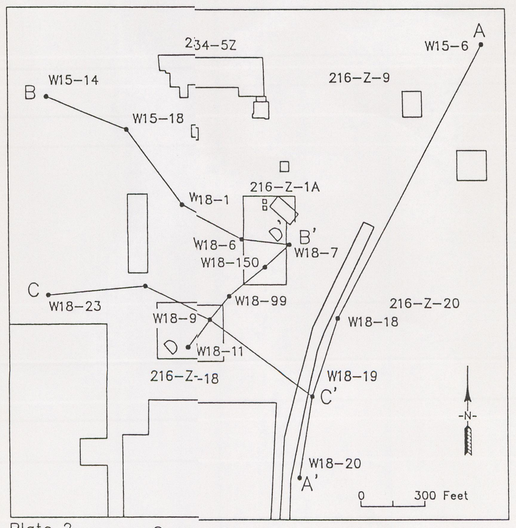


Plate 2 Cross Section Locations

Explanation

Dominant grain size scale

C/Z	Clay and silt
S	Sand
P	Pebble Gravel
C/B	Cobble and boulder gravel

Additional Lithologic Symbols

	Clay rich		Paleosol
	Silt rich		Ashy
	Sandy		Carbonate-rich
	Pebbly		Basalt
	Cobbly/bouldery		Formation major unit contacts
			Facies contact

Major Units

- H – Hanford formation, divided into stratigraphic intervals labeled A, Al, B, C, D, AND E
- EP – early "Palouse" soil
- PP – Plio-Pleistocene unit
- UR – Upper unit of Ringold Formation
- FSE – Ringold gravel unit E
- LM – Ringold mud unit
- FSA – Ringold gravel unit A
- CRB – Columbia river basalt

Water Table Elevation (Dashed Where Approximate)

W18-18 Well Number (all well numbers are prefixed by 299-)

Note: To convert to metric, multiply elevation (feet) by 0.3048 to obtain elevation (meters)

Horizontal Scale
500 ft

Vertical Scale
100 ft

Vertical Exaggeration
2.1 X

Plate 2

Geologic Cross Sections in the Vicinity of Z Plant

GEOSCI\042691-C

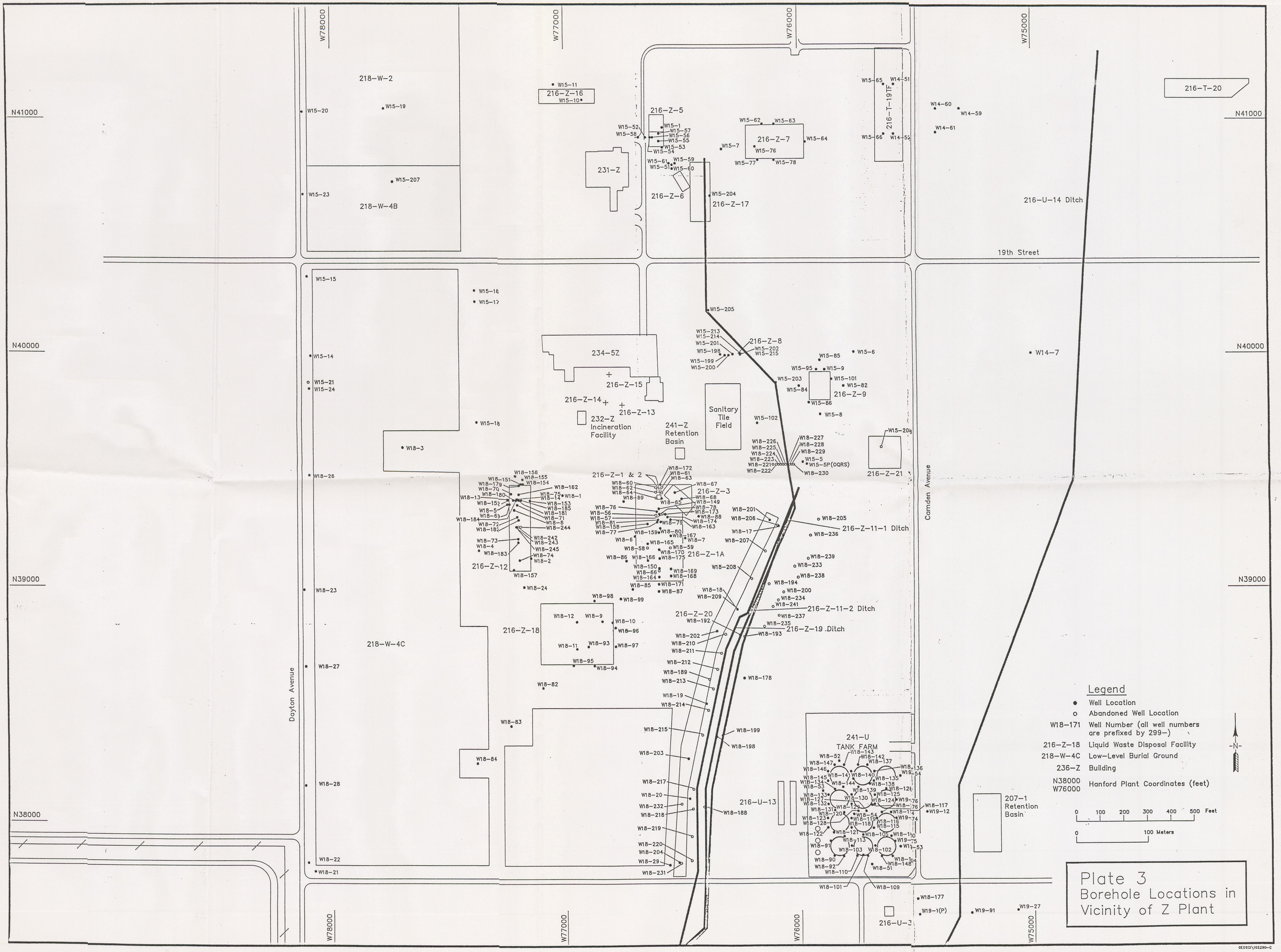
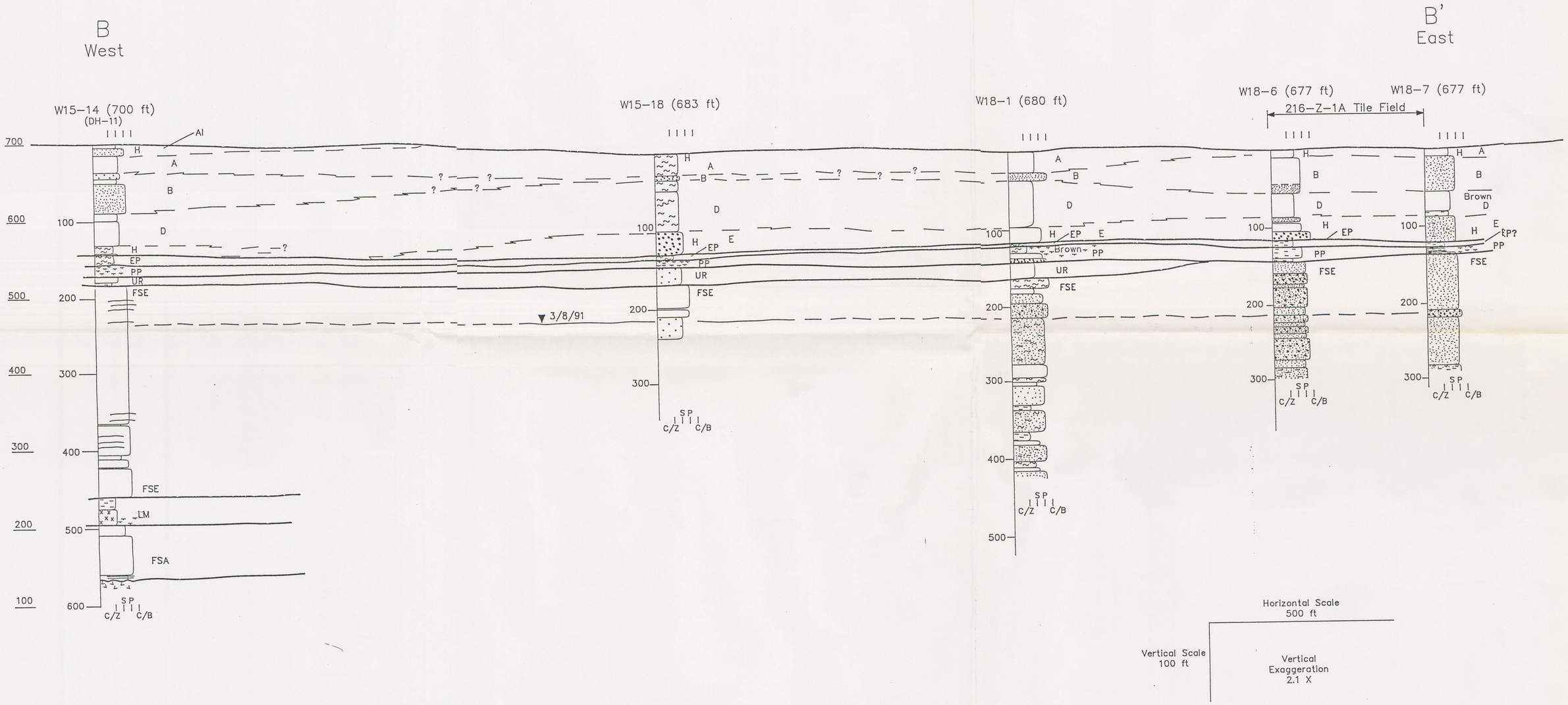


Plate 3
Borehole Locations in Vicinity of Z Plant



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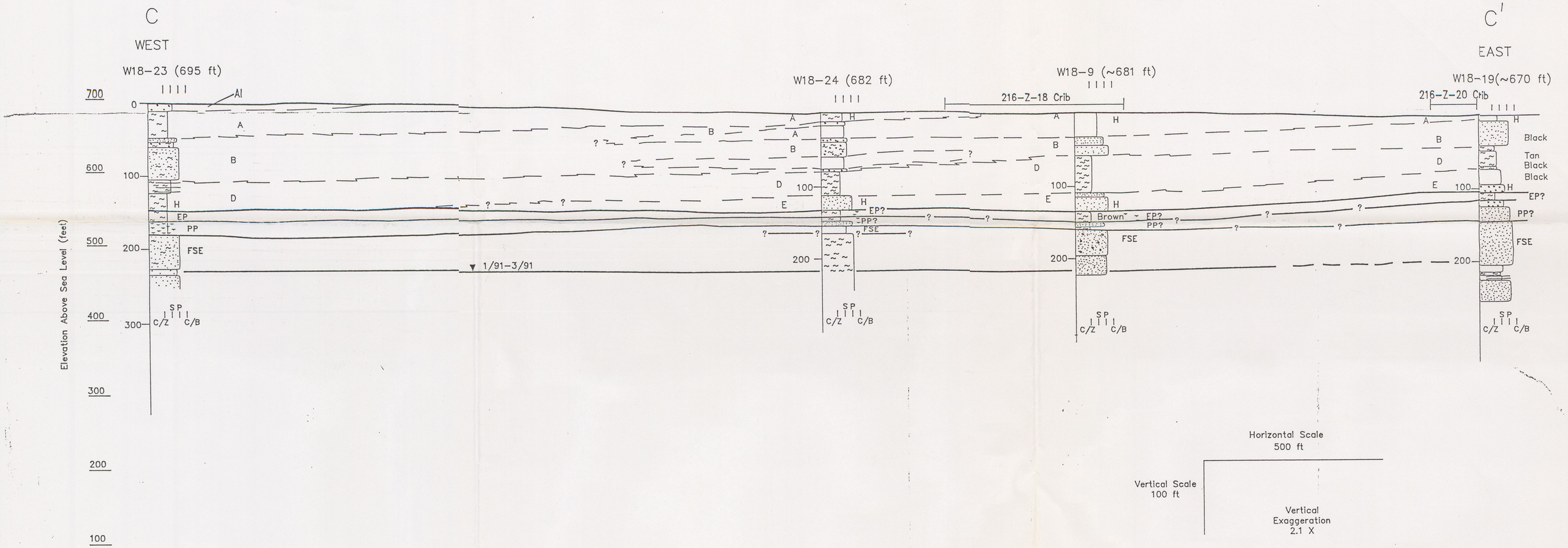

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Figure E-1. Comparison of Interlaboratory Results for Carbon Tetrachloride in 200 West Area Ground Water.

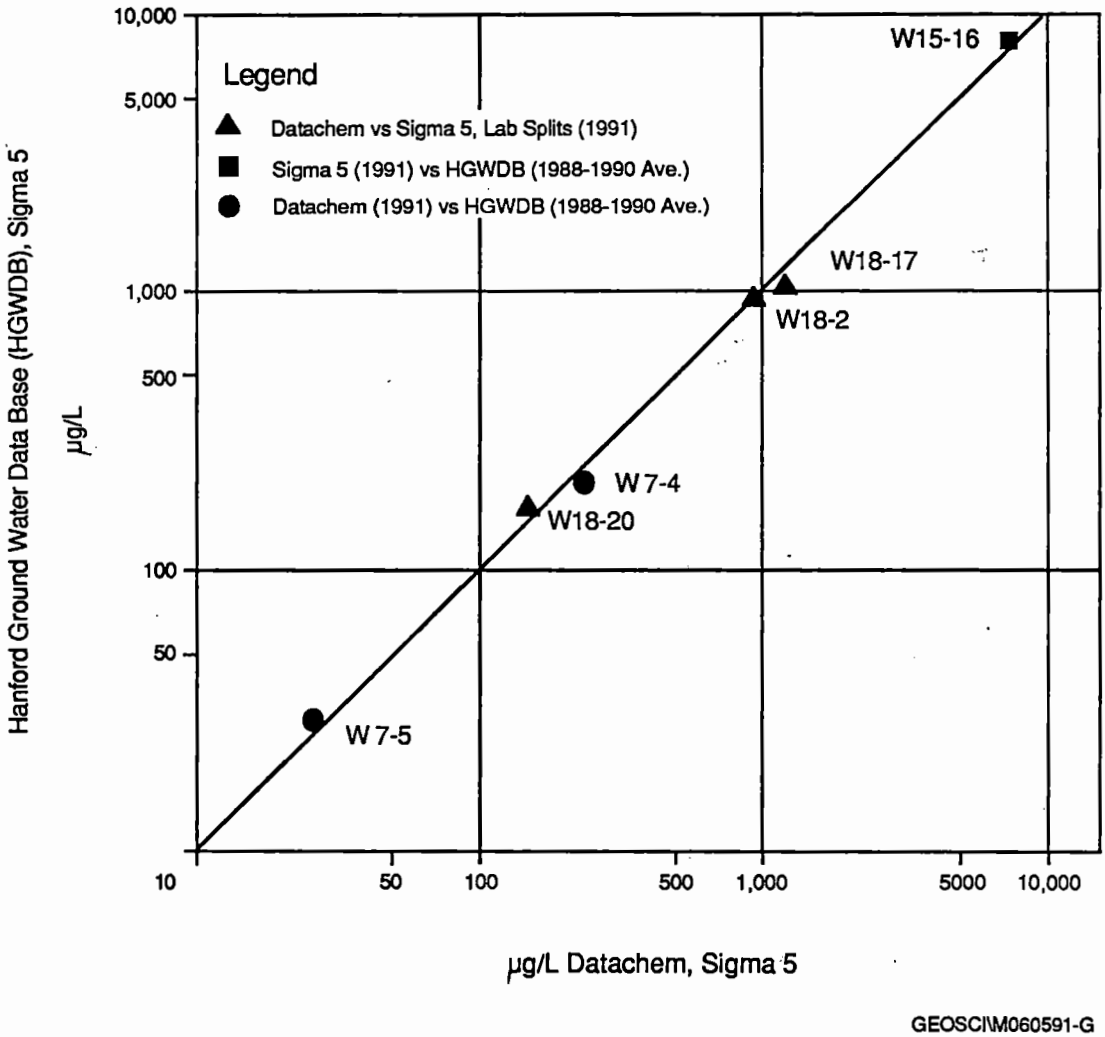

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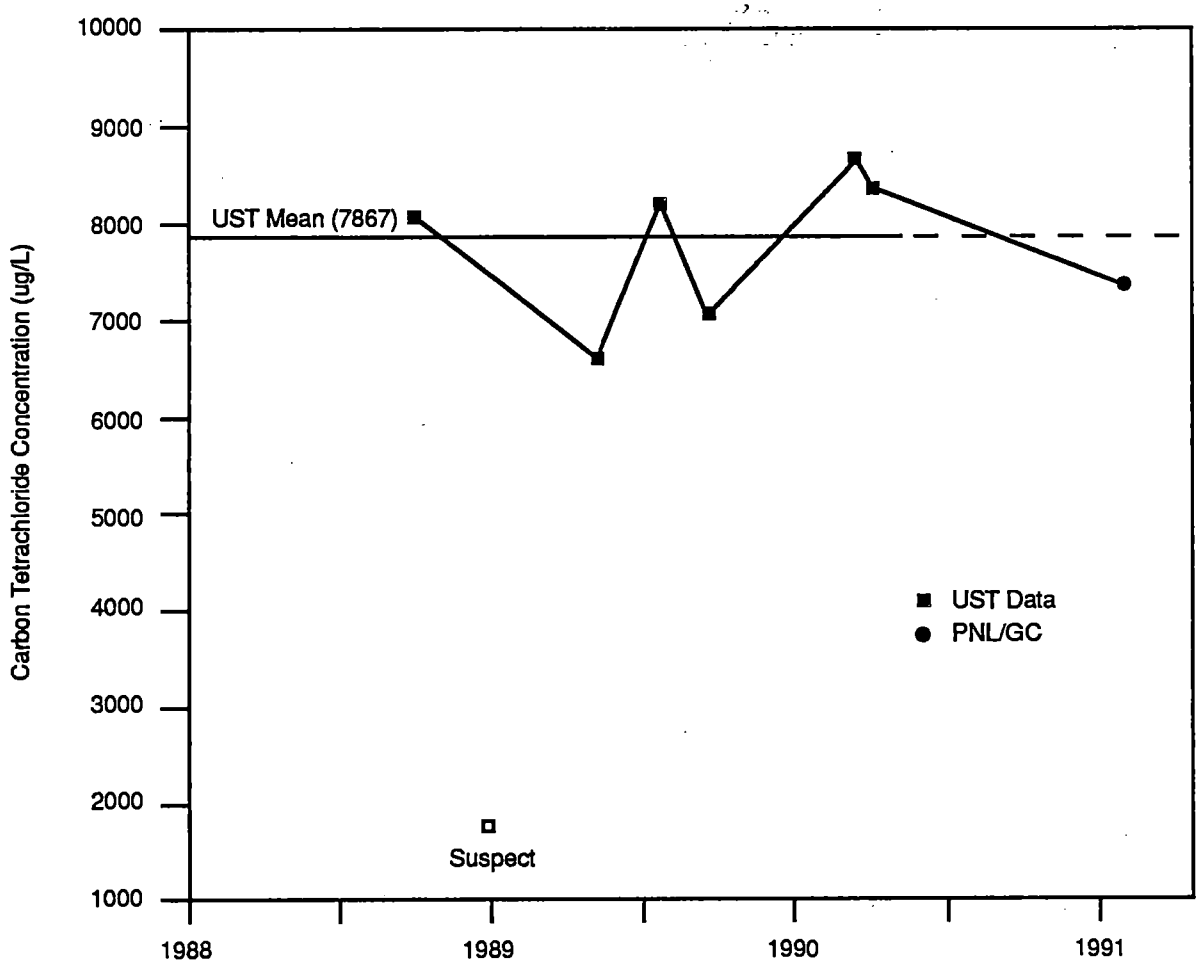
Table E-5. Summary of 200 West Area Carbon Tetrachloride Data (1/88 to 5/91).

WELL	EW	NS	DIAM	DEPTH	PERF MIN	PERF MAX	DRILL DATE	SAMPLER	RESULT
W10-13	78297	43137	4	247			9/25/87	P-Hydstr	11.8
W10-14	78330	43143	4	447			11/18/87	P-Hydstr	5.0
W10-4	75977	43033	8	236	190	245	11/30/52	P-Submrsbl	2663.0
W10-9	75930	43760	6	220	0	0	10/31/73	P-Submrsbl	2000.0
W11-14	73000	44000	8	310	250	313	12/31/62	Bailer	767.0
W11-7	74251	43350	8	306	245	290	9/30/51	Bailer	2290.0
W14-10	71905	40810	8	330	260	275	7/31/81		5.0
W14-2	75330	42255	8	220	181	222	5/31/55	P-Submrsbl	983.0
W14-5	75440	41160	6	238	190	225	10/31/74	P-Submrsbl	630.0
W14-6	75440	41360	6	236	195	225	12/31/74	P-Submrsbl	301.0
W15-10	76920	41080	8	298	183	297	1/31/68	P-Submrsbl	3893.0
W15-11	77040	41145	8	300	183	297	3/31/68	P-Submrsbl	4900.0
W15-12	76095	42350	6	220	195	215	10/31/73	Bailer	1580.0
W15-15	78103	40330	4	253			9/02/87	P-Hydstr	471.0
W15-16	77387	40269	4	238			9/02/87	P-Hydstr	7867.0
W15-18	77383	39705	4	238			8/04/87	P-Hydstr	1897.0
W15-19	77772	41041	4	235	214	235		P-Hydstr	1105.0
W15-20	78120	41028	4	240	220	240		P-Hydstr	192.5
W15-24	78096	39851	4	241	220	241		P-Hydstr	380.0
W15-4	75700	41200	8	212	170	216	1/31/56	P-Submrsbl	1960.0
W15-6	75765	40005	6	410	175	408	1/03/59	P-Submrsbl	4744.0
W15-7	76180	40880	8	325	182	350	3/31/66	P-Submrsbl	2350.0
W18-15	77152	36990	8	243	170	243	4/30/80	P-Submrsbl	106.0
W18-17	76091	39256	8	265	220	250	9/30/81	P-Submrsbl	1004.0
W18-2	77150	39120	8	280	200	278	1/11/58		929.0
W18-20	76477	38103	8	250	220	249	8/31/82		183.0
W18-21	78080	37794	4	226			7/29/87	P-Hydstr	139.0
W18-23	78120	38987	4	251			7/01/87	P-Hydstr	749.0
W18-24	77180	38998	4	235			8/11/87	P-Hydstr	816.0
W18-26	78097	39477	4	243	222	243		P-Hydstr	229.0
W18-4	77375	39150	8	246	200	278	2/28/59	Bailer	137.0
W18-5	77250	39350	8	272	195	274	11/30/58	P-Submrsbl	3517.0
W18-9	76846	38852	6	217	180	218	12/31/68	Bailer	165.0
W19-1	75491	37613	8	208	178	299	5/31/59	Bailer	7.0
W19-11	74210	37860	6	250			4/30/83		115.0
W19-12	75456	38052	6	250			1/31/83	P-Submrsbl	20.0
W19-13	74180	37510	6	250			6/30/84	P-Submrsbl	36.0
W19-15	74285	37775	6	283			6/30/85	P-Submrsbl	84.2
W19-16	74230	37950	6	285			6/30/85	P-Submrsbl	162.0
W19-18	73936	37895	6	356			11/30/85	P-Submrsbl	44.5
W19-19	72406	37569	5	249			1/31/87	P-Submrsbl	15.0
W19-2	73000	36849	8	240	235	295	8/31/57	P-Submrsbl	22.0
W19-20	72252	37525	6	248			6/30/86	P-Submrsbl	33.4
W19-21	75273	37462	6	223			7/31/86	P-Submrsbl	5.0
W19-23	72587	37499	5	252			3/31/87	P-Submrsbl	28.5

Table E-5. (Continued).

WELL	EW	NS	DIAM	DEPTH	PERF MIN	PERF MAX	DRILL DATE	SAMPLER	RESULT
W19-24	72588	37613	5	249			4/30/87	P-Submrsbl	19.0
W19-25	72250	37575	5	246			4/30/87	P-Submrsbl	26.0
W19-26	72345	37504	5	248			4/30/87	P-Submrsbl	30.0
W19-27	75072	37629	5	230			4/30/87	P-Submrsbl	10.0
W19-28	73184	37823	4	256	236	256		P-Hydstr	50.0
W19-3	74098	37819	8	244	230	280	9/30/57	P-Submrsbl	87.7
W19-5	74685	36850	6	230	205	230	11/30/68	P-Pump	4.0
W19-9	74225	37895	6	284	263	302	8/31/44	P-Submrsbl	110.0
W22-1	75208	35455	8	285	190	280	6/30/56	P-Submrsbl	5.0
W22-12	74499	35180	8	310	200	319	1/31/56	P-Submrsbl	5.0
W22-20	73182	34175	8	238	205	299	6/30/57	P-Submrsbl	10.8
W22-22	73098	36094	8	297	225	300	7/31/60	P-Submrsbl	5.0
W22-26	74450	36100	8	282	200	298	12/31/63	P-Submrsbl	5.0
W23-10	76535	35420	6	224	165	230	10/31/72	P-Submrsbl	5.0
W27-1	73242	33752	6	250			6/30/84	P-Submrsbl	5.0
W6-2	75302	45571	4	245			11/13/87	P-Hydstr	105.7
W7-1	78601	46551	4	244			7/30/87	P-Hydstr	5.0
W7-2	77385	46519	4	222			9/30/87	P-Hydstr	5.0
W7-4	77040	45435	4	233			11/19/87	P-Hydstr	212.4
W7-5	76816	46509	4	228			11/19/87	P-Hydstr	29.5
W7-6	76219	46509	4	229			11/02/87	P-Hydstr	5.0
W7-7	76519	46509	4	228	207	228		P-Hydstr	5.0
W7-8	75880	46510	4	241	220	241		P-Hydstr	5.0
W7-9	78889	46549	4	241	220	241		P-Hydstr	5.0
W8-1	79200	46551	4	256			7/23/87	P-Hydstr	5.0
W9-1	79507	44508	4	286			10/22/87	P-Hydstr	5.0
6-38-70	70226	38142	8	295	255	380	6/30/57	P-Submrsbl	39.0
6-39-79	78751	39198	8	240	195	295	9/30/48	P-Submrsbl	768.0

Figure E-2. Carbon Tetrachloride History in Well W15-16.



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Water Table Elevations

Water levels or elevations used to prepare the water table map for the 216-Z cribs area are listed in Table E-6. Water table elevations were extracted from the HGWDB using Westinghouse Hanford Geosciences Group's Paradox software. Most of the data were for December 1990 to January 1991. However, some earlier dates were used to obtain the coverage needed (e.g., June and July 1990). Major shifts in the water table are not likely over this interval of time. In addition it should be noted that it was necessary to estimate ground surface elevation from a topographic map to obtain water table elevations for wells 2-W18-17 and 2-W18-20. In addition it should be noted that the number of significant figures do not indicate accuracy. While steel tape readings can be made to +/-0.01 ft, the greatest uncertainty is in the elevation of the well casing for which an uncertainty of +/-1 ft is likely. More accurate survey results are needed to improve this source of possible error.

Table E-6. Water Table Data for Wells Near 216-Z Cribs.

WELL	EW	NS	DATE	HEAD
W15-15	78103	40330	12/11/90	467.13
W15-16	77387	40269	2/21/91	469.71
W15-17	77387	40221	12/11/90	467.38
W15-18	77383	39705	12/11/90	468.10
W15-24	78096	39851	12/11/90	467.33
W15-5	75984	39537	12/12/90	469.21
W15-6	75765	40005	1/30/91	468.82
W15-8	75910	39740	5/07/90	470.77
W15-9	75890	39930	1/31/91	470.10
W18-10	76803	38847	6/20/90	470.85
W18-17	76091	39256	1/29/91	468.92
W18-20	76477	38103	2/06/91	469.71
W18-21	78080	37794	12/11/90	467.38
W18-22	78109	37831	12/11/90	466.63
W18-23	78120	38987	12/11/90	467.40
W18-24	77180	38998	12/11/90	468.35
W18-26	78097	39477	12/11/90	467.39
W18-3	77700	39600	12/17/90	463.06
W18-4	77375	39150	12/17/90	466.62
W18-5	77250	39350	12/14/90	467.22
W18-9	76846	38852	5/03/90	470.02

CONCLUSIONS AND RECOMMENDATIONS

The need for a number of improvements was evident from this reconnaissance ground water characterization effort. Some conclusions or observations of a more general nature are also provided.

1. There is a very limited number of reliable monitoring wells in the vicinity of the 216-Z-1A Tile Field, the 216-Z-9 Trench, and the 216-Z-18 Crib to monitor the potential response of ground water to remediation of the unsaturated zone. The wells include: 2-W18-2, 2-18-17, and possibly 2-W15-6. The last two of this group are old (ca 1982 and 1957) for which preferential pathways around the casing may be a possibility. Either some new wells need to be installed, or alternative sampling systems used.

2. Improved ground water sampling procedures are needed, especially for assessing the depth distribution near the surface of the aquifer. This can be accomplished by discrete depth sampling at 0.5-m intervals after slowly purging the well. Elimination of aeration from the Hydrostar sampling system is needed for sampling in the standard configuration.

3. Dedicated analytical instrumentation is needed for ground water as well as soil gas analyses. The turnaround time for laboratory work is becoming a major obstacle to timely decisions. Field located GC equipment can be cross referenced (comparative sampling) to other ongoing RCRA and CERCLA water sampling activities for which CLP Level IV results are required. Results of this investigation show that only a few volatile constituents are present in ground water. A GC is adequate instrumentation in this situation.

4. Low range as well as high range analytical capability is needed to assess the extent of the low concentration boundary (<0.3 p/b) of the carbon tetrachloride plume. These two types of samples need to be segregated so that ultrasensitive instrumentation is not overloaded by a high range sample.

5. Results of this study indicate that past carbon tetrachloride data, and perhaps other volatile constituent data as well, are reliable even though rigorous validation checks of the data cannot be performed post facto.

REFERENCES

PNL, 1989, *Procedures for Groundwater Investigations*, PNL-MA-567, Pacific Northwest Laboratory, Richland, Washington.

WHC, 1990, *Fiscal Year 1991 Sampling and Analysis Statement of Work*, Ltr # 057081R1, from K. R. Fecht, Westinghouse Hanford Company to M. A. Neely, Pacific Northwest Laboratory, Richland, Washington.

WHC, 1991, *200 West Area Carbon Tetrachloride Expedited Response Action Project Plan*, WHC-SD-EN-AP-046, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX F

TASK #7 - SOIL VENTING CHARACTERIZATION

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APPENDIX F1

CEA REVIEW OF SOIL VENTING CHARACTERIZATION REPORT - 216-Z-1A TILE FIELD

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Christine Eddy & Associates, Inc.
16408 N.E. 170th Place
Woodinville, WA 98072
(206) 485-5860

June 5, 1991

Mr. Grover Buhr
A.T. Kearney, Inc.
1 Lagoon Drive
Redwood City, CA 94065

Dear Grover:

Christine Eddy & Associates, Inc. (CEA) was requested by Michael Hagood of Westinghouse Hanford Company (WHC) on May 29, 1991, to provide a review of the 216-Z-1A Tile Field Soil Venting Characterization Report prepared by Hart Crowser for Ebasco Services and dated May 23, 1991. This review was performed in cooperation with Hart Crowser. The purpose of this review was to evaluate the model to determine:

- the appropriateness of the model to simulate the 216-Z-1A Tile Field vapor extraction test;
- the appropriateness of the input parameters; and
- the validity of the model calibration process.

This work was performed on an expedited basis in order to meet the publishing requirements of WHC.

The computer code (MODFLOW) chosen by Hart Crowser to model the withdrawal scenarios appears to be appropriate to the problem. Many of the input parameters were modified by Hart Crowser to simulate the flow of air through the vadose zone. The modifications were checked and the conversions of most parameters appears to be correct.

The solutions provided by the final calibrated model were, however, based on several assumptions that CEA believes should be revised. The permeability chosen for the final model was more than 2 orders of magnitude higher than the permeability predicted from the field testing. After discussions with Kearney and WHC, CEA determined that a lower permeability would be more appropriate given the site conditions and the data from the on-site wells. The boundary conditions used in the model calibration were influencing the model results slightly along the east and west sides of the model area. In addition, as Hart Crowser agreed, the vertical conductivity parameters (referred to as VCONT) were incorrectly computed and input in the model. VCONT was calculated by Hart Crowser as the thickness of an element divided by the vertical hydraulic conductivity. VCONT should be calculated as a series which takes into account the thickness and vertical hydraulic conductivity of each layer and the layer below it (VCONT = 2/(T1/K1 + T2/K2), where T and K are the thickness and vertical hydraulic conductivity of each layer). This change in

VCONT was minor and only had a slight effect on the model results. Based on the items outline above, CEA believed it was necessary to rerun the model to obtain a more realistic solution.

Model Recalibration

CEA calibrated the revised model to data from the venting well (W18-171). This was done because the observation well did not appear to have data representative of the system, especially when compared to the venting well data. This lack of representativeness may be the result of barometric pressure effects, the well not performing adequately (due to perforations in a lower permeability interval, inadequate perforations, etc.), or other reasons. Therefore, the venting well data appear to be a more reliable representation of the hydraulic parameters in the area.

The larger model grid (41 X 26), used in the Hart Crowser scenario modeling, was used in the CEA model calibration to reduce the effects of the boundary conditions. The vertical conductivity values were corrected, and all other input parameters were the same as those used in the Hart Crowser modeling. The time of simulation was increased to 80 hours to match the actual time of the venting test. Steady state in the model was reached between 10 and 20 hours after the start of the venting test. The venting rate at well W18-171 was 305 cfm, between the average rate of 300 to 310 cfm as reported for the 80-hr vent test. The permeability of the layers was adjusted until the drawdown in the venting well was within the observed range of 35 to 40 in. water gauge (w.g.). The final calibrated model predicted a drawdown of 35.9 in. w.g. (Figure 1) using a permeability of 7.5 darcies (8.25×10^{-8} cm^2) in the upper layers and a permeability of 15 darcies (1.65×10^{-7} cm^2) in the lower layer. These values match fairly well with the permeability calculated from the Phase 2 venting test of about 3.76 darcies (3.8×10^{-8} cm^2).

Venting Scenarios

Using the recalibrated model, venting scenarios were run to determine the venting rates necessary to obtain a drawdown of 0.2 in. w.g. and 1.0 in. w.g. at the edge of the crib using either one well or three wells.

Figures 2 and 3 show the drawdown for the one well scenarios. To obtain a model predicted drawdown of 0.2 in. w.g. at the edge of the crib, it was necessary to pump at a rate of 160 cfm from the center of the tile field. A drawdown of 1.0 in. w.g. was observed at the edge of the crib using a pumping rate of 813 cfm.

Figures 4 and 5 show the drawdown for the three well scenarios. A drawdown of 0.2 in. w.g. at the edge of the crib was obtained using a pumping rate of 21.6 cfm from each well. A pumping rate of 108 cfm at each well was required to obtain a predicted drawdown of 1.0 in. w.g. at the edge of the crib.

Conclusions

The assumptions of boundary conditions and model size as well as the vertical condutivity (VCONT) input values in the original calibrated model were changed and the model recalibrated. The model was recalibrated to the venting well which is expected to be more representative of the site conditions. The recalibrated model predicts significant differences in the area of influence of the venting well in the 216-Z-1A tile field from those predicted by the original model.

Sincerely,
Christine Eddy & Associates, Inc.

Christine Eddy

Christine Eddy
President

cc: Michael Hagood, WHC

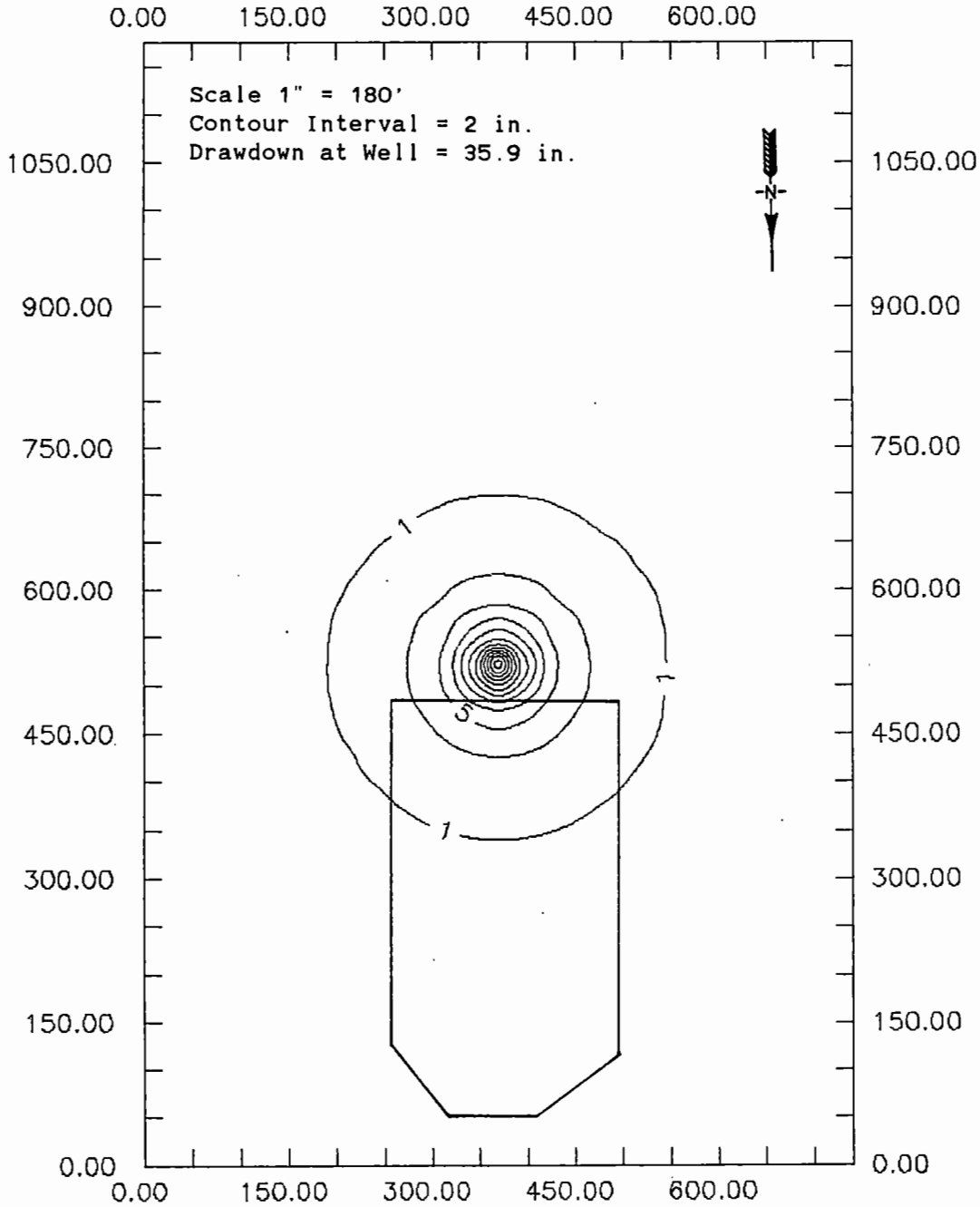

Figure 1. Drawdown Predicted in Well W18-171 for Final Model Calibration Run

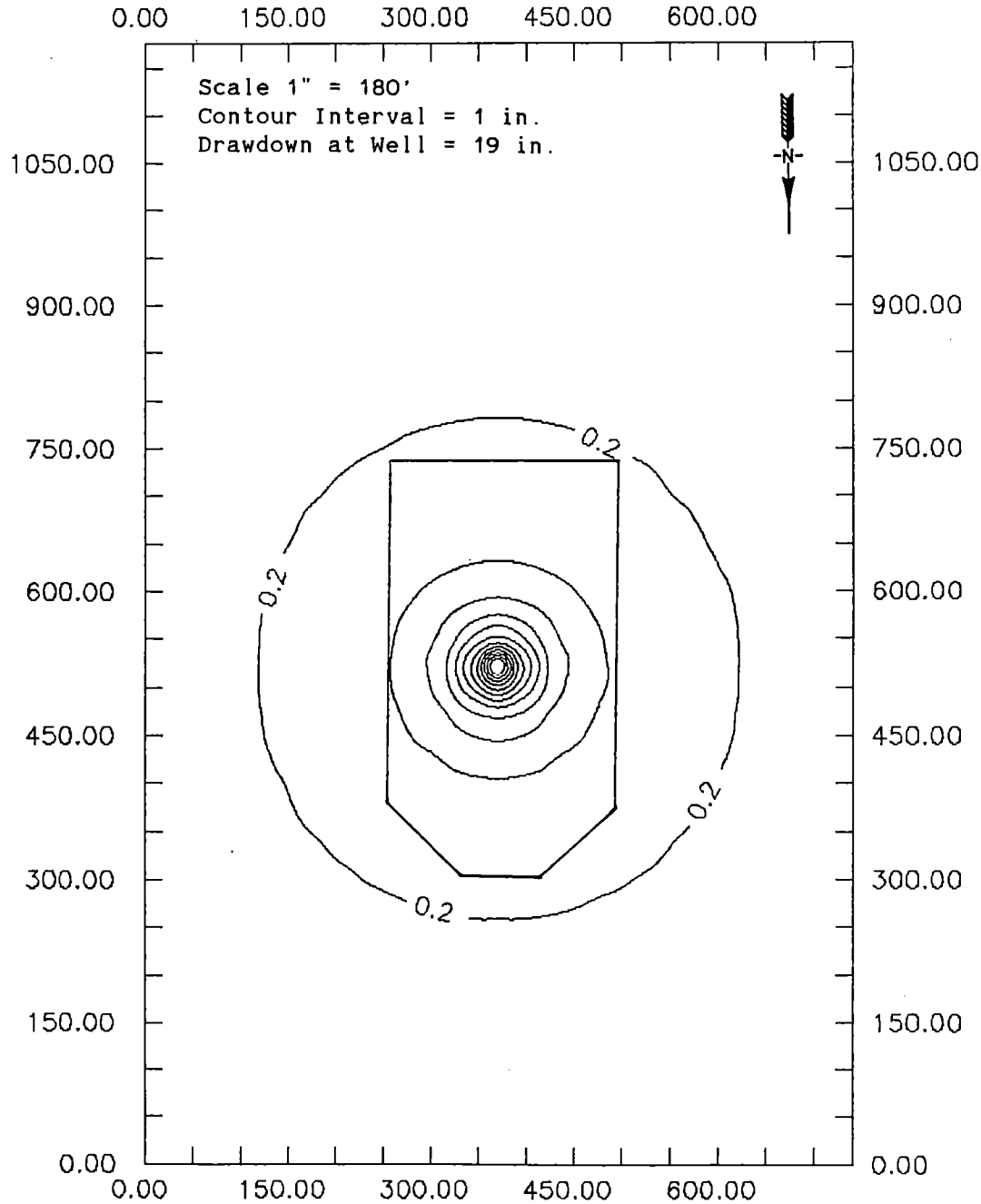

Figure 2. Drawdown of 0.2 in. w.g. at the Edge of the Crib Using One Well

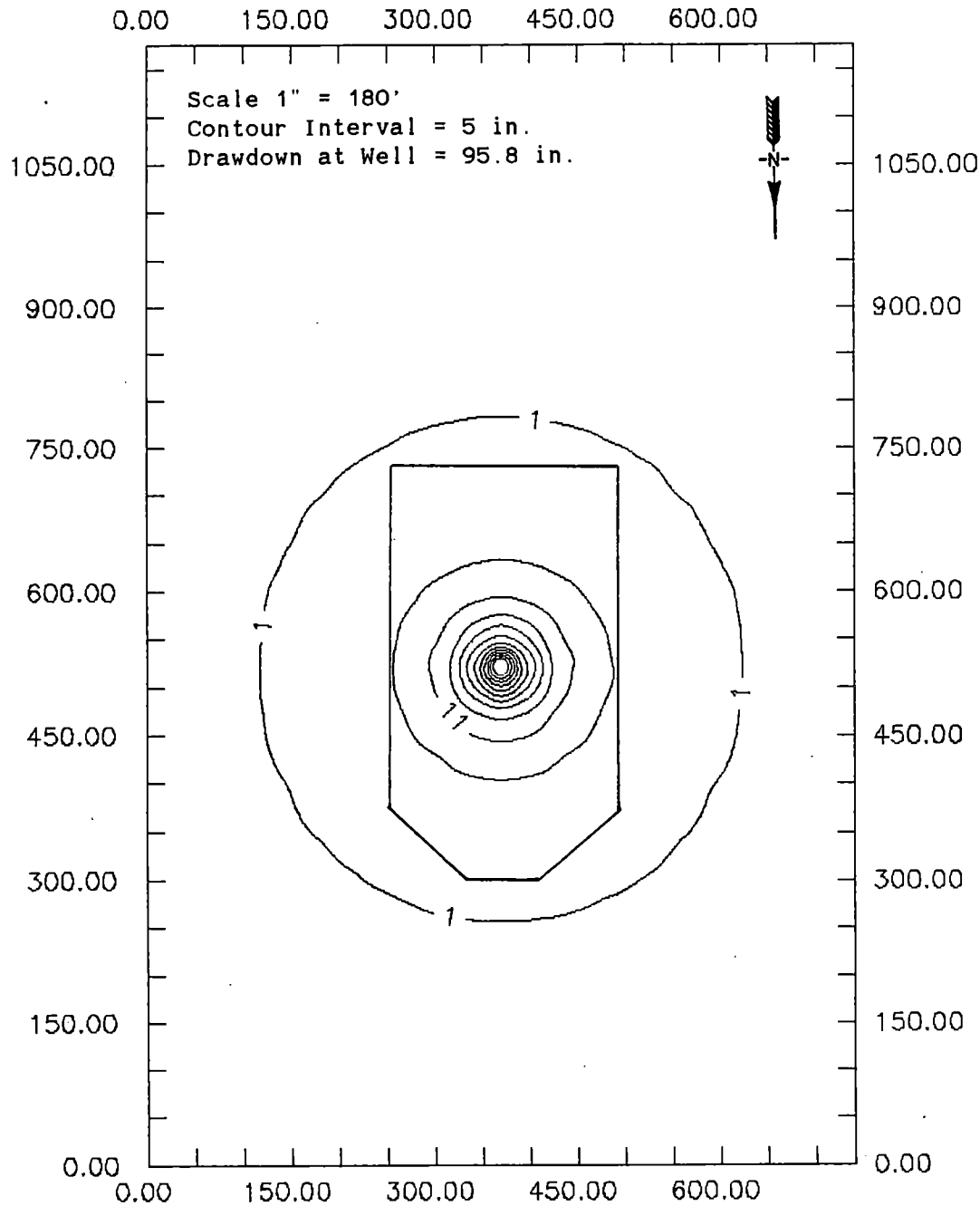

Figure 3. Drawdown of 1.0 in. w.g. at the Edge of the Crib Using One Well

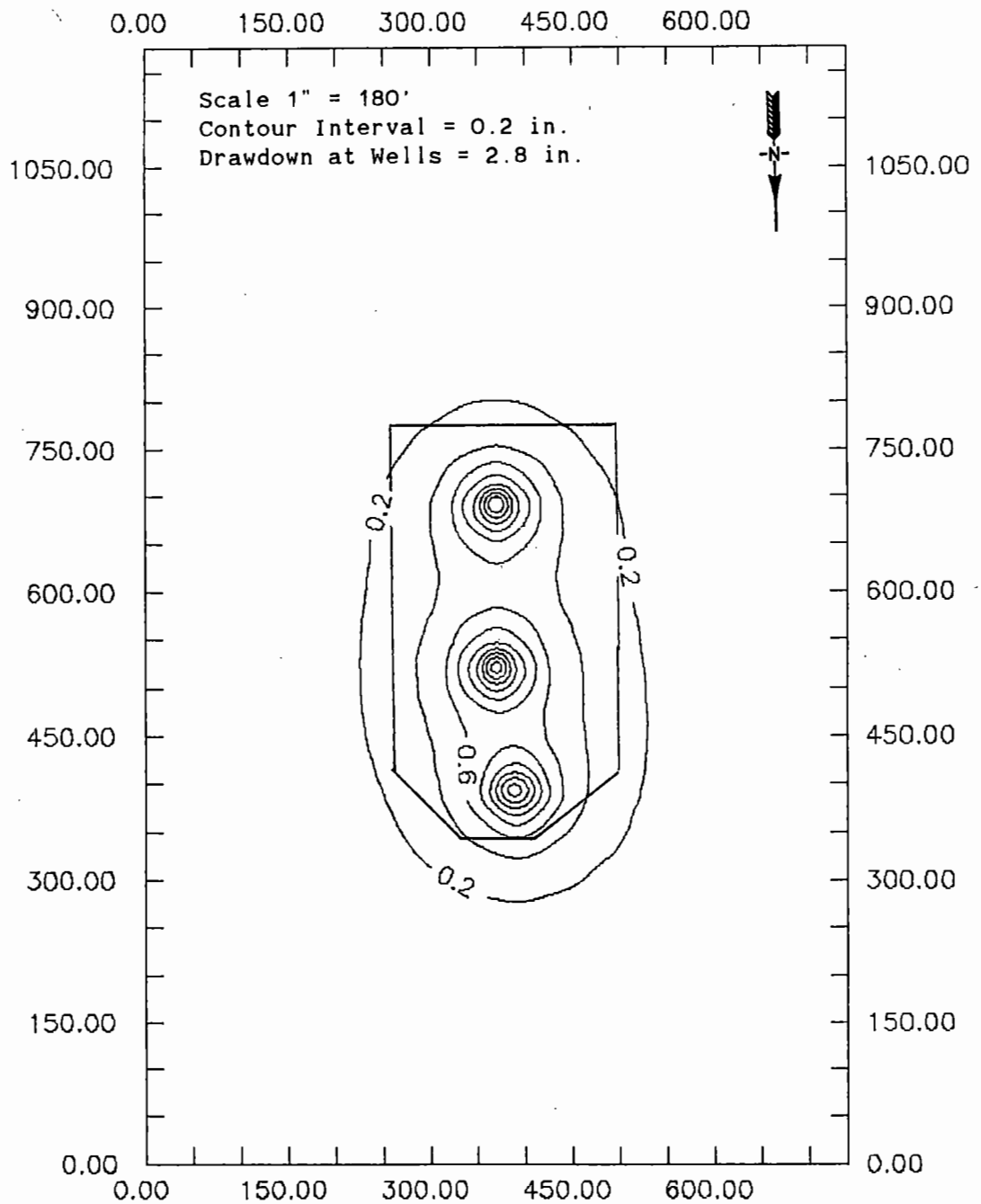

Figure 4. Drawdown of 0.2 in. w.g. at the Edge of the Crib Using Three Wells

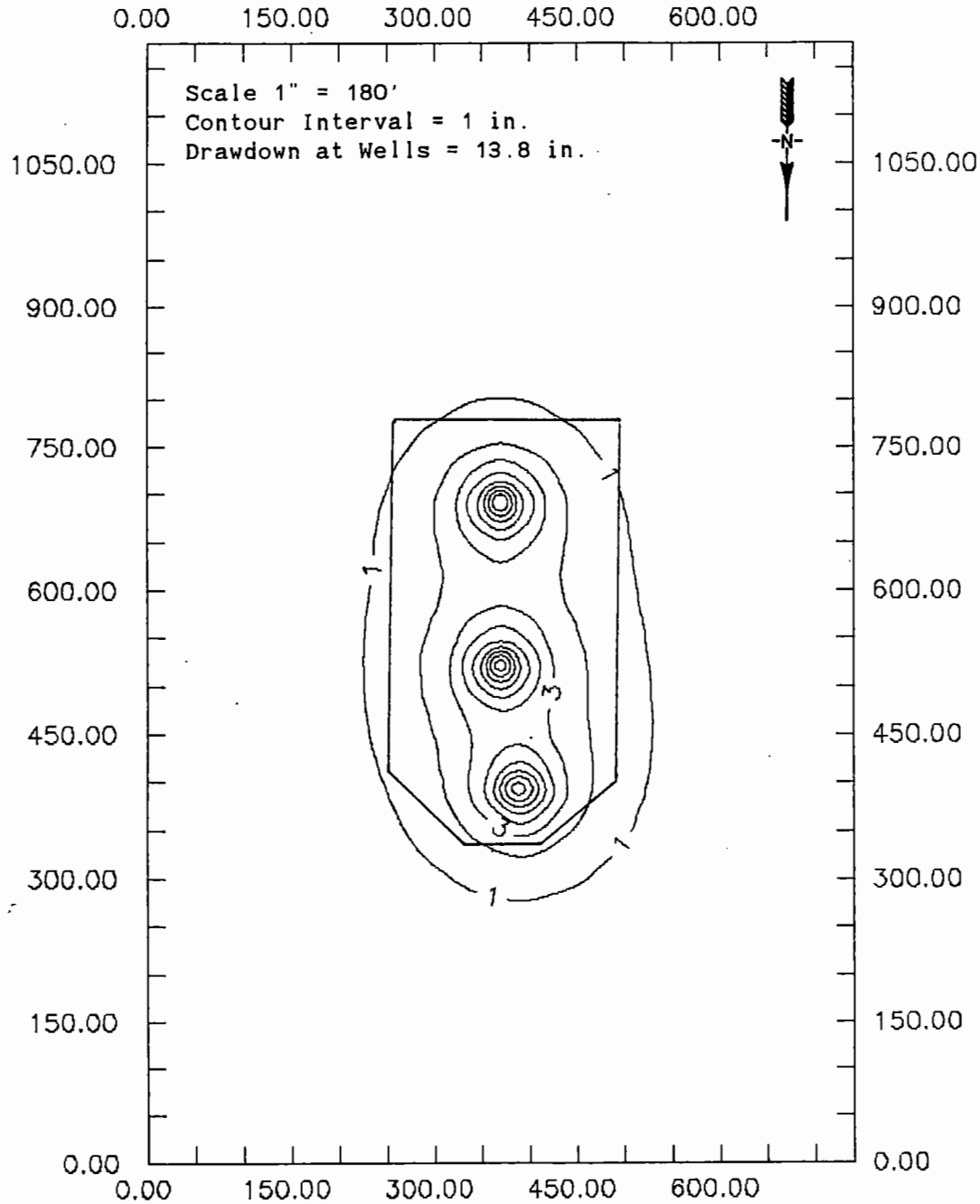

Figure 5. Drawdown of 1.0 in. w.g. at the Edge of the Crib Using Three Wells

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APPENDIX F2

FINAL TEST REPORT
REVISION 1

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FINAL TEST REPORT
REVISION 1

216-Z-1A TILE FIELD
SOIL VENTING CHARACTERIZATION
(TASK 7 OF 200 WEST AREA
CARBON TETRACHLORIDE
EXPEDITED RESPONSE ACTION)

June 14, 1991

Submitted to
WESTINGHOUSE HANFORD COMPANY
Task Order E-91-13 of Order No. MLW-SVV-037106

Prepared for
EBASCO SERVICES INCORPORATED

by
Hart Crowser, Incorporated

9112210204

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1201 Jadwin Ave., Suite 202, Richland, WA 99352-3429

June 14, 1991
ERL-WHC/91-13-L-91-145

Mr. L.C. Swanson
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

SUBJECT: WHC ORDER NO. MLW-SVV-037106
TASK ORDER NO. E-91-13
VAPOR VACUUM EXTRACTION TEST
FINAL REPORT

Dear Mr. Swanson:

Ebasco is pleased to submit its revised final report under Task Order E-91-13, "Final Test Report, 216-A-1A Tile Field Soil Venting Characterization." This report contains resolution of comments provided by WHC on the previous submittal and addresses the results of Task 7 of the Expedited Response Action dealing with carbon tetrachloride contamination of vadose zone sediments in the 200-West Area of the Hanford Site. The submittal of this revised final report completes the Ebasco scope of work under this task order.

Please contact Jim Wilder at (206) 324-9530 or Rick Cameron at 943-0550 if you have any questions on this final submittal.

Very truly yours,

Russell H Boyd

Russell H. Boyd, P.E.
Project Manager
Ebasco Services Incorporated

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enclosure

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File: 2.2/14.2

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EXECUTIVE SUMMARY

Westinghouse Hanford Company (WHC) performed a soil venting characterization study at the 216-Z-1A Tile Field during April 1991 to assess the feasibility of using a soil vapor extraction system (VES) to remove carbon tetrachloride (CCl_4) vapors and other volatile organic compounds from the unsaturated soil beneath the tile field. The study was completed as Task 7 of the Expedited Response Action Project Plan that was drafted by WHC in response to the joint agreement between The U.S. Environmental Protection Agency, the Washington State Department of Ecology, and the U.S. Department of Energy - Richland Operations Office.

The 216-Z-1A Tile Field was selected as the study site for several reasons. First, historical operations resulted in the disposal of about 5,200,000 liters of wastewater containing about 245 metric tons of CCl_4 to the tile field between 1964 and 1969. Second, many test casings had already been installed to about 150 feet below ground at the 216-Z-1A Tile Field. Third, some of the casings were outside the fenced zone at the tile field, which allowed easy access for the venting tests.

