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Underground Storage Tank Site Remediation Plan

Oak Ridge National Laboratory Gasoline Tank 7069b Leak Site

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ORNL/RAP/Sub/88-SC678/1

UNDERGROUND STORAGE TANK SITE REMEDIATION PLAN

OAK RIDGE NATIONAL LABORATORY
GASOLINE TANK 7069b LEAK SITE

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CONTENTS

PAGE

LIST OF FIGURES v

LIST OF TABLES vii

ABSTRACT ix

1. INTRODUCTION 1

2. BACKGROUND 1
   2.1 HISTORY 1
   2.2 SITE HYDROLOGY 6
   2.3 REGULATORY REQUIREMENTS 7

3. EVALUATION 9

4. FUTURE ACTIONS..... 10
   4.1 INVESTIGATION..... 11
   4.2 BASIS FOR PROPOSED CLEANUP ACTIVITIES AT OAK RIDGE NATIONAL LABORATORY..... 14
   4.3 PROPOSED REMEDIATION..... 14
   4.4 SCHEDULE..... 15
   4.5 COST..... 17

5. REFERENCES..... 19

Appendix A. GEOHYDROLOGIC DATA..... 21

Appendix B. DESIGN DATA..... 39

LIST OF FIGURES

Figure		Page
1	Tank 7069b leak site at Oak Ridge National Laboratory	2
2	Monitoring well and soil sample locations for gasoline tank 7069b leak site	6
3	Schedule of activities for remediation of gasoline tank 7069b leak site	16

LIST OF TABLES

Table		Page
1	Summary of groundwater analyses for gasoline tank 7069b leak site (ppb).....	3
2	Summary of soil sample analyses for gasoline tank 7069b leak site.....	4
3	Summary of analyses from tank pit samples for gasoline tank 7069b leak site after tank removal (November 1988).....	7
4	Proposed cleanup standards for groundwater and soils contaminated with gasoline.....	9
5	Data collection objectives for gasoline tank 7069b leak site.....	11
6	Summary of sampling and analysis for gasoline tank 7069b leak site	12
7	Conceptual cost summary for remediation of gasoline tank 7069b leak site.....	18

ABSTRACT

Since the discovery of a leaking underground gasoline storage tank in 1986, corrective actions have been implemented to prevent further environmental insult. The tank was excavated and disposed of in November 1988. Contaminated soil removed from the excavation pit was treated and subsequently released as clean fill. This report provides a strategy for performing additional characterization and corrective actions that are required per federal and state regulations. Soil samples will be collected and monitoring wells will be installed at various locations around the former tank site to assess the extent of plume migration. Based on this detailed site assessment, a corrective action plan will be put in place to remediate those areas that contain gasoline contamination above regulatory levels. Contaminated groundwater will be pumped from the wells and treated via air strippers or carbon filters. Contaminated soil will be excavated and treated by aeration. Since preliminary data indicate that contamination is restricted to the former tank site, these corrective actions are believed to be sufficient to remediate the site.

1. INTRODUCTION

Following the discovery of a gasoline inventory shortage at Oak Ridge National Laboratory (ORNL), an investigation was initiated, the results of which have been published.[1] The Tennessee Department of Health and Environment (TDHE) requested that remedial actions be implemented as soon as possible. Described in the following sections are the actions necessary to characterize and to remediate the areas impacted by the underground storage tank leak.

2. BACKGROUND

2.1 HISTORY

Located north of Building 7005 (see Fig. 1), tank 7069b was constructed of steel and was approximately 30 years old. Inventory information indicated that approximately 800 gal of unleaded gasoline of its 8300-gal capacity <u>may</u> have leaked. The tank was emptied and capped in August 1986. Subsequent sampling and analysis of water from three piezometers (i.e., 794, 795, and 796) installed in June 1986 near the tank confirmed the presence of gasoline in the groundwater. Petroleum hydrocarbons were detected in each of the piezometers. Table 1 lists the results of three groundwater sampling and analysis events. The highest concentrations were detected in groundwater samples collected from piezometers 794 and 796; concentrations in samples from piezometer 795, which is south of the tank, were consistently lower. During the installation of piezometer 794, water was collected from the boring in a clear glass container. A thin film of product formed on the surface indicating the potential presence of product floating on the water table. Soil samples were also collected during the installation of the piezometers; Table 2 lists the results of their analyses. The concentrations of benzene, toluene, and xylene (BTX) detected in the samples were less than 1 ppm.