The VES apparatus, which was purchased from a contractor, was designed to vent 500 cubic feet per minute of soil gas and treat it using high efficiency particulate air (HEPA) filters and canisters filled with granular activated carbon to remove radiological and organic components, respectively, before the treated air was discharged to the atmosphere. In-line monitors were installed to measure the process stream concentrations continuously. The data acquisition system was programmed to automatically shut down the venting system if the measured concentrations in the process piping exceeded allowable limits.

The VES apparatus was equipped with sampling ports to allow sampling of the extracted soil vapor for chemical analysis by the WHC laboratory. Sampling was performed for the following constituents: volatile organic compounds (primarily CCl_4); particulate radionuclides; butyl alcohol and other possible breakdown products of the disposed process chemical; and water vapor, which is not toxic but which could affect the performance of a full-scale venting system.

Four existing wells at the tile field were used for the study. They were configured in a nearly linear relationship from north to south. Two of the wells were inside the fenced area and penetrated the tile field itself, and two wells were outside the fence. The northernmost and southernmost wells were about 250 feet apart, with well spacings of 30 feet, 95 feet, and 250 feet. Based on inspection of historical boring logs, each of the four casings were perforated at strategic vertical intervals to provide access to the soil strata that were considered most likely to have accumulated volatile compounds. The perforated intervals in each were isolated using straddle packers, allowing the different strata under the tile field to be tested independently.

Phase One of the study was devoted to assessing the lateral and vertical distributions of CCl_4 under the tile field. "Puff tests" were used, where low flowrates of soil gas were vented for a short duration from many of the perforated intervals while gas samples were taken. The Phase One tests showed that the CCl_4 vapor was mainly concentrated in the lower soil zones under the tile field, but that significant CCl_4 vapor concentrations were found in subsurface soils outside the tile field boundary.

Phase Two of the study was devoted to assessing the air permeability of the soil within two strata at the edge of the tile field. The measured permeability of a sandy soil layer about 60 feet below ground surface ranged from about 2 to 7 darcies. The second hydraulic venting test, of the fine sand layer about 120 feet below ground surface, did not produce usable data. After the test was completed it was determined that the vacuum data measured during that second test were adversely affected by variations caused by barometric pressure swings.

Phase Three of the study involved long-term venting tests at two of the wells, at perforated intervals near where the highest CCl_4 concentrations were found during Phase One. The first test was done by venting a well near the center of the tile field at about 55 cubic feet per minute (cfm) for 24 hours. The CCl_4 vapor concentration quickly stabilized at about 200 part per million volume (ppm_v), and about 8 pounds of CCl_4 were removed during the 24-hour test. The second test was performed by venting a well at the outer edge of the tile field at about 330 cfm for about 80 hours. The CCl_4 vapor concentration increased steadily to about 900 parts per million (ppm), indicating that a surge of CCl_4 was being drawn to the venting well from the interior of the tile field. About 300 pounds of CCl_4 was removed during the 80-hour test.

Low concentrations of particulate alpha and gamma activity were measured at the VES inlet, upstream of the particulate prefilters and HEPA filters. The particulate activity was not detected consistently at all time intervals, and it is not certain whether the radionuclides actually appeared and disappeared during the course of the test or whether the detected radionuclides were in fact sampling artifacts.

Spectral gamma logging of the exterior of the GAC canisters after completion of all tests indicated that what appears to be radon and radon daughter products were captured by the GAC. Radon is a naturally occurring compound in soil, and it is believed that most of the accumulated radon originated from natural sources.

Based on the results of the venting tests, a design description for a full-scale VES is provided in this Test Report. The design is based on constructing a VES capable of venting 1,400 cfm of soil gas and treating it to satisfy upcoming air toxics regulations. The full-scale VES is designed to remove and treat about 580 pounds per day of CCl_4 during the initial startup period; after that time the CCl_4 removal rate is expected to decrease as the CCl_4 in the soil is depleted.

The recommended full-scale VES consists of trailer-mounted equipment that can be moved as needed to vent the 216-Z-1A, 216-Z-18, and 216-Z-9 tile fields. The use of a mobile VES is recommended over the use of a stationary system that would be connected to the various tile fields by long piping networks. The key components of the recommended VES are as follows:

- Several venting wells should be used at each of the tile fields to be vented. This will provide flexibility to allow more aggressive venting at the portions of the tile fields that display the highest concentrations of CCl_4 vapor.

- The venting wells at each tile field should be connected to the mobile VES using above-ground flexible hose, which should be heated to minimize uncontrolled moisture condensation in the hoses. Flexible hose will be much easier to implement at Hanford than would buried solid piping that is more commonly used at industrial sites.

- It is recommended that 220-volt line electrical power be permanently installed at each of the tile fields so that the mobile VES can be used without the need for diesel electrical generators.

- The vacuum pump modules should be designed to provide a maximum venting flowrate of 1,400 cfm at a vacuum of about 100 inches water at the well heads.

- Efficient water vapor removal, by either efficient water vapor knockouts or by electric chillers, should be installed at the VES inlet to prevent moisture condensation inside the ducting and process equipment.

- Particulate prefilters and dual HEPA filters should be installed on the vacuum side of the system to remove low concentrations of particulate radionuclides that might be entrained in the vented air.

- The presence of radon at concentrations near or slightly above natural levels should be considered in the design and licensing of the VES. The VES should be equipped with continuous radiation monitoring to ensure that the concentrations of radon, radon daughter products, and/or particulate radionuclides in the emitted gas are within acceptable limits.

- The system should be designed to permanently destroy an assumed 750 ppm of CCl_4 in the vented air stream, and to reduce the stack concentrations of all contaminants to meet upcoming air toxics limits at the property line. A commercially available catalytic oxidizer is recommended, although a high efficiency thermal oxidizer would also work well.

- Monitoring equipment should be designed more specifically for the expected operating conditions, e.g., the equipment will not degrade in the presence of CCL_4; will provide reliable information on system operation under varying flow characteristics; and will withstand expected relative humidity conditions.

- Based on the observation that the electronic and manual sensors measuring the vacuum pressures at the wells did not correspond closely at times, it is recommended that the vacuum gauges used for the full-scale VES be of a different type than those used for the vent test.

- Hydrochloric acid (HCl) emissions that would be formed by the combustion of the CCl_4 are a major concern. The estimated property line concentrations of HCl that would result from the recommended VES are less than the allowable air toxics limit. Although Ecology might normally require the use of an HCl scrubber on a VES as large as the one described herein, it is recommended that WHC negotiate with Ecology to allow the system to operate without a scrubber. This recommendation is based on the difficulty, expense, and secondary waste that would result from the use of a wet HCl scrubber at Hanford.

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1.0 INTRODUCTION

On December 20, 1990, a letter to the U. S. Department of Energy - Richland Operations Office requesting an Expedited Response Action (ERA) Plan to address the 200 West Area carbon tetrachloride contamination was issued jointly by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology). In response to that request, an ERA Project Plan (WHC-SD-EN-AP-046) was drafted on January 9, 1991, by Westinghouse Hanford Company (WHC). Seven initial work tasks were identified in the ERA Project Plan, the goal of which was to minimize or stabilize the spread of carbon tetrachloride vapors from the unsaturated soils (vadose zone) beneath the Z Plant disposal sites by intercepting much of that material before it enters the groundwater.

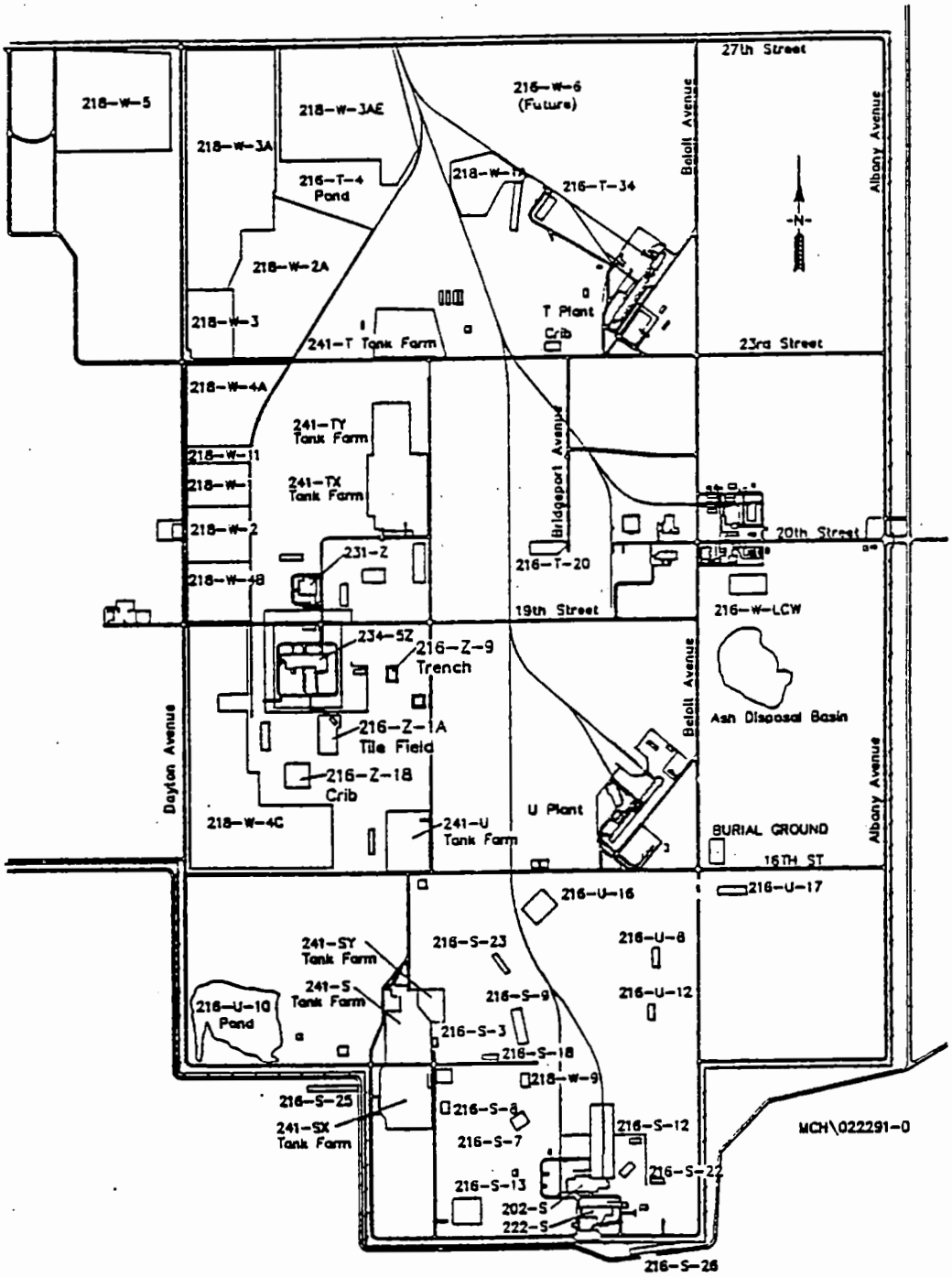
This Test Report describes the soil venting demonstration test performed under Task 7, "Vacuum Extraction Test", of the ERA Project Plan. The venting tests were performed at the 216-Z-1A Tile Field in the 200 West Area (Figure 1-1).

The procedures that were originally specified for this venting test were described in the WHC document entitled "Test Plan: 216-Z-1A Tile Field Soil Venting Characterization, WHC-SD-EN-TP-003, February 25, 1991. During the course of the field testing a limited number of changes to the Test Plan were required based on unforseen conditions. Those deviations from the original Test Plan are described in this Test Report as well as in Engineering Change Notices.

This report is organized as follows:

- 1.0 INTRODUCTION
- 2.0 TEST OBJECTIVES AND TEST SCOPE
- 3.0 TEST PROCEDURES
- 4.0 TEST RESULTS
- 5.0 DESIGN DESCRIPTION FOR FULL-SCALE VES
- 6.0 SUMMARY AND RECOMMENDATIONS
- 7.0 REFERENCES
- APPENDIX A — CALCULATION PROCEDURES FOR NET SOIL VACUUM DETERMINATION
- APPENDIX B — SOIL VENTING TEST ANALYSIS AND VENTING SYSTEM DESIGN EVALUATION
- APPENDIX C — CHRONOLOGICAL FIELD LOG

Figure 1-1
Z Plant Liquid Waste Sites



2.0 TEST OBJECTIVES AND TEST SCOPE

The objectives of the Task 7 vapor extraction test were to obtain the following information:

(1) Approximate vertical and lateral distribution of volatile organic compounds (VOCs) in soil strata under and near the tile field to confirm whether VOCs have accumulated in the strata.

(2) Soil permeability and venting radius of influence in strata for aiding in the design of a full-scale VES.

(3) Trends in concentration, volumes, and types of components that are vented under conditions likely to be used in operating a full-scale VES.

(4) Concentrations of particulate radionuclides that might be entrained by the vented soil gas during operation of a full-scale VES.

(5) Other data for designing and permitting a full-scale VES for installation by September 7, 1991.

This information is likely to have applicability to vapor extraction at other CCl_4 disposal cribs in the 200 West Area if the soil stratigraphy is shown to be consistent across the area and if the nature of the wastes disposed into the different cribs is similar.

2.1 NATURE OF CONTAMINANTS IN THE VADOSE ZONE

Field activities for Task 7 were concerned with the vadose zone under the 216-Z-1A Tile Field, where elevated concentrations of contaminants and their breakdown products were likely to occur. The following historical information in this tile field is based on the ERA Project Plan (WHC-SD-EN-AD-046) dated January 9, 1991.

2.1.1 Contaminant Sources

The cited historical information indicates that the predominant use of the tile field was for disposal of process wastewater from Z Plant operations. A plume of contaminants, probably associated with these discharges, has been identified in the groundwater below the site. In addition, the vadose (unsaturated) zone above the groundwater table is known as a result of vapors encountered during drilling to contain elevated concentrations of contaminants.

The 216-Z-1A Tile Field received overflow process wastewater from 1949 to 1959. That wastewater did not contain carbon tetrachloride. During that period, the tile field received about one million liters of wastewater which had a pH of between 8 and 10.

In 1964, the 216-Z-1A Tile Field was reactivated for receipt of aqueous and organic wastes from the Plutonium Reclamation Facility in the 236-Z Building and the 242-Z Waste Treatment and Americium Recovery Building. The high-salt aqueous waste discharged to the tile field was primarily a concentrated (5M to 6M), acidic (pH ~ 1.0), sodium nitrate solution. In addition to the aqueous phase, organic liquids consisting of carbon tetrachloride (CCl_4), tributylphosphate (TBP), and dibutylbutylphosphonate (DBBP) occurred in saturation amounts in the aqueous phase and were also discharged separately in relatively pure batches. Less than 5% of the volume of high-salt aqueous waste consisted of organic components. The tile field received approximately 5.2 x 10^6 liters of liquid waste between June 1964 and June 1969. The varying amounts of organic material discharged to the tile field in 1967 were estimated to be 80 vol% CCl_4/20 vol% TBP at a rate of 4,400 gallons per year (gal/yr), and 70 vol% CCl_4/30 vol% DBBP at a rate of 6,600 gal/yr. If the rate of waste discharges remained constant over the 5-year operating period (1964-1969), the tile field would have received about 245 to 265 metric tons of CCl_4. The use of the 216-Z-1A Tile Field was terminated in 1969, and the waste stream was subsequently rerouted to the 216-Z-18 tile field.

Based on the organic compounds that were known to be discharged to the tile field, it is possible that the following breakdown products may exist in the vadose zone in significant concentrations; chloroform, methylene chloride, and butyl alcohol. All of these breakdown products are regulated toxic air pollutant compounds, .

The chemical processes used to purify plutonium resulted in the production of actinide-bearing waste liquid. The primary radionuclides discharged to the disposal site in these liquids were plutonium-239/240 and plutonium decay products, including americium-241. The 216-Z-1A Tile Field received an estimated 57 kg of plutonium.

Another waste stream disposed in the tile field was fabrication cutting oil (fab oil), which is a low-volatility animal fat blended with CCl_4. Fab oil was not included in these estimates because it was intermittently processed with relatively small volumes involved. In 1967, about 6,000 gallons of fab oil remained in storage to be processed; it was subsequently routed to 216-Z-1A for disposal. It is unlikely that the fab oil contained significant concentrations of volatile compounds other than CCl_4 that would be stripped by a soil vapor extraction system. However, it is possible that the compounds in the fab oil could be biologically degraded, resulting in significant concentrations of methane gas, which is explosive when present in sufficient concentrations in the presence of air.

2.1.2 Soil Contamination

In 1979, the highest measured concentrations of plutonium-239/240 (4 x 10^4 nCi/g) and americium-241 (2.5 x 10^3 nCi/g) at the 216-Z-1A Tile Field occurred in sediments located immediately beneath the tile field. The concentration of actinides in sediments generally decreased with depth beneath the tile field, with the exception of silt-enriched horizons and boundary areas between major sedimentary units. The maximum vertical penetration of actinide contamination (defined by the 1 x 10^{-2} nCi/g isopleth) was located approximately 100 feet below the bottom of the tile field. The estimated lateral extent of contamination is located within about a 30-foot-wide zone around the tile field.

Carbon tetrachloride vapors have been detected during drilling at numerous locations in the 200 West Area. For example, anecdotal reports indicate that CCl_4 vapors were encountered above the Plio-Pleistocene layer ("caliche layer") during drilling of the 216-Z-1A Tile Field after its retirement in 1969; below the caliche layer during remediation of wells at the 216-Z-9 Tile Field in 1987; and below the caliche layer during drilling of Resource Conservation and Recovery Act (RCRA) wells near U and T Tank Farms in 1990.

2.2 COMPOUNDS OF CONCERN

The soil vapor testing was designed to assess the quantities of gaseous and particulate components in the vadose zone near the 216-Z-1A Tile Field, and to obtain engineering data for use in designing a full-scale venting system to remove those components. Based on the historical data presented in the previous section, the compounds of concern are as follows:

- Gaseous carbon tetrachloride and its breakdown products, chloroform and methylene chloride.
- Gaseous butyl alcohol, which is a breakdown product of TBP and DBBP.
- Particulate radionuclides, including plutonium and americium, which would be transported on soil particles that may be entrained by the vented gas stream extracted from the ground during the full-scale soil venting process. Particulate radionuclides were not expected to be present in vented air during these tests, because Spectral Gamma Logging tests that were done in the proposed high-flow venting well 299-W18-171 showed that man-made radionuclides are restricted to a thin strata located 83 to 86 feet below ground. The venting well was not perforated at that interval, so particulate radionuclides were not expected in the vented air.
- Radon gas, which occurs naturally in Hanford soil.
- Methane gas, which is not toxic but is explosive if present at high concentrations.
- Water vapor, which poses no health risks but would affect the design of the vented air control systems.

Tritium; iodine-129; technetium-99; and carbon-14 were of lower concern in the vadose zone soil because their concentrations in groundwater below the site were below detection limits (source: Hanford Groundwater Data Base) and/or they were not disposed in the tile field (source: Distribution of Plutonium and Americium Beneath the 216-Z-1A Crib: A Status Report, RHO-ST-17, 1979).

2.3 TEST PHASES

Vapor extraction testing was done at the 216-Z-1A Tile Field using existing well casings (Refer to Figures 3-1 and 3-2 in Chapter 3.0 of this Test Report). Based on our understanding of the soil stratigraphy under the tile field, four of the existing well casings were perforated at strategic vertical intervals to provide access to the soil strata that were most likely to have accumulated volatile compounds. Contaminants may be distributed unevenly in underlying strata (i.e., higher contaminant concentrations may be present at the interface of higher permeability soils overlying lower permeability soils).

The VES demonstration test was divided into three general phases with the following objectives:

- **Phase One: Soil Vapor Characterization.** Assess the lateral and vertical distribution of soil vapors in selected soil strata under the tile field. Use the data to assess which of the soil strata contain the highest concentrations of ventable components.

- **Phase Two: Hydraulic Assessment.** Collect soil permeability data that can be used to design the extraction well (and associated air injection) wells, if required, for a full-scale VES.

- **Phase Three: Long-Term Soil Venting Test.** Conduct a multi-day venting test to assess the types of VOCs present, the achievable removal rates, the venting radius of influence, and long-term soil hydraulic data that will be used in the future to design the vapor control system for the full-scale VES.

3.0 TEST PROCEDURES

This chapter describes the procedures that were used during the venting tests. The deviations from the original Test Plan are described in the appropriate subsections.

3.1 216-Z-1A TILE FIELD WELLS

The soil venting tests were performed at existing wells within and adjacent to the 216-Z-1A Tile Field (Figure 3-1). Four existing wells were used: 299-W18-87 (W-87); 299-W18-150 (W-150); 299-W18-167 (W-167) and 299-W18-171 (W-171). The vertical intervals in each of the wells from which vapor was extracted are shown on Figure 3-2 and are listed in Table 3-1. All of the wells were installed in the early to mid-1970s using cable tool methods. The casings at W-87 and W-150 were constructed of 6-inch-diameter steel pipe and two casings at W-167 and W-171 of 8-inch diameter).

None of the well casings were perforated until the start of this test program. The slots perforated for this test were made in accordance with the Test Plan using an air actuated star perforator. The Test Plan originally specified perforation of two intervals in W-159 near the center of the tile field. However, the well casing could not be perforated because the soil zone outside the steel casing was surrounded by what appeared to be cement grout. Therefore, W-167 was substituted for W-159. Only the lowermost portion of W-167 was perforated.

The perforated intervals in each well are listed in Table 3-1. The star perforator cuts a series of small holes in a vertical row as the perforator was moved up the casing using hydraulic pumps. Each pass of the perforator provided about 1.1 square inches of opening per linear foot. The 15- and 20-foot-long vertical intervals at W-171 (where the high volume venting was planned) were perforated with four passes each. Four passes created an open area equivalent to a 4-inch-diameter 10-slot PVC screen. The perforation was limited to four passes because it was believed that additional passes would affect the structural strength of the casing. The vertical intervals in each of the remaining wells were perforated using two passes of the perforator.

During the venting tests, the perforated intervals to be studied were isolated using commercially available straddle well packers provided by Aardvark, Incorporated (Aardvark is a registered trademark). The straddle packers were constructed of butyl rubber clad with Viton to protect the rubber from carbon tetrachloride degradation. Each of the packer sections was inflated using bottled nitrogen gas.

The straddle packed sections were vented using 2.5-inch-diameter black steel riser pipe. Each of the well heads were connected to the VES by a flexible vacuum hose with cam-lock fittings. The vacuum at each well was monitored during the tests using one transmitting low-range magnetic gauge for induced vacuum between 0 - 1.0 inch of water; and one high-range pressure transmitter for measuring vacuums up to 150 inches, water gauge (in. w.g.).

Figure 3-1
216-Z-1A Tile Field Well Location Plan

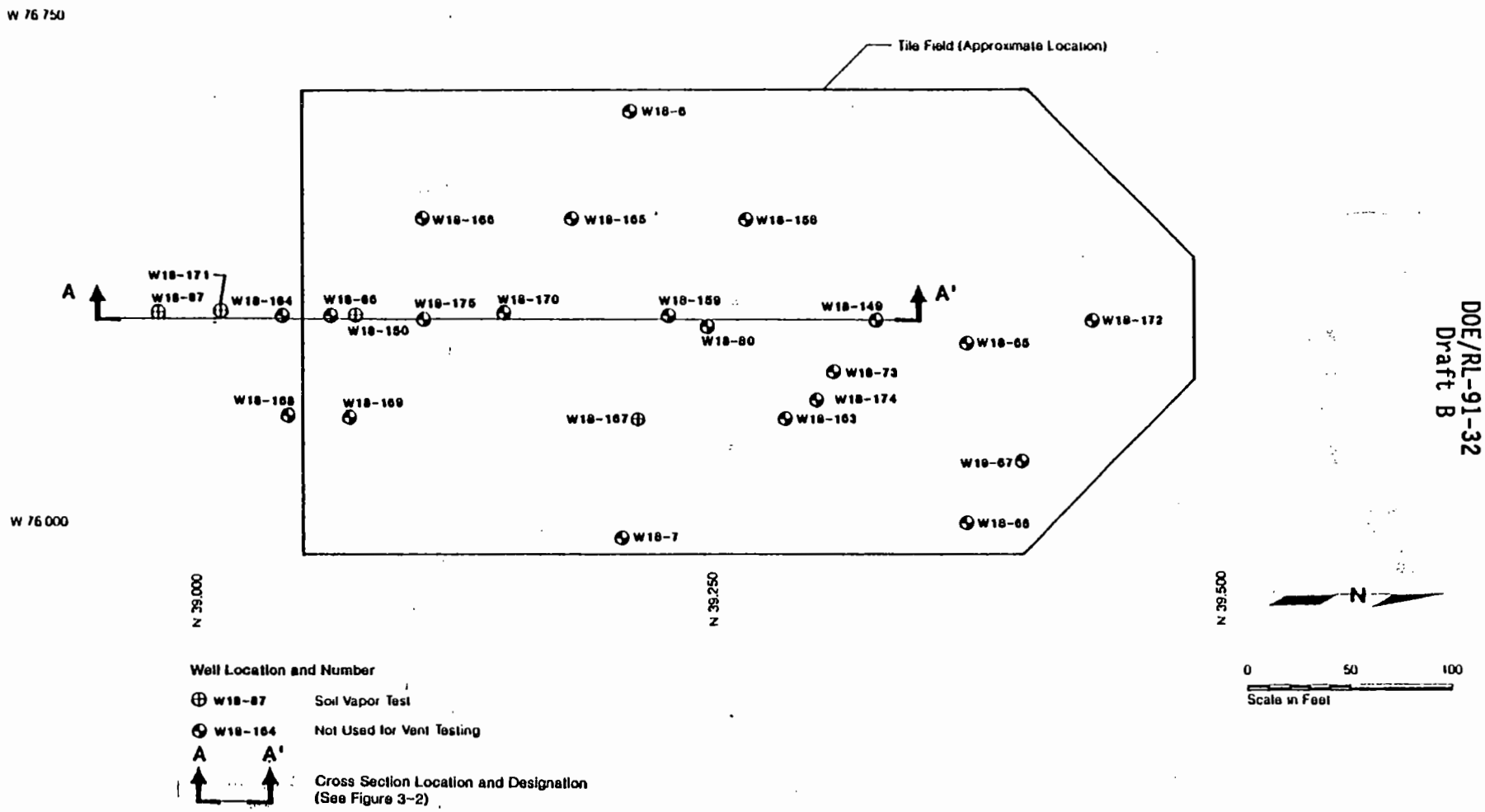
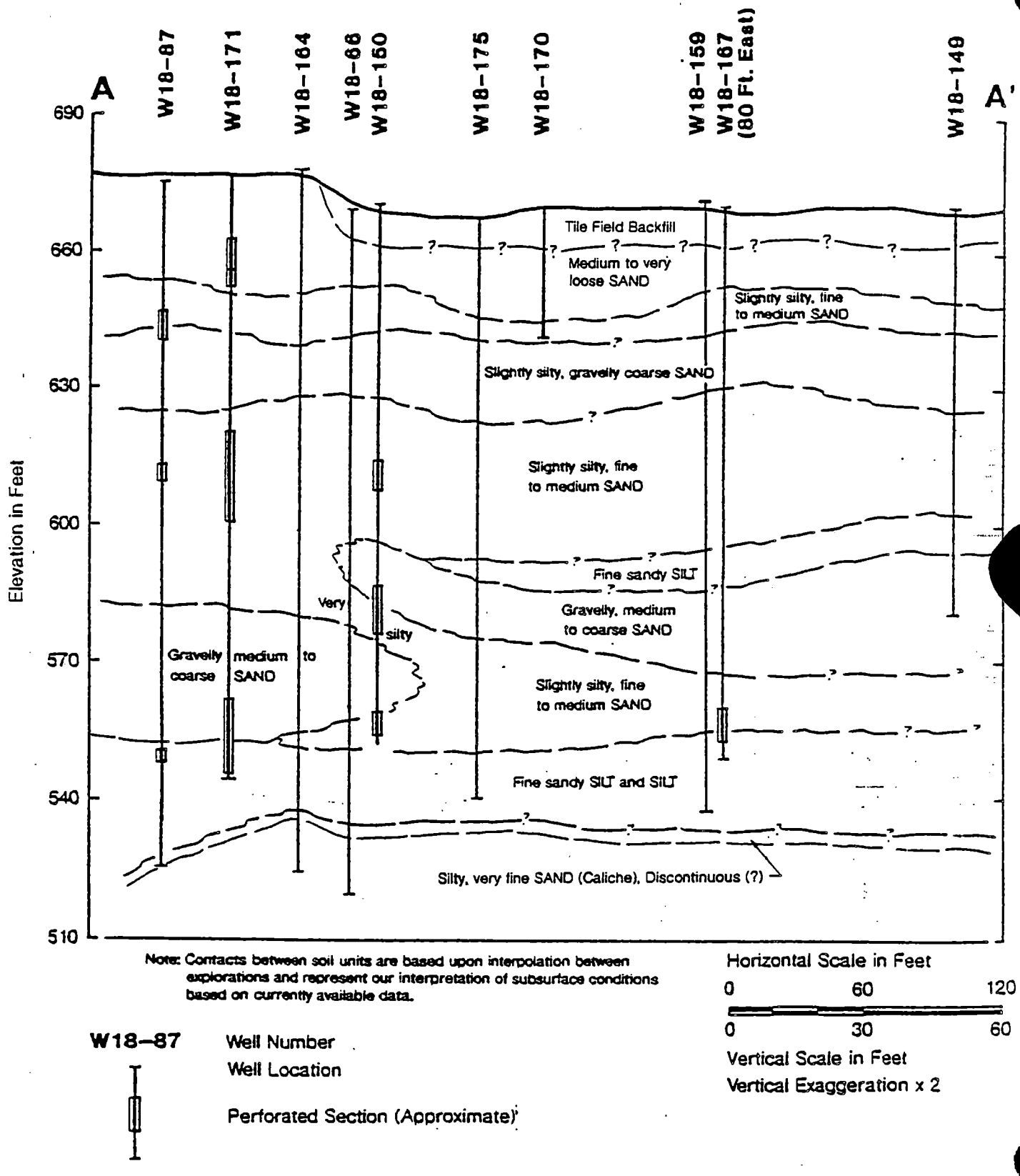


Figure 3-2

Generalized Subsurface Cross Section A-A'



Note: Contacts between soil units are based upon interpolation between explorations and represent our interpretation of subsurface conditions based on currently available data.

Table 3-1 - Well Casing Perforations

Well Number	Well Depth in Feet from Top of Casing	Perforated in Feet Depth from Top of Casing	Number of Perforation Passess	Perforated Interval Soil Type	Type of Test
W18-87	151.6	33 to 38	2	fine SAND	C
		65 to 70	2	silty SAND	H1
		125 to 130	2	SILT	H2
W18-150	118.9	65 to 70	2	silty SAND	H1
		85 to 90	2	medium SAND	C
		113 to 118	2	medium SAND	C/H2
W18-167	120.0	114 to 119	2	silty SAND	C/LT24
W18-171	131.8	20 to 25	2	course SAND	C
		57 to 77	4	silty SAND	C/H1
		115 to 130	4	coarse SAND/ SILT	C/H2/LT80

C- Soil Vapor Characterization Sample (Phase One Test)
H1- Hydraulic Test No. 1 (Phase Two)
H2- Hydraulic Test No. 2 (Phase Two)
LT24- Long-Term Vent Test, 24-hr (Phase Three)
LT80- Long-Term Vent Test, 80-hr (Phase Three)

3.2 TEST PHASES

The testing consisted of three phases:

- Phase One (known as the "puffer tests") was designed to assess the vertical and horizontal distributions of soil vapor concentration. The VES was operated at its lowest sustainable flowrate (about 50 cfm) and the gas samples were taken from the inlet piping as quickly as possible, minimizing the potential "smearing" of the soil vapor that might be caused by excessive pumping.

- Phase Two (Hydraulic Tests) was designed to assess the permeability of two strata that were considered likely to have accumulated soil vapor. The well packers were set at two intervals of W-171 to isolate each of those two strata, and the packers in the remaining wells were set at the same elevation as the venting interval in W-171. The VES was operated at about 320 cfm, and the induced vacuum in the observation wells was recorded. The data reduction methods that were used to calculate the permeability from the measured data are presented in Appendix B.

- Phase Three (Long-Term Vent Tests) consisted of a 24-hour vent test at the lowest interval of W-167 and an 80-hour vent test at the lowest interval of W-171. Gas samples were collected from the inlet piping at prescribed time intervals. During the long-term test at W-171 the packers in the adjacent observation wells (W-87 and W-150) were moved to various vertical intervals, to measure the vertical profiles of induced vacuum near the venting well.

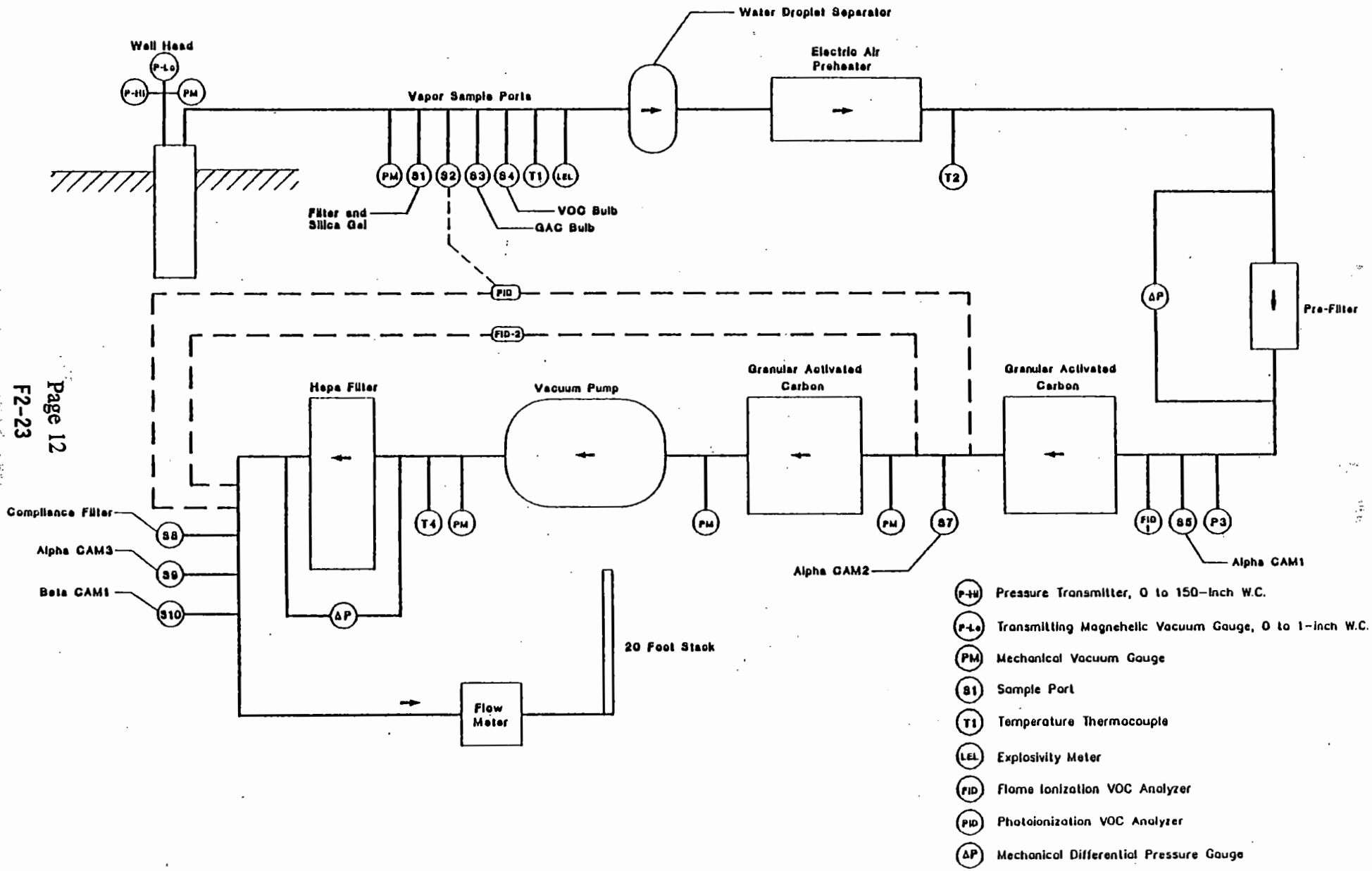
3.3 VAPOR EXTRACTION SYSTEM

The flow diagram for the VES is shown on Figure 3-3. The VES was fabricated and installed at the test site by Terra Vac, Incorporated (Terra Vac is a registered trademark). The VES was designed to vent a maximum of 500 cubic feet per minute (cfm) of soil vapor at a venting vacuum of 150 in. w.g. Key elements of the VES were as follows:

- Materials of Construction - The VES was constructed of carbon steel vessels and piping. The piping between the components was 4-inch-diameter steel pipe. All components of the system were specified to withstand vacuums up to 150 in. w.g. and temperatures up to 150°F. However, during the test, one of the GAC canisters partially buckled when the vacuum temporarily reached 150 in. w.g. (No leaks were detected after the incident and the test continued without interruption).

- Inlet Gas Sampling - As later described in Section 3.3, gas sampling ports were installed at the system inlet to allow for collection of gas samples for off-site chemical analysis.

Figure 3-3
Flow Diagram - Soil Vapor Extraction System



- Water Droplet Separator - A centrifugal water droplet separator was used to remove entrained water droplets that would damage the vacuum pumps.

- Particulate Pre-Filter - A paper cartridge prefilter was used to remove entrained soil particles (which might contain radioactive components) before they could enter the offgas control devices and for vacuum pump protection. The filter medium was rated at 99% removal of particles larger than 10 microns.

- Granular Activated Carbon Canisters - Carbon tetrachloride vapors were removed by passing the vented air through two GAC canisters in series. Each canister held 1,000 pounds (lbs) of GAC. It was estimated that each GAC canister could remove about 250 to 400 lbs of carbon tetrachloride. Continuous VOC monitors between the two canisters were used to indicate breakthrough of carbon tetrachloride from the first canister. At the end of testing, the PID readings taken between the canisters read about 17 to 40 part per million weight (ppm_w), which indicated that the first canister was approaching breakthrough.

- Vacuum Pump Module - A single 15-horsepower (hp) positive displacement vacuum pump was used for all phases of testing. The pump speed and capacity were adjusted by changing pulley sheaves between the electric motor and the vacuum pump. The pump flowrate was fine-tuned by adjusting a recirculation bypass valve. The pump was originally specified to operated over a range of 10 to 500 cfm. However, the actual long-term lower flowrate limit achieved by the pump was about 50 cfm.

- High Efficiency Particle Filter - A HEPA filter was used to remove particulate radionuclides that penetrated the prefilter and GAC canisters. The HEPA filter was manufactured by Flanders Filters, Incorporated (Flanders Filters is a registered trademark). The filter medium was installed by WHC technicians.

- Electronic Flow Meter - An electronic mass flowmeter, manufactured by Omega, was used to continuously monitor the vapor flowrate (Omega is a registered trademark). The flowmeter had a lower flow detection limit of about 20 cfm.

- Lower Explosive Limit Monitor - A combustible sensor type lower explosive limit (LEL) monitor was installed at the system inlet to monitor for presence of potentially explosive concentrations of methane gas, which was originally expected as a component of the soil vapor. Based on sample data, no methane was encountered during the testing. The LEL monitor was originally specified to operate with inlet carbon tetrachloride concentrations up to 10,000 ppm. However, the LEL sensor eventually malfunctioned after several days of testing, reportedly because it was not designed for use with chlorinated VOC concentrations exceeding about 200 ppm. The malfunction did not affect the

safety of the test because before the malfunction occurred it was determined that methane gas concentrations were not significant.

- Continuous VOC Monitors - Two types of continuous VOC monitors were used: flame ionization detector (FID); and photoionization detector (PID). The VES was initially constructed using FIDs (Foxboro Model OVA-88; Foxboro is a registered trademark), with one FID continuously monitoring the system outlet and a second FID manually switched between the system inlet and between the two GAC canisters. A single PID (manufactured by SIP, Incorporated; SIP is a registered trademark) with an 11.7 electronic volt (eV) lamp was used to supplement the FIDs. The single PID was manifolded and manually switched between three sampling points; the system inlet, between the two GAC canisters, and at the stack outlet. The FIDs were never able to reliably measure carbon tetrachloride in the gas stream and the data collected by them have not been used in this report. The PID was able to continuously monitor carbon tetrachloride. However, the PID experienced two recurrent problems: first, the unit did not function when the system vacuum exceeded about 90 in. w.g. in the process piping; and second, the unit experienced significant drift (drifting by about a factor of two during a 12-hour period) which required it to be re-calibrated frequently. The PID also appeared to be affected by condensed moisture in the sampling lines, which commonly occurred during nighttime operation.

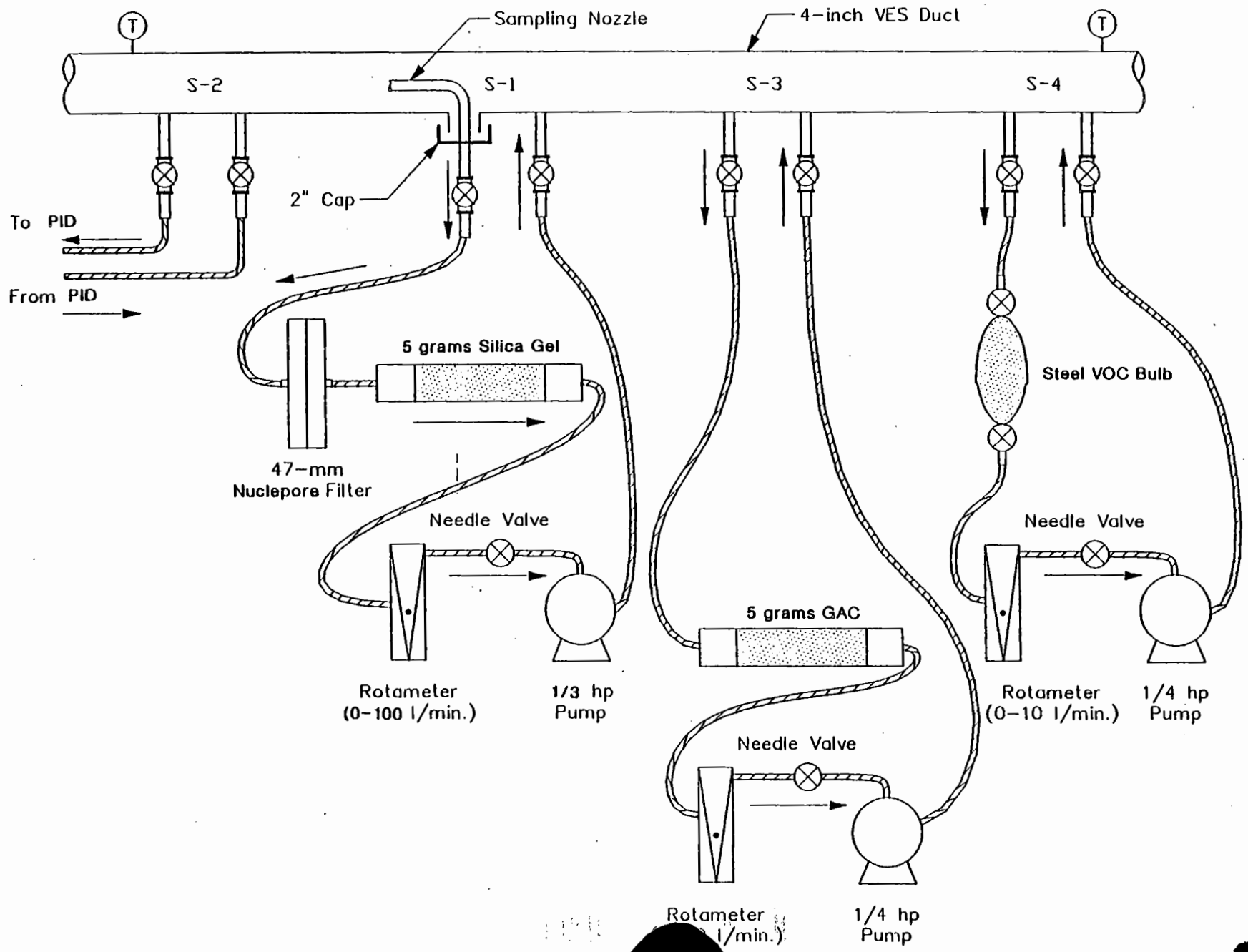
- Particulate Radiation Monitoring - Four continuous air monitors (CAMs) for particulate radionuclides were used. Alpha-CAMs were set up to monitor the process stream at three points: downstream of the particle prefilter; between the two GAC canisters; and at the stack. A Beta-CAM was set up to monitor the stack. In addition, a continuous compliance filter with inlet nozzle was installed at the stack to provide a final record of the emission rate for particulate radionuclides.

- Electronic Data Acquisition System - Two separate data acquisition systems (DASs) were used during the testing. Terra-Vac originally installed a 32-channel Omega "Smart Chart" strip chart recorder. That recorder was used during Phase One. It was damaged during installation of some additional electronic sensors and was discontinued. It was replaced for Phase Two and Phase Three by a 32-channel Strawberry Tree, Incorporated electronic DAS (Strawberry Tree is a registered trademark). The DAS was programmed to automatically download to a portable computer every five minutes and store the data for future processing. The electronic data were also recorded onto a line printer.

3.4 GAS SAMPLING AND ANALYSIS METHODS

Figure 3-4 shows a schematic flow diagram for the gas sampling system. The measurement methods used for each sample train are described below.

Figure 3-4 Soil Vapor Sampling Apparatus



3.4.1 VOC Sampling Using Steel Sampling Bulb

VOCs were sampled directly from the process piping into a 40-milliliter (ml) stainless steel bulb. Each bulb was preconditioned by the laboratory by filling it with helium and delivered to the job site. The bulbs were filled with sample gas by pumping at about 10 liters/minute for about 5 minutes. The exact flowrate and sample volume were not critical, because the residual helium that remained in the bulb after sampling was measured along with the VOCs to assess the bulb flushing efficiency during sampling.

The VOCs in the gas stream were analyzed by the WHC 222S laboratory using the following method:

- 150 to 1,000 microliters (ul) of gas was taken from the bulb through a sample septum using a sampling syringe.
- The 100 ul air sample was purged into 5 ml of distilled and boiled water.
- The VOCs in the water were analyzed using gas chromatography. The liquid VOC concentration was then normalized to the air concentration.

3.4.2 Particulate Sampling

Filter samples were taken at the system inlet and analyzed for particulate radionuclides. The following sampling steps were performed:

- Gas samples were taken from the process piping using a sampling nozzle pointed into the flow stream. The sample flowrate was about 30-50 liters/minute and was measured by a rotameter.
- The particles were collected on a 47-millimeter (mm) Nuclepore filter. The spent filter was analyzed by the 222S laboratory for the following components:
  - Total alpha energy by Method LA-508-051;
  - Total beta energy by Method LA-508-101; and
  - Total gamma energy by Method LA-548-121.

3.4.3 Water Vapor Concentration

As shown on Figure 3-4, the water vapor concentration was measured by gravimetric analysis of silica gel desiccant. The silica gel tube was sampled in line with the 47-mm particle filter described in the previous section. The silica gel sorbent tubes were constructed of 3/4-inch glass tubing and contained about 5 grams of silica gel. The sorbent tubes were run at a flowrate of about 10 liters/minute for about 60 minutes.

3.4.4 Semivolatile Organic Compound by GAC

As shown on Figure 3-4, GAC sorbent tubes were used to collect gas samples for semivolatile organic samples. The sorbent tubes were constructed of 3/4-inch glass tubing and contained about 8 grams of GAC. The tubes were sampled at a flowrate of about 5 liters/minute for about 60 minutes. The sample volume was designed to provide a large sample without risking GAC breakthrough caused by high concentrations of CCl_4.

3.5 Test Schedule

The test schedule that was followed for the vent testing is shown on Figure 3-5. The actual field testing (first test run of Phase One) began on April 1, 1991. Field testing was completed on April 20, 1991.

Figure 3-5
Soil Venting Test Schedule

	March 1991			April, 1991					May, 1991				
	4	21	28	1	7	14	21	28	1	7	14	21	28
Install VES Equipment at Tile Field	xxxxxxxxxxxxxX												
Phase One "Puff Tests"				xxxxxxxX									
Phase Two Hydraulic Tests						xxX							
Phase Three Vent Test at Well 167 Lower Interval							xX						
Phase Three Vent Test at Well 171 Lower Interval							xxxxxX						
Laboratory Analyses							xxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxxxxxxx				
Data Analysis							xxxxxxxxxxxxxx		xxxxxxxxxxxxxxxx				
Prepare Draft Test Report								xxxxxx					
Prepare Design Description and Final Test Report								xxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxX				

Lotus "testsched"

4.0 TEST RESULTS

This chapter of the report summarizes the results of the venting tests. The limitations of the data are also discussed, and the significance of the findings relative to the design of a full scale system is described.

4.1 PHASE ONE - SOIL VAPOR CHARACTERIZATION

The Phase One investigation ("puff tests") was designed to assess the vertical and lateral distribution of ventable components under and around the tile field. As described in Section 3.2, the Phase One tests were designed to collect gas samples as quickly as possible and at the lowest sustainable flowrate (about 50 cfm) to prevent shifting the distributions of soil gas concentrations in the subsurface. Detailed test procedures are described in the Test Plan.

Table 4-1 lists the results of the soil vapor analyses. Figure 4-1 shows the CCl_4 vapor concentrations at the perforated intervals that were sampled.

Based on inspection of Phase One data, the following conclusions are drawn regarding the spatial distribution of the contaminants:

- The CCl_4 vapor concentration generally increased with depth below ground surface. There are two possible explanations for this. First, it is likely that the CCl_4 that was discharged through the tile field has migrated downward during the past 20 years through the relatively coarse upper sediments until it reached the less permeable zone of the lower sediments and caliche. The lower sediments are generally siltier than the upper sediments, and probably contain a higher concentration of natural organic carbon. The CCl_4 would accumulate in those lower sediments because chlorinated solvents are preferentially sorbed onto the organic carbon. Second, it is likely that CCl_4 that accumulated in the shallow sediments would have dissipated during the past 20 years by volatilization and migration to the ground surface.

- Significant concentrations of CCl_4 vapors were detected outside the lateral limit of the tile field. The W-87, which was about 80 feet outside the tile field discharge piping, exhibited a CCl_4 vapor concentration of 19 ppm_v in an upper soil layer. Soil CCl_4 has potentially migrated laterally as well as vertically, and it is possible that the CCl_4 concentrations in the deeper sediments outside the tile field are higher than the value measured at the shallow intervals at W-87.

- No vapor concentration measurements were attempted at vertical intervals below the caliche layer underlying the tile field. There are no data available regarding the integrity of the caliche layer. Although the caliche is expected to provide a temporary barrier to vertical migration, it is probably

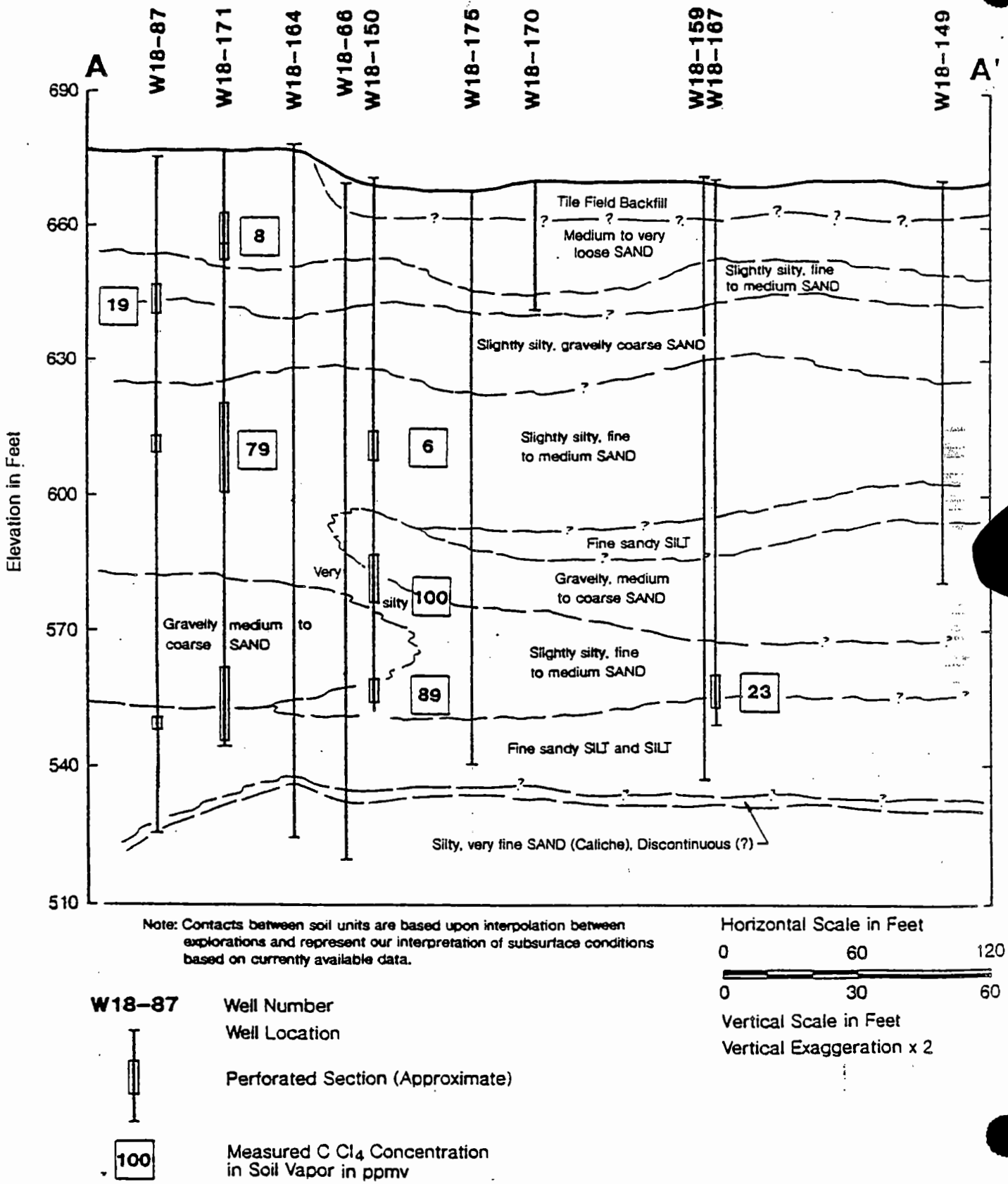
Table 4-1 - Summary of Phase One Vapor Concentrations

Well No.	Perforated Interval (ft)	VOC Bulb Carbon Tetrachloride (ppmv)	Particulate Filter Total Alpha (uCi/m3)	Total Beta (uCi/m3)	Gamma Cs-137 (pCi/m3)
Field Blanks		N.D.	N.D.	3.4E-08	N.D.
W18-87	33-38	19	N.D.	N.D.	N.D.
W18-171	20-25	8	1.7E-06	N.D.	N.D.
	57-77	79	3.4E-06	7.9E-06	N.D.
W18-150	65-70	6	N.D.	N.D.	N.D.
	85-90	100	N.D.	N.D.	N.D.
	113-118	89	N.D.	N.D.	N.D.
W18-167	114-119	23	N.D.	N.D.	N.D.

Approximate Detection Limits: CCl4 = 5 ppmv; Total Alpha = 5e-7 uCi/m3; Total Beta = 6e-6 uCi/m3; Gamma-Cs = 36 pCi/m3; Gamma-Pa = 36 pCi/m3

297816B41.Wk1

Figure 4-1
Measured C Cl_4 Vapor Concentrations (Phase One)



Note: Contacts between soil units are based upon interpolation between explorations and represent our interpretation of subsurface conditions based on currently available data.

discontinuous because of erosion channels, fractures, roots (it was a paleosol), and its non-massive nature. If erosion windows or solution channels exist in the caliche, then it is possible that either liquid or gaseous CCl_4 could have migrated through it into the underlying soil layers.

- No methane gas was detected during the Phase One tests at any sample location, as observed on the continuous readings from the FID and the LEL monitor.

- As shown in Table 4-1 low concentrations of particulate total alpha and total beta activity were measured at the 20- to 25- and 57- to 77-foot-depth intervals of W-171. The concentrations were measured at the inlet of the VES, upstream of the particulate prefilter and the HEPA filter. As described in Section 4.2.1, no particulate activity was measured during the long-term vent tests that were performed at the 115- to 130-foot-depth interval of W-171. No gamma activity was detected during the Phase One tests.

The VOC bulb sample concentrations measured during Phase One are lower than expected based on comparison with the Phase Three results. It was expected that the Phase One concentrations would represent the maximum achievable values for the soil vapor at the well because the CCl_4 should have equilibrated between the liquid and vapor phases long before the start of the testing. However, the initial Phase Three concentrations measured during the long-term vent tests were always higher than the Phase One results at the same well. It is therefore concluded that either the Phase One results are incorrectly low or the Phase Three results are incorrectly high. It is more likely that the Phase One results are in error. The Phase One VOC bulbs were held by the laboratory for 4 days before they were analyzed, as compared to only a one-day holding time for the Phase Three bulbs. A 24- to 48-hour holding time limit is typically used in private industry for bulk gas samples. It is possible that some degradation of the CCl_4 in the sample bulbs could have occurred during the longer Phase One holding time.

4.2 PHASE TWO - HYDRAULIC TEST RESULTS

This section describes the methodology and estimates for permeability of the underlying soils at the tile field. Soil venting test data, venting drawdown plots, and mathematical formulations are presented in Appendix B.

4.2.1 Middle Interval Hydraulic Test

The first test run was performed by venting the middle interval of W-171, which was perforated in slightly silty, fine to medium SAND (Figure 3-2). The vacuum drawdown data collected at W-87 during that test run were well behaved, and allowed the use of published data analysis methods to assess the air permeability. However, the vacuum response at W-150 during the first test run was inadequate to allow an estimate of the permeability.

The middle interval vent test at W-171 was conducted for approximately 4 hours, venting at predetermined step flowrates between 55 and 374 cfm at 60 to 88 in. w.g.. The soil permeability of the middle interval is estimated to range between 2.0 and 5.7 darcies (2 x 10^{-8} to 5.6 x 10^{-8} cm^2). The estimated conductivity is 1.3 x 10^{-4} to 3.7 x 10^{-4} cm/sec. These estimates of soil permeability and conductivity are in agreement with published permeability data for comparable soils (Freeze and Cherry, 1979).

Soil permeabilities were estimated using the procedure outlined by Johnson et al. (1990). Input parameters for the method described are the vacuum flow rate at the venting well and the transient pressure distribution data in an adjoining observation well(s). The procedure requires plotting the vacuum "gauge" pressure observed in an observation well against the log of time (ln(t)). The resulting semi-log plot should exhibit a characteristic straight-line segment upon reaching a "pseudo" steady-state condition. The slope of the straight-line segment on the semi-log plot is used to estimate the soil permeability.

4.2.2 Deep Interval Hydraulic Test

The second Phase Two test run was performed by venting W-171 at its deepest interval, which spanned the interface between medium to coarse SAND and sandy SILT. No significant vacuum response was measured in either W-87 or W-150 during the second test run, so no estimates of the permeability of the deepest interval could be made based on the Phase Two results. It appears that the Phase Two vent test at the deepest interval was adversely affected by the diurnal barometric pressure effect that was later quantified during the Phase Three tests. During the Phase Two test it was noted that CCl_4 vapors were flowing out of the W-171 casing and were presumably originating from the middle perforated interval that was open to the soil and atmosphere. The diurnal barometric pressure change apparently caused an increase in the soil pressure that offset the induced vacuum caused by the vent test. As described in Section 4.3.1, similar effects were later noted in all of the observation wells during the Phase Three testing.

4.3 PHASE THREE - LONG-TERM VENT TEST

The Phase Three testing was designed to assess the "steady state" flowrates, induced vacuums, and soil vapor concentrations that would occur under conditions that are likely to exist during operation of a full-scale venting system. The Test Plan specified running one long-term test for about a 5-day duration at W-171. However, PID readings taken at the VES inlet during Phase One appeared to indicate that significant CCl_4 concentrations existed in the lower soil strata at locations both under the tile field (W-150 and W-167) and outside the tile field (W-171). Therefore, the Test Plan was modified to include two long-term venting tests: a 24-hour test at W-167; and an 80-hour test at the lowest interval of W-171.

Figure 3-5 shows the test schedule for the Phase Three testing. Appendix C gives the operating log for the testing. The Phase Three tests began with the 24-hour test at W-167 and then continued with the 80-hour test at W-171.

4.3.1 80-Hour Test at W-171

The 80-hour vent test at W-171 was performed in the lowermost perforated interval, which was 15 feet long at a depth of 115 to 130 feet below ground surface. The perforated interval spanned the interface between overlying coarse-grained sands and the underlying silt zone. The total test duration at W-171 was 80 hours. Figure 3-5 shows the test schedule. The vent test began at 20:33 hours on Thursday, April 16, 1991. For the first 36 hours of the test the well packers at each of the observation wells (W-87, W-150, and W-167) were set at their lowermost perforated intervals (shown on Figure 3-2). After about 36 hours of venting, the well packer on W-150 was moved to the intermediate perforated interval to test the soil's vertical conductivity. The packer at W-87 was damaged as it was moved to the middle interval, so no vacuum data were taken at W-87 for the time period between 36 to 63 hours duration. During that period W-87 was sealed. During the last part of the test (about 63 to 80 elapsed hours) the well packer on W-87 was repaired and inflated at the middle interval and the well packer at W-150 was moved to its uppermost interval. As shown on Figure 3-2 the elevations of those intervals at W-87 and W-150 were similar.

Table 4-2 summarizes the results of the chemical analyses performed on vented air samples taken during the Phase Three vent testing. The measurements taken during the testing are displayed on Figure 4-2 through Figure 4-12. Observations and conclusions based on inspection of the test data are described below.

Quality of Data from Electronic vs. Manual Gauges - The electronic vacuum gauge readings and the periodic manual gauge readings for observation wells W-87, W-150, and W-167 are shown on Figures 4-2, 4-3, and 4-4, respectively. The electronic and manual data for W-87 match closely until about hour 36 of the test run, at which time the electronic sensor failed. The electronic and manual data for W-150 compare favorably. The electronic gauges on W-167 indicated significantly lower values than the manual gauges for those readings below about 0.1 in. w.g. The electronic sensor stopped working at W-167 at about 58 hours into the test. Based on these findings, it is recommended that the vacuum gauges to be used for the full-scale VES be of a different type than the ones used for the vent test.

Flowrate and Venting Well Vacuum vs. Time - Figure 4-5 shows the flowrate and well vacuum at W-171 during the test. The flowrate during the test was fairly constant at about 300 to 310 cfm, and the well vacuum was fairly steady at about 35 to 40 in. w.g. The Test Plan originally specified that the long-term venting flow should be about 500 cfm. However, the well vacuum in the venting well (and hence the venting flowrate) had to be limited because the PID became unstable at pipeline vacuums exceeding about 40 in. w.g., which corresponded to a system flowrate of about 400 cfm.

Gauge Vacuums at Observation Wells - Figure 4-6 shows the diurnal fluctuations in barometric pressure (taken from the DAS) and the vacuum gauge readings measured at the observation wells. Note that the gauges on the well heads read the differential vacuum between the soil and the atmosphere, so the gauge readings must be adjusted to account for routine fluctuations in the barometric pressure. Inspection of the gauge vacuums demonstrates the following:

Table 4-2 Vented Air Concentrations During Long-Term Vent Tests

Venting Well No.	Elapsed Time (Hours)	VOC Bulb Carbon Tetrachloride (ppmv)	Particulate Filter Total Alpha (uCi/m3)	Total Beta (uCi/m3)	Gamma Cs-137 (pCi/m3)	Gamma Pa-233 (pCi/m3)	Water Vapor (percent)
W18-167	0:00 (Blank)	N.D.	N.D.	N.D.	N.D.	N.D.	
	1:00	117					0.23
	3:45	238					0.20
	8:30	231					0.17
	12:45	256					0.07
	23:00 (Dupl)	135/180	7.2E-07	N.D.	N.D.	990	0.20
W18-171	0:00 (Blank)	N.D.	N.D.	N.D.	N.D.	N.D.	
	0.44	195					0.22
	5:00	420					
	8:30	375					0.40
	12:30	525					0.30
	18:40	489					0.20
	24:00	711	N.D.	N.D.	N.D.	N.D.	0.17
	30:00	570					0.32
	34:00 (Dupl)	485/701	N.D.	N.D.	N.D.	630	0.11
	43:20	701					0.15
	49:30	495					0.24
	55:00	645					0.45
	63:00	630					0.37
	67:00	915					0.12
	71:30	735					0.25
	79:00	585	N.D.	N.D.	N.D.	N.D.	0.11

Approximate Detection Limits: CCl4 = 5 ppmv; Total Alpha = 5e-7 uCi/m3; Total Beta = 6e-6 uCi/m3
Gamma-Cs = 36 pCi/m3; Gamma-Pa = 36 pCi/m3
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FIG 4-2 W-87 MANUAL/ELECTRONIC GAUGES
80 HOUR TEST

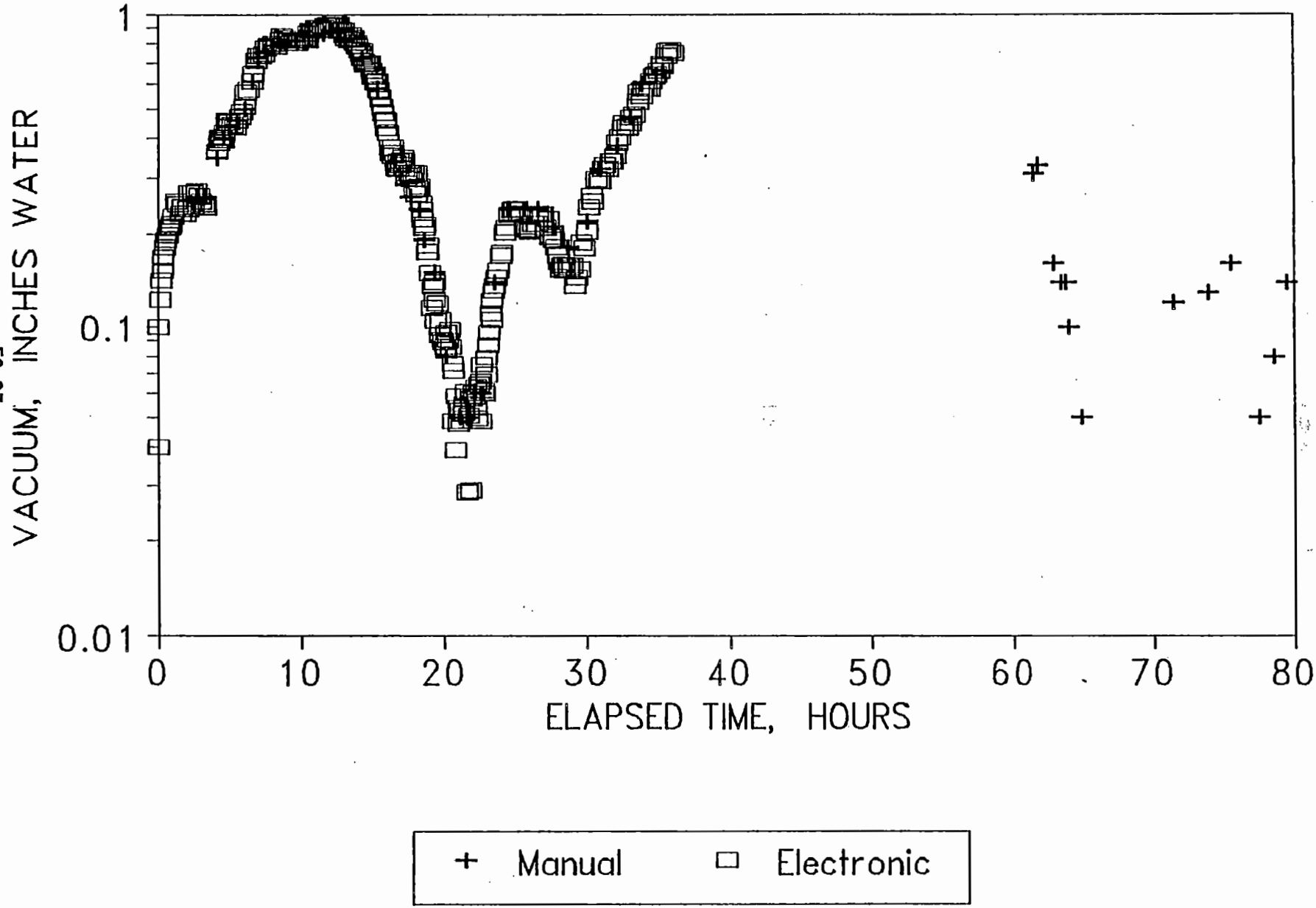
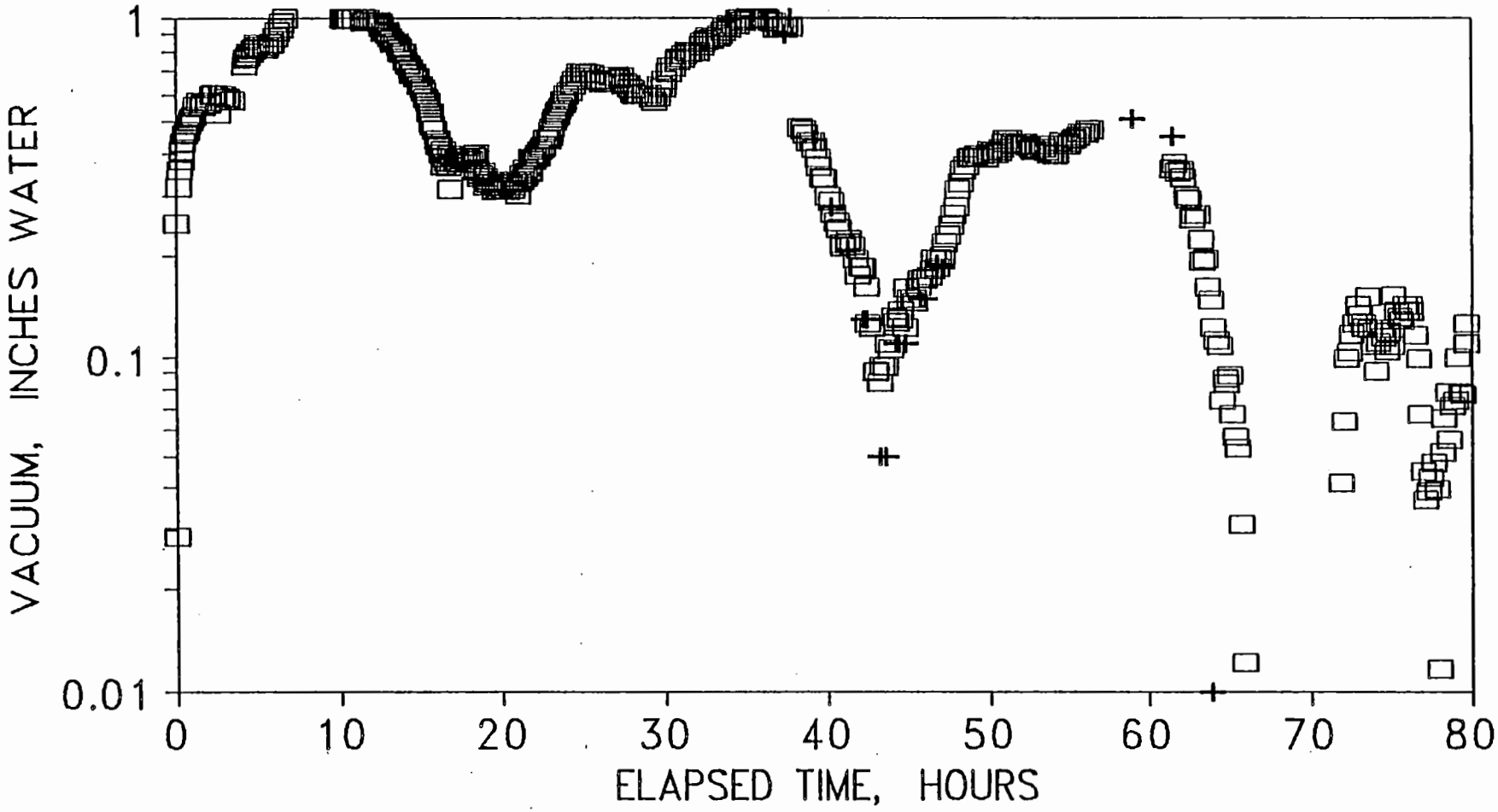


FIG 4-3 W-150 MANUAL/ELECTRONIC GAUGES 80 HOUR TEST



+ Manual □ Electronic

FIG 4-4 W-167 MANUAL/ELECTRONIC GAUGES 80 HOUR TEST

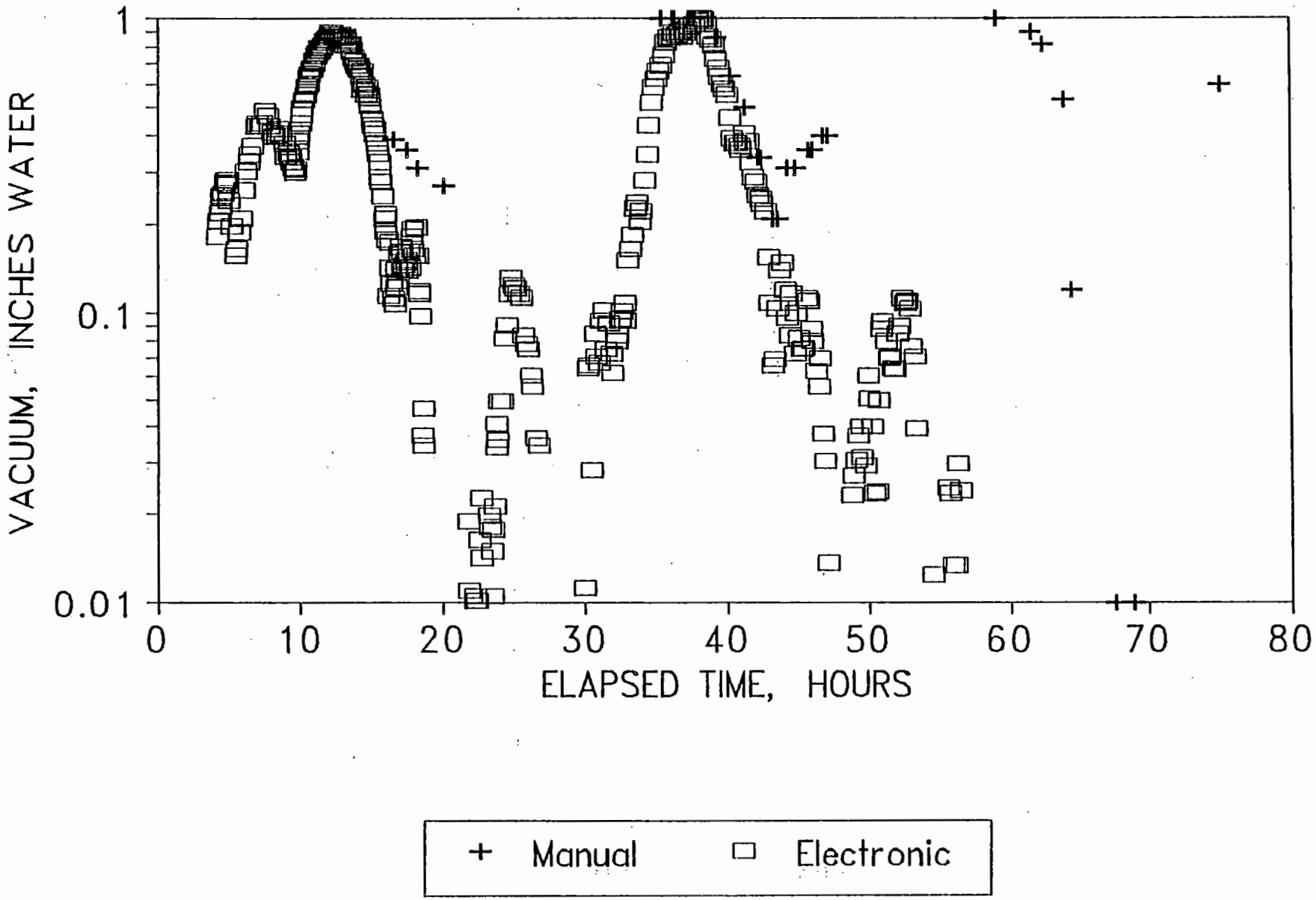


FIGURE 4-5 FLOWRATE AND VACUUM W-171, LONG-TERM TEST

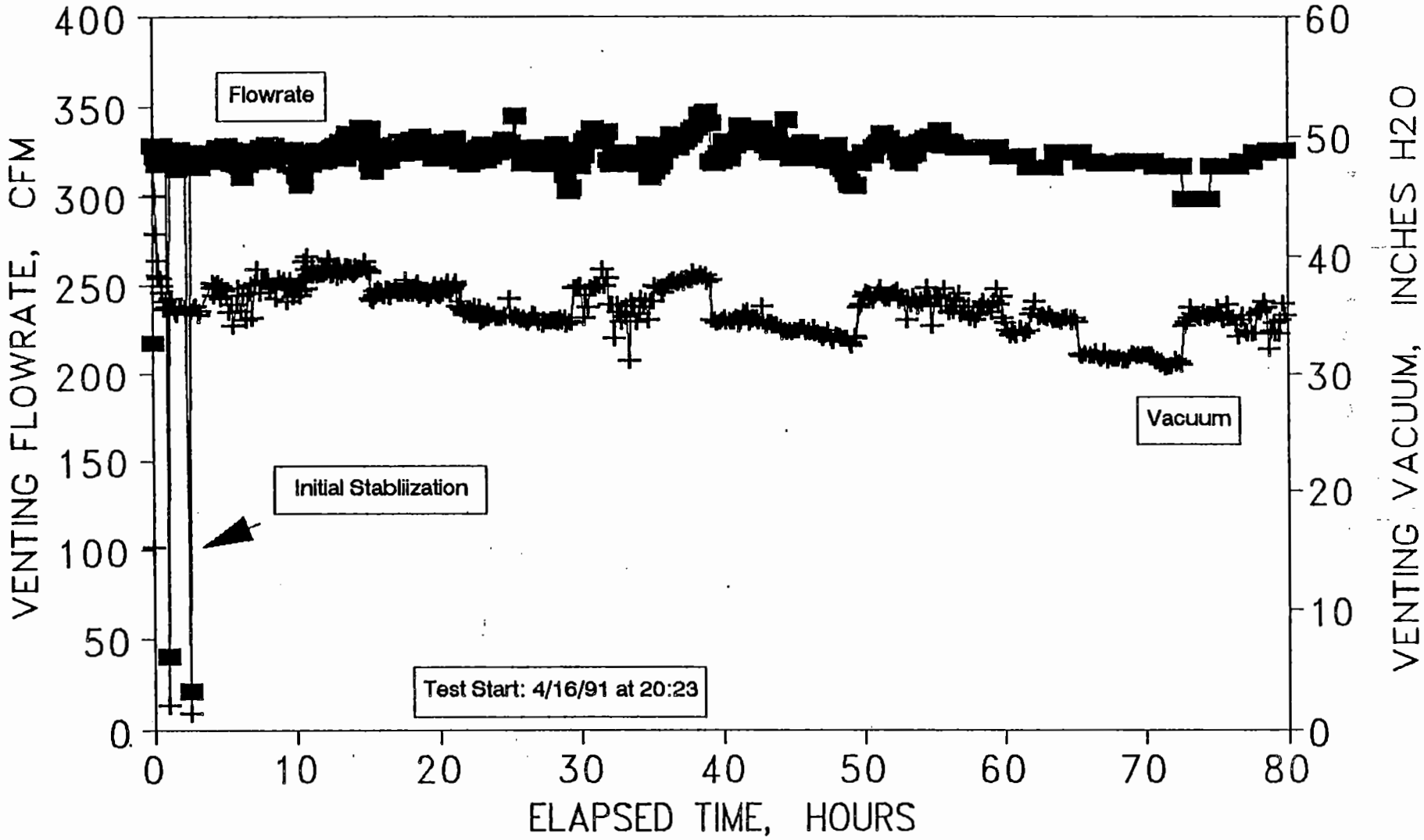


FIG. 4-6 VACUUM & BAROMETRIC EFFECT W-171, LONG-TERM TEST

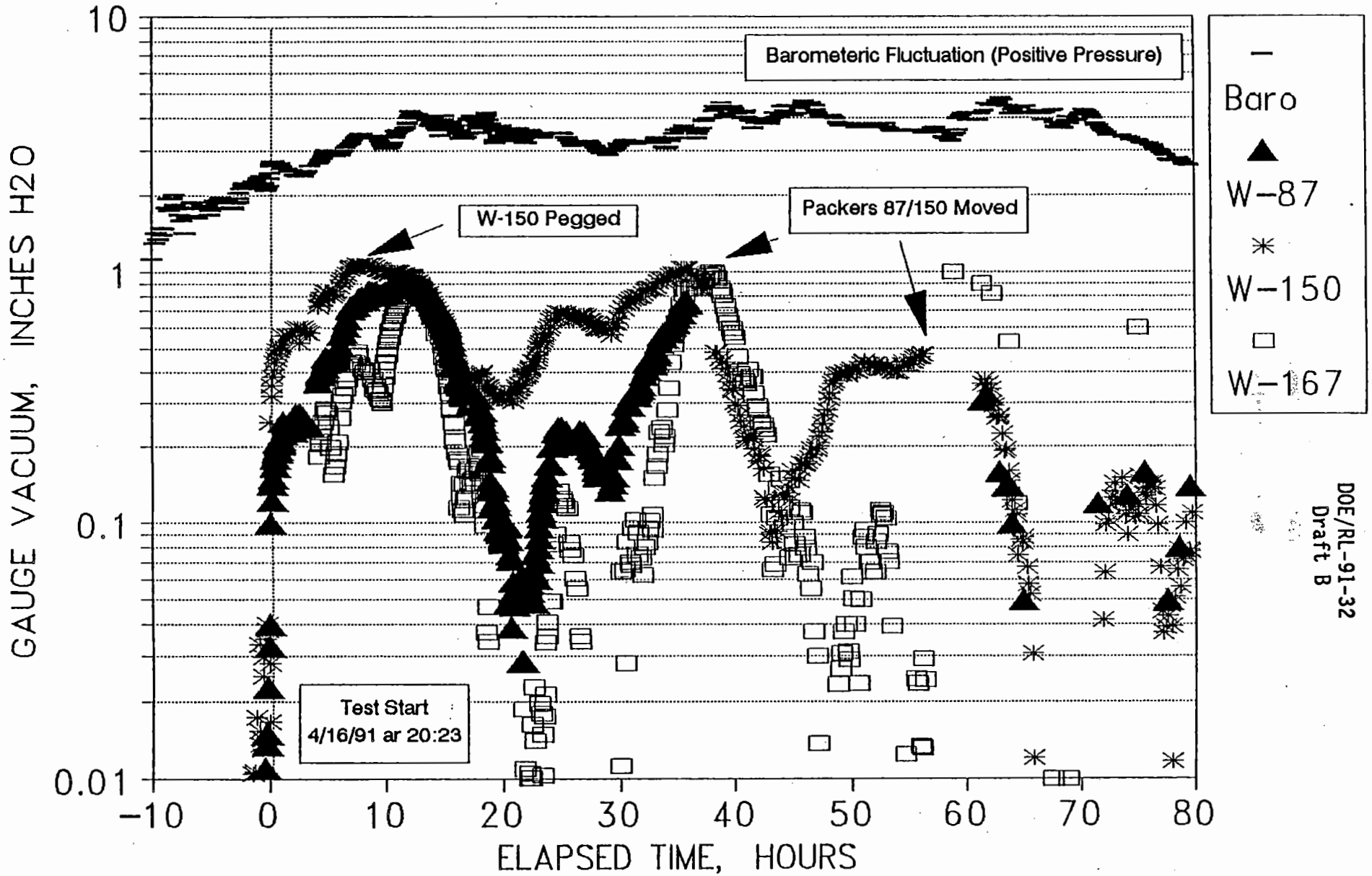


FIG 4-7 ABSOLUTE PRESSURE VARIATIONS
80-HOUR VENT TEST

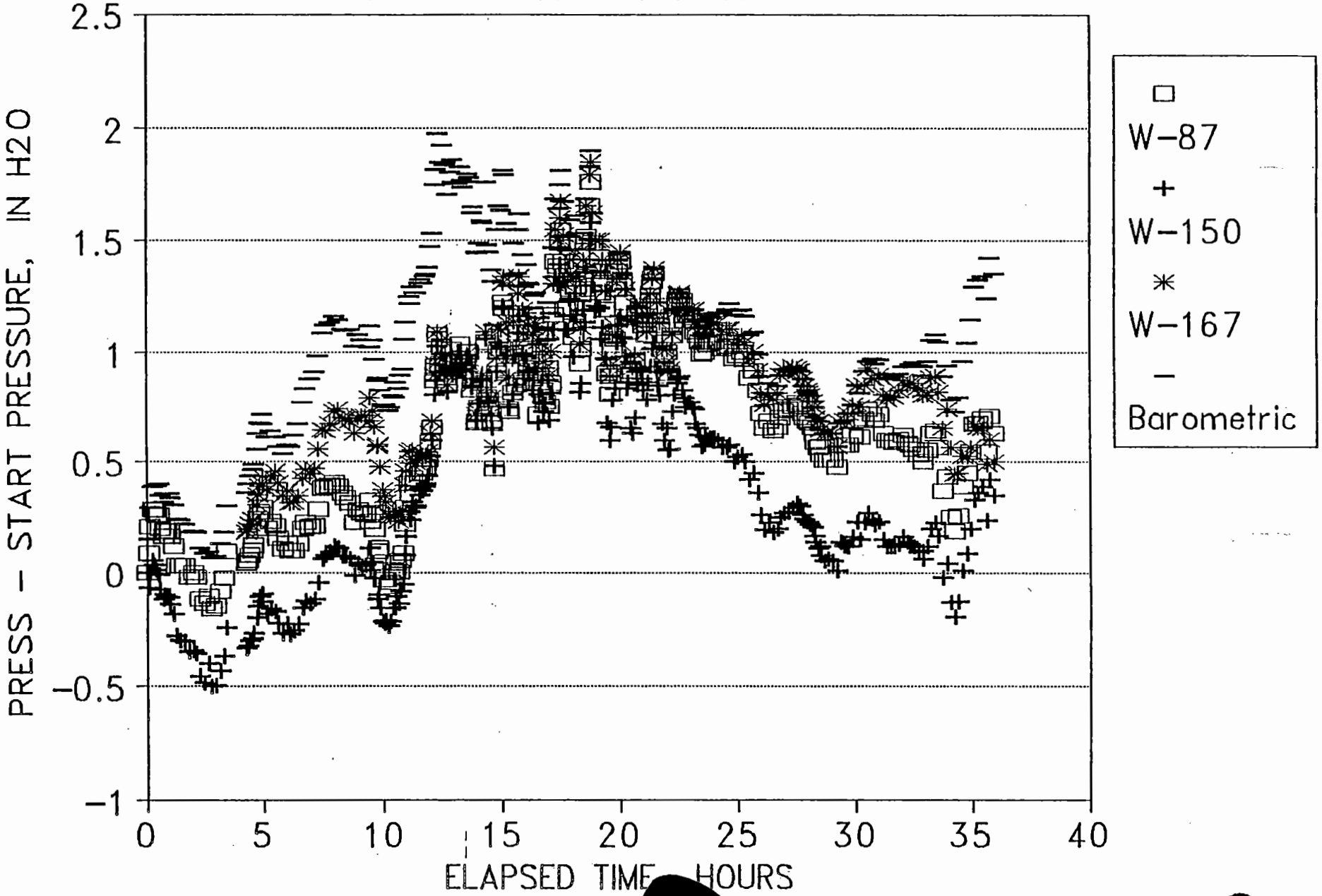


FIG 4-7a ABSOLUTE PRESSURE VARIATIONS
START OF 80-HOUR VENT TEST

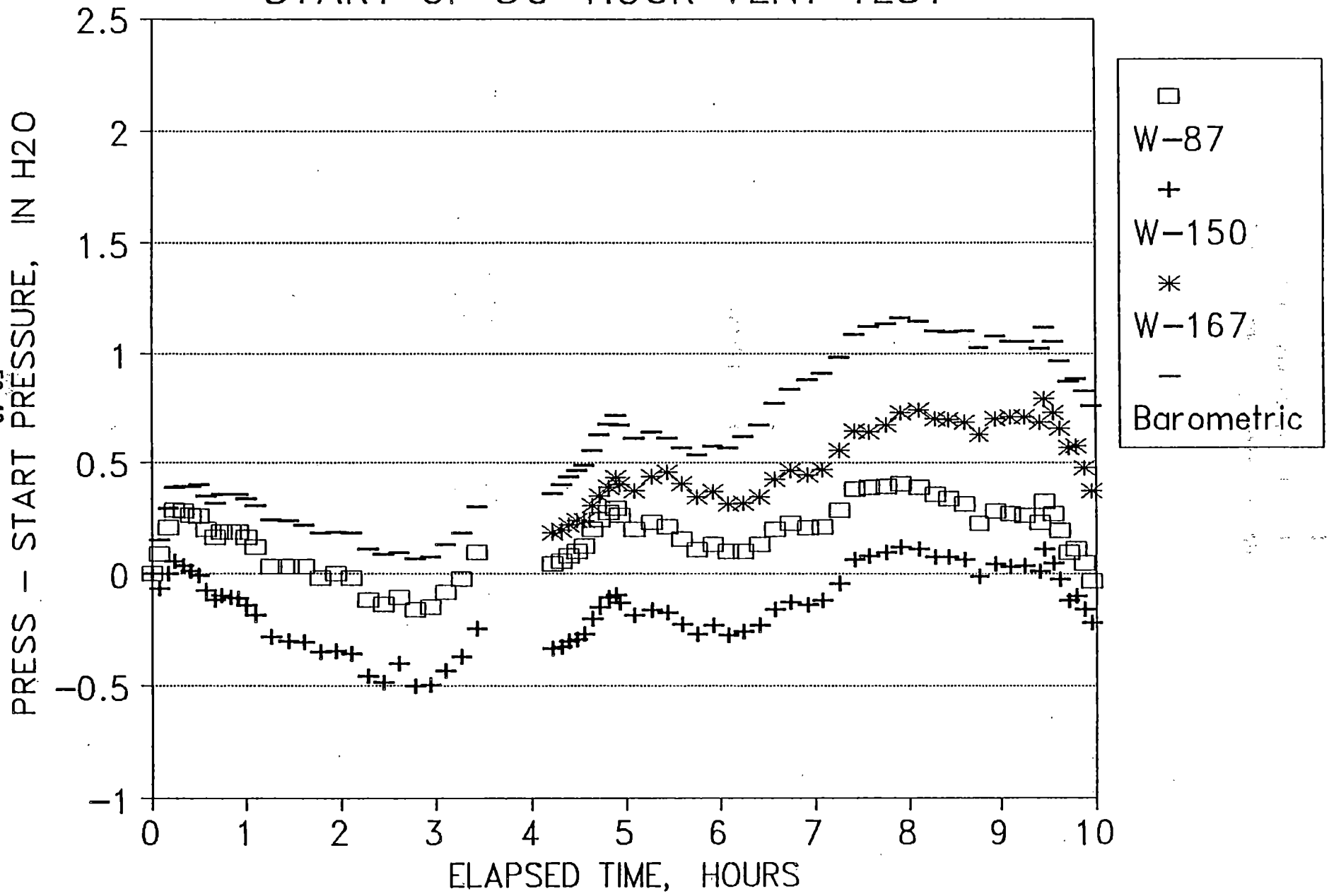


FIG 4-8a PRESSURE CORRELATION, W-87 HOURS 16 - 36 OF LONG TERM TEST

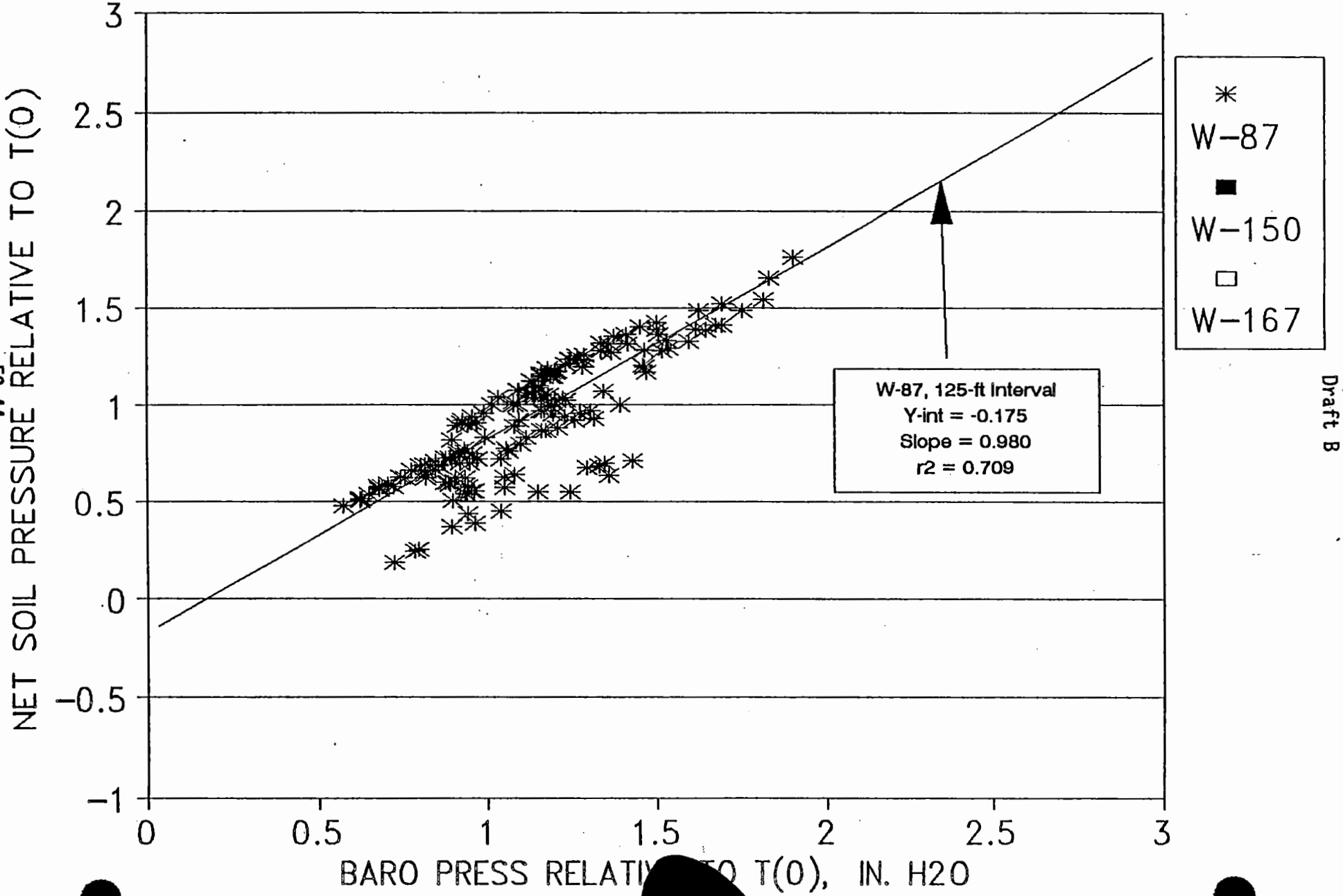


FIG 4-8b PRESSURE CORRELATION, W-150 HOURS 16 - 36 OF LONG TERM TEST

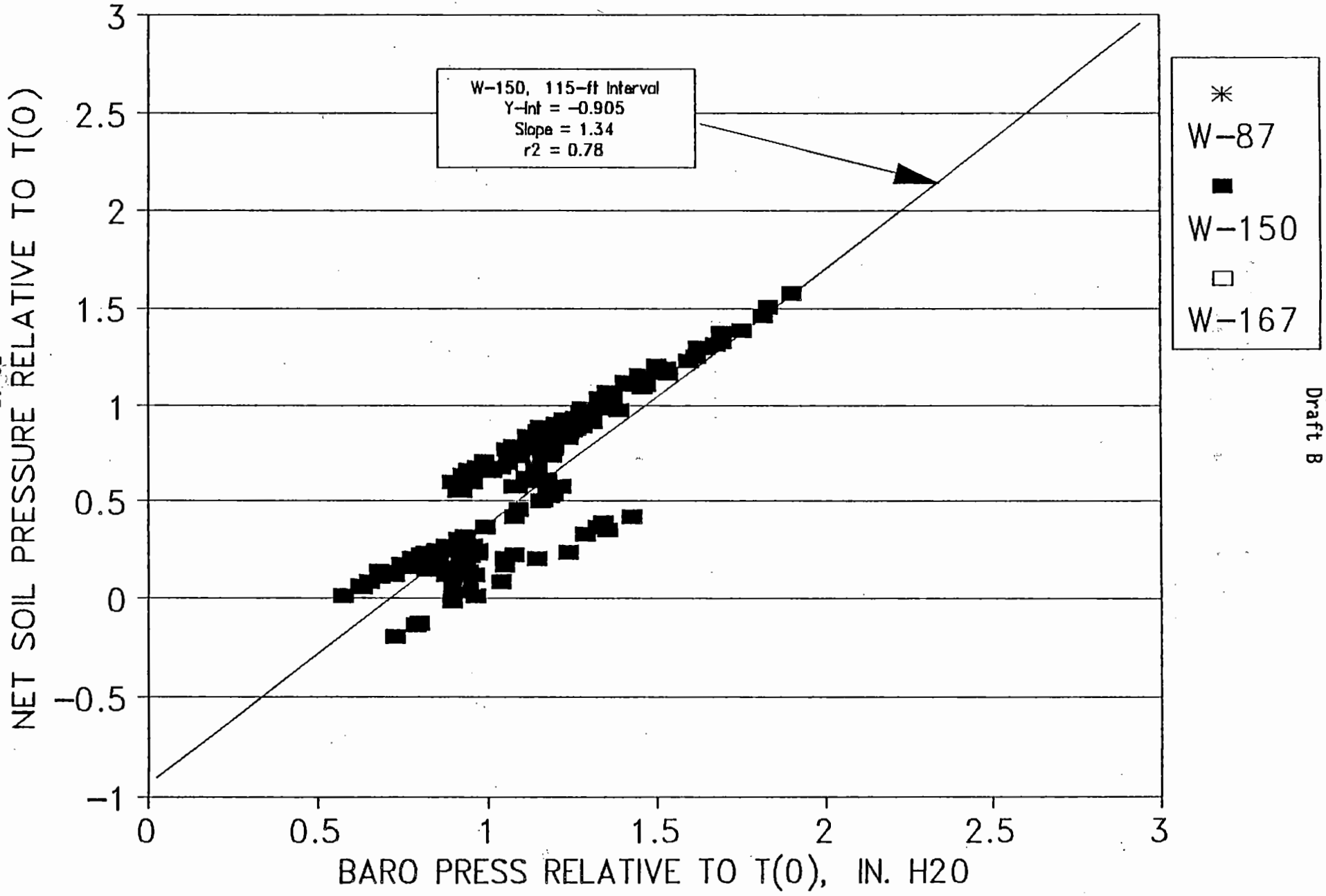


FIG 4-8C PRESSURE CORRELATION, W-167 HOURS 16 - 36 OF LONG TERM TEST

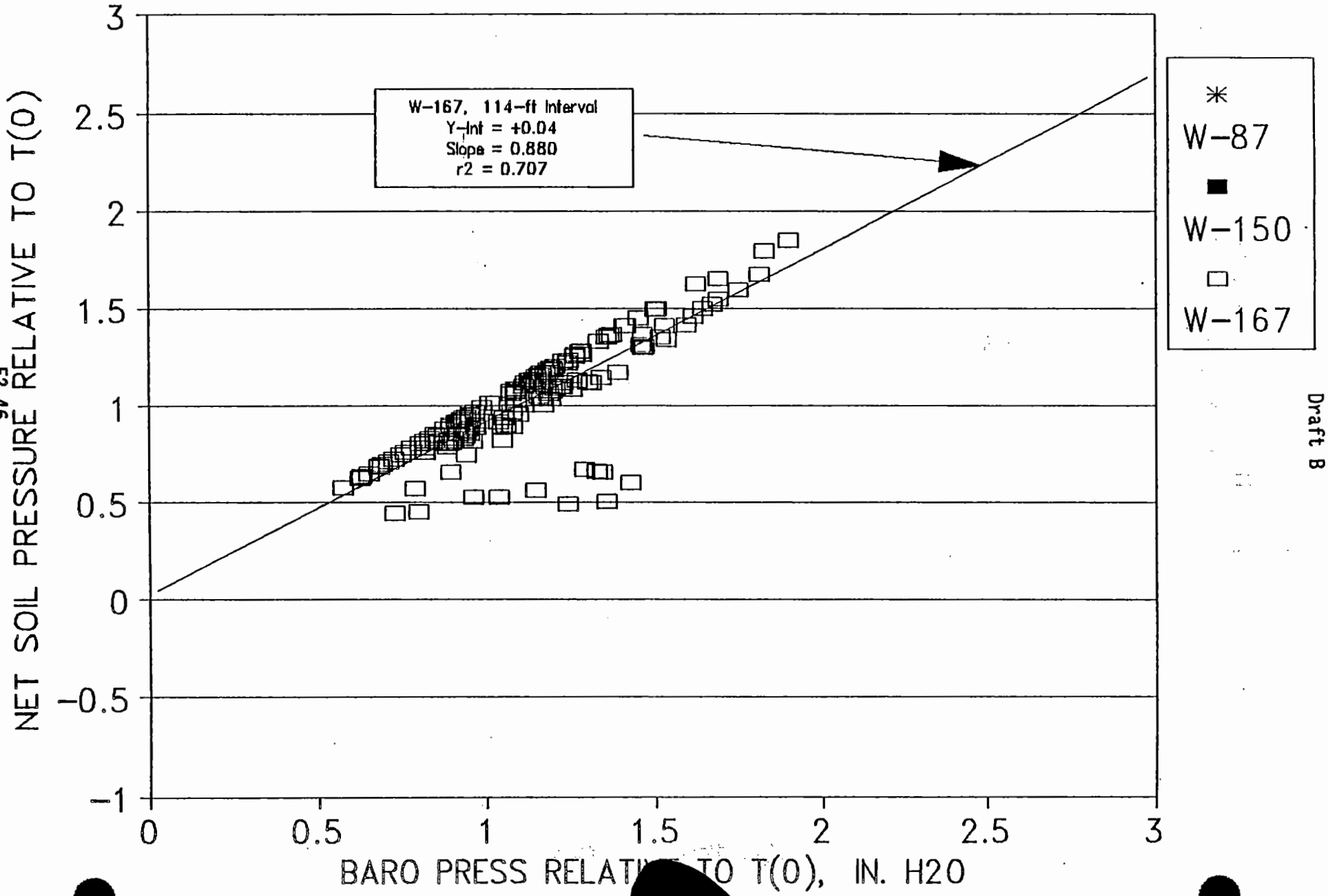


FIG 4-9 VACUUM RELATIVE TO W-167
80-HOUR VENT TEST

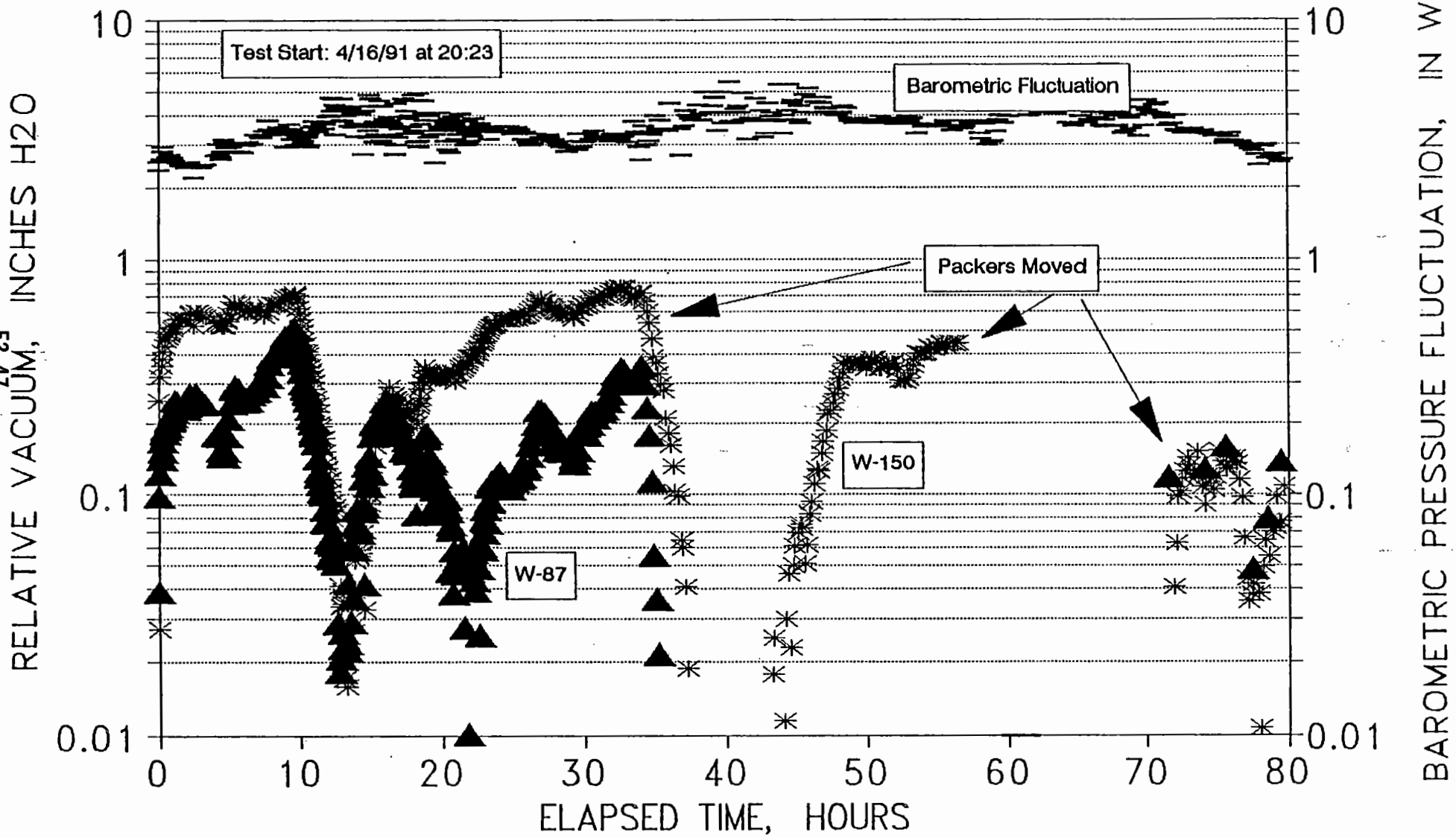


FIG 4-10 VACUUM AT VERTICAL INTERVALS
80-HOUR VENT TEST

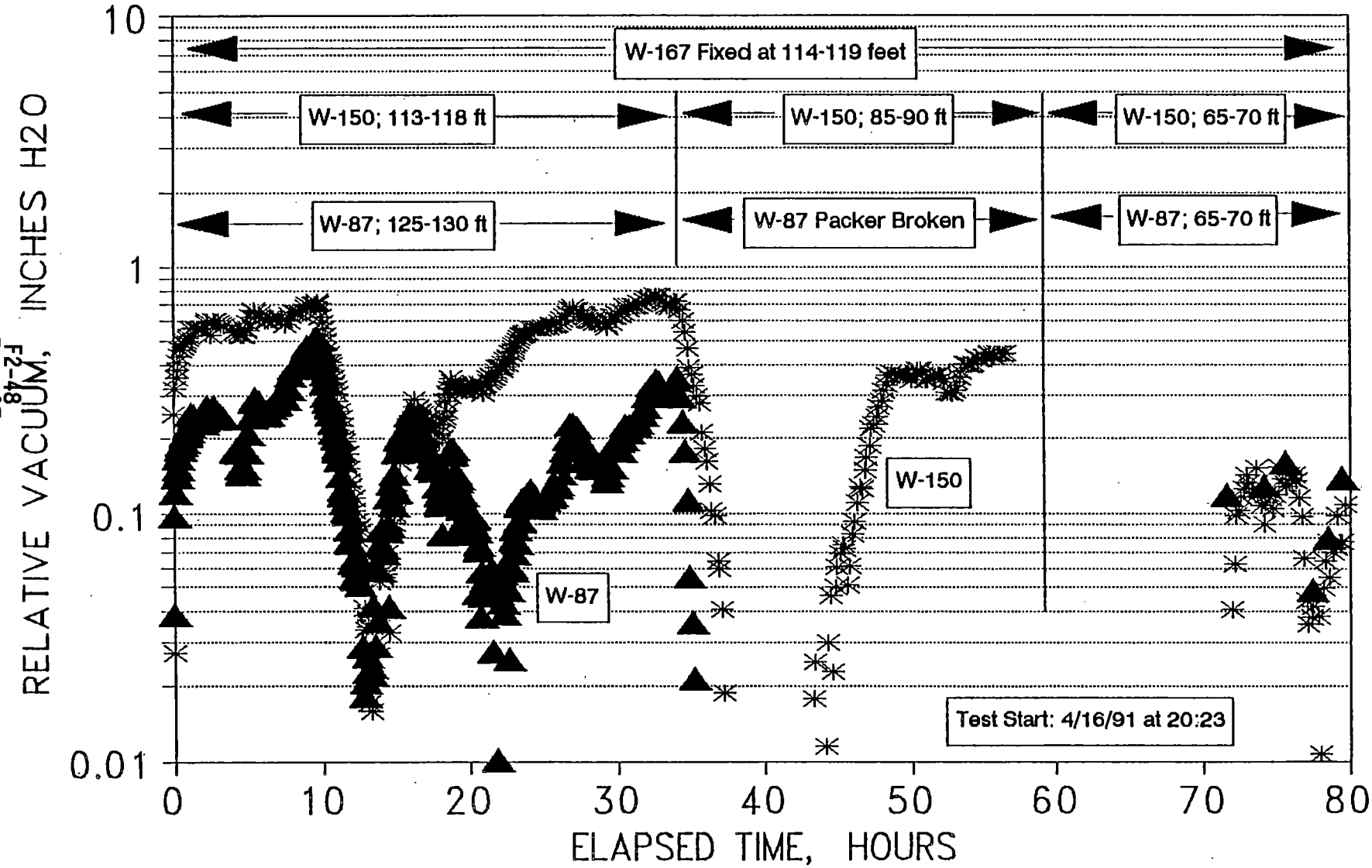


FIG 4-11 BULB SAMPLES VS. PID READINGS WELL 171, LONG-TERM TEST

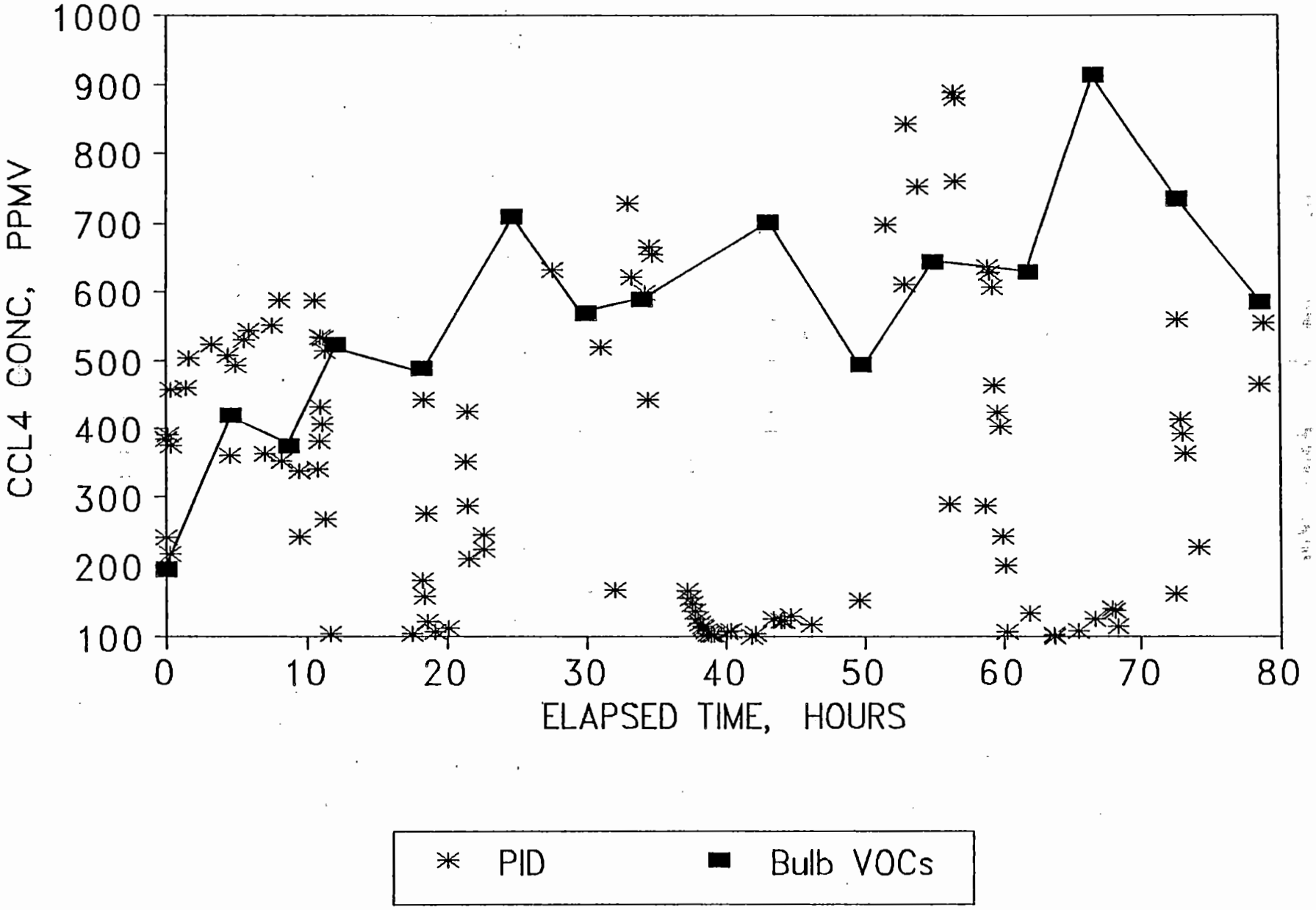
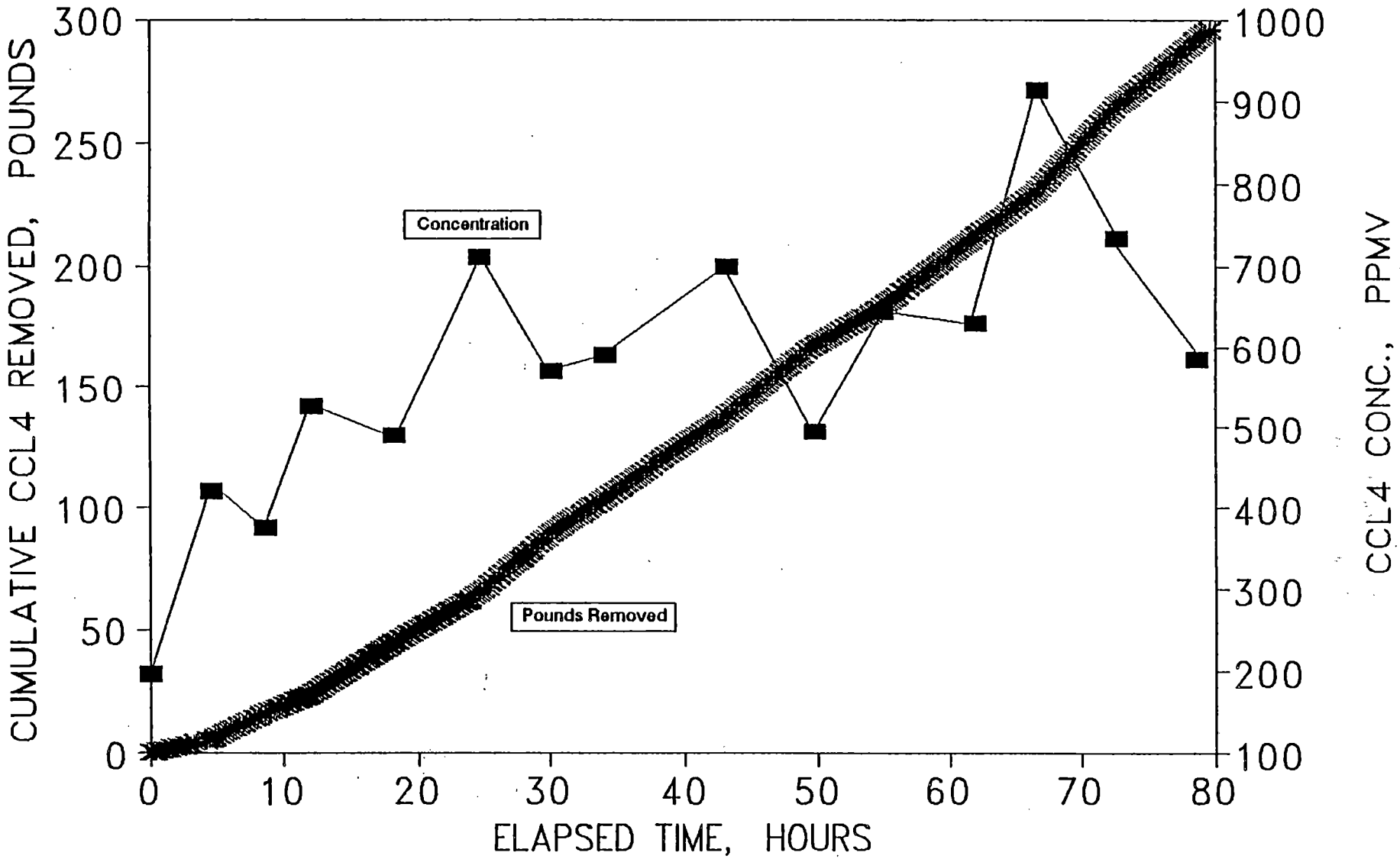


FIG 4-12 CUMULATIVE CCL4 REMOVAL
WELL 171, LONG-TERM TEST



- The diurnal barometric pressure swing during the vent test was about 1.5 in. w.g. The barometric pressure increased sharply for about 10 hours before the start of the test, and continued to increase until about 20 hours into the test.

- The wellhead gauge readings exhibited a diurnal cycle and fluctuated by at least 1.0 in. w.g. The wellhead fluctuation was roughly synchronized with the barometric fluctuations, with the maximum barometric pressure roughly correlated with the minimum wellhead gauge vacuum. However, there was a lag time of about 2 hours between the peak barometric pressure and the minimum gauge vacuum.

- It appears that the diurnal soil gas pressure fluctuation, coupled with the atmospheric/soil lag time, was strong enough to cause the soil pressure to exceed the barometric pressure for a few hours per day. At those times soil gas that contained CCl_4 vapor would flow out of the observation wells.

- The wellhead vacuum gauges were calibrated to zero values several hours before the start of the 80-hour test. Apparent natural diurnal variations in soil pressure caused the gauge vacuum at W-87 and W-150 to increase significantly even before the venting pumps were started.

Adjusted Absolute Soil Pressure - The wellhead vacuum gauges were differential gauges referenced to the atmosphere, so the gauge vacuum readings recorded during the vent test must be adjusted to account for barometric pressure to assess the true influence of the venting. Note that the absolute pressure at any one well at any point in time is not significant with regards to soil venting: what is important is the relative pressure between different wells, which governs the flow of air through the soil. Figure 4-7 shows the fluctuations in the adjusted absolute soil pressure measured at the observation wells during the test. Figure 4-7a shows the absolute pressure trends for the first 10 hours of the test, during which time the overall effect caused by the mechanical venting reached stable conditions. The absolute pressure in all of the wells was governed mainly by fluctuations in the barometric pressure. However, Figure 4-7a shows that the venting quickly reduced the absolute pressure in W-150 to values that were consistently lower than they were in either W-87 or W-167. The stronger response in W-150 compared to W-87 was not anticipated, because W-150 is farther from the venting well than was W-87 (60 feet vs 30 feet, respectively). The stronger response at W-150 probably occurred because W-150 was perforated in the fine SAND horizon while W-87 was perforated in the sandy SILT horizon.

Estimation of Overall Induced Vacuums - The fact that the diurnal soil pressure fluctuation was nearly equal to the response caused by the mechanical venting necessitated the use of statistical analysis to assess the overall induced vacuum at each observation well. Appendix A describes the statistical analysis and provides sample calculations to demonstrate the method. Briefly, the overall induced vacuum caused by the mechanical venting is separated from the barometric effect by plotting the net variation in the absolute soil pressure vs. the net variation in the barometric pressure, for the time period after the mechanical influence

has stabilized. Figures 4-8a, 4-8b, and 4-8c show such plots for W-87, W-150, and W-167, respectively. As described in Appendix A the net induced vacuum is represented by the Y-intercept of the linear regression line through the data, and the barometric efficiency of the observation well is represented by the slope of the linear regression line. Inspection of the figures shows the following estimates for the overall induced vacuum and the barometric well efficiency at each well:

Well	Average Induced Vacuum (in. w.g.)	Barometric Efficiency in Percent
W-87	0.175	98
W-150	0.905	134
W-167	-0.04	88

Based on this statistical analysis it appears that W-167, which was about 220 feet from the venting W-171, was not affected by the venting. The radius of influence during venting W-171 at the 320 cfm flowrate appeared to be between 70 feet and 220 feet.

Use of W-167 as a Reference Well - Considering that W-167 was apparently not influenced by the mechanical venting, the vent test data were adjusted to use W-167 as a "reference well" to separate the diurnal barometric effect from the mechanical venting effect. The adjusted relative vacuums at W-87 and W-150 were calculated by subtracting the measured response at W-167. The result is shown on Figure 4-9. The relative vacuum shown on that figure should ideally represent the induced vacuum caused only by the mechanical venting. In actuality, W-167 was constructed differently than W-87 and W-150, and W-167 displayed a different lag time than the other wells. Therefore, the use of W-167 as a reference well is useful more for estimating trends rather than for detailed analysis. It is concluded from Figure 4-9 that the net induced vacuums at W-87 and W-150 were about 0.1 to 0.2 and about 0.6 to 0.7 in. w.g., respectively. Those estimated values for the induced vacuum are similar to the values that were calculated based on the statistical analysis described in the previous section. The limited response at W-87 compared to W-150 was probably caused by W-87 being perforated in a less permeable soil horizon than was W-150.

Vertical Influence of Induced Vacuum - The induced vacuums in the observation wells were found to change based on the elevation of the observation well interval relative to the venting well interval. The measured data are shown on Figure 4-10 and in Table 4-3. Figure 4-10 shows the response at W-87 and W-150 relative to the "reference well" W-167. The induced vacuums at both observation wells decreased when the packers at those wells were moved to perforated intervals at higher elevations than the venting interval at W-171. This indicates that a full-scale VES that relied on wells perforated in the deepest intervals would be only marginally effective for venting the middle and upper elevations of the tile field. For example, as shown on Figure 3-2 there is a fine sandy SILT layer, which might accumulate CCl_4, at about elevation 590 in the center of the tile field and about 40 to 50 feet higher than the lowermost SILT layer where W-171 was perforated. Based on the data for W-150 shown in Table 4-3 the induced vacuum at the top of the lowermost SILT layer was about 0.7 in.

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Table 4-3
Summary of Vertical Induced Vacuum Measurements
Well 171 Long-Term Vent Test

Well Number	Elapsed Hours	Observation Perforated Interval	Observation Elev above Well 171 in Feet	Maximum Induced Vacuum in in. w.g.
W-87	0 - 36	Lower	0	0.2-0.4
	63 - 80	Middle	60	0.15
W-150	0 - 36	Lower	0	0.7
	36 - 61	Middle	25	0.35
	61 - 80	Upper	55	0.15

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w.g., but the induced vacuum in the medium SAND 55 feet above the venting interval was only about 0.15 in. w.g.

Carbon Tetrachloride in Vented Soil Gas - Figure 4-11 shows the concentrations of carbon tetrachloride that were measured during the 80-hour vent test at W-03171. Table 4-2 lists the concentrations that were measured at each sampling interval. Inspection of the data indicates the following:

- Comparisons of quality control samples (one field blank and one duplicate) taken during the testing showed that the sampling and analysis for VOCs was acceptable for engineering design purposes. As shown in Table 4-2, no carbon tetrachloride was detected in the field blank VOC bulb. The duplicate VOC bulb samples taken after 34 hours of venting showed CCl_4 concentrations of 485 ppm_v and 701 ppm_v, which corresponds to a precision of about 18% deviation from the mean of those duplicate values or a 36% bound.

- As shown on Figure 4-11, the concentration of CCl_4 in the vented air was about 200 ppm at the start of test, and gradually increased to about 600 to 700 ppm after 30 hours of venting. The concentration appeared to stabilize at 600 to 700 ppm for the remainder of the test, although a concentration of 915 ppm_v was measured at 67 hours duration. The temporary concentration increase at that time may have been the result of normal variation in the measurements.

- Although no formal laboratory results were received in time for this report, verbal reports from the laboratory indicate that the concentration of CCl_4 was much higher than any other compounds that were tentatively identified in the gas samples from W-171. Verbal reports from the laboratory indicated that trace quantities of 2-Butanone and Chloroform may have been present in the soil gas.

Carbon Tetrachloride Removal during W-171 Vent Test - As shown on Figure 4-12 an estimated 300 lbs of CCl_4 was removed during the 80-hour test. The removal rate was estimated by numerically integrating between the electronic flowrate data that was continuously recorded and the periodic VOC bulb sample results.

Performance of PID - As shown on Figure 4-11 the PID did not always reliably indicate the concentration of CCl_4 during the test. The PID experienced unacceptable drift during the periods of time between the daily span gas calibrations. The instability of the PID was probably caused by water vapor condensation inside the PID sampling head. The PID showed some limited reliability at night. If a PID is used for continuous monitoring for the full-scale VES, then it must be located at a spot where the gas stream is warm and dry.

Radionuclides Concentrations - As shown in Table 4-2, low concentrations of particulate radionuclides (total alpha and K-40) were detected during venting of W-171. The radionuclide samples were taken at the VES inlet upstream of the particulate prefilter and HEPA filter. Total alpha and gamma activity identified as K-40 was detected in a single sample after 34 hours of venting. However, no activity was detected either before that time

(24 hours elapsed time) or at the end of the test (79 hours elapsed time). It is not known whether the indicated activity was a sampling artifact or whether detectable concentrations did indeed temporarily occur in the vented air stream.

Accumulation of Radon Gas in GAC Canisters - Spectral gamma energy logging of the outside walls of the GAC canisters showed that the GAC had collected radon gas, and that the radon was decaying to form gamma-emitting decay products. The data report is given in WHC Internal Memo 81232-91-020 dated April 29, 1991. The conclusions of the measurements are as follows:

- Bismuth-214 (Bi-214) and Lead-214 (Pb-214), both of which have short half lives, were detected. It was concluded that the GAC had collected Radon-222 (Rn-222) gas, which decayed to Bi-214 and Pb-214.

- Rn-222 gas can be generated by either naturally occurring Uranium (U-238) or from uranium waste. The measurements described here could not distinguish which was the source of the Rn-222.

- No man-made gamma emitters were detected in the GAC, which implies that no uranium or thorium was present.

The downstream GAC canister was found to emit higher gamma counts than did the upstream canister (2,500 counts per minute vs. 3,800 counts per minute), which implied that the downstream canister contained more radon. This result makes sense according to common GAC chemistry. The radon that was initially captured by the first GAC column would have been gradually displaced by the CCl_4 vapors, which have a greater affinity for GAC adsorption than does radon gas. The displaced radon would migrate from the upstream canister and then be re-captured by the downstream canister.

Water Vapor Concentrations - As shown in Table 4-2 the water vapor concentration during venting of W-171 was in the range of 0.11 to 0.45% by volume. That value was lower than was expected. A water vapor concentration of about one percent was anticipated based on the assumption of saturated equilibrium between the pore water and pore air at an assumed 50°F soil temperature. In general the highest concentrations were measured during the afternoon and the lowest values were measured at night (however, there were deviations from this trend). Significant water vapor condensation in the venting hoses and the gas sample lines was observed during the cool nighttime hours. The condensed water evaporated during the warm daytime periods. Based on these results, it is recommended that the full-scale VES be equipped with efficient water vapor removal systems.

4.3.2 24-Hour Test at W-167

The 24-hour vent test at W-167 started on April 15, 1991, at 17:22 hours. W-167 was perforated at only one interval, between depths of 114 and 119 feet below ground surface. The perforated interval spanned the interface between overlying fine sand and underlying silt. The well packers in the observation wells were set at the lowest intervals during the venting at W-167.

Table 4-2 summarizes the results of the chemical analyses performed on vented air samples taken during the vent testing. The measurements taken during the testing are displayed on Figure 4-13 through Figure 4-20. Observations and conclusions based on inspection of the test data are described below.

Quality of Electronic/Manual Vacuum Gauge Readings - The readings from the manual and electronic vacuum gauges are compared on Figure 4-13 through Figure 4-15. The conclusions based on comparing the readings are as follows:

- The vacuum gauge readings at W-87 were inconsistent, and the vacuum data from that well have not been used in the data analysis. The electronic data displayed a strong bias. The manual readings were inconclusive.

- The manual and electronic readings from W-150 compared favorably.

- The manual and electronic readings from W-167 compared favorably.

Flowrate and Well Vacuum vs. Time - Figure 4-16 shows the flowrate and well vacuum at W-167 during the test, as measured by the electronic DAS. The flowrate during the test was fairly constant at about 50 to 60 cfm and the well vacuum was fairly steady at about 90 in. w.g. The venting vacuum at W-167 was higher than it was at W-171, because W-167 was perforated in a less permeable soil and because it used a shorter perforated interval.

Gauge Vacuum at Observation Wells - Figure 4-17 shows the gauge vacuums measured at the observation wells during the venting at W-167. Note that the gauge vacuums are differential pressures between the soil and the atmosphere, and that the barometric pressure must be accounted for when interpreting the data (see the next section for the barometric pressure adjustments). Inspection of the gauge vacuums demonstrates the following:

- Both observation wells displayed a strong diurnal variation that corresponded to the fluctuation in barometric pressure. The gauge vacuum decreased to below detection for two periods during the test, and it is possible that during those periods the soil pressure was actually higher than the barometric pressure.

- Venting at W-167 produced a stronger response at W-171 than at W-150, even though W-150 was considerably closer to the venting well (about 150 ft for W-150 vs. 220 ft for W-171). This result conflicts with the results of the 80-hour vent test at W-171, during which there was no significant response at W-167.

Adjusted Absolute Soil Pressure - It appears that the venting at W-167 had only a minor effect on the soil pressure at the observation wells W-150 and W-171. The trends in the absolute soil pressure (barometric pressure minus differential gauge vacuum) are shown on Figure 4-18. The venting at W-167 caused a slight pressure reduction (about 0.2 to 0.3 in.

FIG 4-13 W-87 MANUAL/ELECTRONIC GAUGES 24-HR TEST

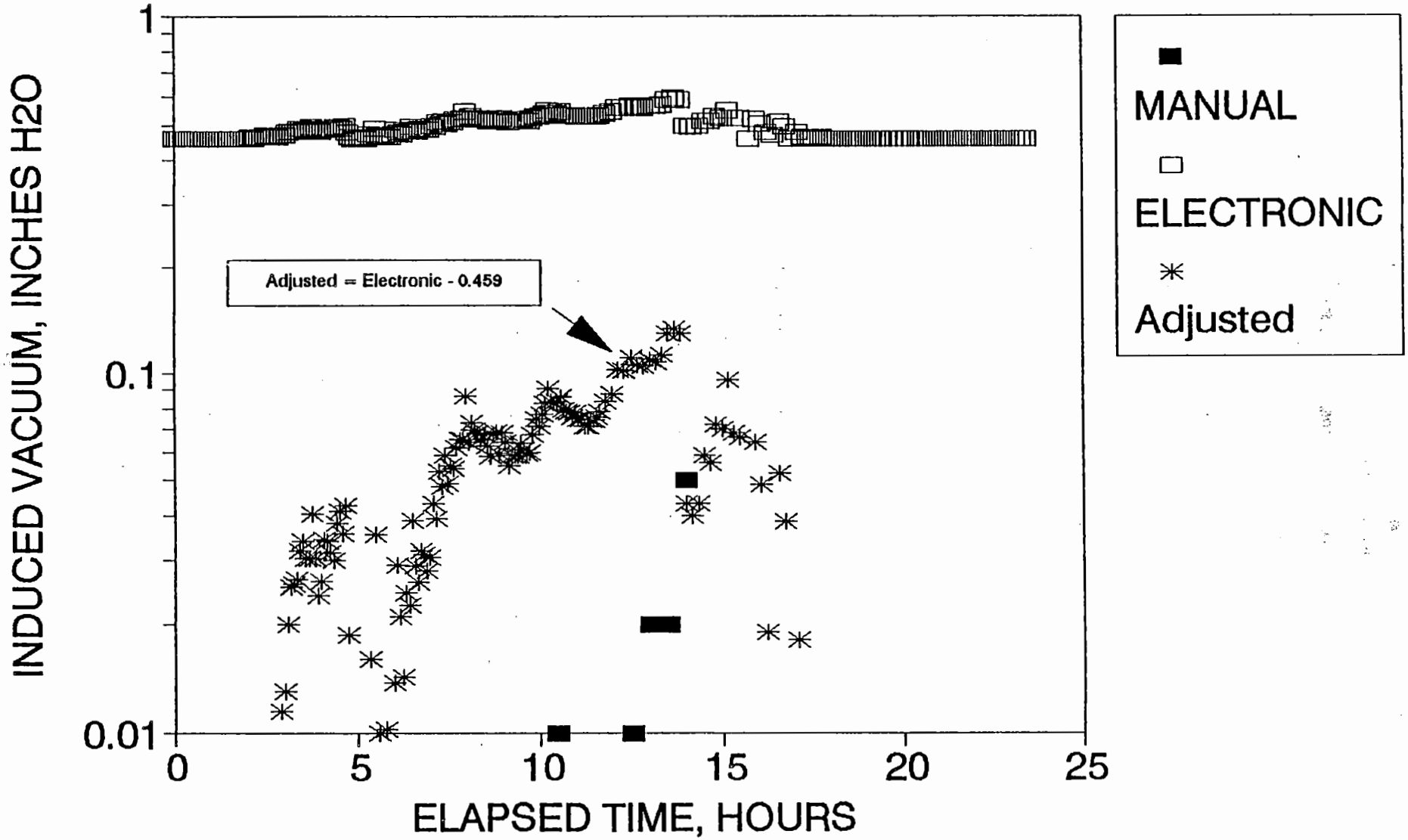


FIG 4-14 W-150 ELECTR/MANUAL GAUGES WELL 167, 24-HR TEST

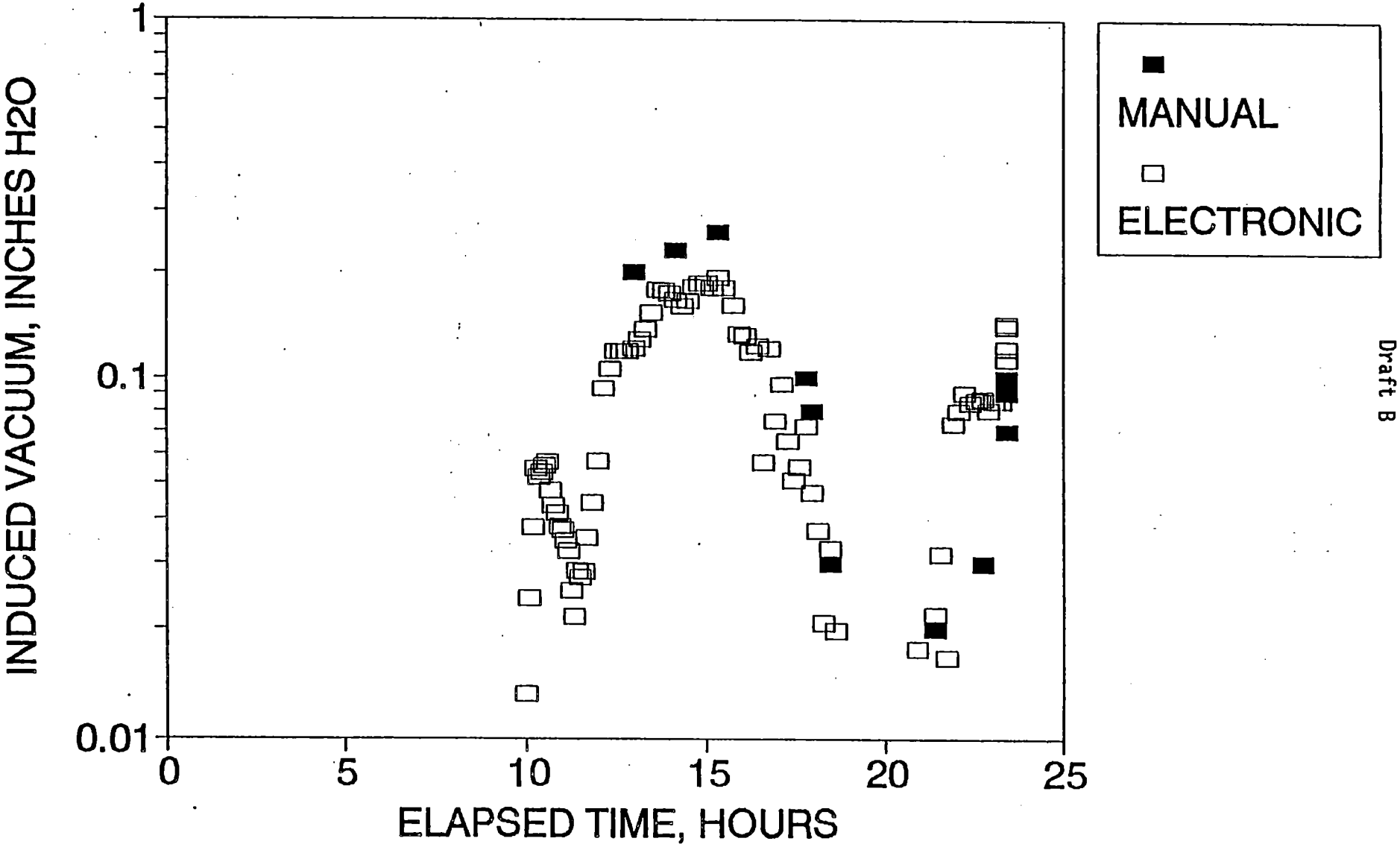


FIG 4-15 W-171 ELECTR/MANUAL GAUGES WELL 167, 24-HR TEST

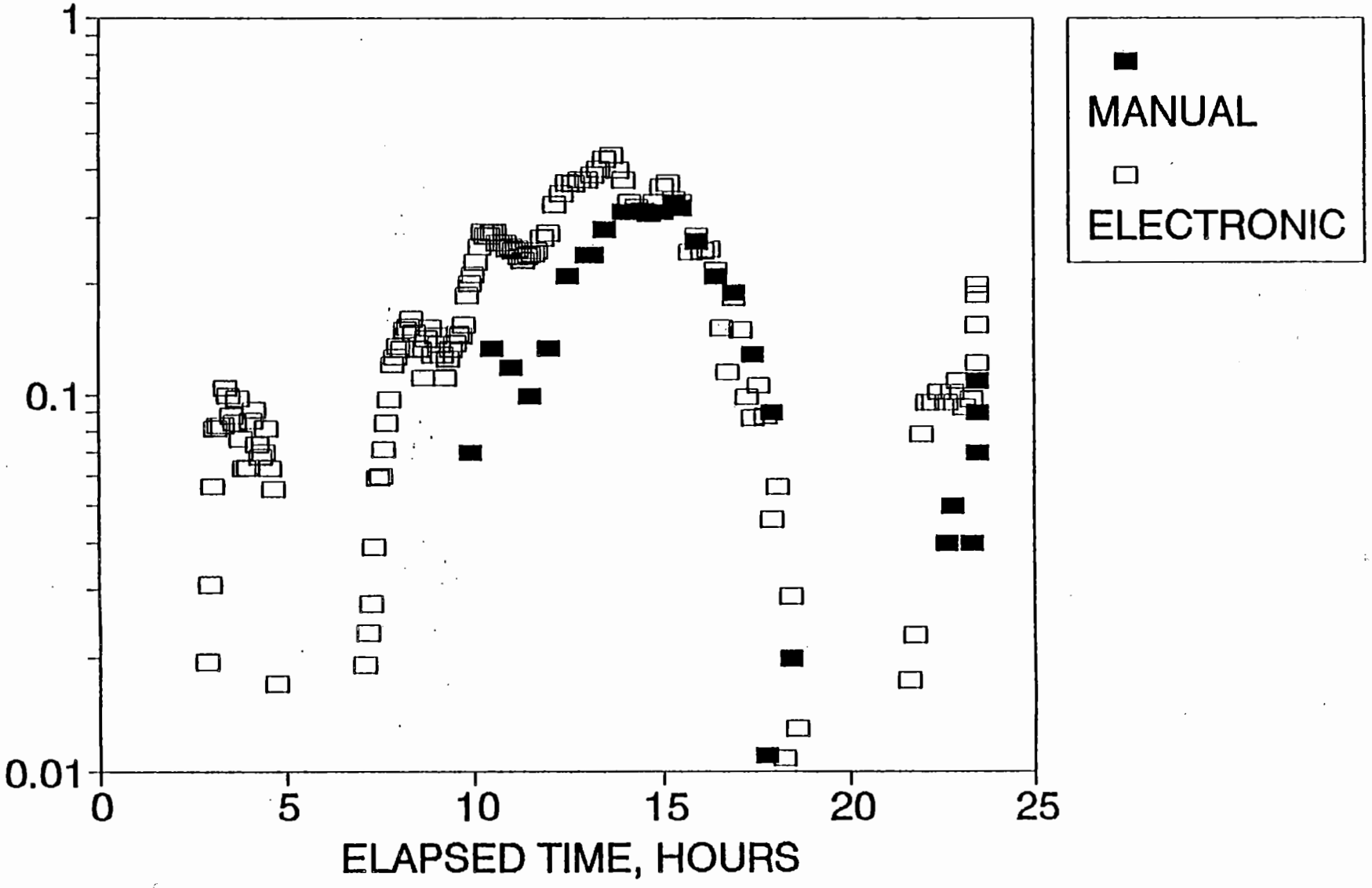


FIGURE 4-16 VENTING FLOWRATE/VACUUM WELL 167, 24-HR TEST

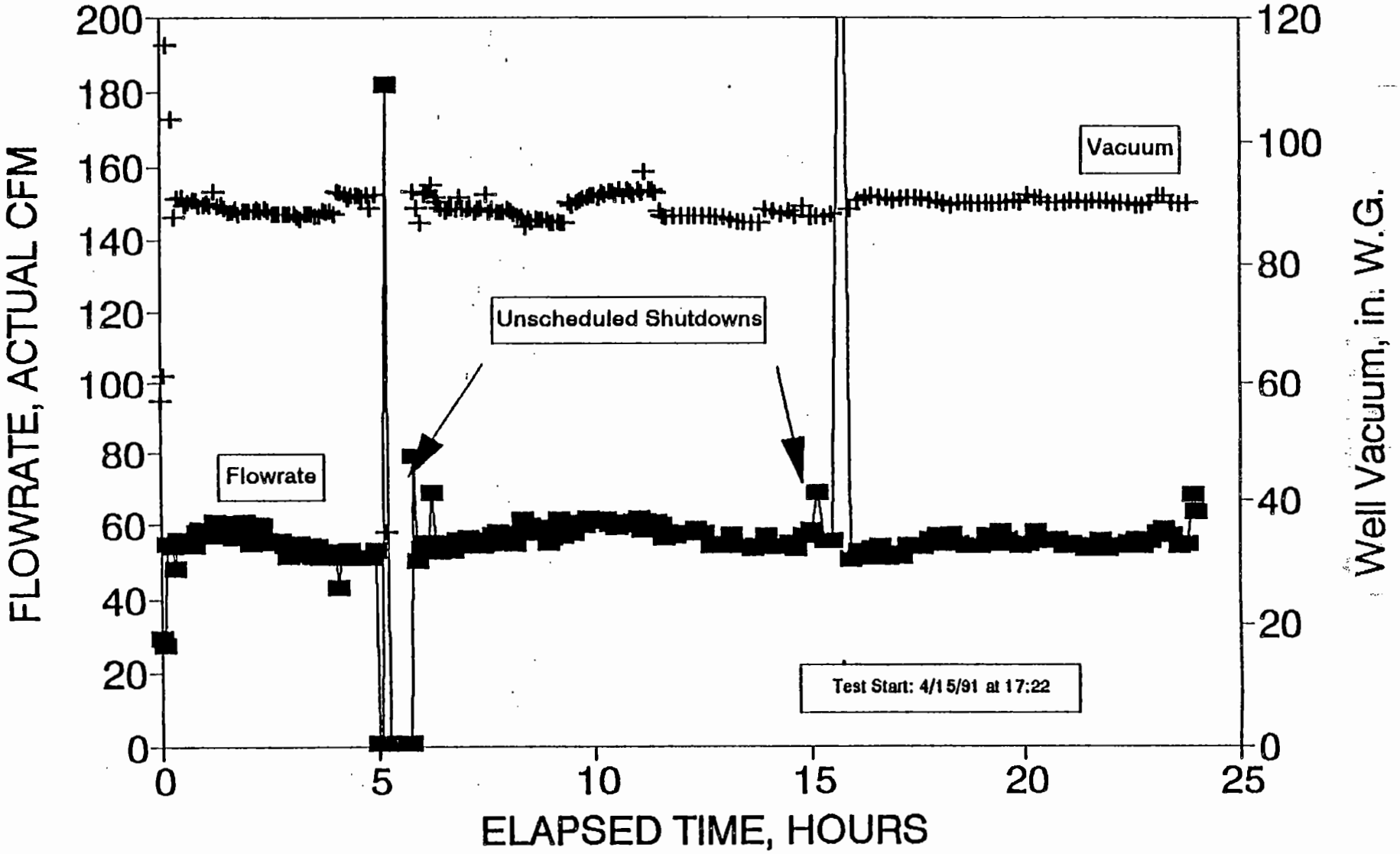


FIGURE 4-17 OBSERVED WELL VACUUMS WELL 167, 24-HR TEST

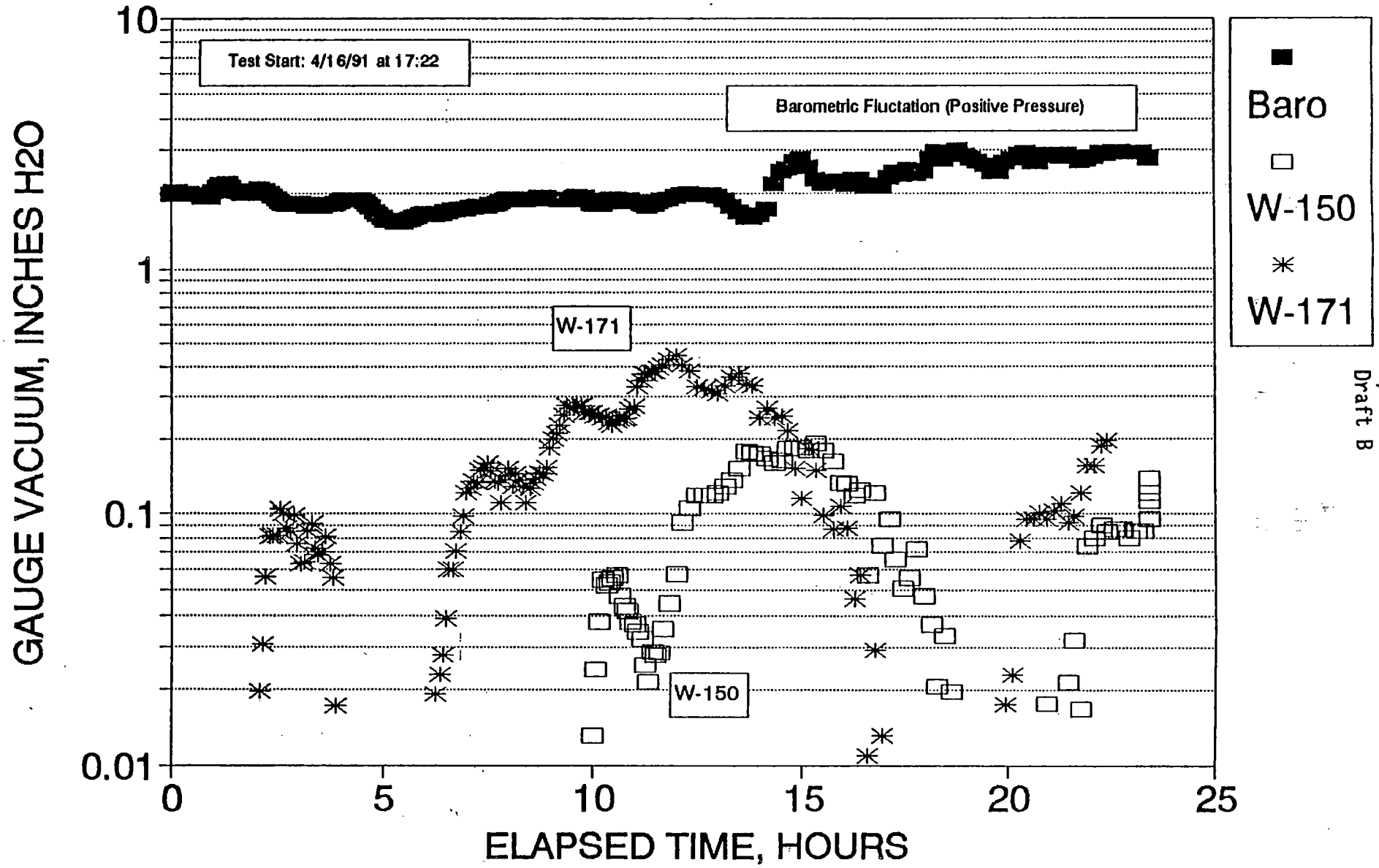


FIGURE 4-18 RELATIVE SOIL PRESSURES 24-HR TEST AT W-167

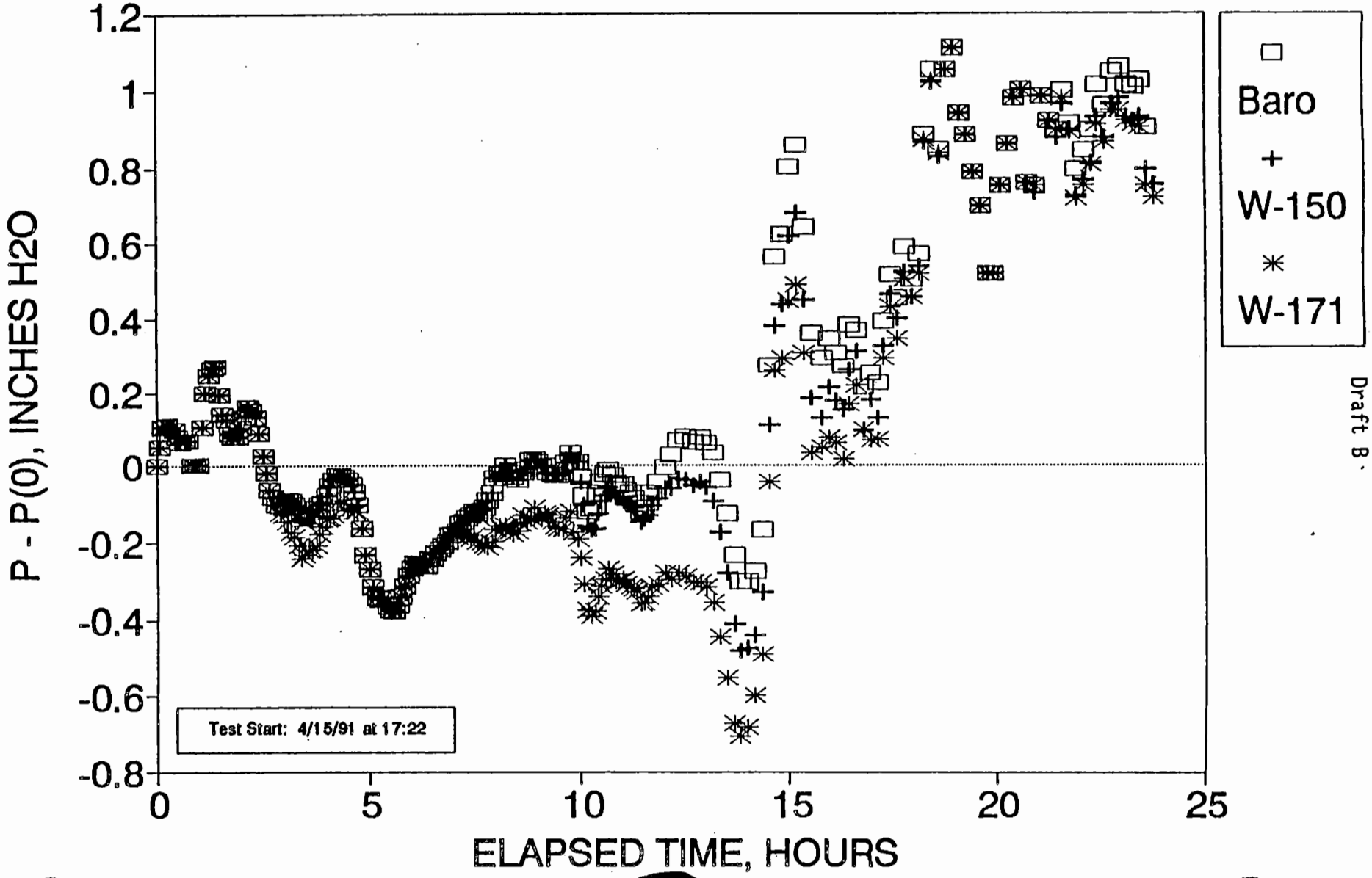


FIGURE 4-19 MEASURED CONCENTRATIONS WELL 167, 24-HR TEST

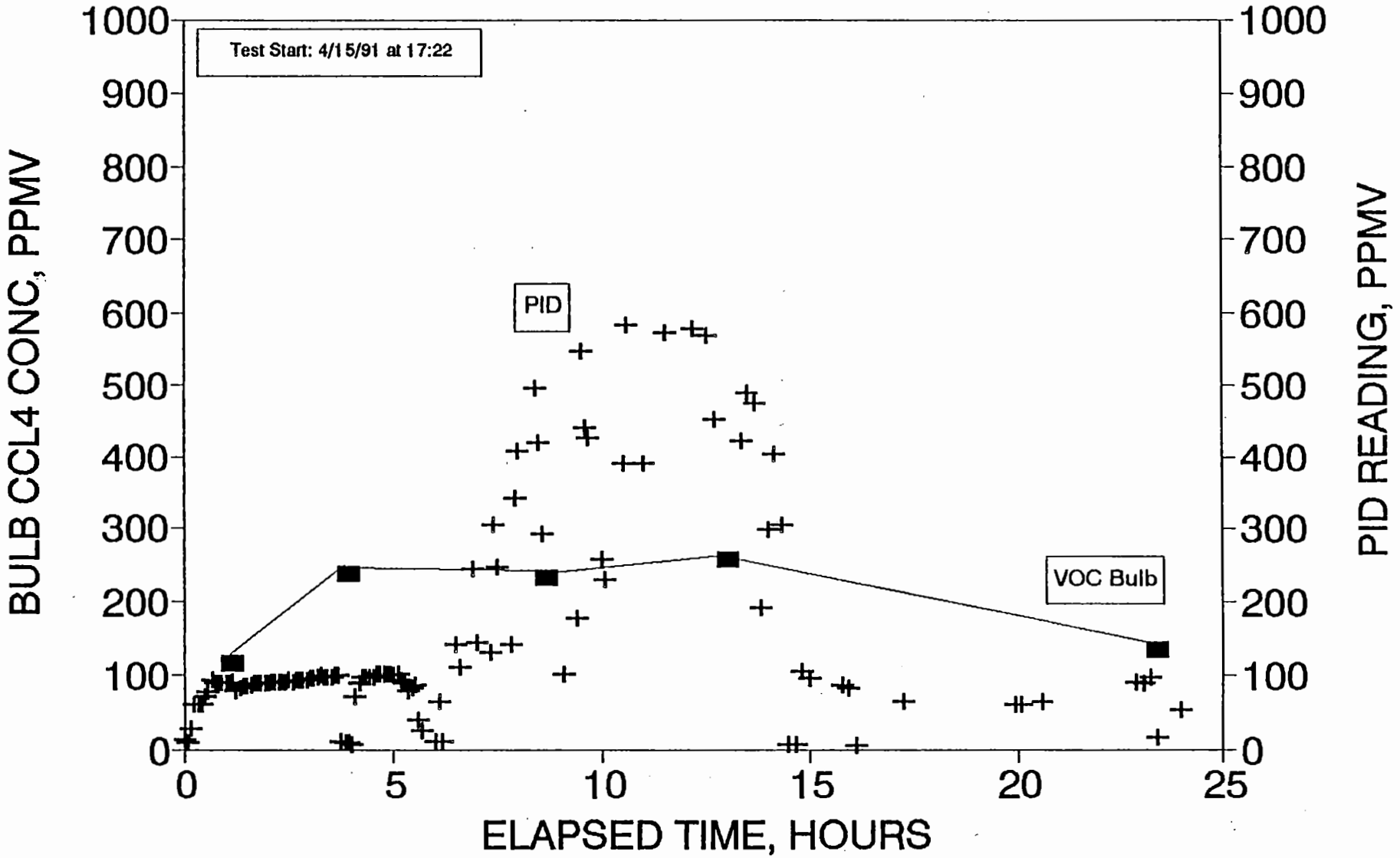
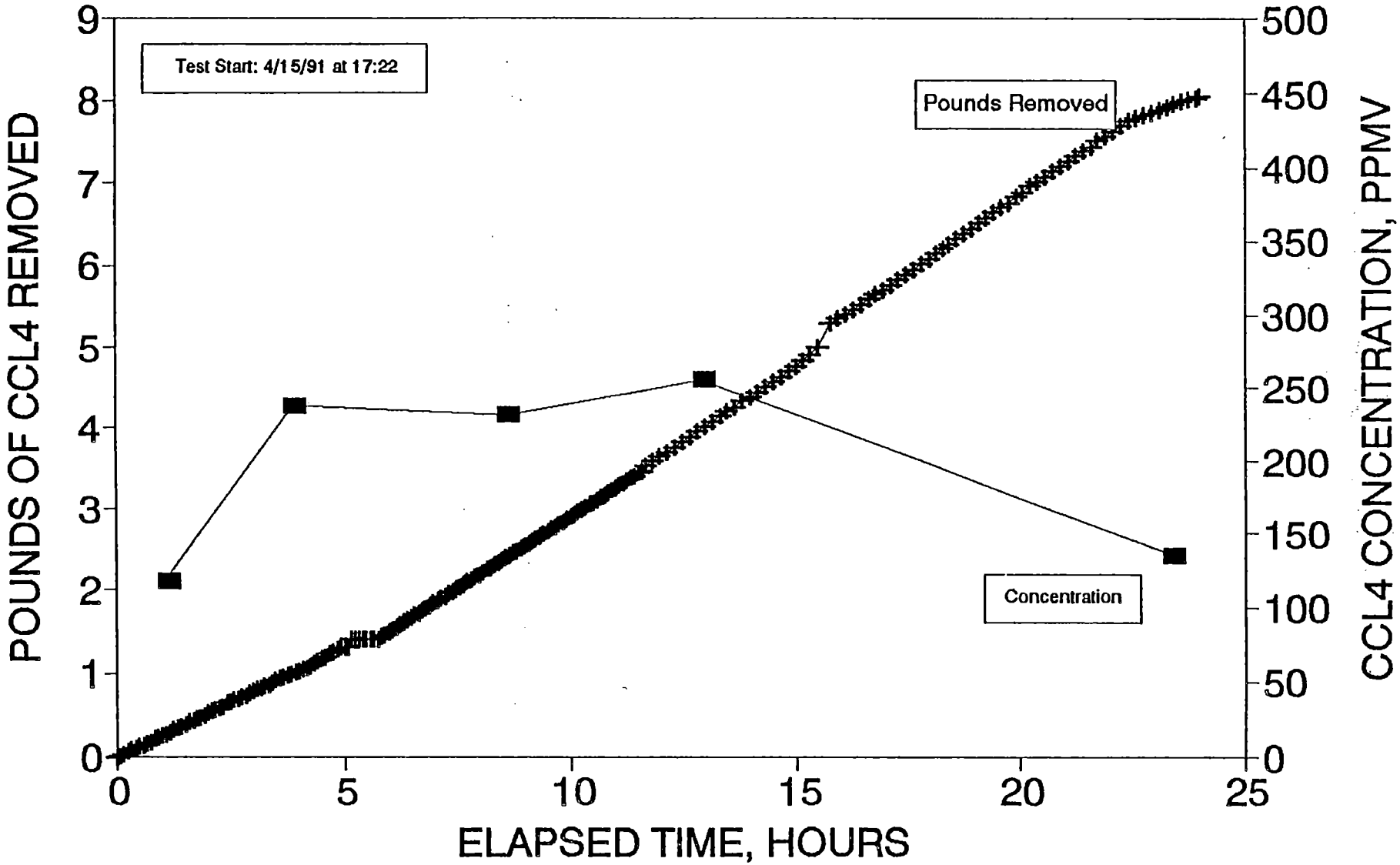


FIGURE 4-20 CUMULATIVE CCL4 REMOVAL WELL 167, 24-HR TEST



w.g.) in W-171 during the time from about 8 to 14 hours duration. After 14 hours the increase in barometric pressure overcame the net effect at W-171. There was no significant response at W-150 during any part of the test, and all pressure fluctuations in that well were caused by the barometric effect. The better response at W-171 compared to W-150 probably occurred because W-171 was perforated partly in a permeable sand, while W-150 was perforated mainly in relatively impermeable silt. The vacuum response during venting of W-167 differ from the responses observed during the venting at W-171: venting of W-171 at a vacuum of about 35 in. w.g. produced no response at W-167, but venting of W-167 at about 90 in. w.g. produced a slight response at W-171. The slightly different results during the two tests are probably caused by the higher venting vacuum that was used when venting W-167. Venting W-167 at a strong vacuum but low flowrate produced a wider radius of influence that did venting of W-171 at a low vacuum but high flowrate.

Carbon Tetrachloride in Vented Soil Gas - Figure 4-19 shows the concentrations of carbon tetrachloride that were measured during the 24-hour vent test at W-167. Table 4-2 lists the concentrations that were measured at each time interval. Inspection of the data demonstrates the following:

- Comparison of field blank and duplicate quality control sample data taken during the testing showed that the sampling and analysis for VOCs were acceptable for engineering design purposes. As shown in Table 4-2, no carbon tetrachloride was detected in the field blank VOC bulb. The duplicate VOC bulb samples taken after 23 hours of venting showed CCl_4 concentrations of 180 ppm_v and 135 ppm_v, which corresponds to a precision of about 14% deviation from the mean.

- As shown on Figure 4-19 the concentrations of CCl4 in the vented air, as measured by direct sampling using the VOC Bulbs, remained fairly constant at about 150 ppm_v to 200 ppmv during most of the test. The concentration decreased to about 130 ppm_v during the last sample at 23.5 hours duration, but it is not clear if that decrease was the result of a downward trend or whether it simply reflects routine variation in the data.

- Although the official laboratory data were not received in time for this report, verbal reports from the laboratory indicate that carbon tetrachloride was the only VOC measured in significant concentrations during venting of W-167. Verbal reports from the laboratory indicated that trace quantities of 2-Butanone and Chloroform may have been present in the soil gas.

Performance of PID - As shown on Figure 4-19 the PID did not consistently indicate the concentration of CCl4 during the test. The PID operated relatively well during evening hours (shown on Figure 4-19 as being test durations of 0 to 5 hours and 15 to 24 hours), during which period it indicated a constant ratio of about 50% the measured CCl_4 concentration. However, during early morning hours the PID experienced difficulties, possibly because of problems with water vapor condensation inside the PID sampling lines.

Carbon Tetrachloride Removal during W-167 Vent Test - As shown on Figure 4-20 an estimated 8 lbs of CCl_4 was removed during the 24-hour test. The removal rate was calculated by numerically integrating between the electronically measured flowrate and the periodically collected VOC bulb samples.

Radionuclide Concentrations - As shown in Table 4-2 detectable concentrations of particulate total alpha activity and gamma activity were measured after about 23 hours of venting. The samples were taken at the VES inlet, upstream of any particulate filters and the HEPA filter. The gamma activity was identified as K-40. As described in Section 4.3.1 of this report, spectral gamma logging of the outside wall of the GAC canisters indicated that the GAC had collected radon gas during the combined testing. It is not known how much of the radon in the GAC was contributed by the venting at W-167 as compared to the venting at W-171.

Water Vapor Concentrations - As shown in Table 4-2 the water vapor concentration at the VES inlet ranged from 0.07 to 0.23% by volume. This range was lower than expected. It was anticipated that the water vapor concentration would be about one percent based on the assumption that the soil gas vented from the subsurface would be saturated with water vapor at a 50°F temperature. The lowest water vapor concentration was observed at dawn and the highest concentrations were observed in the afternoon, so it is concluded that the water vapor concentrations measured at the VES inlet were affected by moisture condensation in the 200-foot-long above-ground flexible hose leading to the W-167 venting well.

5.0 DESIGN DESCRIPTION FOR FULL-SCALE VES FOR TILE FIELD AT Z PLANT

A design description of a system to extract carbon tetrachloride vapor from the tile fields near the Z Plant is recommended based on the results of the testing of the Vapor Extraction System pilot unit. This chapter compares several design alternatives, their advantages and disadvantages, and their relative costs. Additionally, the recommended design alternative is discussed in terms of expected performance, components, and other considerations.

5.1 SCOPE OF DESIGN DESCRIPTION

The following design description applies to the vadose zone underlying the 216-Z-1A Tile Field near the Z Plant. By assuming a similar stratigraphic sequence, the design description may also apply to the other associated cribs such as 216-Z-9 and 216-Z-18. The recommended alternative is based on several factors including state and federal air release limits, readily available technology and equipment, and the performance parameters established by the pilot testing. The discussion is limited to a description of the system, a mass flow diagram, a piping and instrumentation diagram, the expected effectiveness of the system, and a presentation of some of the specific system components and other considerations.

The intent of the design description is not to provide a detailed design with selected components, but rather it is to aid in the selection of a general system from which more specific design features can be established.

5.2 REGULATIONS AFFECTING DESIGN

The design of the emission control system used for the VES is governed mainly by air quality regulations under Ecology jurisdiction. It is understood that the VES will be licensed under the status of the federal Comprehesive Environmental Response, Compensation and Liability Act (CERCLA) and the Washington Model Toxics Control Act (MTCA) rather than under the federal Resource Conservation and Recovery Act (RCRA). RCRA mandates its own strict performance standards for emission control systems based on Best Available Technology, while MTCA and CERCLA defer to state environmental regulations that set emission limits based on satisfying ambient concentration limits. Under either MTCA or CERCLA the VES must satisfy the following air quality regulations:

- Chapter 402-80 of the Washington Administrative Code (WAC), "Monitoring and Enforcement of Emission Standards for Radionuclides".
- National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR Part 61 Subpart H, "Emission Standards of Radionuclide Emissions from DOE Facilities".

- Chapter 173-460 WAC, "Controls for New Sources of Toxic Air Pollutants". This regulation sets property line limits for toxic air pollutants: 0.067 micrograms per cubic meter for CCl_4; and 23.3 micrograms per cubic meter for HCl. It also requires the installation of a negotiable "Best Available Control Technology" for each pollutant.

Note that under MTCA and CERCLA it is not necessary to obtain the formal permits described under these regulations, but that the VES must be designed to satisfy all of the numerical limits associated with the regulations.

5.3 DESIGN ALTERNATIVES FOR SUBSURFACE VENTING SYSTEM

It is recommended that a multi-well venting system be used at each of the tile fields using the existing steel casings perforated at the top of the silt layer about 120 feet below ground surface. Use of multiple wells will provide flexibility during the venting by allowing any of the wells to be either throttled down or shut off, depending on the VOC concentrations in that well relative to the others.

The effectiveness of alternative venting configuarations were assessed by using the MODFLOW computer model (McDonald and Harbaugh, 1988) to predict the venting flowrate that would be required to produce a predetermined induced vacuum within the tile field. Appendix B presents the methods and results.

Three venting configuration alternatives were compared for the full scale system:

- 3 Wells; 1.0 in. w.g Vacuum - As shown on Figure 5-1, three wells would be perforated for a 20-foot interval and used to produce an induced vacuum of at least 1.0 in. w.g. within the lower soil layer at all points within the tile field. The minimum induced vacuum of 1.0 in. w.g. is based on discussions with soil venting vendors, who indicate that such a minimum value is often used at routine sites such as service stations. An estimated 1,120 cfm per well (3,360 cfm total) would be required. Based on the computer modeling, one pore volume would be vented every 4.5 hours.

- 3 Wells; 0.2 in. w.g. Vacuum - As shown on Figure 5-2, three wells would be used to produce at least 0.2 in. w.g vacuum at all points withing the lower soil layer. The estimated total flowrate is 320 cfm per well (960 cfm total). The 0.2 inch vacuum would vent one pore volume every 16 hours.

- 1 Well; 0.2 in. w.g Vacuum - As shown on Figure 5-3, a single well placed near the center of the tile field would be used to produce at least 0.2 in. w.g vacuum at all points within the lower soil layer. The modeled flowrate is 640 cfm, and one pore volume of air would be vented every 32 hours.

It is recommended that three wells be used, and vented to produce at least 0.2 in. w.g. of vacuum at the outer edge of the tile field. The 0.2 in. w.g vacuum is expected to produce a

Figure 5-1

Three Venting Well Scenario

0.2 in.w.g. at the Edge of the Tile Field

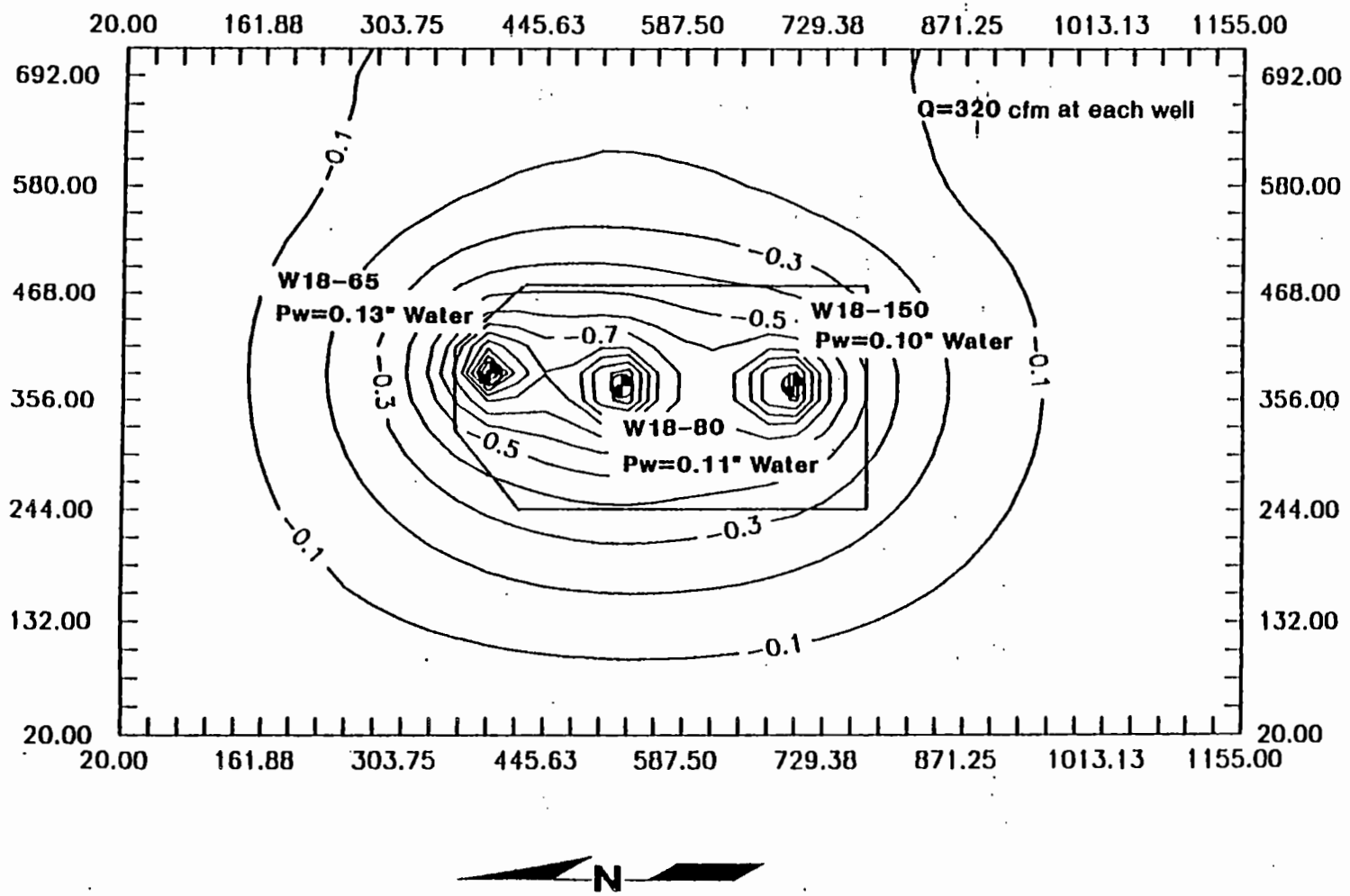


Figure 5-2

Three Venting Well Scenario

1.0 in.w.g. at the Edge of the Tile Field

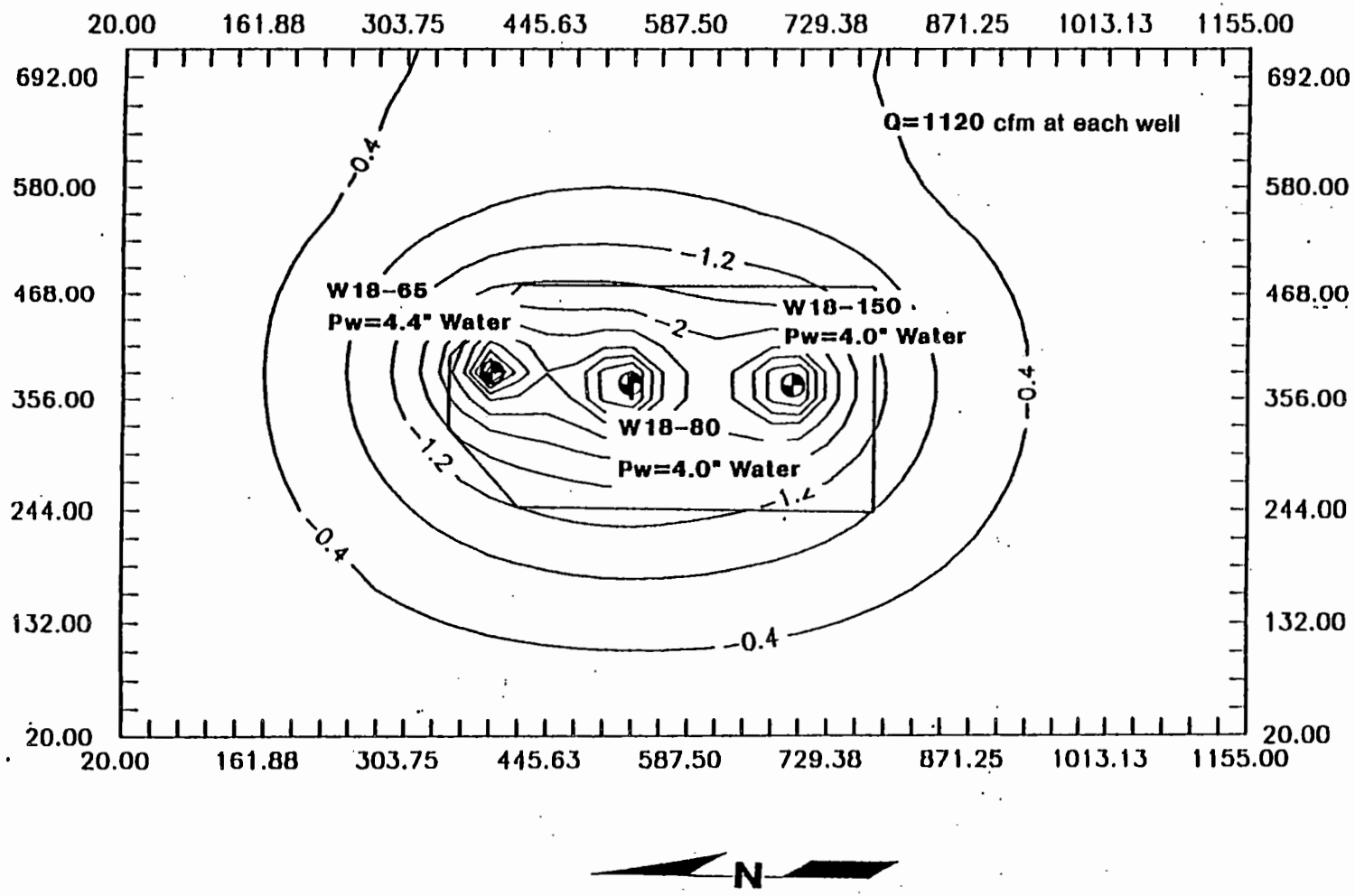


Figure 5-3

One Venting Well Scenario

0.2 in.w.g. at the Edge of the Tile Field

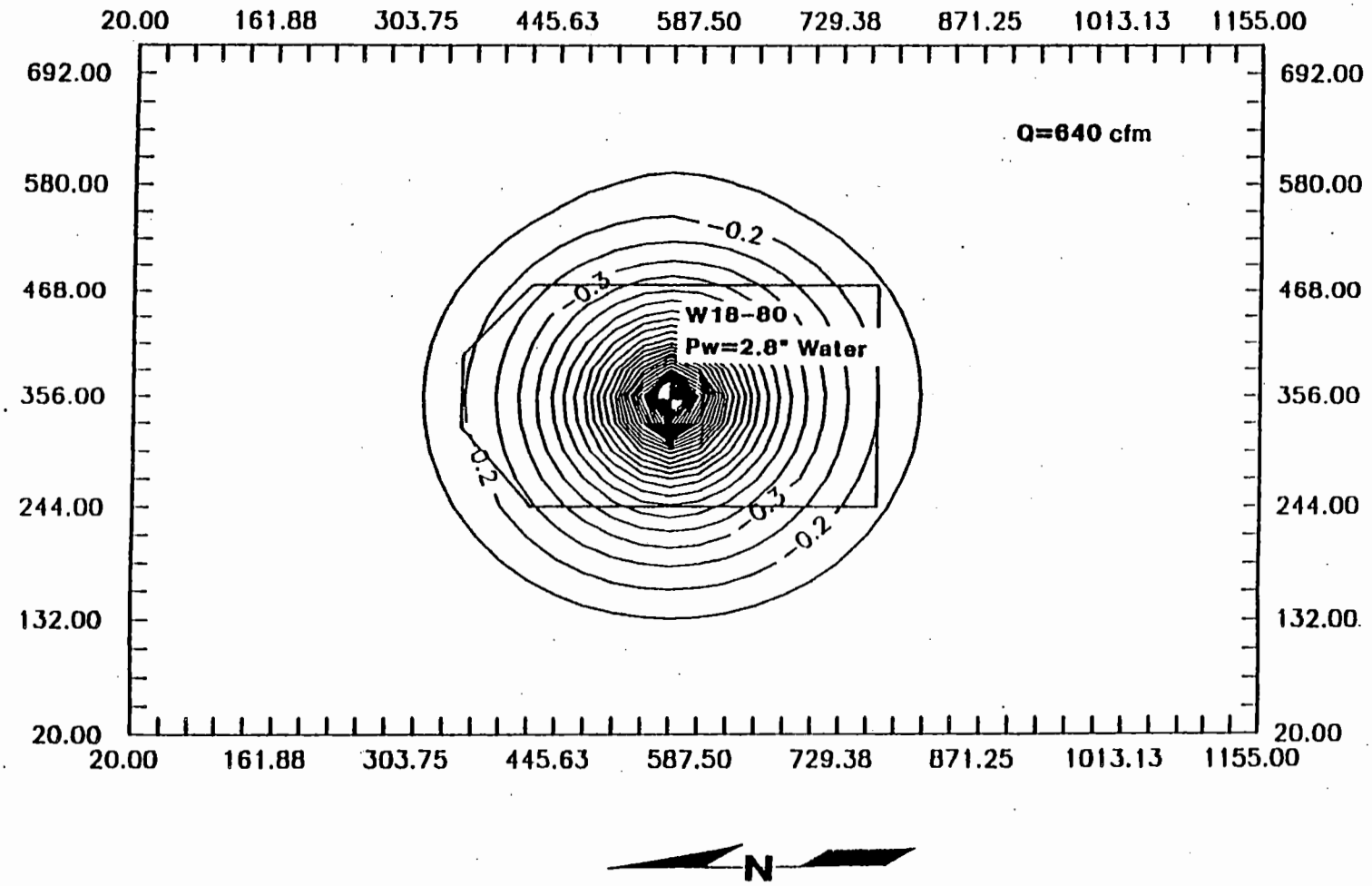
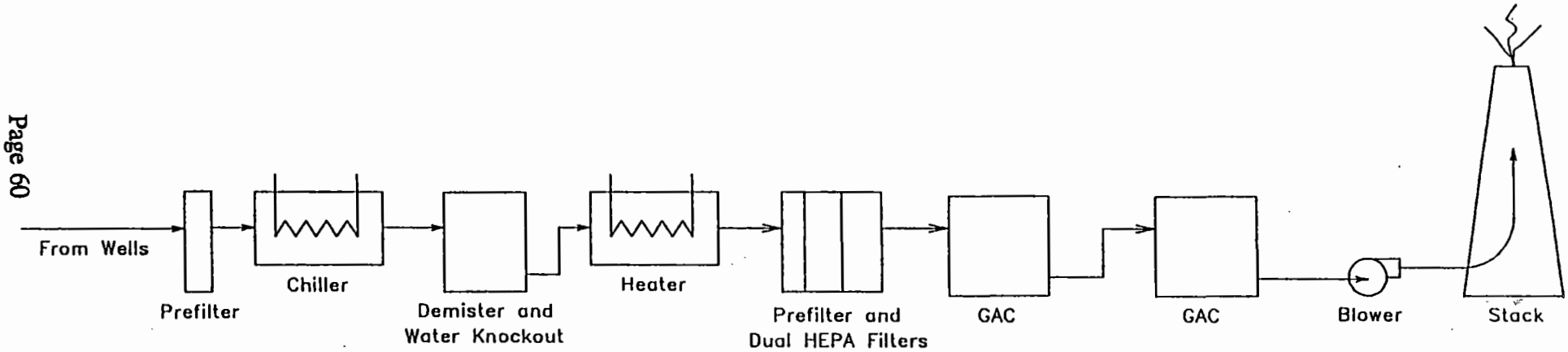


FIGURE 5-4 GAC SYSTEM



net venting flow throughout the lower soil layers and is expected to be strong enough to counteract the diurnal barometric pressure effect.

The modeled total flowrate that would be required to achieve the induced vacuum is 960 cfm. It is recommended that a 50% safety factor be incorporated in the design flowrate. Hence, it is recommended that the VES be designed to vent and treat a total flowrate of 1.46 x 960 cfm or about 1,400 cfm.

5.4 DESIGN ALTERNATIVES FOR VAPOR CONTROL SYSTEM

This section presents five alternatives for the design. The alternatives are based on the findings of the pilot testing, information on readily available technology and equipment, and the present understanding of the regulations affecting the design. The assumptions affecting the design are shown in Table 5-1.

The first two design alternatives discussed utilize different methodologies for removing the carbon tetrachloride from the soil gas. The first alternative uses GAC to remove the carbon tetrachloride. The second alternative uses Catalytic Oxidation (CATOX) to remove the carbon tetrachloride. The third design alternative presents the same CATOX alternative with the addition of acid scrubbing. The fourth alternative presents a small-scale, less complex system that uses GAC for treatment. The final design alternative addresses mobility of the system and how the system connects to the wells. Table 5-2 lists some of the relative advantages and disadvantages of the alternatives.

An order-of-magnitude estimate of costs of the equipment and the first year operation of the system for the first two design alternatives is presented in Table 5-3. The cost estimate does not include labor costs or non-operational costs such as sampling and analysis.

5.4.1 System Utilizing GAC for Off-Gas Treatment

The first design alternative is similar in concept and design of the system employed in the pilot test. As was demonstrated during pilot testing, using GAC to adsorb the carbon tetrachloride from the soil gas worked well. This design alternative utilizes all essential parts of the pilot system and incorporates changes which enhance the operation of the system under the parameters established during the testing (see Figure 5-4).

Three significant design changes were made for this alternative relative to the test unit. These are (1) the addition of a roughing filter at the inlet to the system, (2) the addition of a chiller/condenser, and (3) the placement of the HEPA filters on the vacuum side of the system.

The roughing filter is placed as the first component downstream of the wells to remove the gross particulate contamination entrained by the soil gas flow. This helps prevent an accumulation of solids in the condenser collection tank which is more difficult to clean or dispose than is the roughing filter.

TABLE 5-1

ASSUMPTIONS AFFECTING DESIGN DESCRIPTION

Assumptions Common to the Design Alternatives

- The zone of influence of the venting system includes all subsurface areas subjected to 0.2-in. w.g. water vacuum or higher.
- A flowrate of 1,400 cfm of soil gas will be maintained.
- The soil gas temperature is about 50°F
- The soil gas is atmospheric air in composition, but contains a maximum of about 750 ppm_v carbon tetrachloride. No other significant concentrations of VOCs are present.
- The daily removal rate of carbon tetrachloride from the subsurface is about 580 lbs.
- Potentially explosive gases, such as methane, will not be encountered at concentrations exceeding 10% of the Lower Explosive Limit (LEL).
- No tritium will be encountered.
- All of the radon extracted from the subsurface in the soil gas may be emitted from the system without treatment.
- A system vacuum of not greater than 150 in. w.g. will be required.
- Condensed water collected by the system will be removed on a routine basis and disposed of at Tank Farms or other appropriate locations.
- Continuous operation of the system is not required. However, it is assumed for costing purposes that the unit will operate 24 hours per day for 360 days the first year.
- The thermal efficiencies of both the heater and the chiller are 25%.
- The cost of electricity is $0.06/kWh.
- The soil gas contains 0.45% water vapor, which yields about 50 gallons per day if the system is 100% efficient in removing water from the soil gas.

TABLE 5-1 (continued)

ASSUMPTIONS AFFECTING DESIGN DESCRIPTION

- The effluent stack is 30 feet tall.
- The chiller will lower the soil gas temperature from 50°F to 40°F.
- The heater will raise the soil gas flow temperature from 40°F to 50° F.

Assumptions Specific to the GAC Unit

- Adsorption of carbon tetrachloride on the GAC is 40% by weight.
- Four 8-foot-diameter by 8-foot-tall carbon canister capable of withstanding 150 in. w.g. vacuum as possibly required by the system.
- The cost for carbon to be delivered and taken offsite for regeneration is $1.50 per pound.

Assumptions Specific to the CATOX Unit

- All of the chlorine molecules from the carbon tetrachloride are converted to hydrochloric acid during the oxidation process.
- At a concentration of 750 ppm_v of carbon tetrachloride in the soil gas, about 2,500 ppm_v HCl will be produced as a byproduct of the catalytic oxidation. (One pound of carbon tetrachloride entering the system produces about one pound of hydrochloric acid.)
- Use of CATOX with no HCl scrubbing will be negotiated as Best Available Control Technology.
- The effluent temperature from the CATOX unit is 350° F.
- The thermal efficiency of the heat exchanger is 50%.
- The CATOX unit has rated heat input of 371,000 Btu/hr.
- The cost of Liquid Propane Gas is $0.85 per gallon.
- The life of a catalyst is three years; replacement costs $36,000.

TABLE 5-1 (continued)

ASSUMPTIONS AFFECTING DESIGN DESCRIPTION

Assumptions Specific to the CATOX Unit with Acid Scrubbing

- A spray dryer dewaters the sodium chloride solution to 50% by weight.
- The 50% sodium chloride solution may be disposed without further treatment.
- The efficiency of the specialty carbon is 10% by weight for the adsorption of hydrochloric acid.
- The bulk density of the specialty carbon is 36 lbs per cubic foot.
- The cost of the specialty carbon is $2.25 per pound.

9 1 1 2 2 1 7 0 9 7 9

TABLE 5-2

ADVANTAGES & DISADVANTAGES OF DESIGN ALTERNATIVES

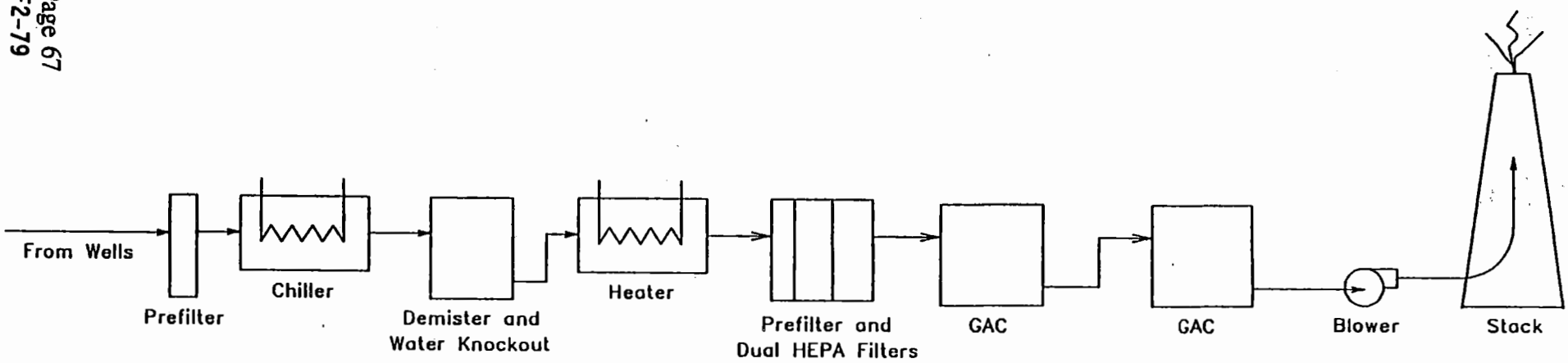
ADVANTAGES	DISADVANTAGES
GAC	GAC
- GAC treatment proven effective in pilot testing and industry.	- Requires transportation of hazardous waste and generation of hazardous waste manifests.
- GAC supplies are readily available.	- Potential off-site liability at carbon regenerator's facility.
- High-efficiency system as long as canisters are not near breakthrough.	- Expensive in comparison with CATOX.
- Relatively simple design and implementation.	- Frequent sampling of GAC effluent; non-real time monitoring creates potential for unknown breakthrough.
	- Frequent changing of GAC canisters
	- Radiation readings on GAC canisters may require holding zone to allow levels to decay. Would require additional monitoring and handling.
CATOX	CATOX
- No generation of secondary waste to be shipped offsite or treated; Carbon tet is destroyed at time of removal from subsurface.	- Generation of HCl as byproduct of catalytic oxidation.
- Less expensive than GAC	- Safety issues concerning high temperature and LPG.
- Confirmation record of carbon tet destruction is temperature of catalyst and other carbon tet monitoring is not required.	
- Real time monitoring via catalyst temperature monitoring allows instantaneous shutdown of system if temperature decreases.	
Small-Scale System	Small-Scale System
- Less complicates design and operation than larger systems.	- Small volume flowrate and small vacuum result in small area of influence.
- Lower expense system and less labor intensive.	- Low extraction rates result in low volumes of carbon tet removed.
- Units may be placed with no limitation on geographic separation.	

TABLE 5-3
ESTIMATED COSTS

This table provides an order-of-magnitude cost comparison of design alternatives utilizing GAC and CATOX for removal of carbon tetrachloride from the soil gas for one year assuming static operating conditions. Costs do not include licensing and approvals, piping to the tile fields, installation, labor costs, nor non-operational costs such as sampling.

Items Common to Both Systems			
Components			
Trailers; Roughing Filter; Chiller; Demister & Knockout; Heater; Prefilter with Dual HEPA Filters; Blower; Stack; Instrumentation & Sampling Equipment	$262,000		
Annual Electrical Usage			
15 hp Blower	$6,000		
20 kW Chiller	$10,000		
20 kW Heater	$10,000		
Total of Items Common to Both Systems		$288,000	
GAC System			
Four 8-foot-tall by 8-foot-diameter carbon canisters to withstand 150 in. w.g. vacuum	$110,000		
Carbon usage @ $1.50/lb	$812,000		
GAC Component Total		$922,000	
GAC System Total (including common items)			**$1,210,000**
CATOX System			
Catalytic Oxidation Unit	$150,000		
Catalyst depreciation (Avg. life 3 years)	$12,000		
Cost of liquid propane gas (LPG)	$34,000		
Electrical usage for 5 hp blower on CATOX	$2,000		
CATOX Component Total		$198,000	
CATOX System Total (including common items)			**$486,000**

FIGURE 5-4 GAC SYSTEM



The function of the chiller is to lower the temperature of the soil gas to below the dewpoint. This significantly improves the efficiency of the water knockout and demister in reducing the moisture of the soil gas. The removal of the moisture is important for the proper functioning of the HEPA filters, GAC canisters, and instrumentation, and for preventing damage to the blower in the event excessive water is encountered. (The excessive water could be a source of large drops of water which could impact the impeller on the blower, damaging the bearings.)

The placement of the HEPA filters immediately downstream of the moisture removal and drying components is helpful for two reasons. First, the HEPA filters are in the flowpath to the GAC canisters, which should aid in the removing the particulate radionuclide contamination so that it does contaminate the GAC canisters with particulate radioactivity. Second, if a leak develops at the HEPA filters, it would be a suction leak and would be less likely to spread contamination.

As shown in Table 5-3, the estimated cost of the base extraction unit and electricity to operate for one year is in the range of $288,000. The cost for four canisters to hold the carbon is in the range of $110,000. The cost of carbon for one year is in the range of $812,000. The total cost of the system for purchase and operation for one year, not including labor or sampling, is in the range of $1,210,000.

5.4.2 System Utilizing CATOX for Off-Gas Treatment

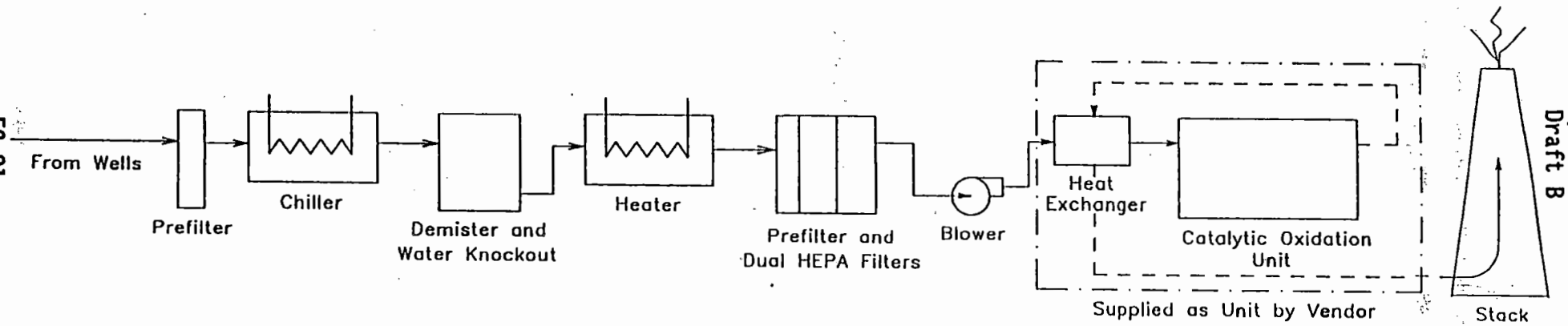
The second design alternative utilizes CATOX instead of GAC to remove the carbon tetrachloride from the soil gas (see Figure 5-5).

This alternative employs only the essential elements of the test unit. The significant design changes between this system and the test unit are the GAC canisters are replaced by a CATOX unit. The CATOX unit is located downstream of the vacuum pump because of the need to push the soil gas through the unit rather than pulling it through under vacuum.

Catalytic oxidation is a technology that is used throughout industry to combust volatile organic compounds. The CATOX functions by employing a bed of active material (catalyst) that facilitates the overall combustion reaction. The catalyst increases the reaction rate and requires a lower temperature for conversion than is possible in a strictly thermal oxidation unit. However, it is still necessary to heat the soil gas as it enters the CATOX unit. Liquid propane gas (LPG) is normally used as fuel to preheat the soil gas. This preheated soil gas passes over the catalyst bed and the resulting chemical reaction takes place at the catalyst surface.

The products of the combustion of soil gas containing carbon tetrachloride are water, nitrogen, oxygen, carbon dioxide, and HCl. The mass of HCl produced is roughly equivalent to the mass of carbon tetrachloride entering the CATOX. For the operational parameters of the system, the 580 pounds per day of carbon tetrachloride pulled from the
subsurface in the soil gases is produces about 580 pounds per day of HCl.

FIGURE 5-5 CATOX SYSTEM



It is assumed that Ecology will designate the CATOX unit without an HCl scrubber as Best Available Control Technology because of the difficulty with operating a wet scrubber at Hanford. The uncontrolled HCl emissions will not cause exceedences of any existing or proposed ambient air quality limits for toxic air pollutants. The CATOX unit proposed in this alternative uses LPG to produce the temperature necessary for combustion of the carbon tetrachloride. Table 5-2 lists several advantages and disadvantages of this alternative relative to the GAC alternative.

As shown in Table 5-3, the estimated cost of the base extraction unit and electricity to operate for one year is in the range of $290,000. The cost of the CATOX unit and the one-year depreciation on the catalyst is in the range of $162,000. The cost of liquid propane gas (LPG) for one year of operation is in the range of $34,000. The total cost of the CATOX system for purchase and operation for one year is $486,000.

5.4.3 System Utilizing CATOX with Acid Scrubbing

The third design alternative incorporates the CATOX system from the previous alternative with acid scrubbing to remove HCl from the effluent. This system would be utilized only if Ecology rules that HCl scrubbing is required to satisfy BACT. Two types of scrubbing are considered for this alternative and these are discussed along with generalized estimates of the secondary wastes produced as a result of the scrubbing operation.

The most common alternative for acid scrubbing is placing a packed column downstream of the CATOX unit and flushing a dilute sodium carbonate solution countercurrent to the vapor flow. The hydrochloric acid in the vapor flow is stripped and neutralized by the sodium carbonate solution to form dilute sodium chloride (salt). The vapor-phase continues through the packed column to the stack where it is discharged. In most industrial applications, the dilute sodium chloride wastewater is simply disposed of to a sanitary sewer. However, there is no sanitary sewer at the tile fields, so the wastewater would have to be processed on site. Therefore, for this alternative, the slurry-phase passes through to a containment vessel where it is stored for later dewatering to 50% by weight by a spray dryer and subsequent burial. Based on an assumption that 580 lbs per day of HCl coming out of the CATOX unit is converted by the sodium carbonate solution to sodium chloride and water, 1,860 lbs per day of 50% by weight salt cake is produced.

Another alternative for acid scrubbing is the use of a specially treated granular activated carbon designed for the removal of acids from airstreams. Such a carbon is placed in a canister downstream of the CATOX unit. The effluent from the CATOX unit passes through the carbon and then to the stack where it is discharged. Based on the assumption that 580 lbs per day of hydrochloric acid coming out of the CATOX unit is adsorbed by the carbon and the carbon has a bulk density of 36 lbs per cubic foot and an efficiency of 10% by weight, 5,800 lbs per day of spent carbon is produced. This specialty carbon may not be regenerated and so must be disposed when spent.

5.4.4 Small-Scale System

A small-scale system is presented as a contrast to the previously discussed alternatives. This system is less complicated in design and operation than is either of the two large systems (see Figure 5-6).

The small-scale system employs a different approach to the removal of carbon tetrachloride from the soil plume. Whereas the large systems operate at relatively high flowrates and affect areas as far as several hundred feet away, the small-scale system utilizes natural venting of the wells to affect the area immediately adjacent to each well.

The difference in approach addresses the goal in removing carbon tetrachloride. The large systems discussed are expected to operate on several wells simultaneously and to remove several tons per year of carbon tetrachloride from the soil. In contrast, the small-scale system is expected to remove considerably less than that for each well where a system is placed, but at a smaller capital investment per system.

The small-scale system is individually sized and designed for placement at each well where carbon tetrachloride is encountered, allowing easy set-up, short response time, and avoiding piping runs from the well to the system. Though the system is expected to remove the carbon tetrachloride adequately from immediately around a well over time, the rate and area of influence are very limiting factors.

The advantages and disadvantages of the small-scale system are discussed further in Table 5-2. Costing for the system is not provided because pilot testing has not been performed to establish operational parameters.

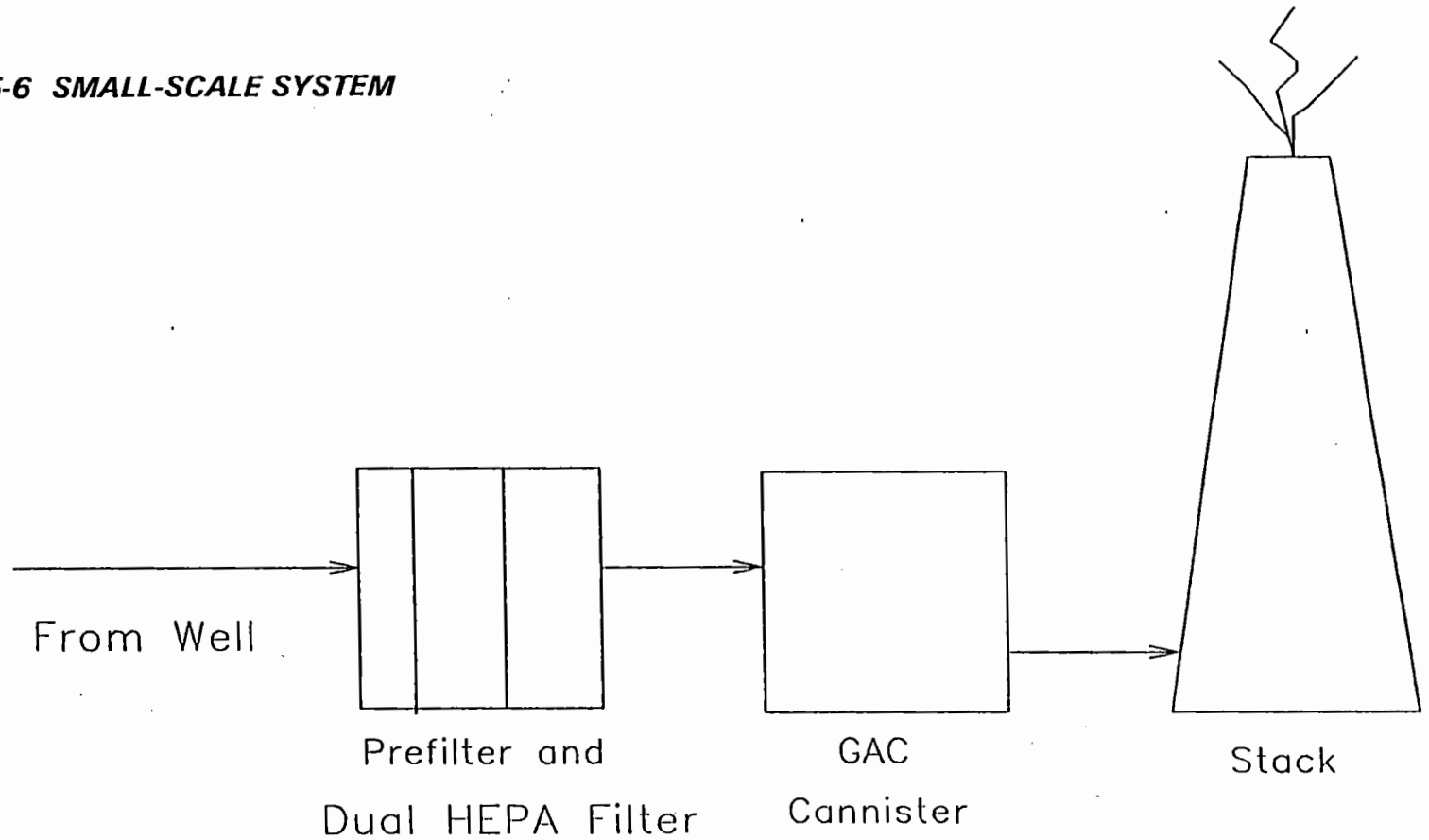
5.4.5 System Mobility

The final design alternative addresses the mobility of the system and the means by which the system connects to the wells.

Due to the potential need to operate the system in different location over time, the mobility of the system should be considered. The required mobility of the system can be satisfied through at least two approaches. One approach uses a fully transportable system with all components trailer-mounted. Disconnection and reconnection is easily made so that movement of the system from one tile field to the next is readily achievable. However, this system may require radiation releases, safety clearances, and possibly new air discharge permits each time it is moved. The other approach uses a fixed system with the soil gas transported through longer pipelines to the system. Such an approach could possibly be used to operate the system from one location while extracting soil gas from the three tile fields.

Either option requires that the system be connected by piping to the wells. The recommended option for this connection is the use of flexible hose laid on the ground between the well to the system. The pilot test employed this approach, which is easy and inexpensive. This option eliminates the need to excavate piping trenches into potentially

FIGURE 5-6 SMALL-SCALE SYSTEM



contaminated soil. However, it has the major disadvantage that water vapor condenses in the lines and accumulates at low spots. Therefore, the flexible hose should be heated to minimize condensation in the lines.

5.5 RECOMMENDED ALTERNATIVE

Based on projected system performance, relative costs, and inherent advantages, the recommended alternative for the overall system is the CATOX alternative using a three-well configuration. The system is designed to be trailer-mounted and transportable for future use in other areas. The recommended piping connections between the wells and the vacuum-removal system is above-ground flexible hose, which should be heated to minimize moisture condensation.

A Piping and Instrumentation Diagram (P&ID) of the recommended vapor removal system is shown on Figure 5-7. The projected system performance and specific components are described in the following sections.

5.6 PROJECTED SYSTEM PERFORMANCE

Based on the results of the pilot testing, the characteristics of the selected CATOX vapor removal system, the selected well configuration and the extraction flowrate, several projected system performance parameters have been derived (see Figure 5-8). These parameters are as follows:

- The system has a zone of influence encompassing the entire Z-1-A Tile Field with at least 0.2 in. w.g. of vacuum;
- The system will operate at a flow of 1,400 cfm of soil gas. This flow incorporates a 1.46 safety factor of the design flow of 960 cfm;
- The system is expected to collect about 50 gallons of water per day (~18,000 gal/yr.);
- The system effluent will have a flow of 2,300 actual cubic feet per minute (acfm) at 350°F with 5 ppm_v carbon tetrachloride and 2,500 ppm_v HCl; and,
- Assuming a similar stratigraphic sequence, the system is expected to perform comparably at the other associated cribs such as 216-Z-9 and 216-Z-18.

Emissions from the CATOX unit will satisfy the upcoming Ecology ambient air quality limits for toxic air pollutants. The EPA-approved SCREEN computer model (EPA, 1988) was used to assess the worst-case ambient impacts at the nearest property line (assumed to be

FIGURE 5-7 PIPING AND INSTRUMENTATION DIAGRAM

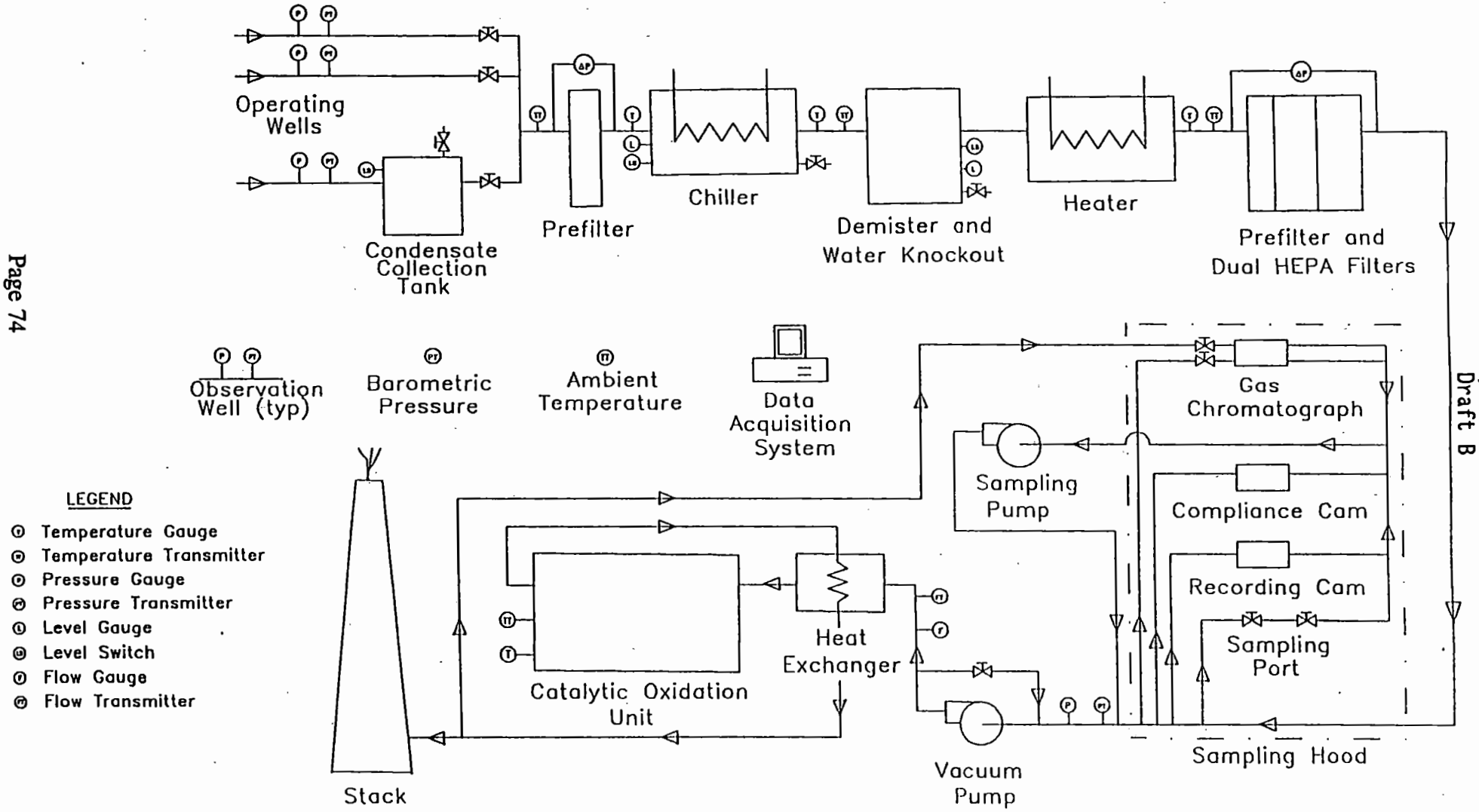
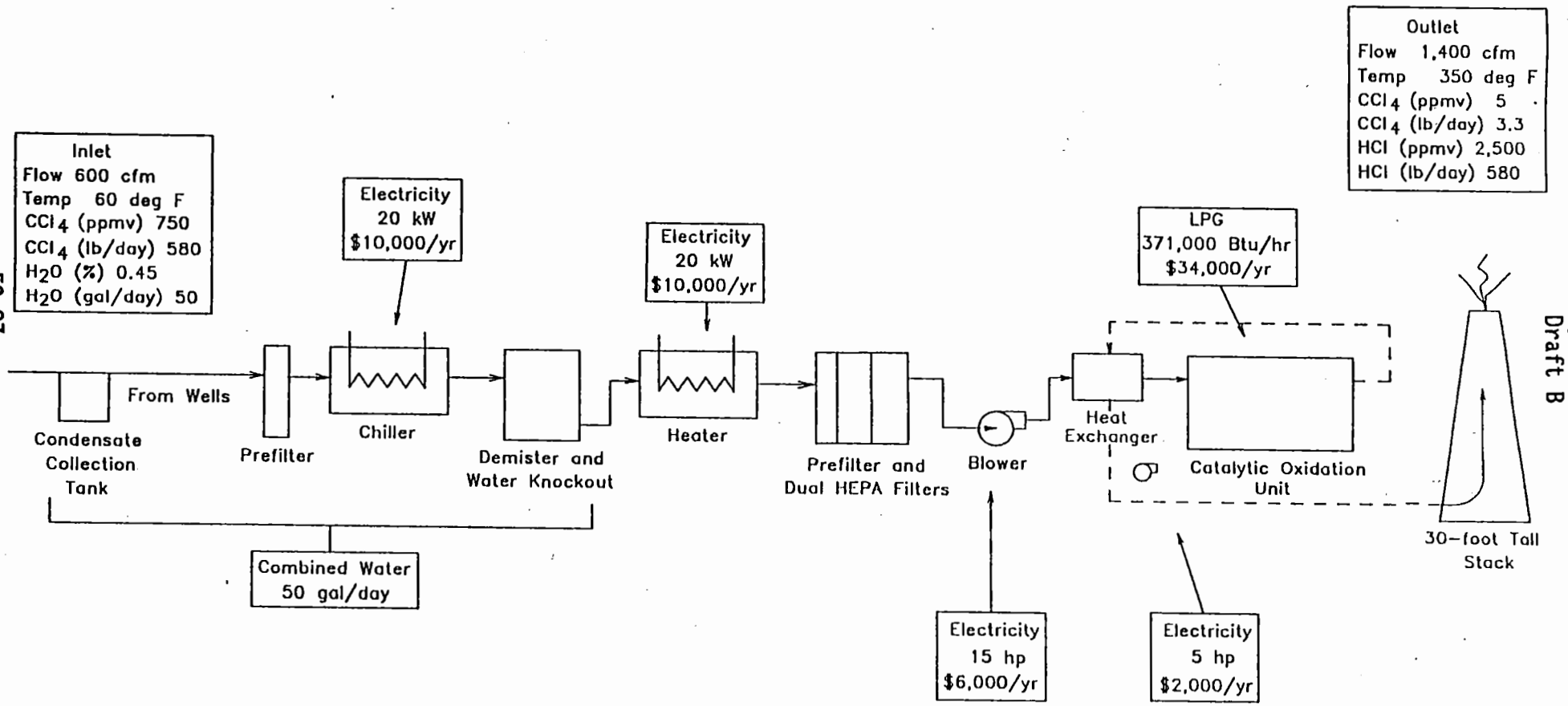


FIGURE 5-8 MASS FLOW DIAGRAM



6.5 miles away). As shown below, the calculated worst-case impacts are well below the allowable limits:

POLLUTANT	AVERAGING TIME	PROPERTY LINE IMPACTS ($\mu g/m^3$)	ALLOWABLE LIMIT ($\mu g/m^3$)
Carbon Tetrachloride	Annual	0.028	0.067
Hydrochloric Acid	24-hour	13.5	23.3

5.7 SPECIFIC COMPONENTS OF RECOMMENDED ALTERNATIVE

This system discusses specific components of the recommended alternative and provides some items to be considered in subsequent design tasks of the system.

5.7.1 Piping Connection to Wells

Above-ground flexible hose is recommended rather than rigid underground piping. For most industrial applications rigid piping would be installed in trenches, and sloped toward condensate tanks to control moisture that condenses between the wells and the VES. However, excavation of piping trenches at Hanford is not practical because of concerns with potentially contaminated soil. Therefore, flexible above-ground hose is recommended.

The flexible hose should be double-contained using a commercially available flexible containment system, to ensure that no leakage of potentially contaminated condensate occurred in the event of a hose breakage.

Moisture condensation in the flexible hoses is of concern, because the condensation would accumulate in uncontollable low spots in the flexible lines. Therefore, it is recommended that the hoses be heated to above the dewpoint temperature to prevent moisture condensation. Commercially available heated flexible hose should be used for the full scale system, rather than the unheated hose that was used for the venting tests.

5.7.2 Filtration

The roughing filter at the inlet to the system provides initial filtration to keep sediment from building up in the catch tanks of the chiller and the water knockout. The roughing filter media is constructed of fiberglass to resist degradation by the moisture-laden soil gas.

The prefilter immediately preceding the HEPA filters is rated at 99% efficient for 10-micron particles, which helps keep the HEPA filters from loading too quickly. The two

HEPA filters are configured in series and function to remove particulate radioactive contamination.

5.7.3 Catalytic Oxidation (CATOX)

The catalytic oxidation unit is a vendor-supplied unit designed to operate at 1,400 cfm flowrate and effectively reduce the carbon tetrachloride in the soil gas from 750 ppm_v to 5 ppm_v by operating at 99.3% efficiency. The unit achieves oxidation of carbon tetrachloride at the surface of the noble metal bed catalyst specially designed to oxidize chlorinated organics. The operating life of the bed is expected to be three years at which time the bed is replaced. The unit achieves the required oxidation at 600°F to 840°F. The heat is supplied to the unit at 371,000 Btu/hr through combustion of LPG. Air heating requirements are reduced by employing a shell and tube heat exchanger with a 50% heat recovery efficiency.

The compliance parameter of the soil gas effluent is temperature measured in the CATOX unit. Temperature is an accepted compliance parameter in industry because the burner temperature is the critical factor controlling high-efficiency destruction of the carbon tetrachloride.

5.7.4 Extraction System Blower

The 30 hp blower is capable of continuous duty at 1,400 cfm and 60 in. w.g. vacuum at the well heads. Automatic system shutdown is achieved with the data acquisition system which can turn the blower off. The flowrate and vacuum created by the blower are monitored by manual gauges and also by transmitting gauges connecting to the data acquisition system.

5.7.5 Instrumentation, Sampling, and Data Acquisition System

The instrumentation and analysis of samples provide information on operational parameters. The data acquisition system uses transmitting devices to store operational information and operates certain components of the system based on that information.

The instrumentation and sampling is quite different from that employed in the pilot testing unit, both in specific instruments and in approach. The pilot testing unit requires extensive data acquisition to establish operational parameters whereas the recommended alternative vapor extraction system requires mostly confirmation that conformance to key operating ranges and limits is achieved.

The instruments included on the pilot testing unit which are not included on the recommended alternative vapor extraction system include the LEL meter, the FIDs, the PID, and the inlet continuous air monitor (CAM). It has been established that the compliance CAM and the recording CAM, both located downstream of the HEPA filters, adequately measure and document the radiologic content of the soil gas flow and, therefore, the inlet CAM is unnecessary. The PID and the FIDs that were used on the pilot testing system are not required for the full-scale system because monitoring of the CATOX temperature provides a constant indication of the efficiency of the unit and subsequently the stack VOC

emissions. It was also determined during the testing that an LEL meter was not necessary due to the absence of explosive gases in the soil gas. The functions of the PID, FIDs, and LEL meter will be met by an on-line automatic ranging, calibrating, and sampling gas chromatograph. To provide further confirmation that the operational parameters are within the required limits, intermittent sampling for laboratory analyses can be conducted.

A separate gas sampling system utilizing one vacuum pump for both instrumentation and sampling operates in place of the several vacuum lines and pumps on the pilot testing unit. This vacuum system is manifolded together and the sampling ports and gas chromatograph are located within a sampling hood which is also under the system vacuum.

The DAS includes a computer which downloads to a disk and input/output boards hardwired to devices throughout the vapor extraction unit and wells. It has the capability of storing operational information from the transmitting gauges. It controls the operation information from the transmitting gauges. It also controls the operation of the chiller and heater. The DAS will shut down the process if a high level is detected in any of the water collection tanks, if the flow or pressure exceed their ranges, if the recording CAM exceeds its limit, or if the temperature of the CATOX unit falls too low. The data acquisition system may be monitored via remote telemetry and the event of a system shutdown can be telephoned automatically to a cognizant individual.

Several gauges are placed throughout the system to monitor the operation. All transmitting pressure, temperature, and flow gauges have accompanying manual gauges. The liquid-level switches have accompanying sight glasses. The operating wells and the observation wells each have a plugged port for intermittent use for reading a liquid-filled manometer.

5.7.6 Electrical

Electrical services are required for the main blower, sampling system vacuum pump, CATOX auxiliary blower, chiller, heater, CAMs, gas chromatograph, data acquisition computer, lighting, and auxiliary outlets. The system is hard-wired with a single electrical connection to an electrical panel and transformer. The electrical distribution to the data acquisition computer is conditioned to reduce signal noise and surges. The system should be capable of operating from either a generator or a power line.

5.7.7 Other Considerations

Materials of Construction

Due to the potentially corrosive nature of the air streams flowing through the system, consideration should be made for the materials of construction of all the vapor-contacting components.

The extracted soil gas vapor contains 750 ppm_v carbon tetrachloride and about 0.5% water vapor. The process piping collection tanks and the seals on all the valves and flanges

The 350°F temperature and the HCl produced as a result of the oxidation process of the carbon tetrachloride creates a corrosive environment immediately downstream of the catalyst. Materials of construction appropriate to this environment should be used. In particular, the effluent stack materials should be carefully chosen.

Separate Trailers

The vapor removal system should be housed in at least three separate trailers to reduce the potential for spreading radioactive contamination (more specifically, to restrict the amount of equipment that potentially could become contaminated). The components extending from the roughing filter through the final HEPA filter should be in the first trailer. The sampling hood, data acquisition system, and a work space should be in a second trailer. The blower should be mounted on the second trailer, but outside the housing due to the noise and the potential for piping leaks on the positive-pressure side. The CATOX unit should be mounted on the third trailer and the stack directly connected to it. The connections between the modular units should be appropriate for enabling the transportation of the entire system.

6.0 SUMMARY AND RECOMMENDATIONS

This chapter presents a summary of the findings of the vent test and recommends configuration for the full-scale VES.

6.1 SUMMARY OF TEST FINDINGS

This section summarizes the results of each of the three test phases.

6.1.1 Phase One Tests

The Phase One Testing was designed to assess the vertical and lateral distribution of VOCs under the tile field. The results were as follows:

- CCl_4 vapor concentrations up to 100 ppm_v were measured. The concentrations were generally highest at the lower sample locations about 100 to 150 feet below ground surface.

- Significant CCl_4 vapor concentrations (up to 79 ppm_v) were measured outside the limit of the tile field, indicating that the vapors (and possibly the liquid waste) migrated laterally as well as downward.

- Low concentrations of alpha and beta activity were detected at the upper two intervals at W-171 at the edge of the tile field. However, no alpha or beta activity was detected during the long term venting at the lowest interval of that well.

6.1.2 Phase Two Tests

The Phase Two tests were designed to assess the lateral permeability of the soil, for use in the design of a full-scale VES. The results of the hydraulic venting tests performed at the middle interval of W-171 at depths of about 57 to 77 feet below ground surface in a silty SAND layer, showed a measured permeability ranging from 2 to 7 darcies. Those values are representative of silty sand, a typical soil known to exist under the tile field.

The hydraulic vent test at the lowest interval of W-171 was not successful. After the test was complete it was determined that the induced vacuum that should have resulted from the mechanical venting was probably overridden by the naturally occurring diurnal fluctuations in barometric pressure. Those barometric fluctuations have been shown to produce significant pressure variations in the subsurface at Hanford, sometimes to the extent of causing CCl_4-contaminated air to be naturally vented out of groundwater monitoring wells that are open to the atmosphere.

6.1.3 Long-Term Tests

Two long-term venting tests were performed: a 24-hour test in which the lower interval of W-167 was vented at about 55 cfm; and an 80-hour test in which the lower zone of W-171 was vented at about 320 cfm. The results are summarized below:

- The vacuums at all of the observation wells were found to be significntly affected by the natural variations in barometric pressure.

- Statistical analysis was used to assess the vacuum caused by the soil venting as compared to the barometric pressure swings. The venting at W-171 caused an apparent induced vacuum of 0.90 in. w.g. at W-150, about 70 feet away. During the same test the response at W-87 (about 30 feet from the venting well) was only about 0.175 in. w.g. The statistical analysis indicated that there was no net response at W-167 about 220 feet from the venting well.

- The observed diurnal effect will have only a slight effect on the efficiency of a full-scale VES. The induced vacuum in the soil will be highest when the diurnal cycle is low, and the induced vacuum will be lowest when the diurnal cycle is high. The full-scale VES should be designed to acheive a reasonable induced vacuum within the entire tile field when the diurnal effect is at a mid-range.

- The limited response at W-87 compared to W-150 during the venting at W-171 was probably caused by the perforated interval at W-87 being in a less permeable soil than was the perforated interval at W-150.

- The induced vacuum, based on the raw data (Figure 4-9), at each of the observation wells was related to the elevation of the observation well perforated interval relative to the venting well interval. During the venting at W-171 the induced vacuum at W-150 decreased from 0.70 in. w.g. down to 0.40 in. w.g. when the well packer was moved from the lower-most perforated interval to the intermediate interval. The induced vacuum at W-150 similarly decreased from 0.40 in. w.g. down to 0.15 in. w.g. when the packer was raised from the lower-most perforated interval to the upper-most perforated interval. The intermediate and upper-most perforated interval in W-150 are 25 and 55 feet, respectively, above the lower-most perforated interval.

- The CCl_4 concentration in the vented gas from W-167 remained fairly constant at about 200 ppm_v (plus or minus about 40%) during the 24-hour test. This suggests that the soil at the center of the tile field may contain a significant reservoir of CCl_4 .

- The CCl_4 concentration in the vented gas from W-171, on the edge of the tile field, increased gradually over the first 60 hours of the test to a maximum of about 900 ppm_v (plus or minus about 40%). The vapor concentration then

stabilized or even decreased slightly during the last part of the test. This pattern suggests that W-171 was drawing contaminated soil vapor from the interior parts of the tile field.

- An estimated 8 lbs of CCl_4 were removed from W-167 during the 24-hour vent test at that well, based on the average 55 cfm flowrate. An estimated 300 lbs of CCl_4 were removed from W-171 during the 80-hour vent test, based on the average 320 cfm flowrate.

- Spectral gamma energy logging of the outside walls of the GAC canisters showed that the GAC had collected radon gas and that the radon was decaying to form gamma-emitting decay products.

6.2 RECOMMENDED FULL-SCALE VAPOR EXTRACTION SYSTEM

6.2.1 Limitations of Extrapolating from Vent Test Data

Care must be exercised when extrapolating from the vent test data to design a full-scale VES. Before the start of the vent test it was documented that the sediments under the 216-Z-1A Tile Field are heterogeneous and vertically stratified. The vent test demonstrated that the induced vacuum caused by mechanical venting is strongly affected by the soil stratigraphy and by the natural diurnal cycle of the barometric pressure. The MODFLOW computer model is generally well suited for predicting hydraulic performance in simple stratigraphic systems. Modeling demonstrated the stratigraphy at the tile field to be relatively complex, and as such the model was only able to approximate observed well vacuums. This indicates that there were one or more non-ideal conditions that were encountered during the vent test. The following should be considered when using the vent test data to design the full scale system:

Quality of Well Construction - It is possible that significant leakage between the steel well casing and the native sediments could have been occurring during the venting tests. In that case a significant fraction of leakage air might have been produced, which would have reduced the radius of influence of the induced vacuum and which would have diluted the measured CCl_4 concentrations. It is recommended that the well casings to be used for the full-scale system be inspected beforehand to assess whether an annular void space exists between the casing and the soil. If such an annulus is discovered then the void space above and below the proposed perforated interval should be grouted to minimize leakage around the casing.

Integrity of Caliche Layer - No measurements from below the caliche layer were taken during this test. The caliche probably impedes, but not prevents, downward migration of contaminants. It is possible that the CCl_4 could have migrated downward past the caliche. Soil venting from wells that penetrate the caliche could possibly produce CCl_4 vapor concentrations higher than those measured during this test.

Low Permeability Zones and Permeable Channels - The presence of unforseen low permeability zones and/or permeable channels in the sediments could affect the hydraulic performance of a full-scale VES. It is not certain that the soil stratigraphy and permeability of the soil near W-171 is comparable to the properties that would be encountered at other areas of the 216-Z-1A Tile Field or at the other tile fields in the Z Plant area. The full scale VES could possibly induce either higher vacuums or lower vacuums than were produced during this vent test.

6.2.2 Recommended System

The recommended full scale system is designed to vent the entire 216-Z-1A Tile Field to acheive at least 0.2 in. w.g. of induced vacuum at all points within the lower sediments. The recommended system consists of the following components:

- The system should consist of trailer-mounted equipment that can be easily transported to each of the tile fields to be vented and quickly set up for operation.

- Multiple wells within each of the tile fields should be vented to provide system flexibility. Above-ground flexible hoses should be used to connect the mobile VES to the venting wells.

- Based on MODFLOW computer modeling of the site, the vent system should be sized to remove and treat 1,400 cfm of air. That flowrate would induce an estimated 0.2 in. w.g. of vacuum across the entire tile field.

- Based on the observation that the electronic and manual sensors measuring the vacuum pressures at the wells did not correspond closely at times, it is recommended that the vacuum gauges used for the full-scale VES be of a different type than those used for the vent test.

- The VES should be equipped with particle prefilters and HEPA filters to remove particulate radionuclides.

- The VES should be designed to treat an influent CCl_4 concentration of 750 ppm, and reduce the CCl_4 to an outlet concentration of about 5 ppm. That discharge concentration was modeled to acheive compliance with the Ecology air toxics limits at the property boundary about 6.5 miles away.

- A commercially available catalytic oxidizer is recommended to permanently destroy the CCl_4. A high efficiency thermal oxidizer would work almost as well.

- Monitoring equipment should be designed more specifically for the expected operating conditions, e.g., the equipment will not degrade in the presence of CCL_4; will provide reliable information on system operation under varying flow characteristics; and will withstand expected relative humidity conditions.

- It is recommended that WHC negotiate with Ecology to define the use of catalytic oxidation with no HCl scrubbing as Best Available Control Technology for CCl_4 and HCl, both of which are regulated toxic air pollutants. Ecology might require the use of HCl scrubbing for a VES as large as the one described here. However, the use of an HCl scrubber at Hanford would produce an unacceptable amount of secondary waste (in the form of sodium chloride salt cake) that might have to be disposed of as radioactive solid waste.

7.0 REFERENCES

EPA, 1988. Screening Procedures for Estimating the Air Quality Impacts of Stationary Sources. EPA-450/4-88-010, August 1988.

Freeze, R.A. and J.A. Cherry, 1979. Groundwater, Prentice-Hall, Englewood Cliffs, N.J., page 29.

Johnson, P.C., C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart, 1990. A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems, Groundwater Monitoring Review, Spring 1990, page 159-178.

McDonald, M.G., and A.W. Harbaugh, 1988. A Modular Three-Dimensional Finite Difference Groundwater Flow Model, Techniques of Water-Resource Investigations of the United States Geological Survey, Book 6, Chapter A1, United States Geological Survey, Washington, D.C.

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APPENDIX A
CALCULATION PROCEDURES FOR NET SOIL VACUUM DETERMINATION

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APPENDIX A
CALCULATION PROCEDURES FOR NET SOIL VACUUM DETERMINATION

This appendix describes the calculation procedures that were used to assess how much of the apparent vacuum that was measured during the 80-hour Phase Three vent test was caused by the mechanical venting and how much was caused by natural diurnal pressure fluctuations.

These calculations were required for the vent test at the 216-Z-1A Tile Field because the electronic data showed that the diurnal barometric pressure fluctuation correlated strongly to the apparent effect caused by the mechanical venting.

A.1 DEFINITION OF TERMS

The following terms are used to describe the measured and calculated values:

Gauge Vacuum - The vacuum indicated by the electronic and manual magnehelic vacuum gauges that were used on the well heads. Those gauges indicated differential vacuum between the absolute soil pressure and the absolute barometric pressure.

Absolute Soil Pressure - The measured absolute soil pressure is indicated by:

PSOIL(ABS) = Barometric Pressure - Gauge Vacuum

Note that the absolute soil pressure at any one well and at any point in time is not an important value with regards to the efficiency of a soil venting system. What is important is the difference in the absolute pressures between the venting well and the observation wells. It is the pressure difference that is the driving force for soil venting.

Net Pressure - The net pressure indicated (either net soil pressure or net barometric pressure) is the absolute pressure measured at any given time minus the initial pressure measured at the start of the test:

Net Pressure at time t = P(t) - P(0)

Induced Vacuum - The induced vacuum is the vacuum caused by the mechanical venting system. The induced vacuum is determined by measuring the net soil pressure, then subtracting the estimated net barometric influence.

A.2 HYPOTHETICAL TEST DATA

A hypothetical data set was prepared for this appendix to demonstrate the calculation procedures. The data are presented as barometric pressure vs. time and as absolute soil pressure vs. time. The data set is graphed on Figure A-1 and Figure A-2.

The data set shown on Figure A-1 shows the absolute soil pressure being influenced by barometric pressure under two different assumptions: the first case where there is 100%

efficiency between the barometric fluctuation and the soil pressure; and the second case where there is 50% efficiency. In the first case (100% efficiency) the net barometric fluctuation is transferred completely to the soil. In the second case (50% efficiency) only one-half the barometric pressure fluctuation is transferred to the soil pressure.

The data set on Figure A-2 shows the absolute soil pressure being affected by mechanical soil venting. The upper curve is the barometric fluctuation; the middle curve is the net soil pressure (with 100% efficiency) with no applied vacuum; and the lower curve shows the net soil pressure assuming that a mechanical soil venting system causes a 2-inch vacuum within 6 hours after the vacuum is applied at time zero.

A.3 CALCULATION OF BAROMETRIC EFFICIENCY OF AN OBSERVATION WELL

The effect that barometric fluctuation has on the observed soil pressure at an observation well is determined by comparing the net barometric fluctuation (PBARO(t) - PBARO (0)) and the observed net soil pressure (PSOIL(t) - PSOIL(0)). As shown on Figure A-3 the net barometric fluctuation at every measurement time interval is plotted on the X-axis while the net soil pressure is plotted on the Y-axis. The resulting plot should theoretically form a straight line. The slope of the line should equal the barometric efficiency of the well.

A.4 CALCULATION OF AVERAGE INDUCED VACUUM

As shown on Figure A-4 the net vacuum is calculated by plotting the net barometric pressure variation on the X-axis and the net soil pressure on the Y-axis, but only for the time period after the mechanical venting produces a stable affect. In the hypothetical example the system stabilized after 6 hours of venting (Figure A-2). As shown on Figure A-4 the plotted data for the time period after the first 6 hours should produce a straight line. The Y-intercept represents the average induced vacuum at the observation well.

A.5 AFFECT OF BAROMETRIC LAG TIME

A lag time between the barometric pressure variation and the resultant soil pressure variation causes a spreading in the plotted data and reduces the least-squares correlation coefficient, but it does not appear to affect the slope or y-intercept of the resultant correlation. Therefore the calculation procedures described in the preceding sections can be used to estimate the barometric efficiency, and the mechanically induced vacuum even if there is a slight lag time that is small compared to the overall barometric cycle period.

A hypothetical data set with a 3-hour lag time, 100% barometric efficiency and no induced vacuum is shown on Figure A-5. Figure A-6 shows the correlation between the net barometric pressure and the net soil pressure. The center line represents the condition where there is no lag time, in which case the slope of the line is 1.0 (100% efficiency) and the y-intercept is zero (no induced vacuum).

The upper and lower lines on Figure A-6 represent the correlation plot for the case where there is a 3-hour lag time. In this case the upper line represents the time period when both the barometric pressure and the soil pressure are falling, and the lower line represents the period when both the barometric and soil pressures are increasing. If a least-squares fit is made to the combined data then the slope would be unity (100% efficiency) and the y-intercept would be zero (no induced vacuum). The existence of the two separate correlation lines demonstrates that a full diurnal cycle must be used to assess the induced vacuum, to prevent either overestimating or underestimating the y-intercept by improper use of only the separate rising or falling pressure phases of the cycle.

A.6 INSPECTION OF PHASE THREE VENT TEST DATA

The preceding data analysis method was applied to the Phase Three vent test data for the 80-hour test venting at W-171. The time period starting 16 hours into the test and ending 36 hours into the test was chosen for the data analysis. Application of the preceding data analysis methods indicates the following:

- As shown on Figure A-7 it appears that W-87 was only slightly influenced by the venting. The y-intercept of the linear regression plot is -0.175, indicating an overall mechanical venting influence of 0.175 in. w.g. vacuum. The slope of the regression line is 0.980, which indicates that the barometric efficiency of the W-87 was 98%.

- As shown on Figure A-8 it appears that W-150 was significantly influenced by the venting. The y-intercept of the linear regression line is -0.905, indicating an overall induced vacuum of 0.905 in. w.g. during the test. The slope of the regression line is 1.34, which implies that the barometric efficiency of the well exceeds 100%. That is not theoretically possible, and the high regression line slope is probably caused by normal variation in the field data.

- As shown on Figure A-9 it appears that W-167 was not significantly influenced by the venting. The y-intercept of the regression line is +0.04, indicating that there was no net average induced vacuum at the observation well. The slope of the regression line is 0.880, indicating an apparent barometric efficiency of 88%.

Figure A-1

BAROMETRIC WELL EFFICIENCY DUMMY TEST DATA

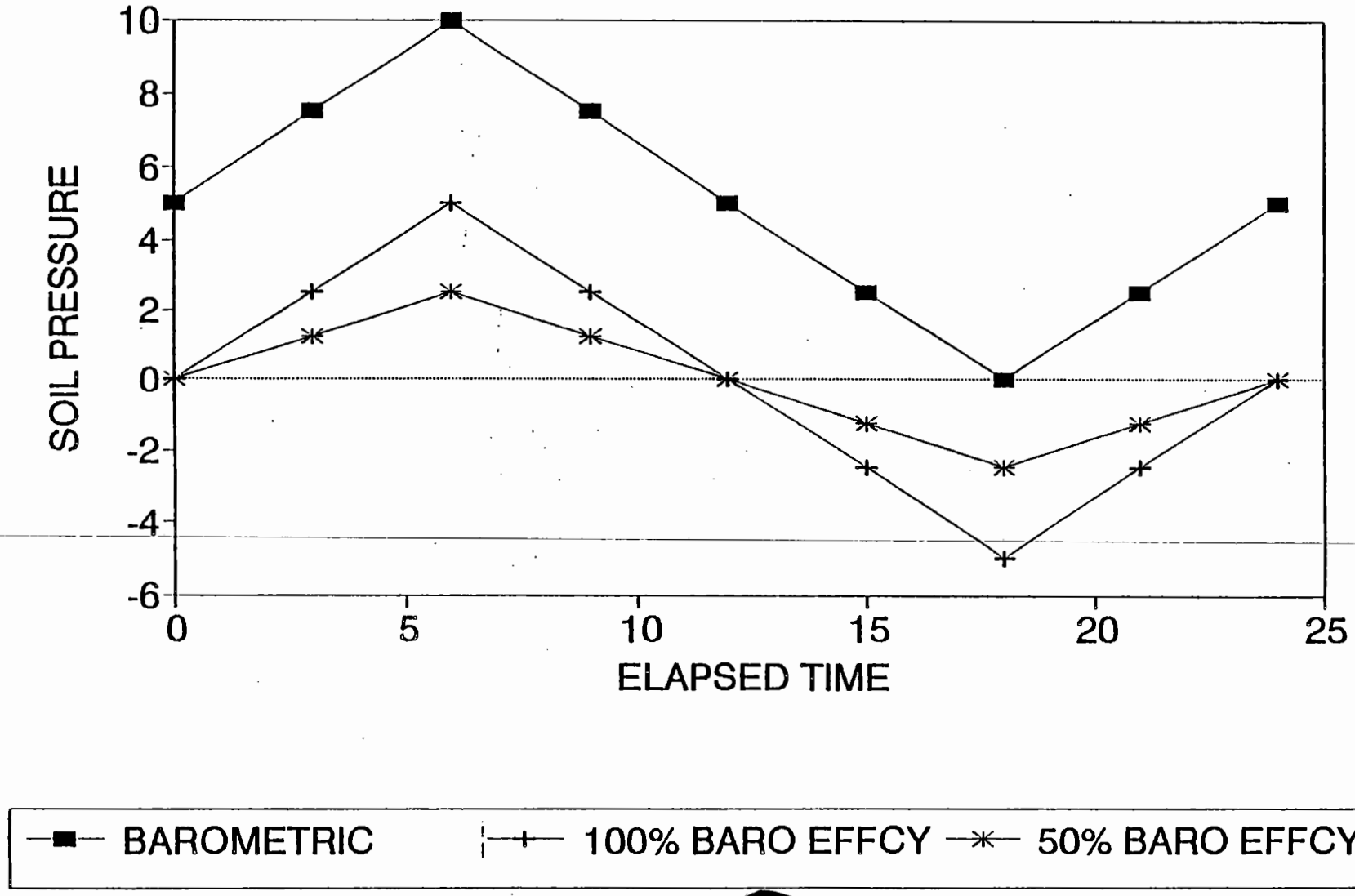


Figure A–2

2-INCH NET VACUUM AFTER 6 HOURS DUMMY TEST DATA

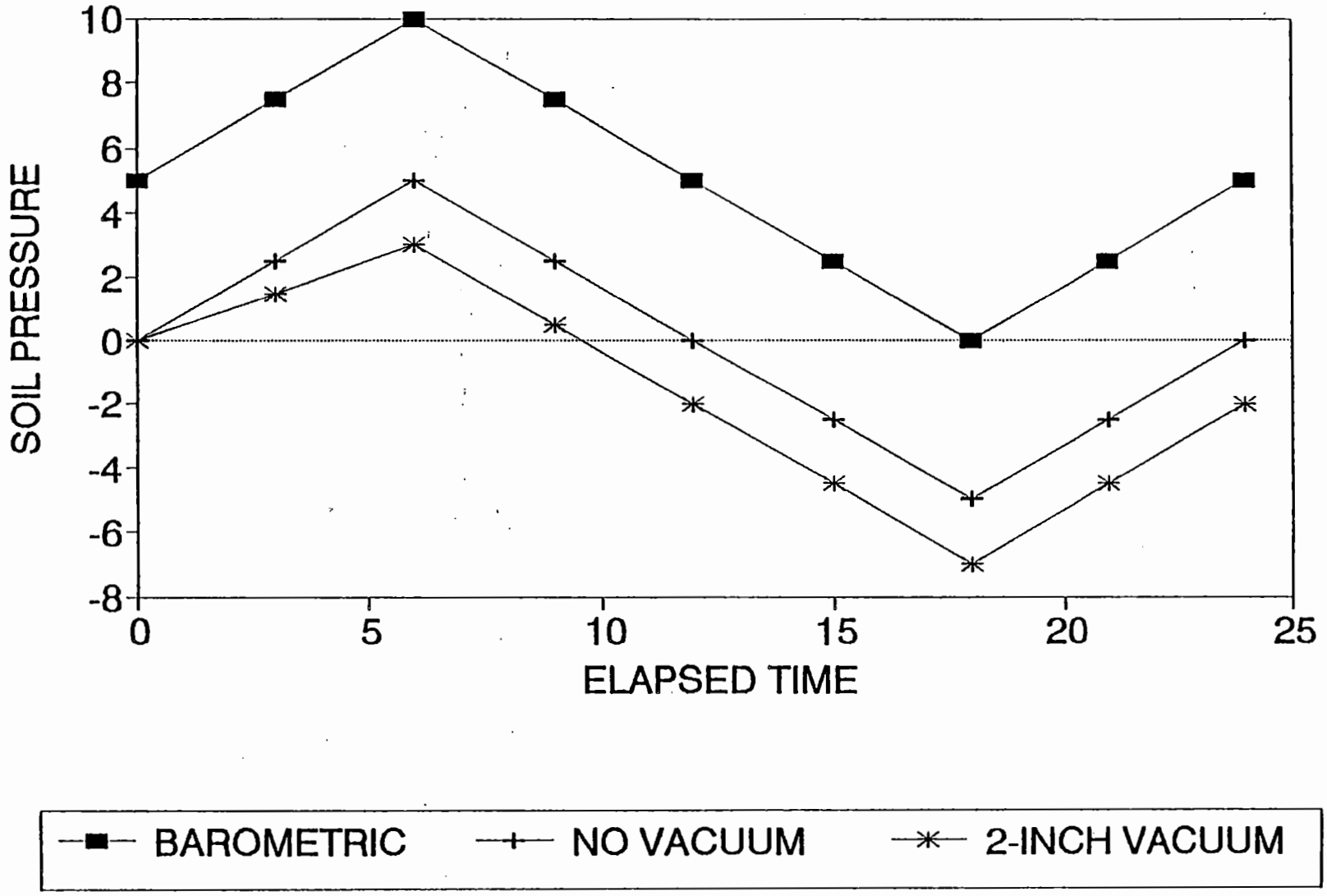


Figure A-3

CORRELATION OF PRESSURE VARIATIONS CALCULATION OF BAROMETRIC EFFICIENCY

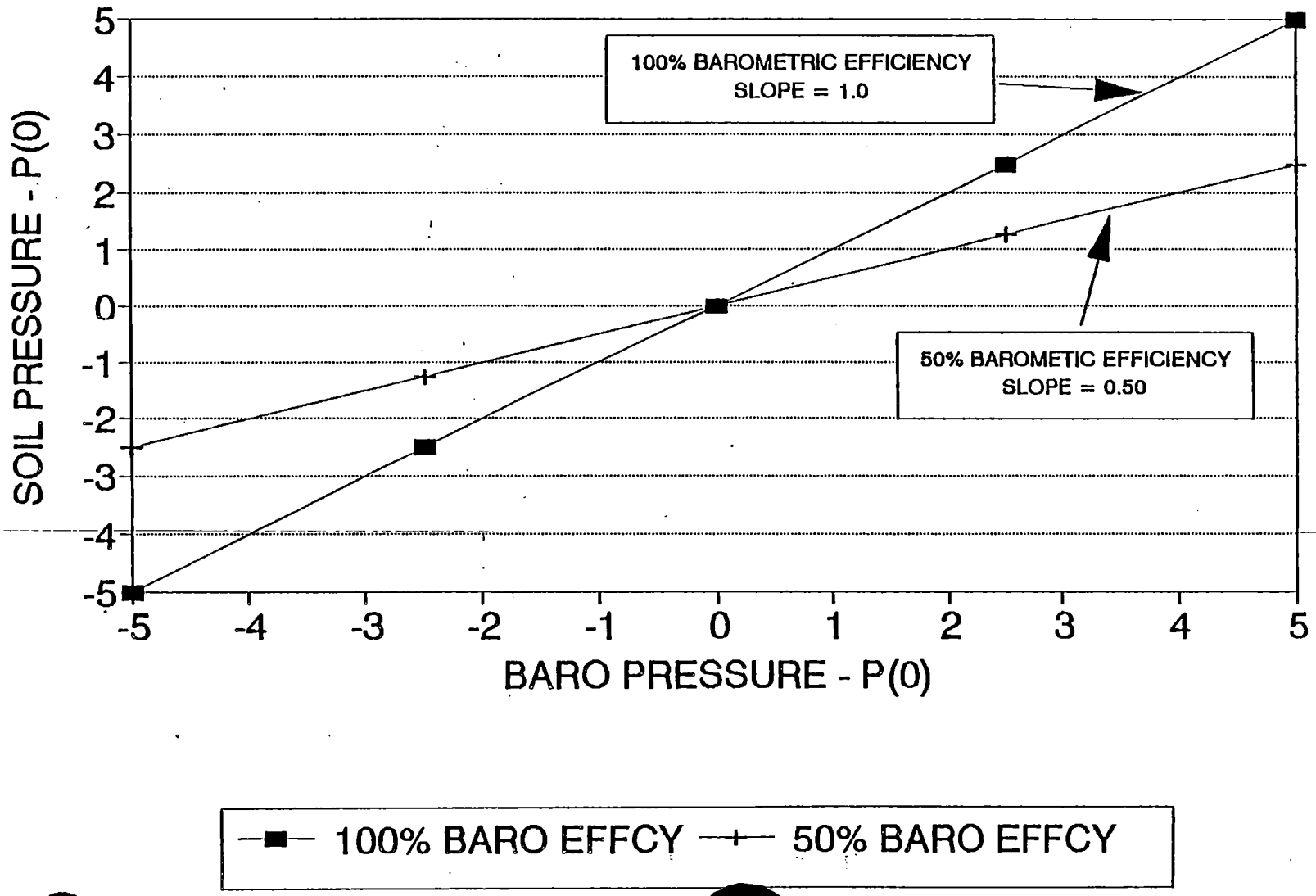


Figure A–4

CORRELATION OF PRESSURE VARIATIONS 2-INCH NET VACUUM

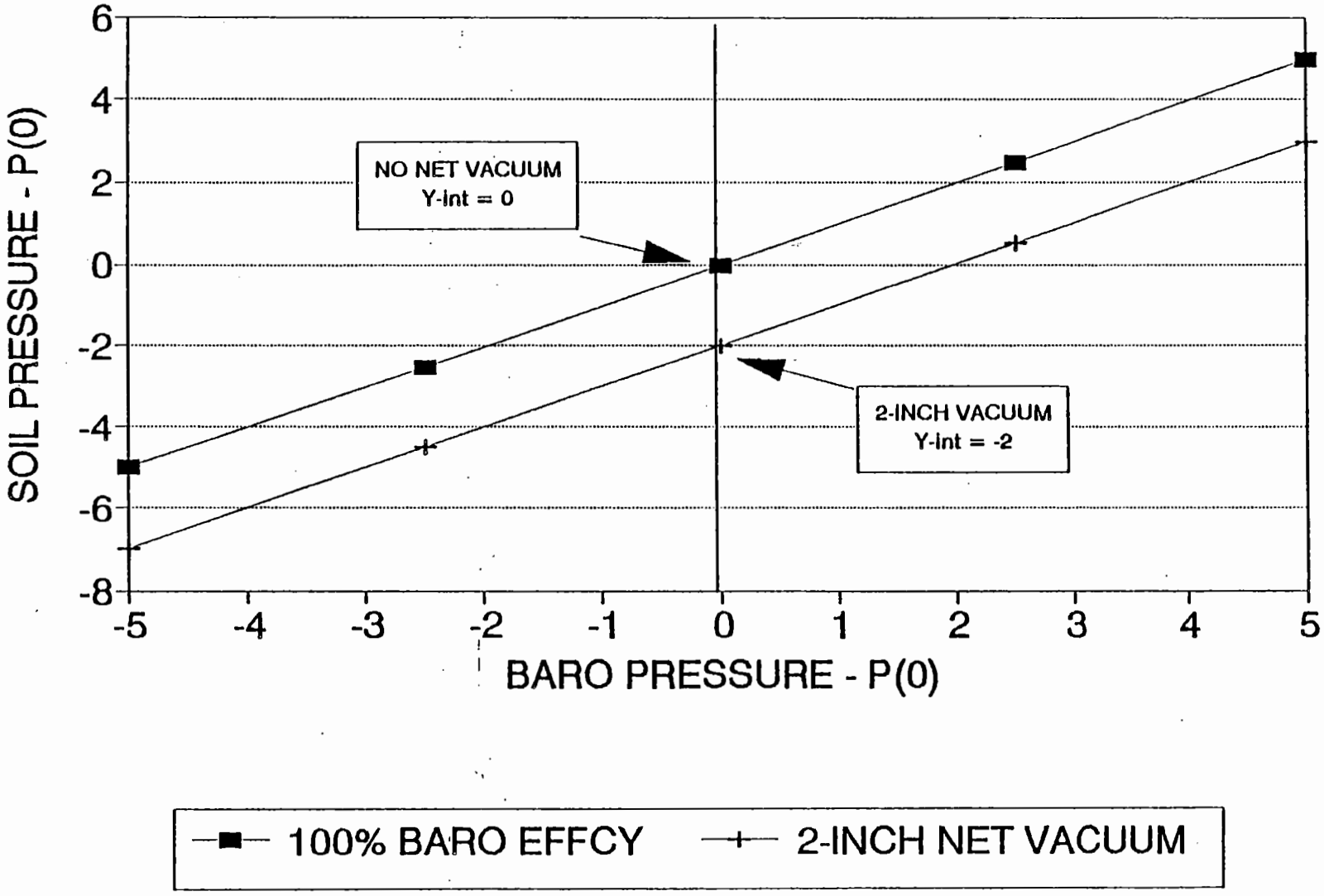


Figure A–5

BAROMETRIC EFFECT LAG TIME
DUMMY TEST DATA

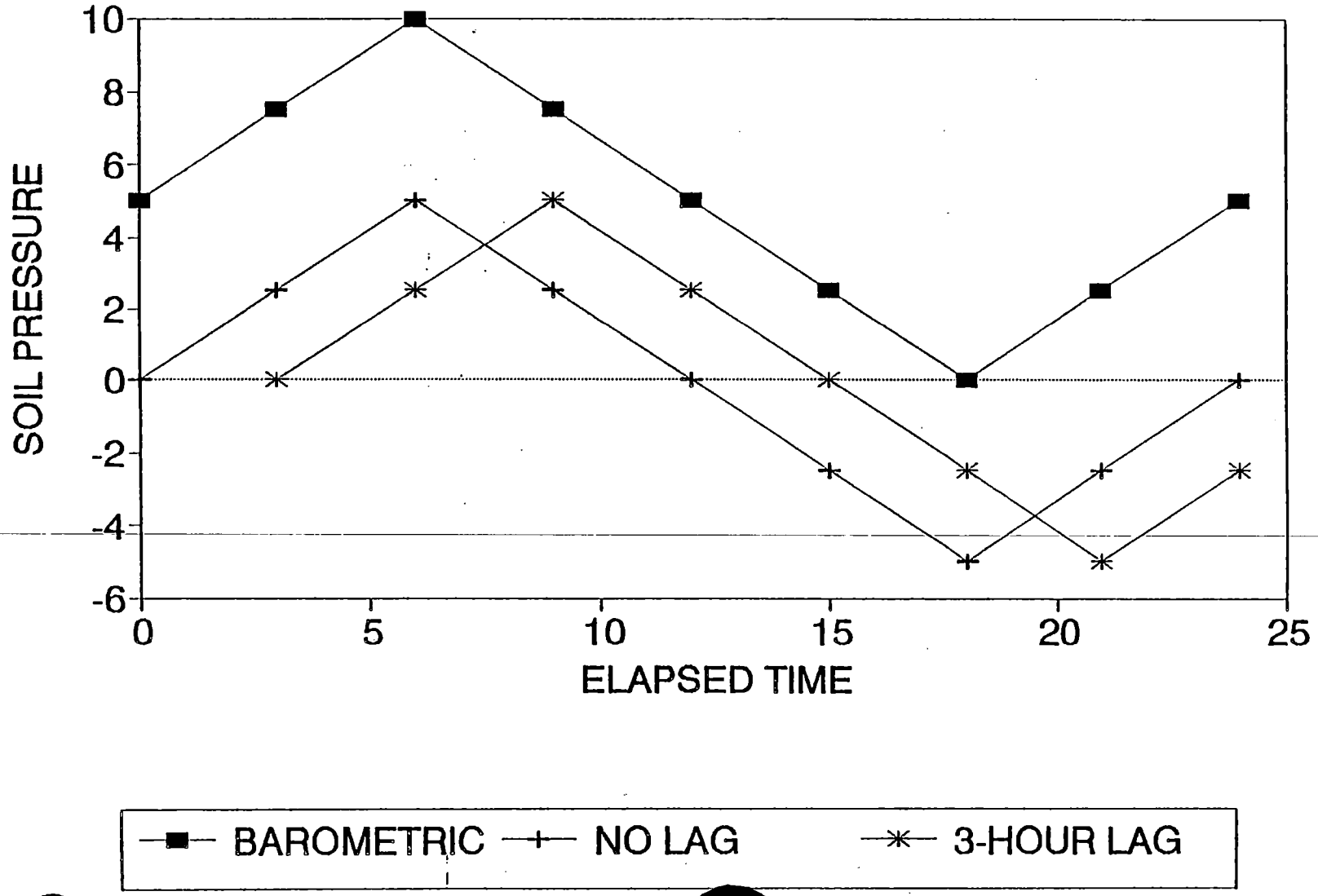


Figure A-6

EFFECT OF LAG TIME PRESSURE VARIATION CORRELATION

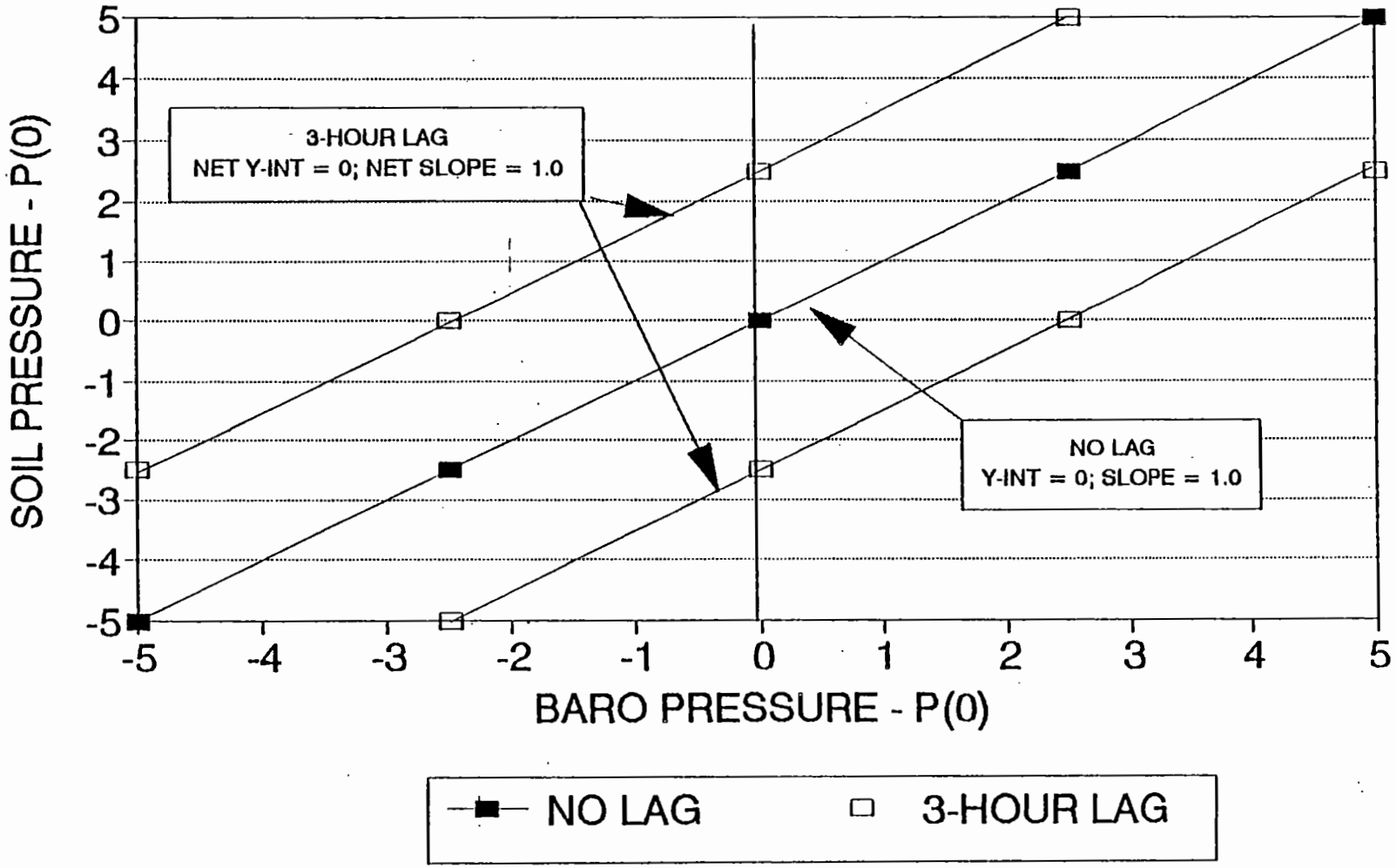


FIG A-7 PRESSURE CORRELATION, W-87
HOURS 16 - 36 OF LONG TERM TEST

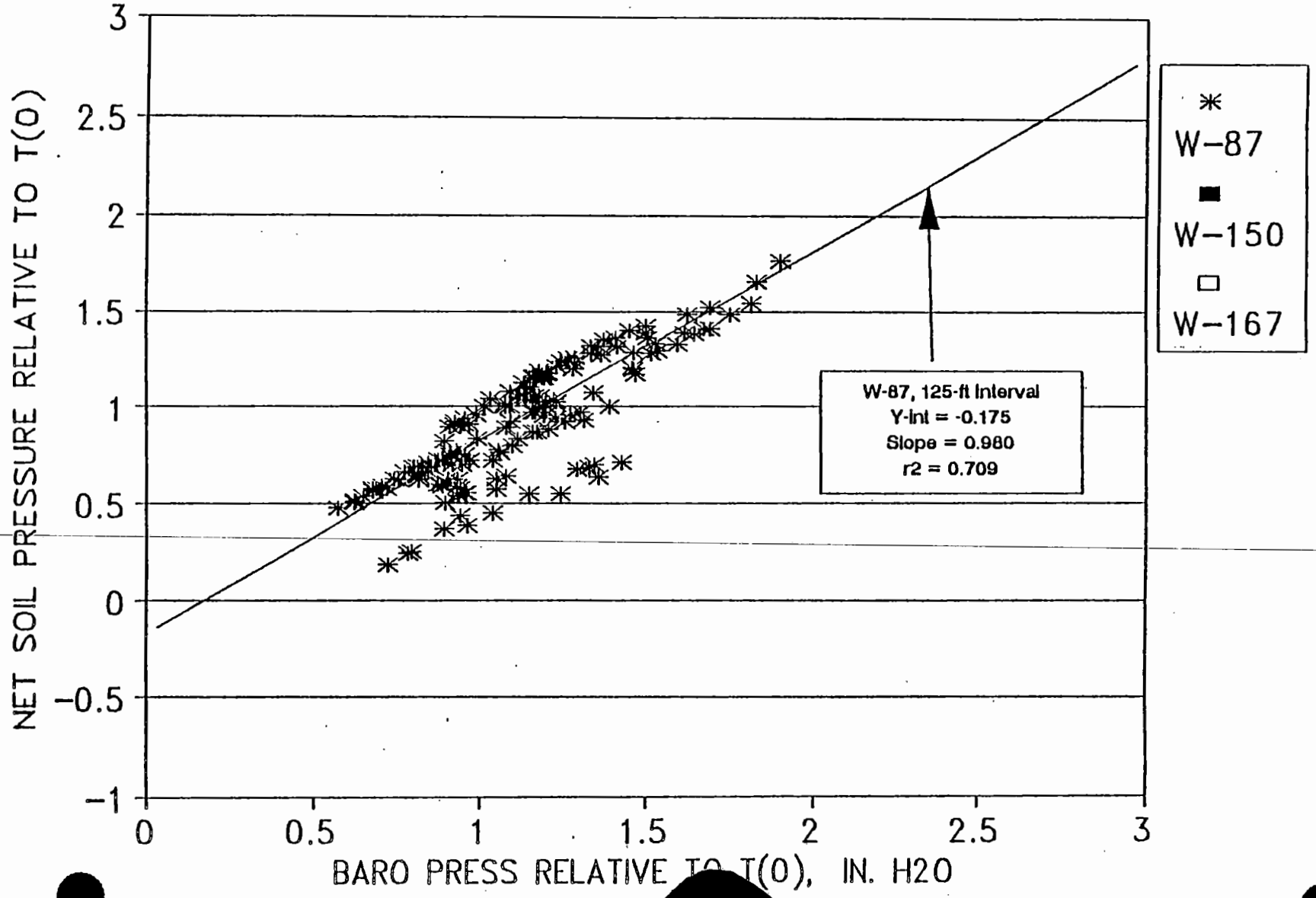


FIG A-8 PRESSURE CORRELATION, W-150
HOURS 16 - 36 OF LONG TERM TEST

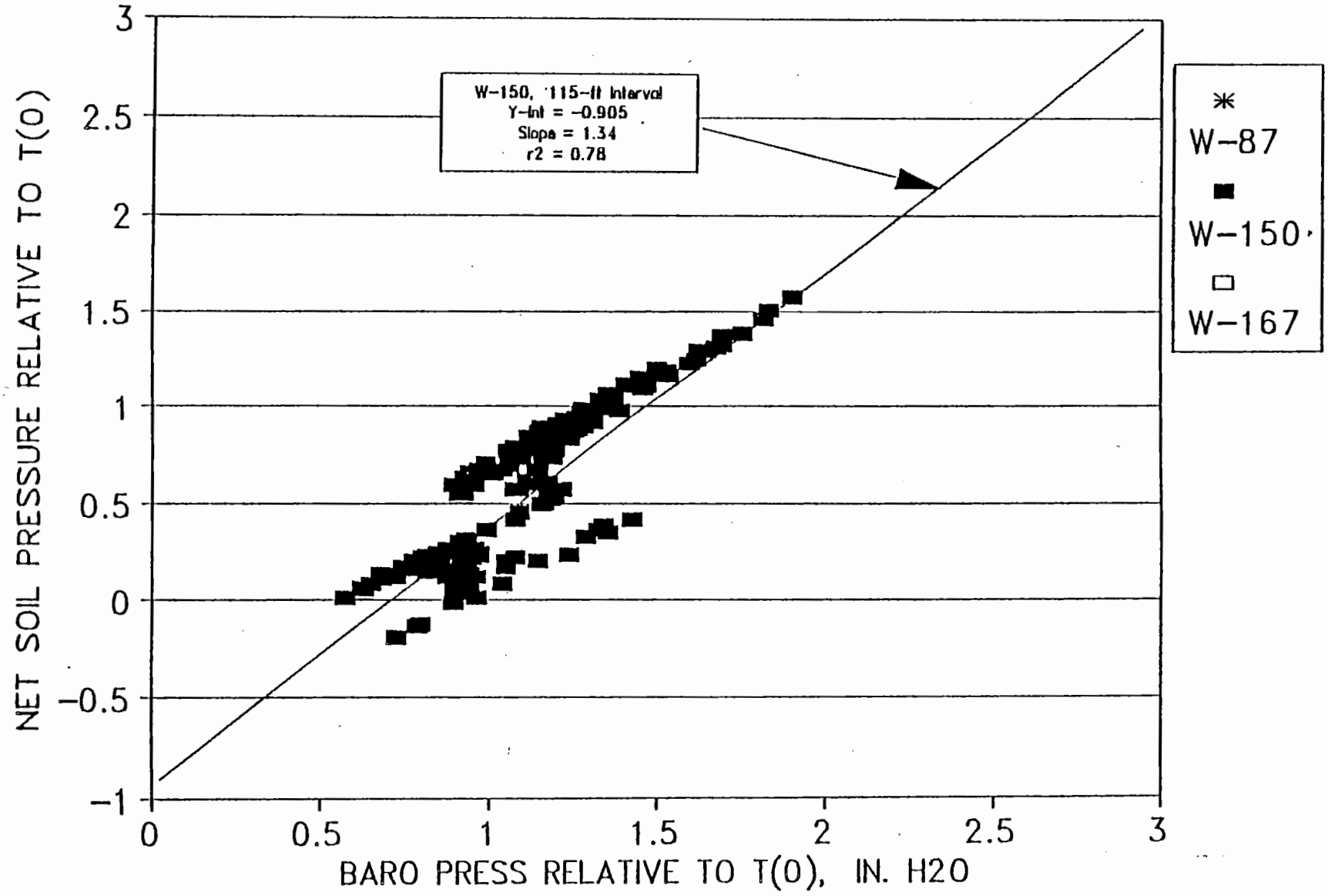
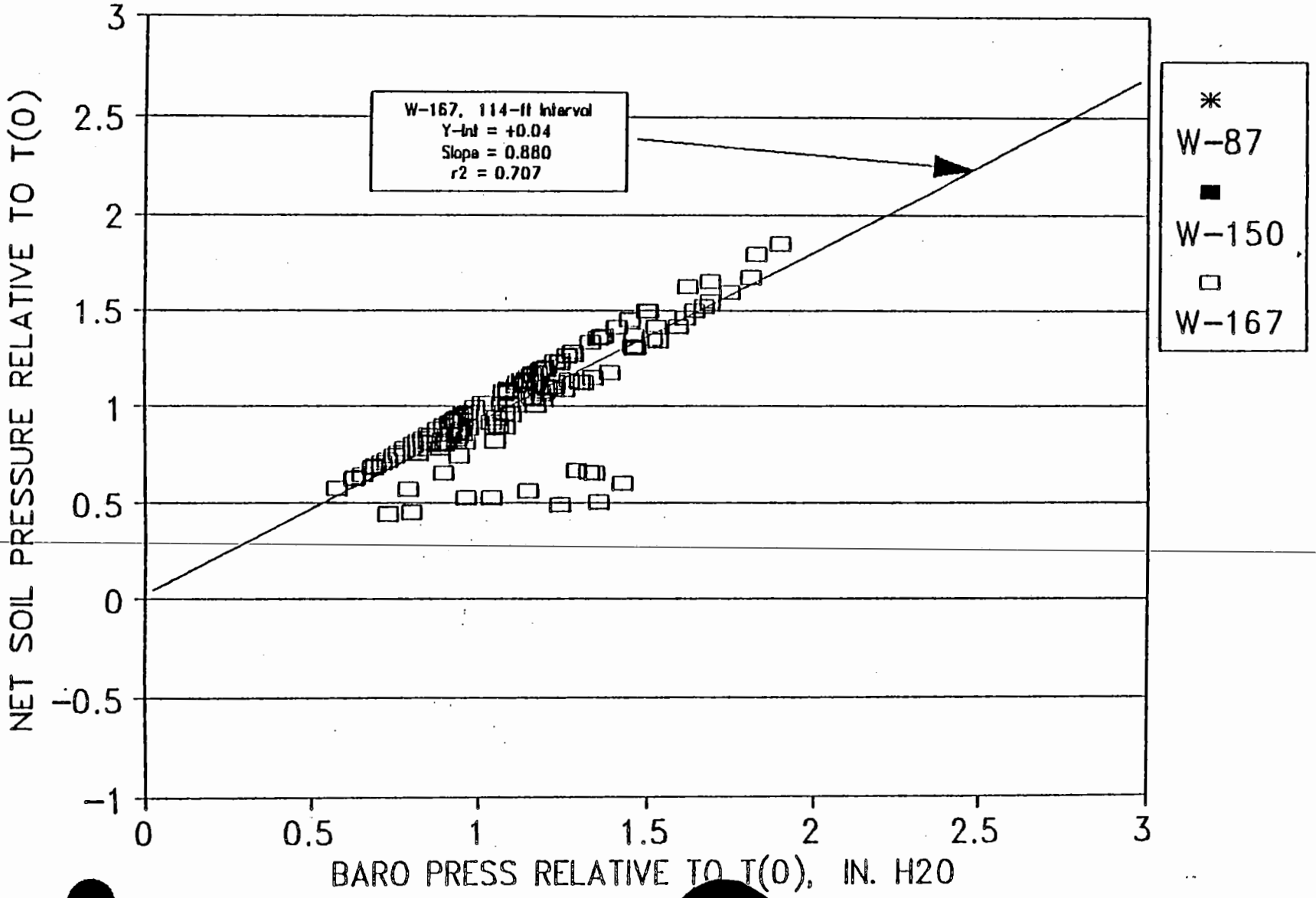


FIG A-9 PRESSURE CORRELATION, W-167
HOURS 16 - 36 OF LONG TERM TEST



APPENDIX B
SOIL VENTING TEST ANALYSIS AND VENTING SYSTEM DESIGN EVALUATION

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APPENDIX B
SOIL VENTING TEST ANALYSIS AND VENTING SYSTEM DESIGN EVALUATION

This appendix presents an analysis of soil and venting test data, and the use of these data to evaluate alternative soil venting system configurations. Included in this appendix are the results of two separate soil venting tests conducted at the Hanford 216-Z-1A Tile Field in April 1991. Two soil horizons were tested to assess the soil's permeability to air. The resulting soil air permeability estimates and other data regarding site conditions were used to assess two alternative venting system configuration using the numerical flow model MODFLOW (McDonald and Harbaugh, 1988).

B.1 ESTIMATION OF SOIL AIR PERMEABILITY BASED ON FIELD DATA

The field data measured during the Phase Two hydraulic tests were used to estimate the soil air permeability. The following sections describe the analysis methods.

Theoretical Basis for Soil Air Permeability Estimation

Johnson et al. (1990) outlines a procedure to estimate soil air permeability using pressure transient test data. Input parameters for this method include:

- Volumetric flow rate at the vacuum extraction well;
- Transient pressure distribution data obtained from observation wells;
- *In situ* air density and viscosity; and
- The thickness of the soil horizon vented.

In soil venting operations the expected change in the subsurface pressure distribution with time P'(r,t) is predicted (Johnson et al., 1990) by:

$$P' = \frac{Q}{4\pi m(k/\mu)} \int_{\frac{r^2 \epsilon \mu}{4kP_{atm}t}}^{\infty} \frac{e^{-x}}{x} dx \qquad (1)$$

This is a variation on the so called "exponential integral" commonly used in groundwater pumping test analysis (Freeze and Cherry, 1979).

Where:

P' = vacuum measured at distance r and time t (g/cm-s^2)
m = thickness of the soil horizon vented (cm)
r = radial distance from vapor extraction well (cm)
k = soil permeability to air flow (cm^2)
μ = viscosity of air (1.8 x 10^{-4} g/cm-s)
ϵ = air-filled soil void fraction (dimensionless)
t = time (seconds)
Q = volumetric extraction rate from the venting well (cm^3/s)
P_{atm} = ambient atmospheric pressure (1 atm = 1.013 x 106 g/cm-s^2)

Equation (1) assumes the following:

- Radial laminar flow;
- Single layer, homogeneous and isotropic soil conditions;
- Horizontal and infinite acting soil horizon;
- Confined conditions above and below the soil horizon; and
- Extraction well screen fully penetrates the test horizon.

When an observation well is relatively close to the pumped well and the test has continued for some time such that $(r^2\epsilon\mu/4kP_{atm}t) < 0.1$, Equation (1) can be approximated by the Jacob-Cooper approximation:

$$P' = \frac{Q}{4\pi m(k/\mu)}\left[-0.5772 - \ln\left(\frac{r^2\epsilon\mu}{4kP_{atm}}\right) + \ln(t)\right] \tag{2}$$

If all the assumptions inherent in applying Equation (1) are generally met, Equation (2) predicts that a plot of the change in pressure at a given observation well, at a constant radius from a venting well, versus the log of elapsed pumping time should be a straight line. The equation of the best fit straight line with slope A and y-intercept B is:

$$P' = A\ln(t) + B \tag{3}$$

where:

$$A = \frac{Q}{4\pi m(k/\mu)} \tag{4}$$

$$B = A\left[-0.5772 - \ln\left(\frac{r^2\epsilon\mu}{4kP_{atm}}\right)\right] \tag{5}$$

Equation (4) can be rearranged in terms of soil permeability to yield:

$$k = \frac{Q\mu}{4A\pi m} \tag{6}$$

Soil permeability can then be estimated by fitting a straight line to the observed time-vacuum data and substituting the known values of A, Q, μ and m into Equation (6).

Use of the MODFLOW model described in Section B.2 requires that a soil air hydraulic conductivity value (K) be estimated. Hydraulic conductivity is estimated for air as follows (Freeze and Cherry, 1979):

$$K_a = \rho_a g \frac{k}{\mu_a} \tag{7}$$

Where:

K_a	=	equivalent air hydraulic conductivity (cm/s)
ρ_a	=	density of air (1.204×10^{-3} g/cm^3)
g	=	acceleration of gravity (980 cm/s^2)
k	=	permeability (cm^2)
μ_a	=	viscosity of air (1.8×10^{-4} g/cm-s)

Soil Venting Test Data and Results

Middle Soil Layer

The middle layer in the northern portion of the tile field lies between depths of 45 and 90 feet and consists of a slightly silty, fine to medium sand overlying a thin layer of fine sandy silt.

On April 11, 1991, soil vent testing was conducted on the middle soil layer underlying the referenced site. The venting test was conducted for approximately 4 hours, at stepped increasing extraction rates between 50 and 400 cfm at a wellhead vacuum equivalent of 5 to 45 in. w.g. in venting W-171. Transient pressure distribution data were measured at W-87. The middle layer soil venting test data used to estimate the air permeability are shown in Table B-1.

The soil venting extraction rate was increased three times during the 4-hour test. Figure B-1 shows the transient pressure distribution data of W-87 plotted against the log of elapsed time. A straight line was drawn through the "pseudo" steady state segment of each constant rate test, and the slopes were determined. Soil permeabilities were estimated using Equation (6), and the parameters shown in Table B-2. Table B-2 shows a summary of the estimated soil permeabilities in the middle layer. The soil permeability in the middle soil layer was estimated to range between 2×10^{-8} and 5.6×10^{-8} cm^2 with calculated air conductivities of 1.3×10^{-4} and 3.7×10^{-4} cm/sec. Freeze and Cherry (1979) indicate that the permeability of silty sands typically range between 10^{-10} and 10^{-6} cm^2. These permeability estimates fall within the range of these published permeability values.

Lower Soil Layer

The lower layer beneath the tile field lies between depths of 90 and 105 feet and primarily consists of gravelly, medium to coarse sand interbedded with slightly silty, fine to medium sand; and fine sandy silt.

Long-term soil venting tests were conducted on the lower soil layer between April 15 and 18, 1991. Vacuum flow rates in W-171 ranged between 50 and 400 cfm at 4 to 55 in.

w.g. Venting tests were performed venting from wells W-167 and W-171 in separate situations. Observations of the change in pressure were observed in wells W-87, W-150, W-167, and W-171.

Data from these soil venting tests were plotted on semi-log paper, and although large amounts of data were generated by these tests, no distinct correlation could be determined on the effect of venting these wells other than the effect of barometric pressure on the soil column. Figure B-2 shows the effect of barometric pressure on the middle soil layer in W-150 when venting from W-171. It was concluded that the same barometric pressure effect is seen in the lower soil layer, and this barometric effect seriously affected the vent test data results. A more detailed description on the barometric effect is presented in the main body of this report.

B.2 VENTING SYSTEM DESIGN EVALUATION

The field data were used along with the groundwater flow model MODFLOW, to compare two alternative methods for venting the 216-Z-1A Tile Field. The following sections describe the analysis methods.

Theoretical Basis

The numerical groundwater model MODFLOW (McDonald and Harbaugh, 1988) was applied to the tile field system to:

- To verify and reproduce the transient pressure distribution observed during the different venting tests; and
- Design a soil venting system at the Hanford 216-Z-1A Tile Field using the numerically calibrated groundwater model, MODFLOW.

MODFLOW is a three-dimensional, finite difference groundwater flow model which can simulate steady-state or transient flow conditions. The three-dimensional movement of

groundwater of constant density through a porous medium may be described by the partial-differential equation:-

$$\frac{\partial}{\partial x}\left(K_{xx}\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_{yy}\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_{zz}\frac{\partial h}{\partial z}\right)-W=S_s\frac{\partial h}{\partial t} \qquad (8)$$

where:

K_{xx}, K_{yy}, and K_{zz} =	the values of the hydraulic conductivity along the x, y, and z coordinate axes, which are assumed to be parallel to the major axes of hydraulic conductivity (ft/hr),
h =	the potentiometric head (ft),
W =	the volumetric flux per unit volume and represents sources and/or sinks of water (ft^3/hr),
Ss =	the specific storage, and
t =	time (hr).

Unfortunately, there is no exact analytical solution for Equation (8) for a generalized set of boundary conditions, soil and fluid properties, and pumping stresses such as those likely to occur at the Hanford site. However, the method of finite difference modeling is capable of providing an approximate solution to the groundwater flow equation (see Wang and Anderson, 1980).

MODFLOW is a 3-dimensional numerical groundwater (or air) flow system model developed by the United States Geological Survey which has been applied to a number of sites throughout the United States. Within MODFLOW, lateral and vertical fluid flow are simulated by linking horizontal layers of finite difference cells. The finite difference cells are linked by conductance equations which are used to solve Equation (8) by discretizing time and space. An apriori assumption implicit in the application of any finite difference model is that no pressure gradients occur within a finite difference cell. Numerical modeling is then only as accurate as this assumption allows.

In practice, the modeler will make the finite difference cells smaller near the area of interest or an area where substantial changes in pressure or head are expected, i.e., smaller near a pumped well and larger on the margins of the modeled area. Also, in general practice, vertical gradients of head or pressure are typically less important and of less magnitude than horizontal gradients. This is because in most geologic media, horizontal conductivities are greater than vertical conductivities. As a result, pumping from a well generally produces predominantly horizontal flow. For this reason, finite difference models generally have more horizontal rows and columns of finite difference cells that vertical cells or layers. Also, for computational efficiency, most finite difference models, including MODFLOW, use a numerical solution which treats the real 3-dimensional flow system as a series of layers of horizontal rows and vertical columns. Pressure or head within a layer is

constant: the overall vertical gradient is modeled as a series of discrete steps controlled by the fluid conductance between layers.

Equation (8) describes groundwater flow under non-equilibrium conditions in a heterogenous and isotropic medium, provided the principal axes of the hydraulic conductivity are aligned with the coordinate directions.

Together with specification of flow and/or head conditions at the boundaries of an aquifer system, and specifications of initial-head conditions, Equation (8) constitutes a mathematical representation of a groundwater flow system.

Massmann (1989) discusses the theoretical basis for applying analytical and numerical groundwater flow models to model vapor and gas transport in porous systems. Massmann points out that several limiting assumptions must be made in using groundwater flow models for vapor flow. These assumptions and limitations include:

- The equation of motion for gas transport can be approximated using an equation similar to Darcy's Law. In fine-grained materials Darcy's Law underestimates the fluid discharge by neglecting the effect of gas slippage (Klinkenberg Effect, Amyx et al., 1960), thus underestimating the conductivity of the porous medium. However, this assumption is a likely valid approximation for low areal flow rates in silty sands and gravels encountered at the site.

- The effects of diffusional flow are negligible. This is a valid assumption for predicting pressure distributions because advective fluid flow is the dominating driving force in vapor extraction systems.

- The vapor behaves as an ideal gas as demonstrated by Massmann (1989) at temperature and pressure conditions which are typical of vapor extraction systems.

- Constant and uniform porosity, even though the porosity will generally vary with time and with location due to natural variations in geologic materials, and due to temporal and spatial variations in moisture content. But, crude sensitivity studies performed in conjunction with this report showed that reasonable changes in porosity did not have a major effect.

- The molecular weight of the fluid is uniform. The molecular weight will vary with gas composition, but small quantities of carbon tetrachloride will significantly affected the total mass of the flowing fluid.

- Gravitational effects are negligible because they are overwhelmed by advection and a uniform fluid density.

- The compressibility of the porous media is negligible in comparison to the compressibility of the vapor. The compressibility of porous media is in the

order of 10^6 psi^{-1}, whereas the compressibility of air is in the order of 10^{-3} to 10^{-6} psi^{-1} (Amyx et al., 1960)

- Gas flow can be modeled using the equation for incompressible flow. This assumption is reasonable because the minimum absolute pressure variation that will exist in the vapor stream is on the order of one-half an atmosphere and less.

Input Parameters and Boundary Conditions

The input parameters required to model vapor transport using numerical groundwater models can be broken into three categories: 1) air properties; 2) the properties of the porous media; and 3) boundary conditions and simulation parameters.

Air Properties

The air properties are the viscosity, initial air and vapor densities, temperature, and the molecular weight of air. These air parameters are necessary to determine the specific storage of the porous media. The specific storage of a porous medium is a function of the pressure and density of the system. Mathematically, specific storage is presented by Massmann (1989) as:

$$S_s = \frac{gnW_m}{RT} \tag{9}$$

here:

S_s = the specific storage of the porous media (cm^{-1})
g = the acceleration of gravity (980 cm/s^2)
n = the air filled porosity
W_m = the molecular weight of air (28 g/mole)
R = the universal gas constant (8.528×10^7 cm^2g/s^2-mole-K)
T = the temperature, Kelvin (20 °C = 273.15 K)

Only the flow of air within the soil beneath the tile field was modeled. Equation (9) can be used to calculate the specific storage of multi-component gas systems by modifying the gas density and molecular weight terms by the appropriate molar fractions of the gas phase *in situ*.

Properties of the Porous Media

Soil permeabilities were estimated using the method outlined in Johnson et al. (1990). For use in MODFLOW, these permeability values must be converted into equivalent hydraulic conductivities using Equation (7).

An estimated vertical equivalent hydraulic conductivity equal to one-tenth the horizontal equivalent hydraulic conductivity was used to represent the site conditions beneath the tile field.

Air filled porosity was estimated to be 0.15. Air filled porosity differs from total and/or effective porosity because it is a direct function of the moisture content of the soil. Without obtaining soil moisture data, or performing representative soil moisture tests on the soils beneath the tile field, this estimate of air filled porosity seems reasonable and most likely under estimates the actual air filled porosity of the soil conditions in an arid environment like that of eastern Washington. The effect of under estimating the air filled porosity is small in comparison to the magnitude of the specific yield, and is therefore justified considering the lack of physical data.

To simplify the analysis, we assumed that the porous media was homogenous and isotropic. Based on the well logs and other geologic data, there are reasons to believe that non-homogeneous or anisotropic conditions exist beneath the site, but the magnitude and exact locations of these non-homogenities is not documented. Crude sensitivity analysis indicated that the model was not very sensitive to changes in porosity.

Boundary Conditions and Simulation Parameters

A 41-row, 26-column grid system having variable grid spacing was modeled. A diagram of the modeled grid is shown on Figure B-3. Due to the memory storage constraints of the groundwater model, a five layer system, having a total depth of 135 feet was modeled. The five layer system consisted of a 1-foot numerical representative upper boundary condition, a 44-foot soil layer, a 45-foot soil layer, a 25-foot soil layer, and a 20-foot soil layer used as the venting interval.

The following boundary conditions were imposed on the system modeled:

- A no flow boundary below the lower soil layer. It was assumed that the silt and caliche layer underlying the test zone does not permit substantial flow;
- Constant head lateral boundaries. It was assumed that at some distance from the pumped wells, soil venting does not substantially affect fluid pressures;
- Constant head boundaries set to atmospheric pressure over the entire surface of the top soil layer. It was assumed that venting would not substantially affect atmospheric pressure at the site; and
- Initial heads equal to atmospheric pressure throughout the system.

These boundary and initial conditions were expressed in **equivalent meters of air** if using metric units or **equivalent feet of air** if modeling in English units. This is a necessary

adjustment since all the input parameters used in the simulation are defined in units of air. Based on fluid statics, equivalent feet or meters are expressed as (Streeter and Wylie, 1979):

$$P_{w,a}=\rho_w g h_w=\rho_a g h_a \tag{10}$$

Here $P_{w,a}$ is the static pressure head of water or air. Equation (10) can be rearranged in terms of equivalent head of air as:

$$h_a=\frac{\rho_w}{\rho_a}h_w \tag{11}$$

where:

h_a = equivalent head of air (feet or meters)
ρ_w = density of water (1.0 g/cm^3)
ρ_a = density of air (1.204 x 10^{-3} g/cm^3)
h_w = equivalent length of water (feet or meters)

The resulting head and/or drawdown outputs of the simulation are expressed in terms of equivalent head of air. These values of heads and/or drawdowns can then be converted into conventional units of head of water by appropriate substitution into Equation (11).

Simulation run times and time steps in hours were chosen. A simulation run time of 12 hours, using 5 time steps, and a time step multiplier of 2 were used. Steady state flow conditions were observed within two or three time steps.

Numerical Verification of Estimated Permeabilities

Numerical simulation was performed on the system to verify the accuracy of the estimated permeabilities calculated from soil venting test data. An arithematic average value of equivalent air conductivity from the estimated equivalent air permeabilities determined using the using the soil venting test data results from the intermediate soil layer (35- to 70-foot depth) was used to represent the soils at and above these depths. Based on the well logs and other geologic data, an assumed equivalent air conductivity twice the estimated equivalent air conductivity in the intermediate soil layer was used to represent the between depths of 70 and 105 feet. Table B-3 shows the equivalent air conductivities, and specific storage used for each layer in this simulation.

Well locations and vacuum flow rates used in the calibration procedure were the same as those used in the soil venting tests. Venting W-171, and observation well W-167 were chosen to verify the estimates of permeability in the lower soil layer.

These numerical calibration runs were performed using the same soil and simulation parameters as mentioned above, but using a smaller grid system (33-by-17) than the grid system used in the soil venting system design analysis. It was seen that the constant head lateral boundaries had little effect on the near-wellbore vacuum contours up to a radial distance of approximately 110 feet from the venting well. Use of the smaller grid system greatly increased the visual accuracy of this calibration procedure.

Figure B-4 shows a contour map of the simulated system at steady state conditions in equivalent vacuum in. w.g. using the arithematic average estimate of permeability obtained from the soil venting test. Figure B-4 shows that the groundwater flow model over estimates the calibration criteria value of 0.52 inches at W-150 by approximately 1000% (52 in. w.g. equivalent simulated vs. 0.52 inches actual).

The conductivities and leakage terms of the five layers were increased to better approximate the results of the numerical vent test data to the actual vent test data. Figure B-5 shows the results of increasing the conductivity and leakage terms by a factor of 10. This vacuum contour map shows that the groundwater model still over estimates the actual vacuum created in-situ by approximately 100%. Figure B-6 shows the results of increasing the conductivity and leakage terms by a factor of 100. Figure B-6 shows a reasonably good correlation of the numerical vent test to the actual vent test results when the conductivities and the leakage terms are increased by two orders of magnitude.

The conductivity of this system estimated by numerical calibration is only a numerical value that includes all the non-idealities of the system modeled and should only be used for extrapolatory purposes.

Soil Venting System Design Analysis

We explored two soil venting systems that would produce a vacuum of 1-in. w.g. equivalent at the outer extent of the tile field. A vacuum of 1-in. w.g. equivalent provides for rapid displacement of one pore volume of vapor within the system, and will allow for the venting well and aquifer losses (Terra Vac, 1991). The two scenarios we explored are:

- Venting from three wells, spaced laterally across the tile field. Each well was assumed to be perforated over a 20-foot vertical interval toward the bottom of the lower soil layer.

- Venting from a single well in the middle of the tile field. The well was assumed to be perforated over a 20-foot interval toward the bottom of the lower soil layer.

The equivalent air conductivity values determined by numerical calibration were used in this model to simulate the two soil venting scenarios.

Figure B-7 shows the results of venting wells W-150, W-80, and W-65 at 320 cfm. Although W-80 is only 21 feet in depth, W-80 was chosen for illustrative purposes due to its central location. Figure B-7 shows that a 0.2-in. w.g. vacuum is produced at the edge of the

tile field when venting each of the three wells at 320 cfm. Figure B-8 shows the induced advective flow vectors produced by a 320 cfm vacuum flow rate. The one pore volume displacement rate resultant from venting at a combined flow rate of 960 cfm is calculated to be 16 hours/pore-volume based on a 45-foot soil layer. One pore volume of air or liquid is defined as the volume of air or liquid, at standard conditions, which occupies the interconnected void space within a porous medium.

Figure B-9 shows the effect of venting each of the three wells at a flow rate of 1,120 cfm. It is seen on Figure B-9 that a total combined flow rate of 3,360 cfm will produce a 1-in. w.g. vacuum at the edge of the tile field. The one pore volume displacement rate resultant from venting the three wells at a total combined flow rate of 3,360 cfm is calculated to be 4.5 hours/pore-volume based on a 45-foot soil layer.

Figure B-10 shows the results of venting a centrally located well at a flow rate of 640 cfm. A single well, vented under the calibrated circumstances at a flow rate of 640 scfm will produce a 0.2 in. w.g. vacuum at the edge of the tile field. The one pore volume displacement rate resultant from venting a single well at 640 cfm is calculated to be 32 hours/pore-volume based on a 45-foot soil layer.

Table B-1 - Middle Soil Layer Vent Test Data

Flow Rate (cfm)	Delta Time (hr)	Log Delta Time (hr)	Vacuum (g/cms2)
74	0.19	-0.71	-99.46
74	0.22	-0.65	-248.66
74	0.25	-0.61	-223.79
74	0.29	-0.53	-198.92
74	0.33	-0.48	-248.66
77	0.39	-0.41	-248.66
115	0.47	-0.33	-248.66
124	0.50	-0.30	-248.66
124	0.52	-0.29	-298.39
124	0.53	-0.27	-348.12
123	0.58	-0.24	-348.12
123	0.63	-0.20	-397.85
123	0.78	-0.11	-397.85
120	0.89	-0.05	-410.28
220	0.94	-0.03	-447.58
220	0.95	-0.02	-497.31
220	1.00	0.00	-920.03
217	1.03	0.01	-1044.35
217	1.07	0.03	-1094.09
220	1.16	0.07	-1268.15
220	1.25	0.10	-1293.01
220	1.32	0.12	-1342.74

Flow Rate (cfm)	Delta Time (hr)	Log Delta Time (hr)	Vacuum (g/cms2)
220	1.42	0.15	-1392.47
218	1.48	0.17	-1467.07
220	1.57	0.19	-1417.34
218	1.60	0.20	-1442.20
324	1.68	0.23	-1815.19
324	1.69	0.23	-1864.92
324	1.70	0.23	-1939.52
324	1.71	0.23	-1989.25
324	1.71	0.23	-2038.98
324	1.72	0.24	-2088.71
324	1.74	0.24	-2138.44
324	1.74	0.24	-2188.17
324	1.75	0.24	-2237.90
324	1.77	0.25	-2287.63
324	1.78	0.25	-2337.37
324	1.80	0.25	-2387.10
324	1.81	0.26	-2436.83
323	1.85	0.27	-2486.56
323	-1.92	0.28	-2486.56
395	3.49	0.54	-1243.28
395	3.49	0.54	-1342.74
395	3.50	0.54	-1491.94

Table B-1 – (Cont.)

Flow Rate (cfm)	Delta Time (hr)	Log Delta Time (hr)	Vacuum (g/cms2)
395	3.50	0.54	-1591.40
395	3.51	0.55	-1740.59
395	3.52	0.55	-1840.05
395	3.52	0.55	-1989.25
395	3.53	0.55	-2088.71
395	3.55	0.55	-2337.37
395	3.56	0.55	-2486.56

Table B-2 – Middle Soil Layer Estimated Air Permeability Input Parameters

Flow Rate (cm3/s)	Soil Thickness (cm)	Air Viscosity (g/cm-s)	Semi-Log Slope (g/cm-s2)	Estimated Air Permeability (cm2)
103828.3	1371.6	0.00018	19273.15	5.60E-08
152910.8	1371.6	0.00018	78538.67	2.00E-08
186491.1	1371.6	0.00018	87852.07	2.20E-08

Table B-3 – Estimated Soil Parameters

Layer Number	Soil Thickness (ft)	Specific Storage	Leakage (hr-1)	Equivalent Air Conductivity (ft/hr)	Equivalent Air Transmissivity (ft2/hr)
1	1	5.19E-06	2.54E-03	0.025	0.03
2	44	2.28E-04	5.77E-05	0.025	1.12
3	45	2.33E-04	5.64E-05	0.025	1.14
4	25	1.29E-04	2.13E-04	0.053	1.33
5	20	1.03E-04	0.00E+00	0.053	1.07

Middle Soil Layer Permeability Plot

Venting Well No. W18-171, Observation Well No, W18-87

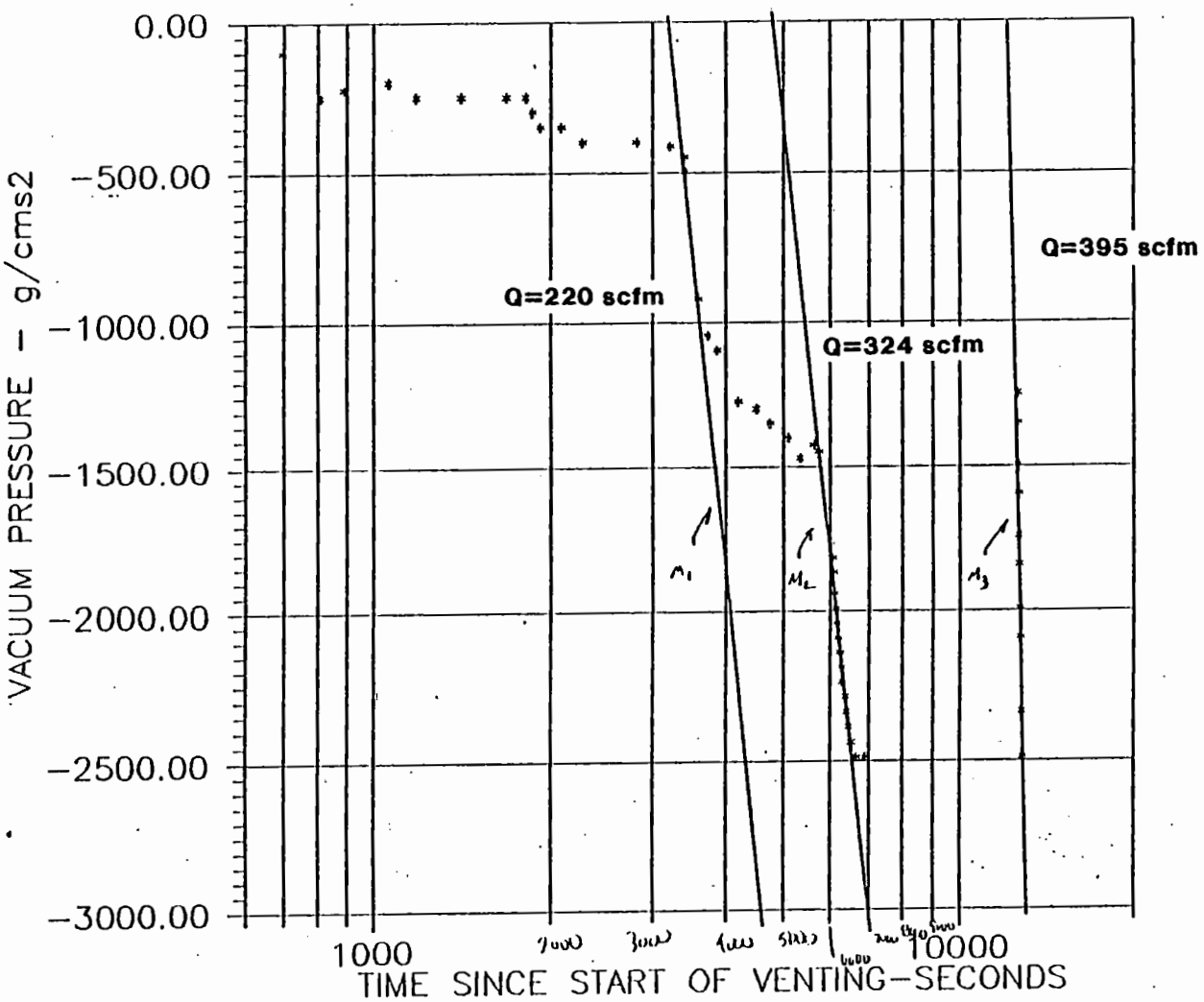

Figure B-1

Phase 2 Hydraulic Test, W18-171 Middle Layer Soil Pressure Trends at W18-150

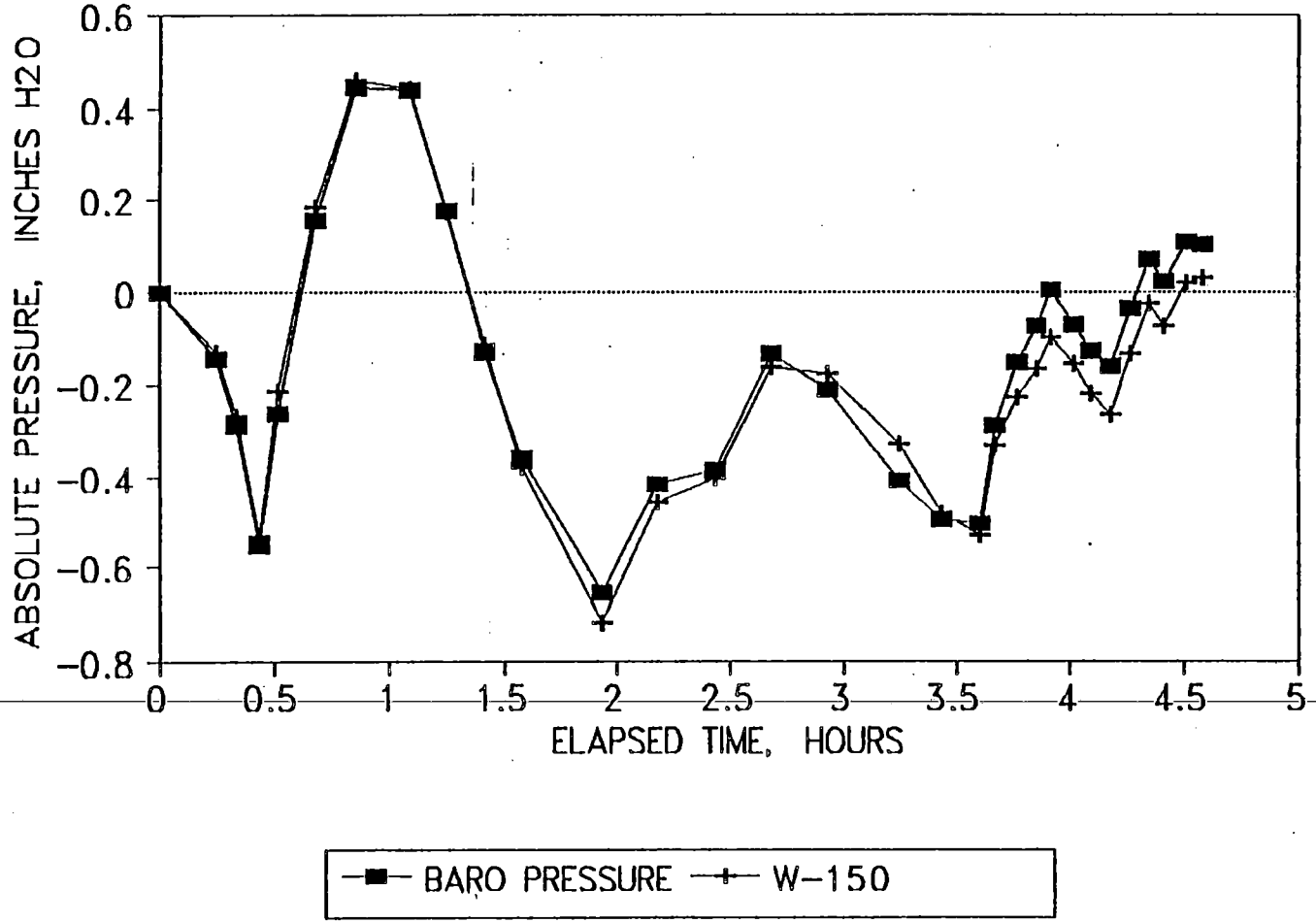

Figure B-2

41x26 Grid System

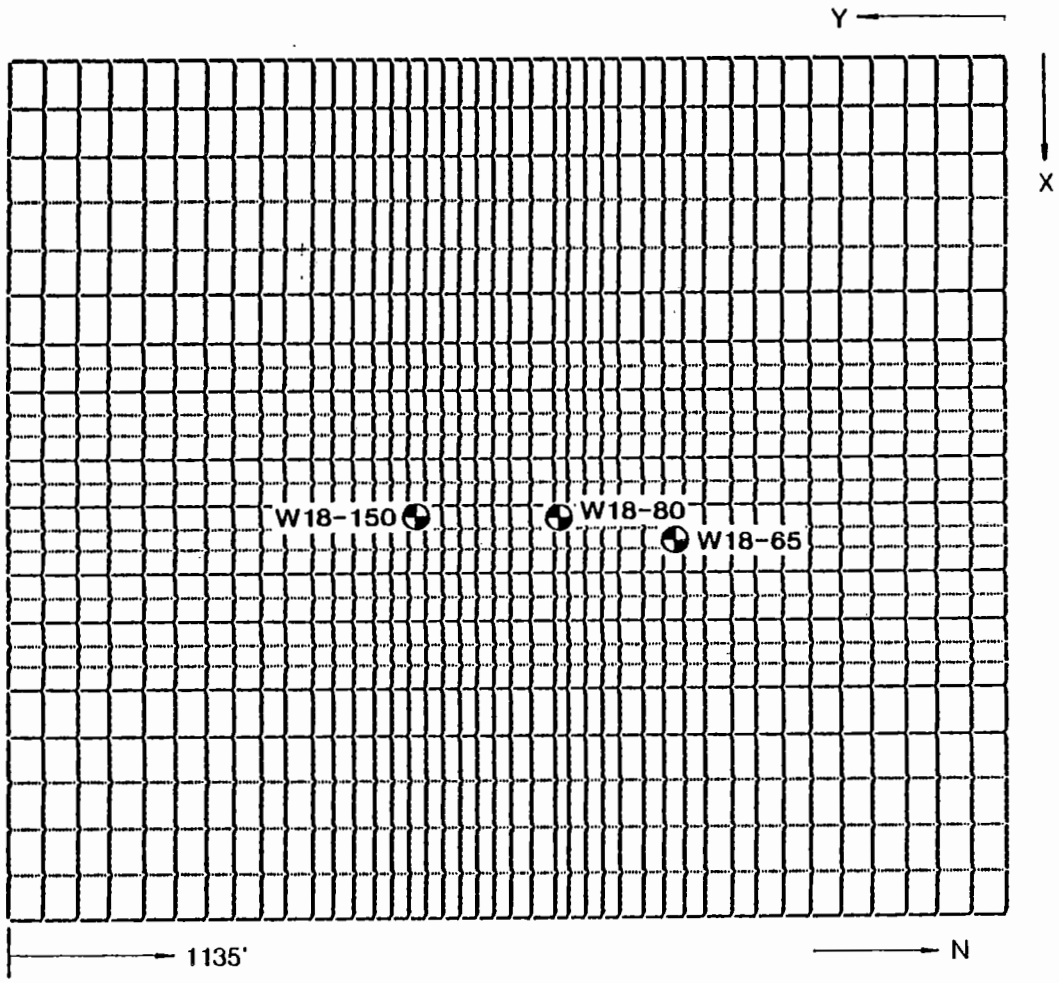

Figure B-3

Calibration Contour Map: Base Case

Permeability k=7 Darcies

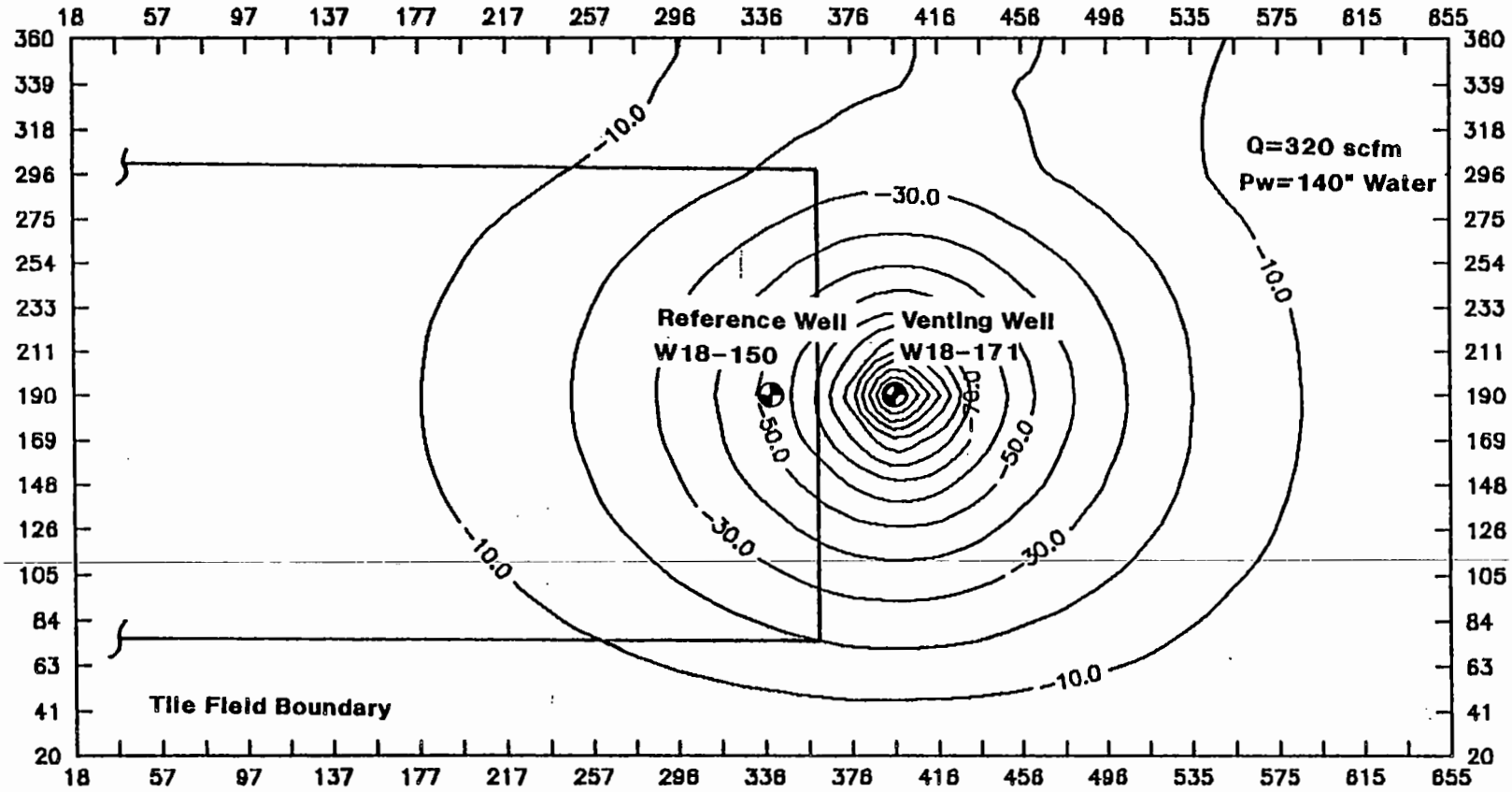

Figure B-4

Calibration Contour Map

Permeability k=70 Darcies

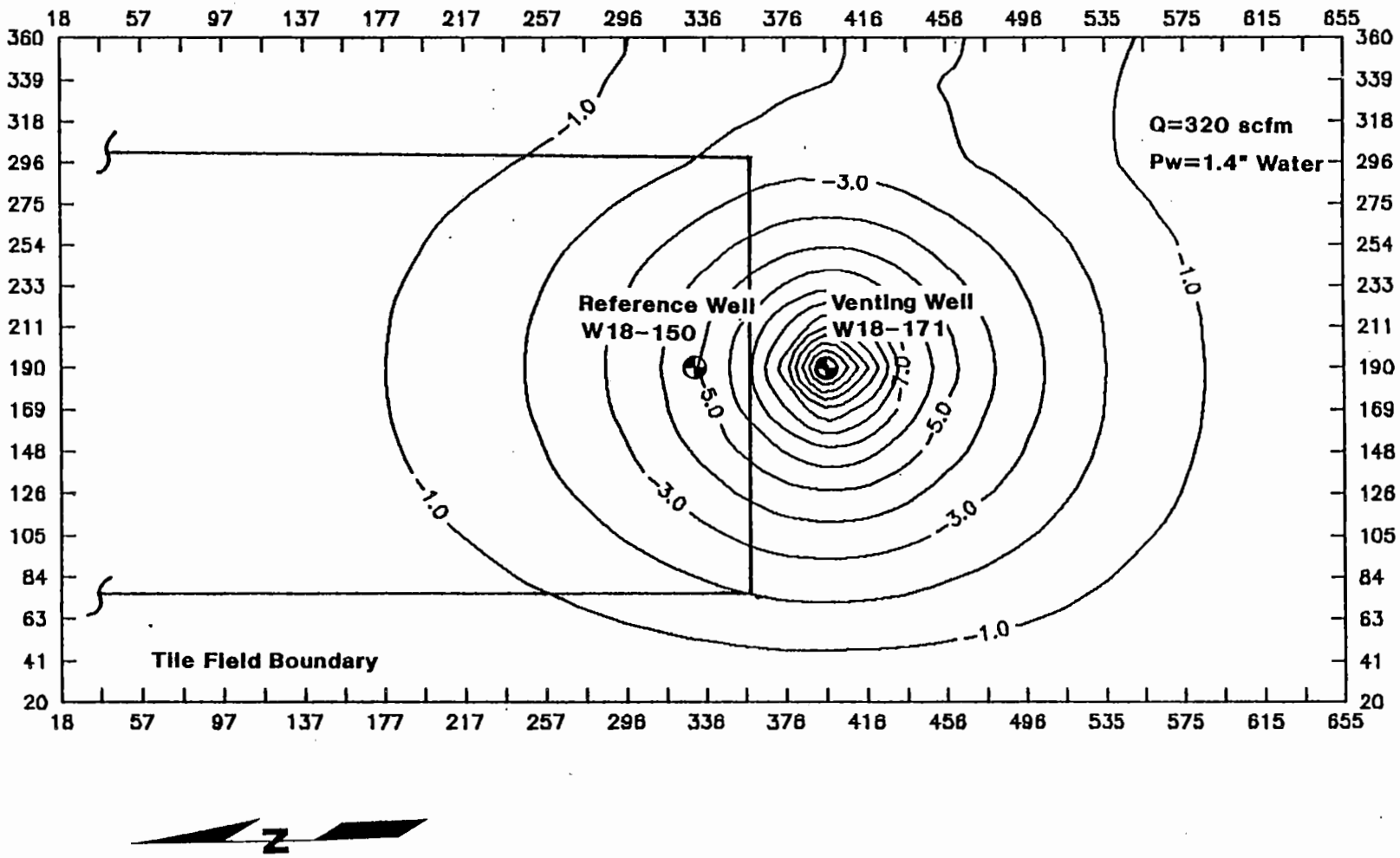

Figure B-5

Calibration Contour Map
Permeability k=700 Darcies

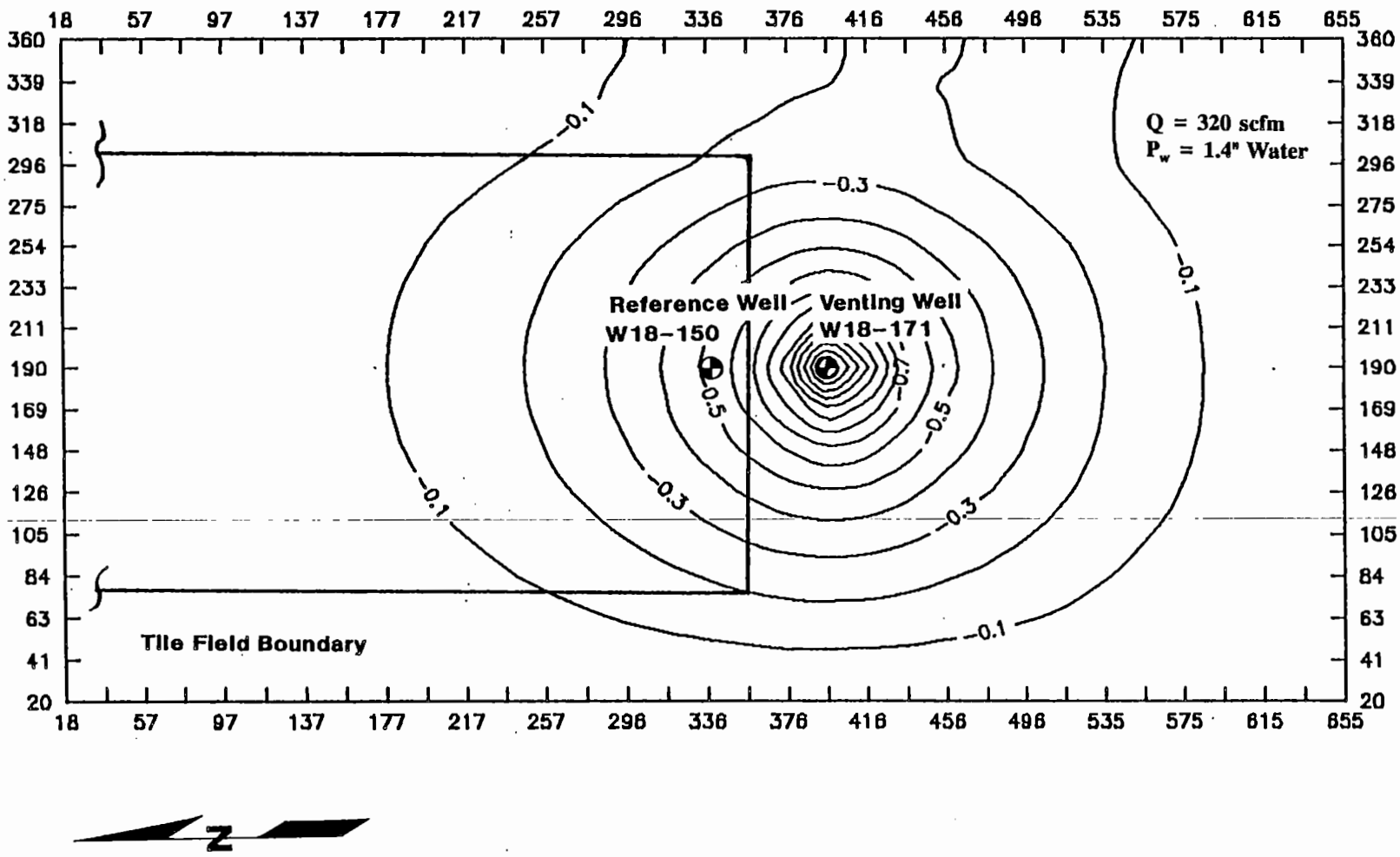

Figure B-6

Three Venting Well Scenario

0.2 in.w.g. at the Edge of the Tile Field

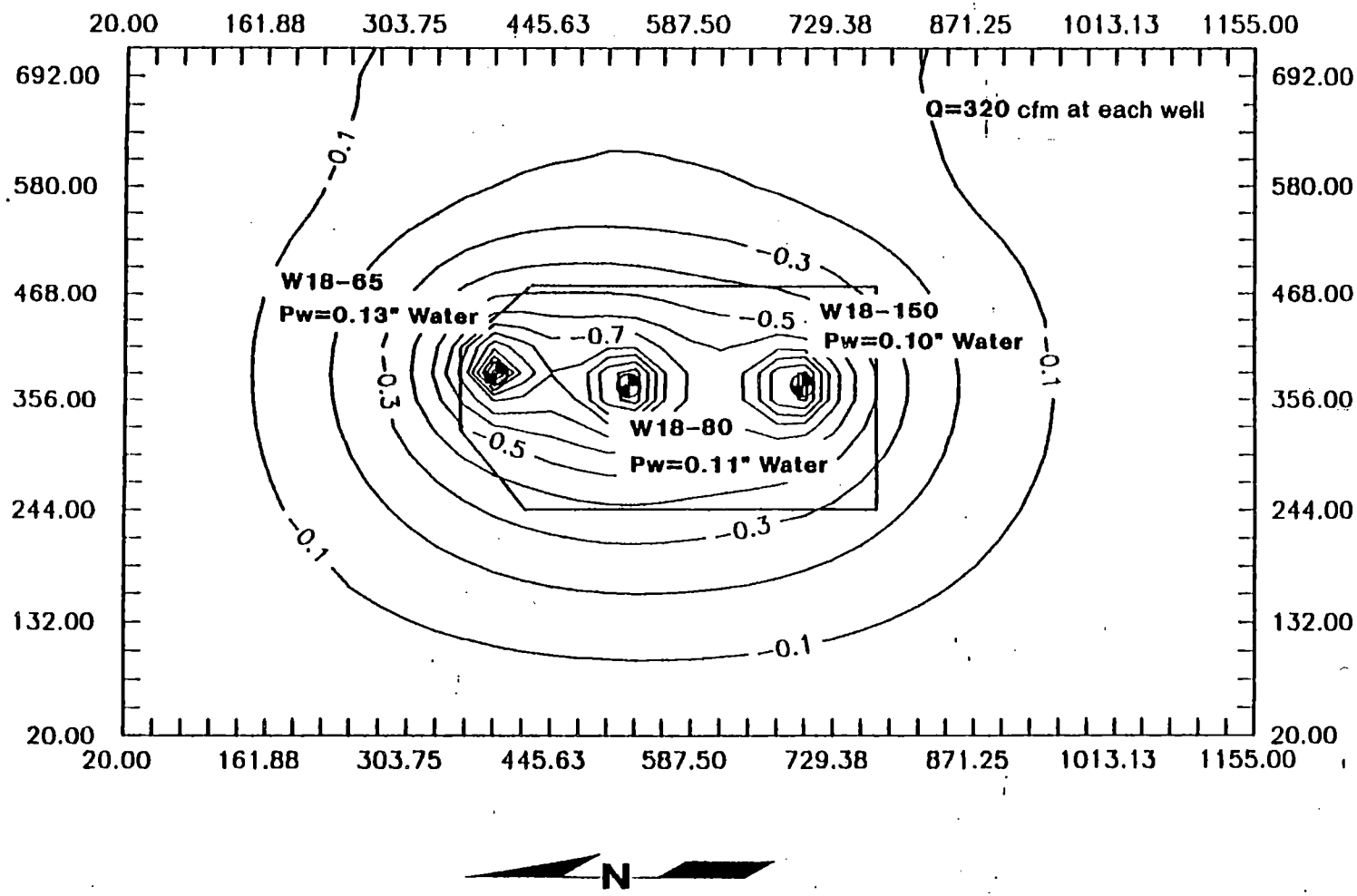

Figure B-7

Flow Vectors – Three Venting Wells

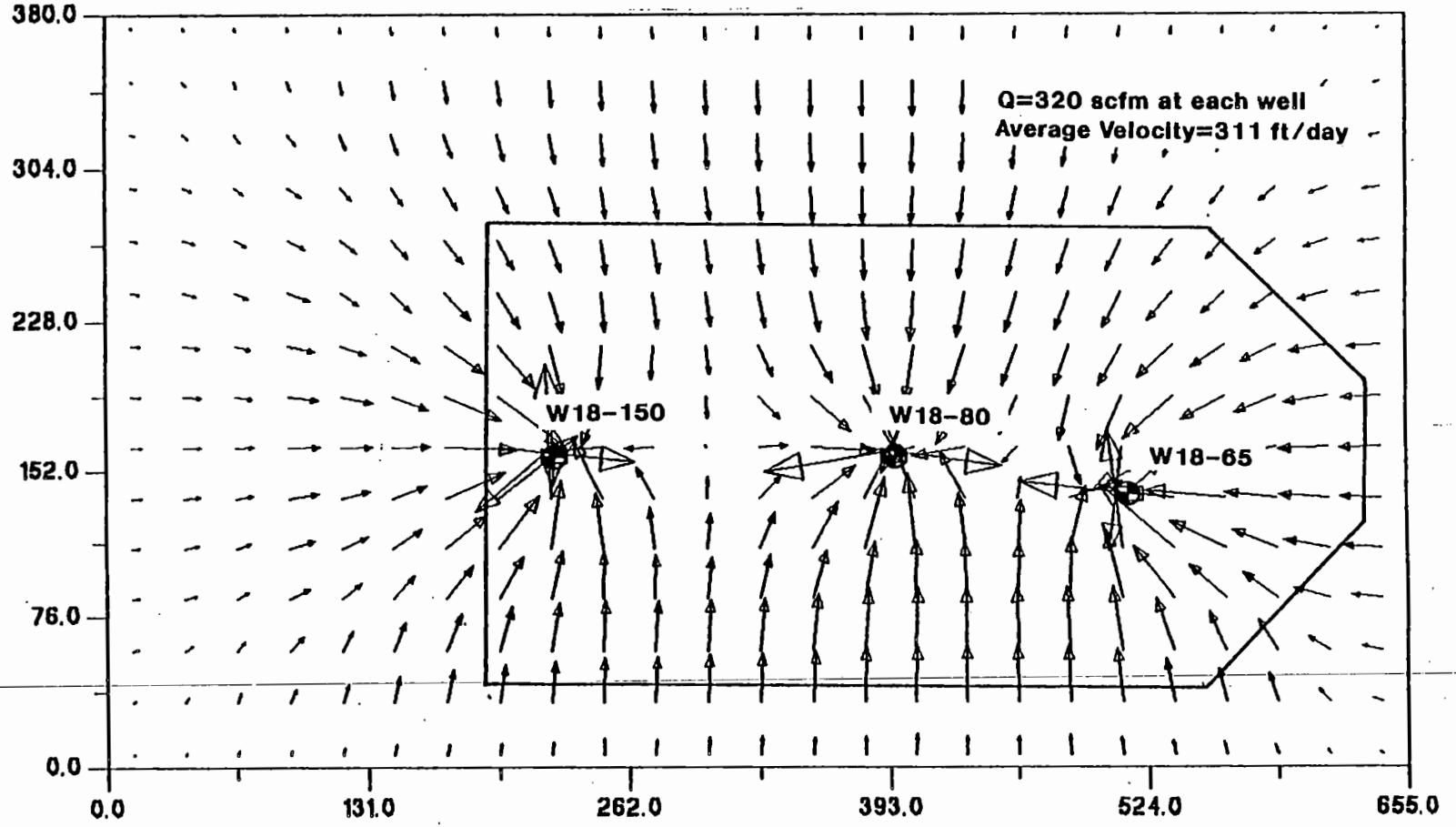

Figure B-

Three Venting Well Scenario

1.0 in.w.g. at the Edge of the Tile Field

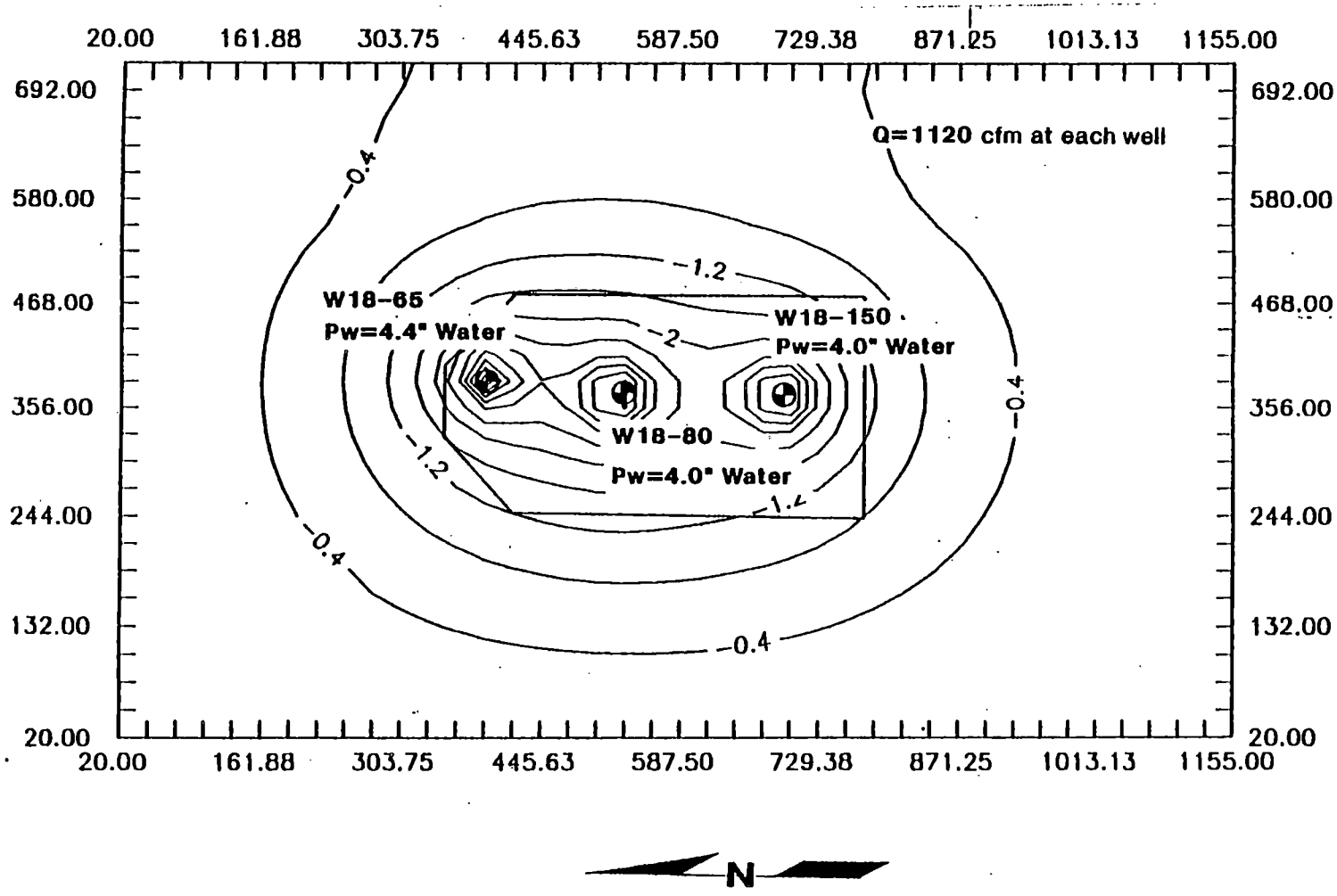

Figure B-9

One Venting Well Scenario

0.2 in.w.g. at the Edge of the Tile Field

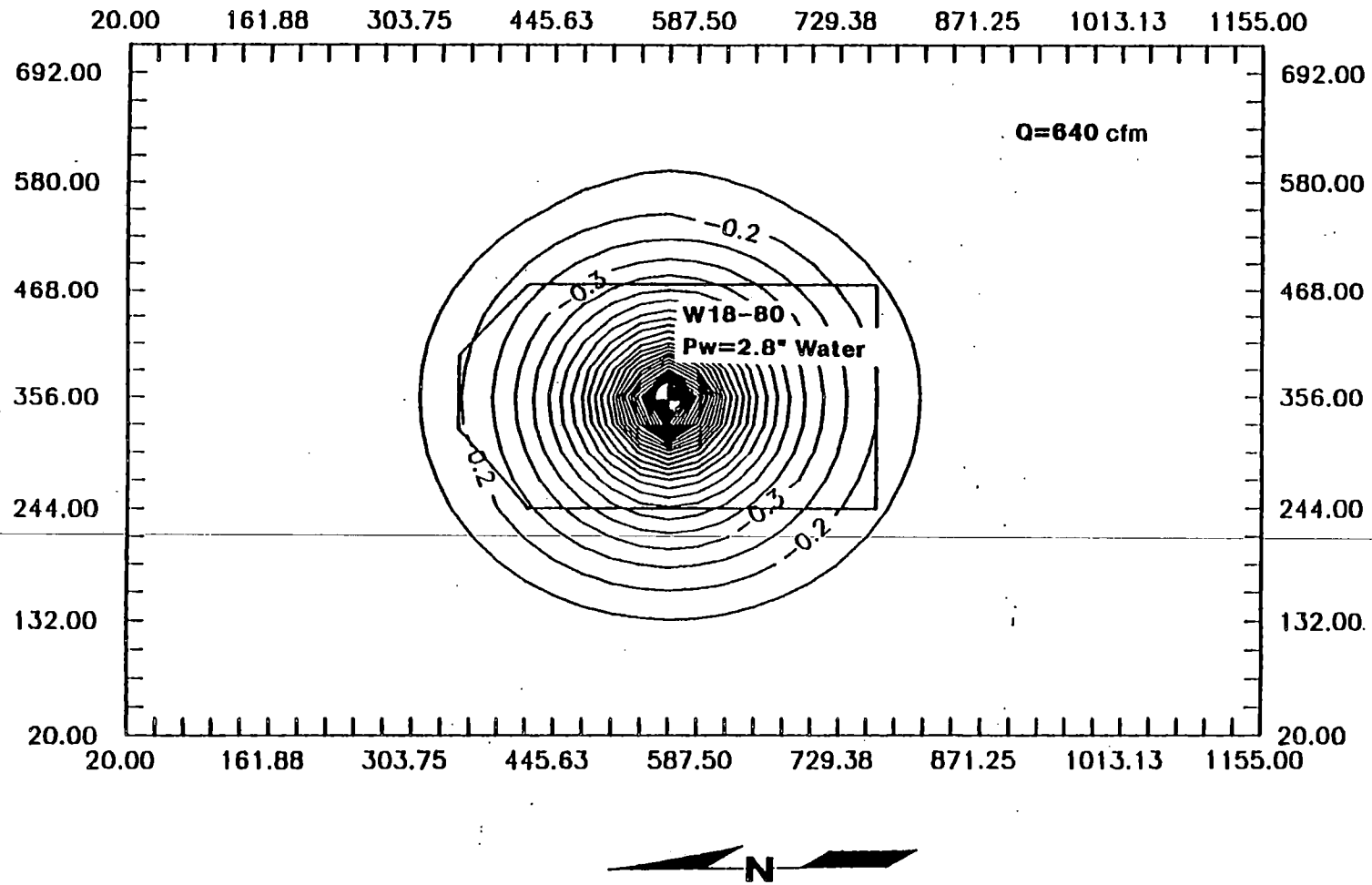

Figure B-1

APPENDIX F3

VOA DATA - 216-Z-1A TILE FIELD

9112210241

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Westinghouse Hanford Company

Internal Memo

From: Organic Chemistry 28210-91-042
Phone: 3-1213 T6-50
Date: June 12, 1991
Subject: VOLATILE ORGANIC ANALYSIS DATA - 216-Z1A TILE FIELD

To: K. N. Pool T6-20

cc: D. A. Dodd T6-50
M. C. Hagood H4-55
E. J. Kosiancic S0-61
C. J. Simiele T6-08
C. R. Stroup T6-07
SGM File/LB

The analytical data for the volatile organic analysis of the 216-Z1A tile field samples are given in the attached forms. EPA forms were used to report the data because WHC does not have the appropriate forms.

We have used EPA-defined qualifiers (see column Q in FORM I VOA). They are:

U - Indicates that the compound was analyzed for but not detected, the number given is the method detection limit.

J - Indicates an estimated concentration. If the detection limit is 10 PPB and a concentration of 3 PPB is calculated, the result is reported as 3J.

E - Indicates that the compound concentration found exceed the instrument calibration range.

B - Indicates that the compound was also detected in the blank.

As requested by the customer, we have also included the initial calibration data, continuing calibration data, and copies of our GC/MS shoot log.

Please contact me if you have any questions or need further information.

S. G. Metcalf,
Acting Manager

sp

Hanford Operations and Engineering Contractor for the US Department of Energy

9 1 1 2 2 1 0 4 2

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/20/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8970

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14E

Level: (low/med) LOW Date Received:

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.05	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

167/114/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8971

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14F

Level: (low/med) LOW Date Received:

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.08	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.10	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
87/33/P4/2-QA

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8972

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14G SJH 6/10/91

Level: (low/med) LOW Date Received:

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.15	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

FORM I VOA 3/90

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

87/33/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8973

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14H

Level: (low/med) LOW Date Received:

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.07	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.125	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
150/60/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8974

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14I

Level: (low/med) LOW Date Received: SJM 6/10/91

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.08	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.04	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BLANK/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8975

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14J

Level: (low/med) LOW Date Received: 6/10/91

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.075	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.025	U
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/57/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8985

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14K

Level: (low/med) LOW Date Received: SEM 6/10/91

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.002	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.55	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
~~108-10-1~~	~~4-Methyl-2-pentanone~~	~~0.004~~	~~J~~ SEM 6/10/91
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

150/85/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8986

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14M

Level: (low/med) LOW Date Received: 6/10/91

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.003	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.075	
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.65	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

9112210050

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
150/113/P4/2

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R8987

Sample wt/vol: 1.0 (g/mL) ML Lab File ID: >AD14N

Level: (low/med) LOW Date Received:

% Moisture: not dec. Date Analyzed: 4/14/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.002	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.60	
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

BLANK/P4/A/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9012

Sample wt/vol: 1 (g/mL) ML Lab File ID: >AD16D

Level: (low/med) LOW Date Received: 04/16/91

% Moisture: not dec. Date Analyzed: 4/16/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.025	U
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	0.025	U
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
167/P4/B/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9013

Sample wt/vol: 1 (g/mL) ML Lab File ID: >AD16E

Level: (low/med) LOW Date Received: 04/16/91 SEM 6/10/91

% Moisture: not dec. Date Analyzed: 4/16/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.004	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.04	J
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	1.2	E
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

167/P4/C/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9014

Sample wt/vol: 1 (g/mL) ML Lab File ID: >AD16F

Level: (low/med) LOW Date Received: 04/16/91

% Moisture: not dec. Date Analyzed: 4/16/91 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.005	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	1.6	E
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
167/P4/D/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9015

Sample wt/vol: 1 (g/mL) ML Lab File ID: >AD16G

Level: (low/med) LOW Date Received: 04/16/91

% Moisture: not dec. Date Analyzed: 4/16/91 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.005	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	1.5	E
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
167/P4/E/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9016

Sample wt/vol: 1 (g/mL) ML Lab File ID: >AD16H

Level: (low/med) LOW Date Received: 04/16/91

% Moisture: not dec. Date Analyzed: 4/16/91 6/12/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.05	U
74-83-9	Bromomethane	0.05	U
75-01-4	Vinyl Chloride	0.05	U
75-00-3	Chloroethane	0.05	U
75-09-2	Methylene Chloride	0.025	U
67-64-1	Acetone	0.05	U
75-15-0	Carbon Disulfide	0.025	U
75-35-4	1,1-Dichloroethene	0.025	U
75-34-3	1,1-Dichloroethane	0.025	U
540-59-0	1,2-Dichloroethene (total)	0.025	U
67-66-3	Chloroform	0.005	J
107-02-2	1,2-Dichloroethane	0.025	U
78-93-3	2-Butanone	0.05	U
71-55-6	1,1,1-Trichloroethane	0.025	U
56-23-5	Carbon Tetrachloride	1.7	E
108-05-4	Vinyl Acetate	0.05	U
75-27-4	Bromodichloromethane	0.025	U
78-87-5	1,2-Dichloropropane	0.025	U
10061-01-5	cis-1,3-Dichloropropene	0.025	U
79-01-6	Trichloroethene	0.025	U
124-48-1	Dibromochloromethane	0.025	U
79-00-5	1,1,2-Trichloroethane	0.025	U
71-43-2	Benzene	0.025	U
10061-02-6	trans-1,3-Dichloropropene	0.025	U
75-25-2	Bromoform	0.025	U
108-10-1	4-Methyl-2-pentanone	0.05	U
591-78-6	2-Hexanone	0.05	U
127-18-4	Tetrachloroethene	0.025	U
79-34-5	1,1,2,2-Tetrachloroethane	0.025	U
108-88-3	Toluene	0.025	U
108-90-7	Chlorobenzene	0.025	U
100-41-4	Ethylbenzene	0.025	U
100-42-5	Styrene	0.025	U
133-02-7	Xylene (total)	0.025	U

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/H/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9032

Sample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17D

Level: (low/med) LOW Date Received: 04/17/91

% Moisture: not dec. Date Analyzed: 4/17/91 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.004	J
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.19	
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	2.8	E
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/K/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9033

Sample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17E

Level: (low/med) LOW Date Received: 04/17/91

% Moisture: not dec. Date Analyzed: 4/17/91 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.008	J
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.12	
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	3.5	E
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/G/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9025

Sample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17F

Level: (low/med) LOW Date Received: 04/17/91

% Moisture: not dec. Date Analyzed: 4/17/91 Lefm 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.05	U
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.10	U
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	1.3	
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I-VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/J/G

ab me: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9027

ample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17G

evel: (low/med) LOW Date Received: 04/17/91 Lfm 6/10/91

Moisture: not dec. Date Analyzed: 4/17/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.004	J
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.12	
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	2.6	E
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
167/P4/F/G-Q

ab Name: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9024

ample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17H

evel: (low/med) LOW Date Received: 04/17/91

Moisture: not dec. Date Analyzed: 4/17/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.05	U
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.07	J
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	1.2	
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
167/P4/F/G

ab[illegible]me: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9031

ample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD17I

evel: (low/med) LOW Date Received: 04/17/91

Moisture: not dec. Date Analyzed: 4/17/91 LSM 6/10/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.05	U
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.12	
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	0.89	
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/P/G

ab Name: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9041

ample wt/vol: 0.5 (g/mL) ML Lab File ID: >AD18G

evel: (low/med) LOW Date Received: 04/18/91

Moisture: not dec. Date Analyzed: 4/18/91 6/10/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.10	U
74-83-9	Bromomethane	0.10	U
75-01-4	Vinyl Chloride	0.10	U
75-00-3	Chloroethane	0.10	U
75-09-2	Methylene Chloride	0.05	U
67-64-1	Acetone	0.10	U
75-15-0	Carbon Disulfide	0.05	U
75-35-4	1,1-Dichloroethene	0.05	U
75-34-3	1,1-Dichloroethane	0.05	U
540-59-0	1,2-Dichloroethene (total)	0.05	U
67-66-3	Chloroform	0.006	J
107-02-2	1,2-Dichloroethane	0.05	U
78-93-3	2-Butanone	0.10	U
71-55-6	1,1,1-Trichloroethane	0.05	U
56-23-5	Carbon Tetrachloride	3.2	E
108-05-4	Vinyl Acetate	0.10	U
75-27-4	Bromodichloromethane	0.05	U
78-87-5	1,2-Dichloropropane	0.05	U
10061-01-5	cis-1,3-Dichloropropene	0.05	U
79-01-6	Trichloroethene	0.05	U
124-48-1	Dibromochloromethane	0.05	U
79-00-5	1,1,2-Trichloroethane	0.05	U
71-43-2	Benzene	0.05	U
10061-02-6	trans-1,3-Dichloropropene	0.05	U
75-25-2	Bromoform	0.05	U
108-10-1	4-Methyl-2-pentanone	0.10	U
591-78-6	2-Hexanone	0.10	U
127-18-4	Tetrachloroethene	0.05	U
79-34-5	1,1,2,2-Tetrachloroethane	0.05	U
108-88-3	Toluene	0.05	U
108-90-7	Chlorobenzene	0.05	U
100-41-4	Ethylbenzene	0.05	U
100-42-5	Styrene	0.05	U
133-02-7	Xylene (total)	0.05	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/N/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9040

Sample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD18H

Level: (low/med) LOW Date Received: 04/18/91

% Moisture: not dec. Date Analyzed: 4/18/91 6/10/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.20	U
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	3.8	
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/M/G

ab Name: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9039

ample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD18I

evel: (low/med) LOW Date Received: 04/18/91

Moisture: not dec. Date Analyzed: 4/18/91 6/11/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.20	U
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	4.7	E
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/P/G QA

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9042

Sample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD18J

Level: (low/med) LOW Date Received: 04/18/91 6/10/91

% Moisture: not dec. Date Analyzed: 4/18/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.20	U
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	4.7	E
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/L/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9038

Sample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD18K

Level: (low/med) LOW Date Received: 04/18/91 6/11/91

% Moisture: not dec. Date Analyzed: 4/18/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.26	
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	3.2	
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

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1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/Q/G

ab Name: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9058

ample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD19D

evel: (low/med) LOW Date Received: 04/19/91

Moisture: not dec. Date Analyzed: 4/19/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.20	U
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	3.9	
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

ab Name: WHC PAL Contract: DOE/RL-91-32 Draft B | 171/P4/R/G

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9059

ample wt/vol: 0.25 (g/mL) ML Lab File ID: >AD19E

evel: (low/med) LOW Date Received: 04/19/91 6/11/91

Moisture: not dec. Date Analyzed: 4/19/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.20	U
74-83-9	Bromomethane	0.20	U
75-01-4	Vinyl Chloride	0.20	U
75-00-3	Chloroethane	0.20	U
75-09-2	Methylene Chloride	0.10	U
67-64-1	Acetone	0.20	U
75-15-0	Carbon Disulfide	0.10	U
75-35-4	1,1-Dichloroethene	0.10	U
75-34-3	1,1-Dichloroethane	0.10	U
540-59-0	1,2-Dichloroethene (total)	0.10	U
67-66-3	Chloroform	0.10	U
107-02-2	1,2-Dichloroethane	0.10	U
78-93-3	2-Butanone	0.20	U
71-55-6	1,1,1-Trichloroethane	0.10	U
56-23-5	Carbon Tetrachloride	3.3	
108-05-4	Vinyl Acetate	0.20	U
75-27-4	Bromodichloromethane	0.10	U
78-87-5	1,2-Dichloropropane	0.10	U
10061-01-5	cis-1,3-Dichloropropene	0.10	U
79-01-6	Trichloroethene	0.10	U
124-48-1	Dibromochloromethane	0.10	U
79-00-5	1,1,2-Trichloroethane	0.10	U
71-43-2	Benzene	0.10	U
10061-02-6	trans-1,3-Dichloropropene	0.10	U
75-25-2	Bromoform	0.10	U
108-10-1	4-Methyl-2-pentanone	0.20	U
591-78-6	2-Hexanone	0.20	U
127-18-4	Tetrachloroethene	0.10	U
79-34-5	1,1,2,2-Tetrachloroethane	0.10	U
108-88-3	Toluene	0.10	U
108-90-7	Chlorobenzene	0.10	U
100-41-4	Ethylbenzene	0.10	U
100-42-5	Styrene	0.10	U
133-02-7	Xylene (total)	0.10	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/S/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9060

Sample wt/vol: 0.15 (g/mL) ML Lab File ID: >AD19F

Level: (low/med) LOW Date Received: 04/19/91

% Moisture: not dec. Date Analyzed: 4/19/91 SHM 6/11/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.33	U
74-83-9	Bromomethane	0.33	U
75-01-4	Vinyl Chloride	0.33	U
75-00-3	Chloroethane	0.33	U
75-09-2	Methylene Chloride	0.17	U
67-64-1	Acetone	0.33	U
75-15-0	Carbon Disulfide	0.17	U
75-35-4	1,1-Dichloroethene	0.17	U
75-34-3	1,1-Dichloroethane	0.17	U
540-59-0	1,2-Dichloroethene (total)	0.17	U
67-66-3	Chloroform	0.17	U
107-02-2	1,2-Dichloroethane	0.17	U
78-93-3	2-Butanone	0.46	
71-55-6	1,1,1-Trichloroethane	0.17	U
56-23-5	Carbon Tetrachloride	4.3	
108-05-4	Vinyl Acetate	0.33	U
75-27-4	Bromodichloromethane	0.17	U
78-87-5	1,2-Dichloropropane	0.17	U
10061-01-5	cis-1,3-Dichloropropene	0.17	U
79-01-6	Trichloroethene	0.17	U
124-48-1	Dibromochloromethane	0.17	U
79-00-5	1,1,2-Trichloroethane	0.17	U
71-43-2	Benzene	0.17	U
10061-02-6	trans-1,3-Dichloropropene	0.17	U
75-25-2	Bromoform	0.17	U
108-10-1	4-Methyl-2-pentanone	0.33	U
591-78-6	2-Hexanone	0.33	U
127-18-4	Tetrachloroethene	0.17	U
79-34-5	1,1,2,2-Tetrachloroethane	0.17	U
108-88-3	Toluene	0.17	U
108-90-7	Chlorobenzene	0.17	U
100-41-4	Ethylbenzene	0.17	U
100-42-5	Styrene	0.17	U
133-02-7	Xylene (total)	0.17	U

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FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/T/G

ab Name: WHC PAL Contract:

ab Code: Case No.: SAS No.: SDG No.:

atrix: (soil/water) WATER Lab Sample ID: R9061

ample wt/vol: 0.15 (g/mL) ML Lab File ID: >AD19G JM 6/11/91

evel: (low/med) LOW Date Received: 04/19/91

Moisture: not dec. Date Analyzed: 4/19/91

C Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

oil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.33	U
74-83-9	Bromomethane	0.33	U
75-01-4	Vinyl Chloride	0.33	U
75-00-3	Chloroethane	0.33	U
75-09-2	Methylene Chloride	0.17	U
67-64-1	Acetone	0.33	U
75-15-0	Carbon Disulfide	0.17	U
75-35-4	1,1-Dichloroethene	0.17	U
75-34-3	1,1-Dichloroethane	0.17	U
540-59-0	1,2-Dichloroethene (total)	0.17	U
67-66-3	Chloroform	0.17	U
107-02-2	1,2-Dichloroethane	0.17	U
78-93-3	2-Butanone	0.43	
71-55-6	1,1,1-Trichloroethane	0.17	U
56-23-5	Carbon Tetrachloride	4.2	
108-05-4	Vinyl Acetate	0.33	U
75-27-4	Bromodichloromethane	0.17	U
78-87-5	1,2-Dichloropropane	0.17	U
10061-01-5	cis-1,3-Dichloropropene	0.17	U
79-01-6	Trichloroethene	0.17	U
124-48-1	Dibromochloromethane	0.17	U
79-00-5	1,1,2-Trichloroethane	0.17	U
71-43-2	Benzene	0.17	U
10061-02-6	trans-1,3-Dichloropropene	0.17	U
75-25-2	Bromoform	0.17	U
108-10-1	4-Methyl-2-pentanone	0.33	U
591-78-6	2-Hexanone	0.33	U
127-18-4	Tetrachloroethene	0.17	U
79-34-5	1,1,2,2-Tetrachloroethane	0.17	U
108-88-3	Toluene	0.17	U
108-90-7	Chlorobenzene	0.17	U
100-41-4	Ethylbenzene	0.17	U
100-42-5	Styrene	0.17	U
133-02-7	Xylene (total)	0.17	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/U/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9046

Sample wt/vol: 0.15 (g/mL) ML Lab File ID: >AD20F

Level: (low/med) LOW Date Received: 04/20/91 6/11/91

% Moisture: not dec. Date Analyzed: 4/20/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.33	U
74-83-9	Bromomethane	0.33	U
75-01-4	Vinyl Chloride	0.33	U
75-00-3	Chloroethane	0.33	U
75-09-2	Methylene Chloride	0.17	U
67-64-1	Acetone	0.33	U
75-15-0	Carbon Disulfide	0.17	U
75-35-4	1,1-Dichloroethene	0.17	U
75-34-3	1,1-Dichloroethane	0.17	U
540-59-0	1,2-Dichloroethene (total)	0.17	U
67-66-3	Chloroform	0.17	U
107-02-2	1,2-Dichloroethane	0.17	U
78-93-3	2-Butanone	0.40	
71-55-6	1,1,1-Trichloroethane	0.17	U
56-23-5	Carbon Tetrachloride	6.1	
108-05-4	Vinyl Acetate	0.33	U
75-27-4	Bromodichloromethane	0.17	U
78-87-5	1,2-Dichloropropane	0.17	U
10061-01-5	cis-1,3-Dichloropropene	0.17	U
79-01-6	Trichloroethene	0.17	U
124-48-1	Dibromochloromethane	0.17	U
79-00-5	1,1,2-Trichloroethane	0.17	U
71-43-2	Benzene	0.17	U
10061-02-6	trans-1,3-Dichloropropene	0.17	U
75-25-2	Bromoform	0.17	U
108-10-1	4-Methyl-2-pentanone	0.33	U
591-78-6	2-Hexanone	0.33	U
127-18-4	Tetrachloroethene	0.17	U
79-34-5	1,1,2,2-Tetrachloroethane	0.17	U
108-88-3	Toluene	0.17	U
108-90-7	Chlorobenzene	0.17	U
100-41-4	Ethylbenzene	0.17	U
100-42-5	Styrene	0.17	U
133-02-7	Xylene (total)	0.17	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

171/P4/V/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9047

Sample wt/vol: 0.15 (g/mL) ML Lab File ID: >AD20G 6/11/91

Level: (low/med) LOW Date Received: 04/20/91

% Moisture: not dec. Date Analyzed: 4/20/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.33	U
74-83-9	Bromomethane	0.33	U
75-01-4	Vinyl Chloride	0.33	U
75-00-3	Chloroethane	0.33	U
75-09-2	Methylene Chloride	0.17	U
67-64-1	Acetone	0.33	U
75-15-0	Carbon Disulfide	0.17	U
75-35-4	1,1-Dichloroethene	0.17	U
75-34-3	1,1-Dichloroethane	0.17	U
540-59-0	1,2-Dichloroethene (total)	0.17	U
67-66-3	Chloroform	0.17	U
107-02-2	1,2-Dichloroethane	0.17	U
78-93-3	2-Butanone	0.33	U
71-55-6	1,1,1-Trichloroethane	0.17	U
56-23-5	Carbon Tetrachloride	4.9	
108-05-4	Vinyl Acetate	0.33	U
75-27-4	Bromodichloromethane	0.17	U
78-87-5	1,2-Dichloropropane	0.17	U
10061-01-5	cis-1,3-Dichloropropene	0.17	U
79-01-6	Trichloroethene	0.17	U
124-48-1	Dibromochloromethane	0.17	U
79-00-5	1,1,2-Trichloroethane	0.17	U
71-43-2	Benzene	0.17	U
10061-02-6	trans-1,3-Dichloropropene	0.17	U
75-25-2	Bromoform	0.17	U
108-10-1	4-Methyl-2-pentanone	0.33	U
591-78-6	2-Hexanone	0.33	U
127-18-4	Tetrachloroethene	0.17	U
79-34-5	1,1,2,2-Tetrachloroethane	0.17	U
108-88-3	Toluene	0.17	U
108-90-7	Chlorobenzene	0.17	U
100-41-4	Ethylbenzene	0.17	U
100-42-5	Styrene	0.17	U
133-02-7	Xylene (total)	0.17	U

FORM I VOA 3/90

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
171/P4/W/G

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Matrix: (soil/water) WATER Lab Sample ID: R9048

Sample wt/vol: 0.15 (g/mL) ML Lab File ID: >AD20H DJM 6/4/91

Level: (low/med) LOW Date Received: 04/20/91

% Moisture: not dec. Date Analyzed: 4/20/91

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00000

Soil Extract Volume: (uL) Soil Aliquot Volume: (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/ML AIR	Q
74-87-3	Chloromethane	0.33	U
74-83-9	Bromomethane	0.33	U
75-01-4	Vinyl Chloride	0.33	U
75-00-3	Chloroethane	0.33	U
75-09-2	Methylene Chloride	0.17	U
67-64-1	Acetone	0.33	U
75-15-0	Carbon Disulfide	0.17	U
75-35-4	1,1-Dichloroethene	0.17	U
75-34-3	1,1-Dichloroethane	0.17	U
540-59-0	1,2-Dichloroethene (total)	0.17	U
67-66-3	Chloroform	0.17	U
107-02-2	1,2-Dichloroethane	0.17	U
78-93-3	2-Butanone	0.33	U
71-55-6	1,1,1-Trichloroethane	0.17	U
56-23-5	Carbon Tetrachloride	3.9	
108-05-4	Vinyl Acetate	0.33	U
75-27-4	Bromodichloromethane	0.17	U
78-87-5	1,2-Dichloropropane	0.17	U
10061-01-5	cis-1,3-Dichloropropene	0.17	U
79-01-6	Trichloroethene	0.17	U
124-48-1	Dibromochloromethane	0.17	U
79-00-5	1,1,2-Trichloroethane	0.17	U
71-43-2	Benzene	0.17	U
10061-02-6	trans-1,3-Dichloropropene	0.17	U
75-25-2	Bromoform	0.17	U
108-10-1	4-Methyl-2-pentanone	0.33	U
591-78-6	2-Hexanone	0.33	U
127-18-4	Tetrachloroethene	0.17	U
79-34-5	1,1,2,2-Tetrachloroethane	0.17	U
108-88-3	Toluene	0.17	U
108-90-7	Chlorobenzene	0.17	U
100-41-4	Ethylbenzene	0.17	U
100-42-5	Styrene	0.17	U
133-02-7	Xylene (total)	0.17	U

FORM I VOA 3/90

6A

VOLATILE ORGANICS INITIAL CALIBRATION DATA

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date(s):04/13/91

Heated Purge: (Y/N) N Calibration Times: 1911 2151 6/11/91

GC Column: DB-624 ID: 0.53 (mm)

LAB FILE ID: RRF10 =>AD13G RRF20 =>AD13H
RRF50 =>AD13F RRF100=>AD13I RRF200=>AD13J

COMPOUND		RRF10	RRF20	RRF50	RRF100	RRF200	$\overline{RRF}$	% RSD
Chloromethane		.751	.743	.691	.692	.780	.731	5.3
Bromomethane	*	1.293	1.289	1.209	1.223	1.301	1.263	3.4*
Vinyl Chloride	*	.941	.978	.882	.911	1.015	.945	5.6*
Chloroethane		.620	.619	.590	.581	.628	.608	3.4
Methylene Chloride		1.220	1.191	1.105	1.166	1.196	1.176	3.7
Acetone		.248	.231	.248	.219	.461	.281	35.9
Carbon Disulfide		3.172	3.097	2.934	3.056	3.355	3.123	5.0
1,1-Dichloroethene	*	1.059	1.078	.982	1.020	1.091	1.046	4.3*
1,1-Dichloroethane	*	2.334	2.318	2.184	2.289	2.351	2.295	2.9*
1,2-Dichloroethene (total)		2.582	2.564	2.413	2.514	2.579	2.531	2.8
Chloroform	*	2.993	2.920	2.810	2.848	2.898	2.894	2.4*
1,2-Dichloroethane	*	1.922	1.915	1.850	1.877	1.925	1.898	1.7*
2-Butanone		.852	.580	.484	.441	.627	.597	26.9
1,1,1-Trichloroethane	*	.637	.628	.625	.611	.621	.624	1.5*
Carbon Tetrachloride	*	.587	.608	.601	.594	.615	.601	1.8*
Bromodichloromethane	*	.805	.817	.817	.797	.797	.807	1.2*
1,2-Dichloropropane		.397	.400	.379	.393	.404	.395	2.5
cis-1,3-Dichloropropene	*	.594	.630	.614	.609	.631	.616	2.5*
Trichloroethene	*	.419	.444	.421	.430	.437	.430	2.4*
Dibromochloromethane	*	.723	.749	.757	.743	.751	.745	1.8*
1,1,2-Trichloroethane	*	.369	.369	.350	.364	.372	.365	2.4*
Benzene	*	.842	.857	.821	.831	.850	.840	1.7*
trans-1,3-Dichloropropene	*	.504	.511	.519	.516	.525	.515	1.5*
Bromoform	*	.555	.581	.582	.604	.618	.588	4.1*
4-Methyl-2-pentanone		.294	.314	.336	.354	.378	.335	9.8
2-Hexanone		.195	.182	.211	.214	.262	.213	14.2
Tetrachloroethene	*	.513	.543	.498	.534	.529	.523	3.4*
1,1,2,2-Tetrachloroethane	*	.709	.722	.694	.724	.730	.716	2.0*
Toluene	*	1.229	1.242	1.165	1.238	1.246	1.224	2.7*
Chlorobenzene	*	1.004	1.035	.962	1.010	1.015	1.005	2.6*
Ethylbenzene	*	.428	.446	.410	.434	.430	.430	3.0*
Styrene	*	.866	.891	.855	.889	.903	.881	2.2*
Xylene (total)	*	1.167	1.092	1.072	1.089	1.101	1.103	3.4*
Toluene-d8		1.232	1.223	1.207	1.242	1.172	1.215	2.3
Bromofluorobenzene	*	.858	.857	.832	.822	.789	.831	3.4*
1,2-Dichloroethane-d4		1.668	1.572	1.608	1.595	1.550	1.599	2.8

* Compounds with required minimum RRF and maximum %RSD values.
All other compounds must meet a minimum RRF of 0.010.

FORM VI VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

SJM 6/11/91

Lab Name: WHC PAL Contract:

Lab Code: Case No.: 15680 SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/14/91 Time: 10:28

Lab File ID: >AD14C Init. Calib. Date(s): 02/01/91 02/02/91

Heated Purge: (Y/N) N Init. Calib. Times: 20:34 00:24

GC Column: DB-5 ID: 0.32 (mm)

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D
Chloromethane	.731	.635		13.2	
Bromomethane	1.263	1.216	0.100	3.7	25.0
Vinyl Chloride	.945	.848	0.100	10.3	25.0
Chloroethane	.608	.616		1.3	
Methylene Chloride	1.176	1.178		.2	
Acetone	.281	.232		17.8	
Carbon Disulfide	3.123	2.996		4.1	
1,1-Dichloroethene	1.046	1.040	0.100	.6	25.0
1,1-Dichloroethane	2.295	2.340	0.200	2.0	25.0
1,2-Dichloroethene (total)	0.000	0.000		0.0	
Chloroform	2.894	3.015	0.200	4.2	25.0
1,2-Dichloroethane	1.898	1.976	0.100	4.1	25.0
2-Butanone	.597	.471		21.0	
1,1,1-Trichloroethane	.624	.638	0.100	2.1	25.0
Carbon Tetrachloride	.601	.603	0.100	.3	25.0
Bromodichloromethane	.807	.805	0.200	.3	25.0
1,2-Dichloropropane	.395	.387		2.0	
cis-1,3-Dichloropropene	.616	.614	0.200	.3	25.0
Trichloroethene	.430	.438	0.300	1.9	25.0
Dibromochloromethane	.745	.737	0.100	1.1	25.0
1,1,2-Trichloroethane	.365	.341	0.100	6.4	25.0
Benzene	.840	.838	0.500	.3	25.0
trans-1,3-Dichloropropene	.515	.511	0.100	.7	25.0
Bromoform	.588	.542	0.100	7.8	25.0
4-Methyl-2-pentanone	.335	.318		5.1	
2-Hexanone	.213	.206		2.9	
Tetrachloroethene	.523	.511	0.200	2.4	25.0
1,1,2,2-Tetrachloroethane	.716	.690	0.500	3.7	25.0
Toluene	1.224	1.221	0.400	.2	25.0
Chlorobenzene	1.005	.980	0.500	2.5	25.0
Ethylbenzene	.430	.429	0.100	.1	25.0
Styrene	.881	.877	0.300	.5	25.0
Xylene (total)	0.000	0.000	0.300	0.0	25.0
Toluene-d8	1.215	1.197		1.5	
Bromofluorobenzene	.831	.821	0.200	1.2	25.0
1,2-Dichloroethane-d4	1.599	1.560		2.4	

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/16/91 Time: 12:12

Lab File ID: >AD16B Init. Calib. Date(s):04/13/91

Heated Purge: (Y/N) N Init. Calib. Times: 1911 2151

GC Column: DB-624 ID: 0.53 (mm)

[illegible] 6/11/91

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D
Chloromethane	.731	.404		44.8	
Bromomethane	1.263	1.013	0.100	19.8	25.0
Vinyl Chloride	.945	.608	0.100	35.7	25.0
Chloroethane	.608	.513		15.5	
Methylene Chloride	1.176	1.159		1.4	
Acetone	.281	.245		12.9	
Carbon Disulfide	3.123	2.621		16.1	
1,1-Dichloroethene	1.046	.983	0.100	6.0	25.0
1,1-Dichloroethane	2.295	2.308	0.200	.5	25.0
1,2-Dichloroethene (total)	0.000	0.000		0.0	
Chloroform	2.894	3.046	0.200	5.3	25.0
1,2-Dichloroethane	1.898	2.042	0.100	7.6	25.0
2-Butanone	.597	.477		20.1	
1,1,1-Trichloroethane	.624	.676	0.100	8.3	25.0
Carbon Tetrachloride	.601	.643	0.100	6.9	25.0
Bromodichloromethane	.807	.834	0.200	3.4	25.0
1,2-Dichloropropane	.395	.377		4.4	
cis-1,3-Dichloropropene	.616	.628	0.200	2.1	25.0
Trichloroethene	.430	.449	0.300	4.4	25.0
Dibromochloromethane	.745	.769	0.100	3.3	25.0
1,1,2-Trichloroethane	.365	.360	0.100	1.4	25.0
Benzene	.840	.848	0.500	.9	25.0
trans-1,3-Dichloropropene	.515	.530	0.100	3.0	25.0
Bromoform	.588	.572	0.100	2.7	25.0
4-Methyl-2-pentanone	.335	.324		3.3	
2-Hexanone	.213	.213		.2	
Tetrachloroethene	.523	.531	0.200	1.4	25.0
1,1,2,2-Tetrachloroethane	.716	.720	0.500	.5	25.0
Toluene	1.224	1.226	0.400	.1	25.0
Chlorobenzene	1.005	1.023	0.500	1.7	25.0
Ethylbenzene	.430	.438	0.100	2.0	25.0
Styrene	.881	.893	0.300	1.4	25.0
Xylene (total)	0.000	0.000	0.300	0.0	25.0
Toluene-d8	1.215	1.221		.5	
Bromofluorobenzene	.831	.864	0.200	3.9	25.0
1,2-Dichloroethane-d4	1.599	1.718		7.5	

exceeds max %D.

[illegible] 6/11/91

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/17/91 Time: 14:34

Lab File ID: >AD17B Init. Calib. Date(s):04/13/91

Heated Purge: (Y/N) N Init. Calib. Times: 1911 2151

GC Column: DB-624 ID: 0.53 (mm)

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D
Chloromethane	.731	.295		59.7	
Bromomethane	1.263	.881	0.100	30.2	25.0
Vinyl Chloride	.945	.450	0.100	52.5	25.0
Chloroethane	.608	.447		26.5	
Methylene Chloride	1.176	1.111		5.5	
Acetone	.281	.260		7.5	
Carbon Disulfide	3.123	2.286		26.8	
1,1-Dichloroethene	1.046	.869	0.100	16.9	25.0
1,1-Dichloroethane	2.295	2.200	0.200	4.1	25.0
1,2-Dichloroethene (total)	0.000	0.000		0.0	
Chloroform	2.894	3.006	0.200	3.9	25.0
1,2-Dichloroethane	1.898	2.116	0.100	11.5	25.0
2-Butanone	.597	.535		10.4	
1,1,1-Trichloroethane	.624	.707	0.100	13.3	25.0
Carbon Tetrachloride	.601	.659	0.100	9.6	25.0
Bromodichloromethane	.807	.913	0.200	13.2	25.0
1,2-Dichloropropane	.395	.414		4.8	
cis-1,3-Dichloropropene	.616	.673	0.200	9.3	25.0
Trichloroethene	.430	.480	0.300	11.7	25.0
Dibromochloromethane	.745	.849	0.100	14.1	25.0
1,1,2-Trichloroethane	.365	.415	0.100	13.7	25.0
Benzene	.840	.895	0.500	6.5	25.0
trans-1,3-Dichloropropene	.515	.584	0.100	13.4	25.0
Bromoform	.588	.684	0.100	16.3	25.0
4-Methyl-2-pentanone	.335	.397		18.3	
2-Hexanone	.213	.254		19.6	
Tetrachloroethene	.523	.547	0.200	4.5	25.0
1,1,2,2-Tetrachloroethane	.716	.830	0.500	16.0	25.0
Toluene	1.224	1.276	0.400	4.3	25.0
Chlorobenzene	1.005	1.083	0.500	7.7	25.0
Ethylbenzene	.430	.451	0.100	5.0	25.0
Styrene	.881	.952	0.300	8.1	25.0
Xylene (total)	0.000	0.000	0.300	0.0	25.0
Toluene-d8	1.215	1.264		4.0	
Bromofluorobenzene	.831	.898	0.200	8.0	25.0
1,2-Dichloroethane-d4	1.599	1.764		10.4	

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/18/91 Time: 18:09

Lab File ID: >AD18E Init. Calib. Date(s):04/13/91

Heated Purge: (Y/N) N Init. Calib. Times: 1911 2151

GC Column: DB-624 ID: 0.53 (mm)

DJM 6/11/91

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D
Chloromethane	.731	.416		43.2	
Bromomethane	1.263	1.041	0.100	17.6	25.0
Vinyl Chloride	.945	.644	0.100	31.9	25.0
Chloroethane	.608	.522		14.2	
Methylene Chloride	1.176	1.214		3.3	
Acetone	.281	.247		12.2	
Carbon Disulfide	3.123	2.982		4.5	
1,1-Dichloroethene	1.046	1.040	0.100	.6	25.0
1,1-Dichloroethane	2.295	2.479	0.200	8.0	25.0
1,2-Dichloroethene (total)	0.000	0.000		0.0	
Chloroform	2.894	3.261	0.200	12.7	25.0
1,2-Dichloroethane	1.898	2.289	0.100	20.6	25.0
2-Butanone	.597	.484		18.9	
1,1,1-Trichloroethane	.624	.696	0.100	11.5	25.0
Carbon Tetrachloride	.601	.641	0.100	6.7	25.0
Bromodichloromethane	.807	.883	0.200	9.5	25.0
1,2-Dichloropropane	.395	.397		.7	
cis-1,3-Dichloropropene	.616	.646	0.200	4.9	25.0
Trichloroethene	.430	.459	0.300	6.7	25.0
Dibromochloromethane	.745	.776	0.100	4.2	25.0
1,1,2-Trichloroethane	.365	.373	0.100	2.2	25.0
Benzene	.840	.839	0.500	.2	25.0
trans-1,3-Dichloropropene	.515	.553	0.100	7.4	25.0
Bromoform	.588	.592	0.100	.7	25.0
4-Methyl-2-pentanone	.335	.351		4.7	
2-Hexanone	.213	.219		3.0	
Tetrachloroethene	.523	.537	0.200	2.6	25.0
1,1,2,2-Tetrachloroethane	.716	.752	0.500	5.1	25.0
Toluene	1.224	1.269	0.400	3.7	25.0
Chlorobenzene	1.005	1.002	0.500	.3	25.0
Ethylbenzene	.430	.436	0.100	1.4	25.0
Styrene	.881	.903	0.300	2.5	25.0
Xylene (total)	0.000	0.000	0.300	0.0	25.0
Toluene-d8	1.215	1.214		.1	
Bromofluorobenzene	.831	.845	0.200	1.7	25.0
1,2-Dichloroethane-d4	1.599	1.809		13.2	

exceeds max %D.

DJM 6/11/91

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

Lab Name: WHC PAL Contract: SJM 6/11/91

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/19/91 Time: 14:31

Lab File ID: >AD19B Init. Calib. Date(s):

Heated Purge: (Y/N) Init. Calib. Times:

GC Column: ID: (mm)

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D	
Chloromethane	.731	.317		56.7		
Bromomethane	1.263	.937	0.100	25.8	25.0	exceed max %D
Vinyl Chloride	.945	.541	0.100	42.7	25.0	
Chloroethane	.608	.481		20.8		SJM 6/11/91
Methylene Chloride	1.176	1.086		7.6		
Acetone	.281	.241		14.4		
Carbon Disulfide	3.123	2.694		13.7		
1,1-Dichloroethene	1.046	1.006	0.100	3.8	25.0	
1,1-Dichloroethane	2.295	2.364	0.200	3.0	25.0	
1,2-Dichloroethene (total)	0.000	0.000		0.0		
Chloroform	2.894	3.048	0.200	5.3	25.0	
1,2-Dichloroethane	1.898	2.210	0.100	16.4	25.0	
2-Butanone	.597	.474		20.6		
1,1,1-Trichloroethane	.624	.730	0.100	17.0	25.0	
Carbon Tetrachloride	.601	.693	0.100	15.3	25.0	
Bromodichloromethane	.807	.839	0.200	4.0	25.0	
1,2-Dichloropropane	.395	.372		5.9		
cis-1,3-Dichloropropene	.616	.629	0.200	2.2	25.0	
Trichloroethene	.430	.461	0.300	7.1	25.0	
Dibromochloromethane	.745	.803	0.100	7.8	25.0	
1,1,2-Trichloroethane	.365	.358	0.100	2.0	25.0	
Benzene	.840	.822	0.500	2.2	25.0	
trans-1,3-Dichloropropene	.515	.538	0.100	4.4	25.0	
Bromoform	.588	.595	0.100	1.3	25.0	
4-Methyl-2-pentanone	.335	.339		1.0		
2-Hexanone	.213	.215		1.3		
Tetrachloroethene	.523	.574	0.200	9.7	25.0	
1,1,2,2-Tetrachloroethane	.716	.695	0.500	3.0	25.0	
Toluene	1.224	1.220	0.400	.3	25.0	
Chlorobenzene	1.005	1.013	0.500	.7	25.0	
Ethylbenzene	.430	.442	0.100	2.8	25.0	
Styrene	.881	.899	0.300	2.1	25.0	
Xylene (total)	0.000	0.000	0.300	0.0	25.0	
Toluene-d8	1.215	1.218		.2		
Bromofluorobenzene	.831	.901	0.200	8.4	25.0	
1,2-Dichloroethane-d4	1.599	1.854		16.0		

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

7A

VOLATILE CONTINUING CALIBRATION CHECK

Lab Name: WHC PAL Contract:

Lab Code: Case No.: SAS No.: SDG No.:

Instrument ID: 70 1 Calibration Date: 4/20/91 Time: 11:13

Lab File ID: >AD20B Init. Calib. Date(s):04/13/91 SLM 6/11/91

Heated Purge: (Y/N) N Init. Calib. Times: 1911 2151

GC Column: DB-624 ID: 0.53 (mm)

COMPOUND	$\overline{RRF}$	RRF50	MIN RRF	%D	MAX %D
Chloromethane	.731	.685		6.3	
Bromomethane	1.263	1.181	0.100	6.4	25.0
Vinyl Chloride	.945	.817	0.100	13.5	25.0
Chloroethane	.608	.580		4.6	
Methylene Chloride	1.176	1.116		5.1	
Acetone	.281	.335		19.1	
Carbon Disulfide	3.123	2.635		15.6	
1,1-Dichloroethene	1.046	.938	0.100	10.3	25.0
1,1-Dichloroethane	2.295	2.224	0.200	3.1	25.0
1,2-Dichloroethene (total)	0.000	0.000		0.0	
Chloroform	2.894	2.996	0.200	3.5	25.0
1,2-Dichloroethane	1.898	2.139	0.100	12.7	25.0
2-Butanone	.597	.530		11.2	
1,1,1-Trichloroethane	.624	.680	0.100	8.9	25.0
Carbon Tetrachloride	.601	.638	0.100	6.2	25.0
Bromodichloromethane	.807	.859	0.200	6.5	25.0
1,2-Dichloropropane	.395	.380		3.7	
cis-1,3-Dichloropropene	.616	.615	0.200	.1	25.0
Trichloroethene	.430	.473	0.300	9.9	25.0
Dibromochloromethane	.745	.814	0.100	9.3	25.0
1,1,2-Trichloroethane	.365	.385	0.100	5.4	25.0
Benzene	.840	.830	0.500	1.3	25.0
trans-1,3-Dichloropropene	.515	.538	0.100	4.5	25.0
Bromoform	.588	.639	0.100	8.7	25.0
4-Methyl-2-pentanone	.335	.367		9.4	
2-Hexanone	.213	.225		5.7	
Tetrachloroethene	.523	.541	0.200	3.4	25.0
1,1,2,2-Tetrachloroethane	.716	.739	0.500	3.3	25.0
Toluene	1.224	1.198	0.400	2.1	25.0
Chlorobenzene	1.005	1.014	0.500	.8	25.0
Ethylbenzene	.430	.426	0.100	1.0	25.0
Styrene	.881	.889	0.300	.9	25.0
Xylene (total)	0.000	0.000	0.300	0.0	25.0
Toluene-d8	1.215	1.190		2.1	
Bromofluorobenzene	.831	.872	0.200	4.9	25.0
1,2-Dichloroethane-d4	1.599	1.811		13.3	

All other compounds must meet a minimum RRF of 0.010.

FORM VII VOA 3/90

AD08A	0916	ARH	BFB	std EM rolls up
AD08B	0957	ARH	Daily Cal	failed - need to prep new soln
AD08C	1100	ARH	CCl4 std	8.8 ppm CCl4 in N2 - tank possibly bad - see pr
AD09A	0855	ARH	BFB TUNE	Failed
AD09B	0943	DEN	BFB TUNE	Failed
AD09C	1026	ARH	BFB TUNE	passed
AD09D	1107	ARH	Daily Cal	? new solns - some very high
AD09E	1423	ARH	Daily cal	- PFTBA valve open
AD09F	1512	ARH	BFB TUNE	Failed
AD09G	1549	ARH	BFB TUNE	Failed - EM going up
AD09H	1857	ARH	BFB TUNE	performed autotune prior
AD11A	1714	DEN	BFB TUNE	New EMT installed
AD11B	1755	DEN	BFB TUNE	Adjusted ratios
AD13A	0922	JJM	BFB TUNE	Passed (After Cleaning Source)
AD13B	1001	JJM	BFB TUNE	Passed.
AD13C	1120	DEN	Blank -	5.0788 g Sand
AD13D	~~1001~~ 1223	DEN 4/14/91	BFB TUNE	Failed.
AD13E	1813	DEN	BFB TUNE	Passed
AD13F	1911	DEN	VSTD050	10ul ISTD, 5ul V-50, 5ul VSMC-50
AD13G	1952	DEN	VSTD010	10ul ISTD, 5ul V-10, 5ul VSMC-10
AD13H	2033	DEN	VSTD020	10ul ISTD, 5ul V-20, 5ul VSMC-20
AD13I	2111	DEN	VSTD100	10ul ISTD, 5ul V-100, 5ul VSCM-100
AD13J	2151	DEN	VSTD200	10ul ISTD, 5ul V-200, 5ul VSCM-200
AD13K	2240	DEN	VBLK01	10ul ISTD, 10ul VSMC
AD14A	0912	DEN	BFB TUNE	Failed.
AD14B	0949	DEN	BFB TUNE	Passed.
AD14C	1028	DEN	VSTD050	Daily Cal
AD14D	1134	DEN	VBLK02	Blank 10ul ISTD, 10ul VSMC
AD14E	1327	DEN	VSAM01	171/20/P4/2 R8970 Gas Sampl
AD14F	1405	DEN	VSAM02	167/114/P4/2 R8971 Gas Samp
AD14G	1445	DEN	VSAM03	87/33/P4/2-QA R8972 Gas Samp
AD14H	1526	DEN	VSAM04	87/33/P4/2 R8973 Gas Samp
AD14I	1606	DEN	VSAM05	150/60/P4/2 R8974 Gas Samp
AD14J	1645	DEN	VSAM06	Blank/P4/2 ~~R24~~ DEN 4/14/91 R8975 "
AD14K	1728	DEN	VSAM07	171/57/P4/2 R8985 "
AD14L	1806	DEN	VSAM08	150/85/P4/2 R8986 "
AD14M	1906	DEN	VSAM08	150/85/P4/2 R8986 on
AD14N	1943	DEN	VSAM09	150/113/P4/2 R8987 on
AD15A	1058	DEN	BFB TUNE	Passed.
AD15B	1158	DEN	VSTD050	
AD15C	1312	DEN	VSTD010	
AD15D	1418	DEN	VSTD020	
AD15E		DEN	VSTD100	

Name	Initials	Description	Comments		
15G	DKH	VMSP01	5.03g sand - 10µL ISTD, SMC & MS		
15H	DKH	VBLK01	Soil blank 5.057g sand		
15I	DKH	VMSP02	Sand matrix spike - 4.837g sand		
15J	DKH	VMSP03	Sand matrix spike - 4.656g sand		
15K	DKH	VMSP04	" 4.818g sand		
15L	DKH	VMSP05	" 5.080g sand		
D16A	DEN	BFB TUNE	Passed		
D16B	DEN	VSTD050	10µl ISTD, 5µl V-50, 5µl VSMC ~~V-50~~ DEN 4/16/91		
D16C	DEN	VBLK03	10µl ISTD, 10µl VSMC		
D16D	DEN	VSAM10	Blank/P4/A/G	R9012	
D16E	DKH	VSAM11	167/P4/B/G	R9013	
D16F	DKH	VSAM12	167/P4/C/G	R9014	
D16G	DKH	VSAM13	167/P4/D/G DKH 4-16-91	R9015	
D16H	DKH	VSAM14	167/P4/~~D~~/E/G	R9016	
D17A	DEN	BFB TUNE	Passed		
D17B	DEN	VSTD050	Daily Cal		
D17C	DEN	VBLK04	10µl ISTD, 10µl VSMC		
D17D	DEN	VSAM15	171/P4/H/G	R9032	inject 0.5
D17E	DEN	VSAM16	171/P4/K/G	R9033	inject 0.5
D17F	DEN	VSAM17	171/P4/G/G	R9025	inject 0.
D17G	DEN	VSAM18	171/P4/J/G	R9027	inject 0
D17H	DEN	VSAM19	167/P4/F/G-Q	R9024	inject 0.
D17I	DEN	VSAM20	167/P4/F/G	R9031	inject 0
D18A	DEN	BFB Tune	Passed		
D18B	DEN	BFB TUNE	Failed		
D18C	DEN	BFB TUNE	passed		
D18D	DKH	Daily cal	3 compounds out of QC		
D18E	DKH	Daily cal	new VSTD050 - passed - 1 cmpd out.		
D18F	DKH	daily blank	VBLK05	—	
D18G	DKH	VSAM21	171/P4/P/G	R9041	inject 0.5m
D18H	DKH	VSAM22	171/P4/N/G	R9040	injected 0.25
D18I	DKH	VSAM23	171/P4/M/G	R9039	injected 0.25
D18J	DKH	VSAM24	171/P4/P/G QA	R9042	* Valve on bulb sample may be invalid. injected 0.25mL
D18K	DKH	VSAM25	171/P4/L/G	R9038	injected 0.25mL
D19A	DKH	BFB TUNE	passed		
D19B	DKH	Daily cal			
D19C	DEN	VBLK06	Blank 10µl ISTD, 10µl VSMC		
D19D	DKH	VSAM26	171/P4/Q/G	R9058	0.25mL inje
D19E	DKH	VSAM27	171/P4/R/G	R9059	0.25mL inje
D19F	DKH	VSAM28	171/P4/S/G	R9060	0.150mL inje
D19G	DKH	VSAM29	171/P4/T/G	R9061	0.150 mL inje
D20A	DEN	BFB TUNE	passed		

File Name	Initials	Description	Comments
>AD20C	ARH	daily blank	VBLK07
>AD20D	ARH	QAMB-50	5uL added - NO ISTD or Surrogates a
>AD20E	ARH	QAMB-50	5uL QAMB-50 + 10uL ISTD
>AD20F	ARH	VSAM30	171/P4/U/G R9046 0.150uL in
>AD20G	[illegible]	VSAM31	171/P4/V/G R9047 0.150ml in
>AD20H	[illegible]	VSAM32	171/P4/W/G R9048 0.150ml in
>AD20I	[illegible]	VSTD350	10uL ISTD, 10uL VSMC, 5uL V-350

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APPENDIX F4

IDENTIFICATION OF GAMMA RAY-EMITTING NUCLIDES IN CHARCOAL FILTER

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Westinghouse Hanford Company

Internal Memo

From: Geology Section 81232-91-020
Phone: 6-9534 G6-50
Date: April 29, 1991
Subject: IDENTIFICATION OF GAMMA-RAY-EMITTING NUCLIDES IN CHARCOAL FILTER USED FOR IRA ACTION, CARBON TETRACHLORIDE VAPOR EXTRACTION.

To: D.G. Horton H4-56

cc: L. C. Brown H4-51
D. A. Dodd T6-50
J. W. Fassett G6-50
K. R. Fecht H4-56
R. A. Kent R1-01
K. A. Lane R1-01
L. C. Swanson H4-56
R. R. Thompson L4-88
CJK:RKP:JRB:WHU File/LB

Identification of gamma-ray-emitting nuclides in charcoal filter used for IRA action, carbon tetrachloride vapor extraction.

R. K. Price and R. V. Cram logged RCRA well 299-W18-29 with the RLS HPGe system on April 16, 1991. At the same time, an HPT detected gamma-ray counts from an activated charcoal filter that was in use on the interim response action for carbon tetrachloride vapor extraction at the Z-1A crib. In response to immediate concerns about the identities of the gamma-ray source nuclides, messrs. Price and Cram recorded a gamma-ray spectrum with the RLS logging tool placed near the filter. The spectrum displayed about 40 prominent gamma-ray peaks, all unambiguously indicative of lead-214 and bismuth-214. No peaks attributable to man-made gamma-ray emitters were found. These results were informally conveyed to EWM/ENV personnel at the site. These personnel were relieved to find that the filter had not accumulated detectable amounts of uranium, thorium, or man-made gamma-ray-emitting contaminants.

Pb-214 and Bi-214 occur in the uranium-238 decay chain. Since Pb-214 and Bi-214 have very short half lives (27 min and 20 min, respectively), it is almost certain that the filter had trapped a mobile nuclide whose decay products are Pb-214 and Bi-214. The nuclide would be radon-222, an inert gas with a 3.8-day half life. Rn-222 decays to polonium-218 (3-min half life); Po-218 decays to Pb-214, which decays to Bi-214.

The short half life of Rn-222 implies that the subsurface around Z-1A contains a long-lived radionuclide (e.g., uranium-238, and/or its decay product, radium-226) that acts as a source of Rn-222. Without logs from the holes around the crib, Geophysics Team members cannot determine whether the source of Rn-222 is natural uranium or uranium/radium waste from past nuclear materials processing.

The spectrum did not have a peak associated with the 1001-keV gamma ray of protactinium-234m. Since Pa-234m is a direct indicator of U-238, uranium itself did not collect in the filter.

The activities of Bi-214 and Pb-214 in the filter cannot be calculated because the RLS HPGe system is not calibrated for the filter's source geometry.

Attached to this memo are: (1) a plot of the spectrum, (2) a plot of the background spectrum (showing gamma-ray signals from nuclides on the surface of the ground), and (3) a table of information for the spectral peaks in both spectra. The table shows gamma-ray energies, peak intensities, and gross count rates.

R. K. Price	C. J. Koizumi	J. R. Brodeur	W. H. Ulbricht
Scientist	Scientist	Engineer	Scientist

dyl

Attachments

9 1 1 2 2 0 7 1 0 8 8

TYPE = -1 MCA # 01 SEGMENT # 01 SEQUENCE # 0
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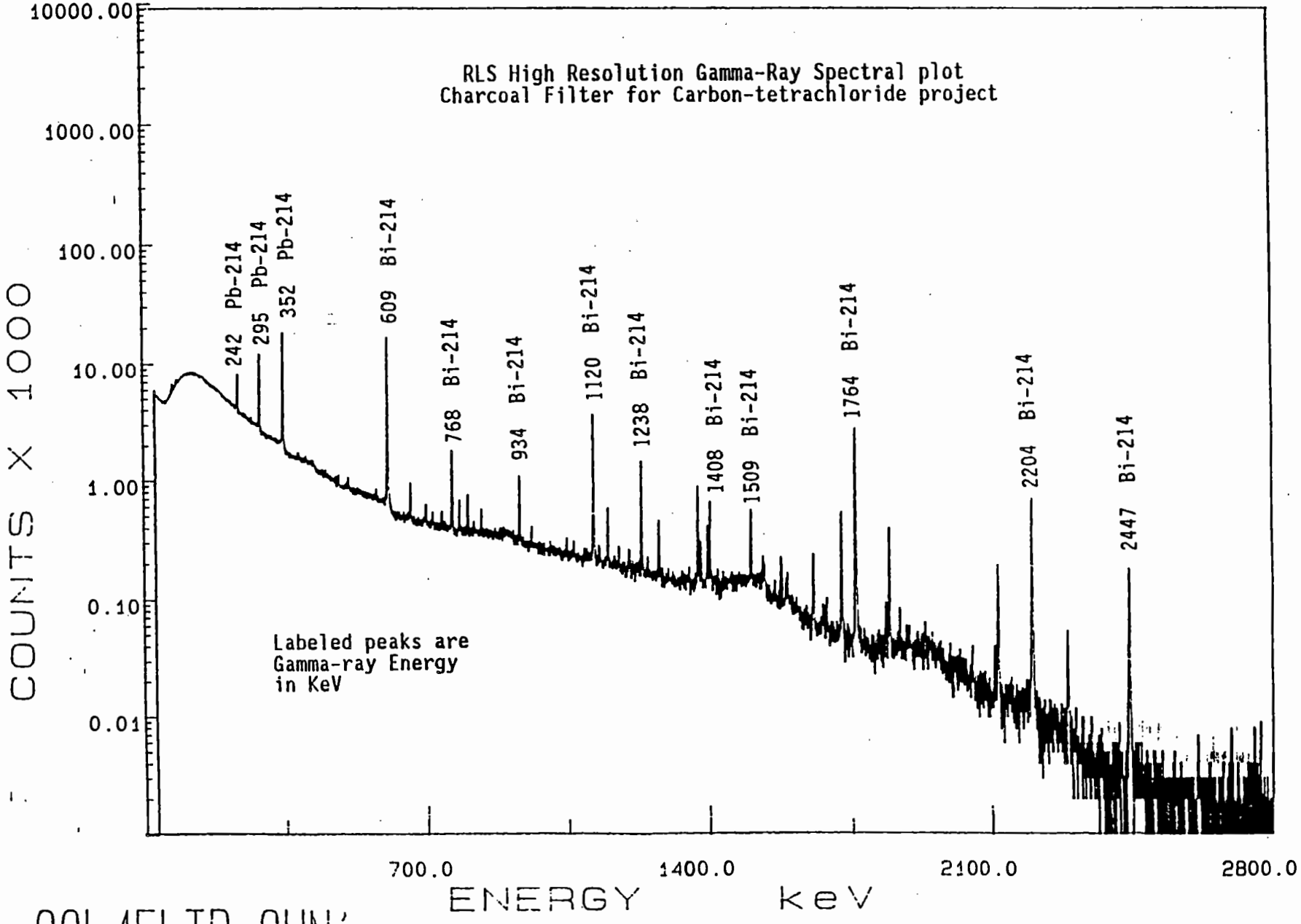

CCI 4FI TR CHN' SAMPLE: CHARCOAL FILTER #1, MAX GAMMA ACTIVITY, 16APR91 14:30

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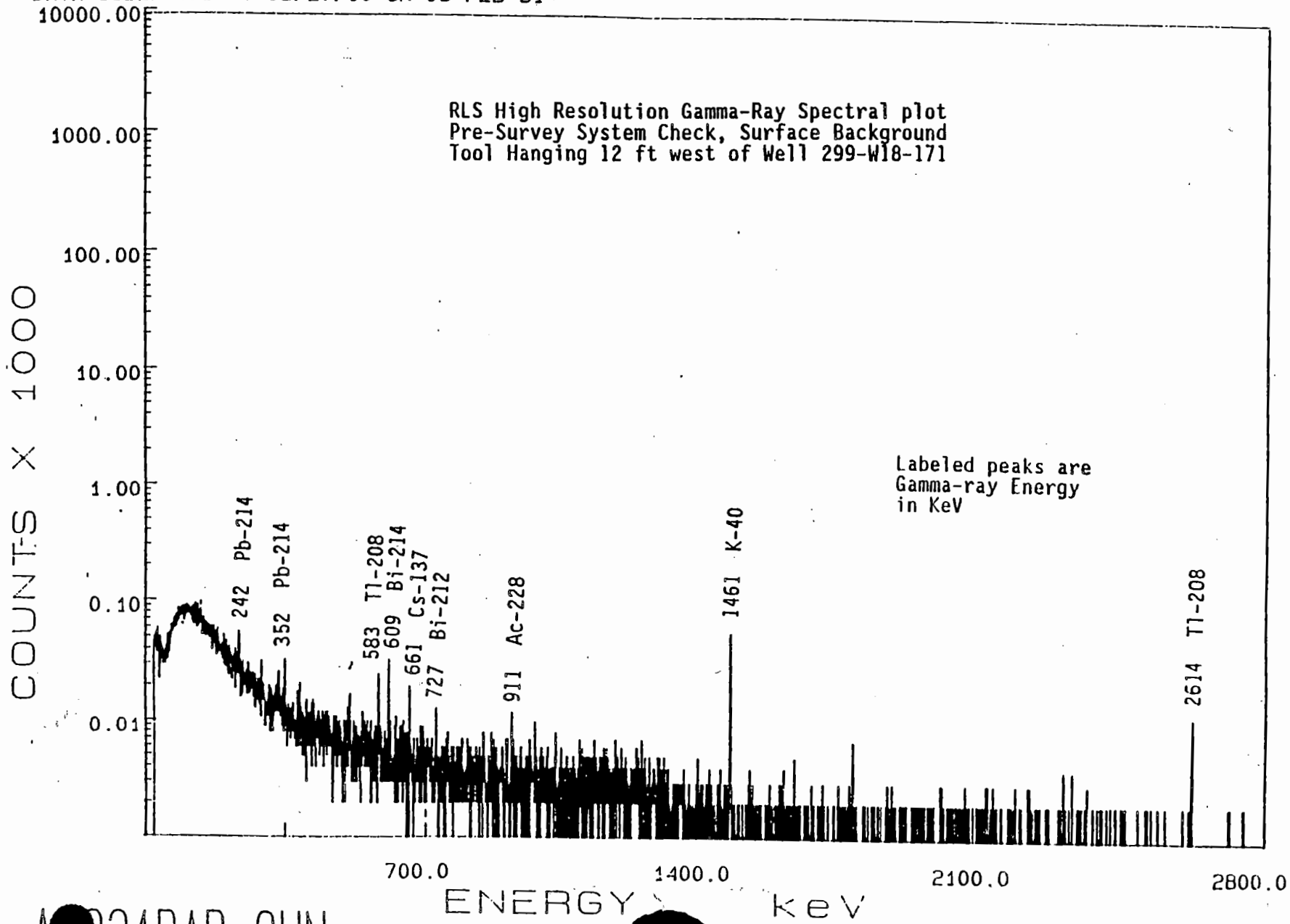

AMP21RAR CHN SAMPLE: Back[illegible] inch above GL; 12ft west of well

Table 1. Gamma-Ray Peak Identification

RLS High Resolution Gamma-Ray spectra file: CCL4FLTR.CHN
Net Peak Area reported by Maestro II
Channel to energy calibration: two points required, 609.3 and 1764.5 KeV
Actual Gamma Peak and Intensity from The Gamma Rays of the Radionuclides by G. Erdtmann and W. Soyka

Gross count rate 11,980 cps

Observed Gamma Peak (KeV)	Net Peak Area (Cnts)	Nuclide	Actual Gamma Peak (KeV)	Intensity (%)	
76.9	2391	Pb-214	77.1	10.70	
241.6	13169	Pb-214	241.9	7.47	
258.3	392	Pb-214	258.9	0.55	
274.2	533	Bi-214	273.7	0.18	
		Pb-214	274.5	0.32	
294.9	29454	Pb-214	295.2	19.20	
351.9	51785	Pb-214	352.0	37.10	
388.3	949	Bi-214	387.0	0.36	
		Bi-214	389.1	0.41	
455.0	494	Bi-214	454.8	0.32	
487.3	979	Pb-214	487.3	0.44	
511.2	1155	Bi-214	511.0	0.15	
579.8	548	Pb-214	580.3	0.36	
609.3	52943	Bi-214	609.3	46.09	
665.5	1518	Bi-214	665.5	1.56	
703.2	534	Bi-214	703.1	0.47	
719.7	503	Bi-214	719.9	0.40	
742.5	429	Bi-214	741.5	0.04	
		Bi-214	742.5		? Double escape 1764.5-1022
768.4	5427	Bi-214	768.4	4.89	
785.8	972	Bi-214	786.1	0.31	
		Pb-214	786.0	1.09	
806.2	1299	Bi-214	806.2	1.23	
838.1	504	Pb-214	839.0	0.59	
934.1	2953	Bi-214	934.0	3.17	
963.8	386	Bi-214	964.1	0.38	
1052.2	338	Bi-214	1052.0	0.32	
1069.8	203	Bi-214	1070.0	0.29	
1120.3	13772	Bi-214	1120.3	15.04	
1133.5	377	Bi-214	1133.7	0.25	
1155.3	1483	Bi-214	1155.2	1.69	
1182.4	350	Bi-214	1182.1		? Double escape 2204.1-1022
1207.8	517	Bi-214	1207.7	0.46	
1238.2	4958	Bi-214	1238.1	5.92	
1253.7	344	Bi-214	1253.5		? Single escape 1764.5-511
1281.0	1216	Bi-214	1281.0	1.47	
1377.7	3282	Bi-214	1377.7	4.02	
1408.0	1846	Bi-214	1408.0	2.48	
1509.4	1641	Bi-214	1509.2	2.19	
1538.7	164	Bi-214	1538.5	0.41	
1583.2	597	Bi-214	1583.2	0.72	
1661.4	760	Bi-214	1661.3	1.15	
1692.9	220	Bi-214	1693.1		? Single escape 2204.1-511
1729.6	2203	Bi-214	1729.6	3.05	
1764.5	11438	Bi-214	1764.5	15.92	
1847.4	1558	Bi-214	1847.4	2.12	
1873.5	123	Bi-214	1873.2	0.23	
1936.7	133	Bi-214	1935.8	0.05	
2118.6	892	Bi-214	2118.5	1.21	
2204.0	3141	Bi-214	2204.1	4.99	
2293.0	218	Bi-214	2293.4	0.32	
2447.5	908	Bi-214	2447.7	1.55	
2695.3	20	Bi-214	2694.8	0.03	

Table 1 Cont. Gamma-Ray Peak Identification

RLS High Resolution Gamma-Ray spectra file: A0221BAB.CHN
Net Peak Area reported by Maestro II
Channel to energy calibration: two points required, 661.6 and 1332.5 KeV
Actual Gamma Peak and Intensity from The Gamma Rays of the Radionuclides by G. Erdtmann and W. Soyka

Observed Gamma Peak (KeV)	Net Peak Area (Cnts)	Nuclide	Actual Gamma Peak (KeV)	Intensity (%)
238.4	86	Pb-214	241.9	7.5
351.3	65	Pb-214	352.0	37.1
582.8	57	Tl-208	583.1	86.0
609.6	54	Bi-214	609.3	46.1
661.2	30	Cs-137	661.6	84.6
727.1	24	Bi-212	727.2	11.8
911.0	20	Ac-228	911.1	29.0
1460.5	189	K-40	1460.8	10.7
2614.5	34	Tl-208	2614.5	100.0

Gross count rate: 81 cps

Gamma γ emitting isotopes for the three natural radionuclides are present.

Natural Radioelement	Decay Chain Daughters detected
Uranium	Bi-214, Pb-214
Thorium	Ac-228, Bi-212, Tl-208
Potassium	K-40

Only one gamma emitting man-made radionuclide detected on the surface,

Cesium-137