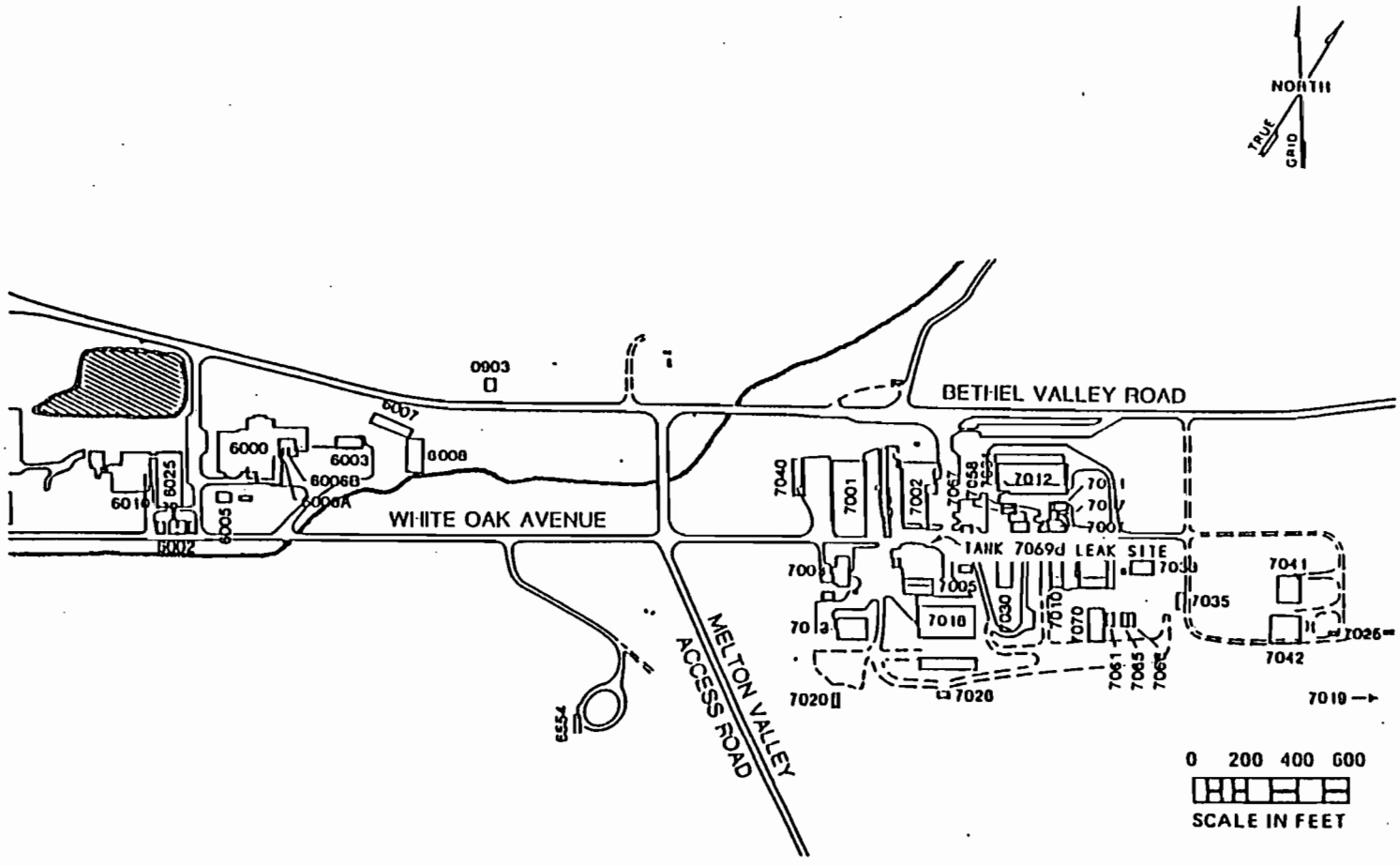

FIGURE 1

TANK 7069b LEAK SITE
OAK RIDGE NATIONAL LABORATORY
OAK RIDGE, TENNESSEE

Source: ORNL Site Development and Facilities Utilization Plan

ERC Environmental

Table 1. Summary of groundwater analyses for gasoline tank 7069b leak site (ppb)

Well number	Date of collection				
	12/19/86		6/3/87		4/8/88
	Benzene	BTX[a]	Benzene	BTX	Total petroleum hydrocarbons[b]
794	1260	4440	650	9850	35,000
795	22	367	32	47	<100
796	870	5645	720	10,420	21,000

[a]BTX - benzene, toluene, and xylene.

[b]Analyses were performed for total petroleum hydrocarbons only.

Source: Contamination Assessments of the Gasoline Leak Site at Oak Ridge National Laboratory, Environ. Compliance and Health Protection Div., Martin Marietta Energy Systems, Oak Ridge Nat. Lab., 1988.

Table 2. Summary of soil sample analyses for gasoline tank 7069b leak site

Well number or soil sample location	Depth (ft)	BTX concentration[a] (ppb)
	June 1986	
794	2	<8
	5	<8
	10	<8
795	5	<8
	10	<8
796	5	52
	10	178
	12	27
	February 1987	
S1	5	<15
	8	4977
S2	4	180
S3	4	<15
	5	<15
S4	8	<15

[a]BTX - benzene, toluene, and xylene.

Sources: Contamination Assessments of the Gasoline Leak Site at Oak Ridge Nat. Lab., Environ. Compliance and Health Protection Div., Martin Marietta Energy Systems, Oak Ridge Nat. Lab., 1988; and Environmental Assessment Plan for Leaking Gasoline Tank, 7000 Area, Environ. Compliance and Health Protection Div., Martin Marietta Energy Systems, Oak Ridge Nat. Lab., 1986.

In December 1986, soil samples were collected at six locations 50 to 100 ft from the tank and at depths from 2 to 10 ft. Gasoline was not detected in concentrations above the 10 ppm BTX regulatory limit. Four additional locations were sampled in February 1987. These soil samples were collected within 50 ft of the tank along utility lines. Table 2 also lists the results of these analyses; Figure 2 shows sampling locations. Petroleum hydrocarbons were not

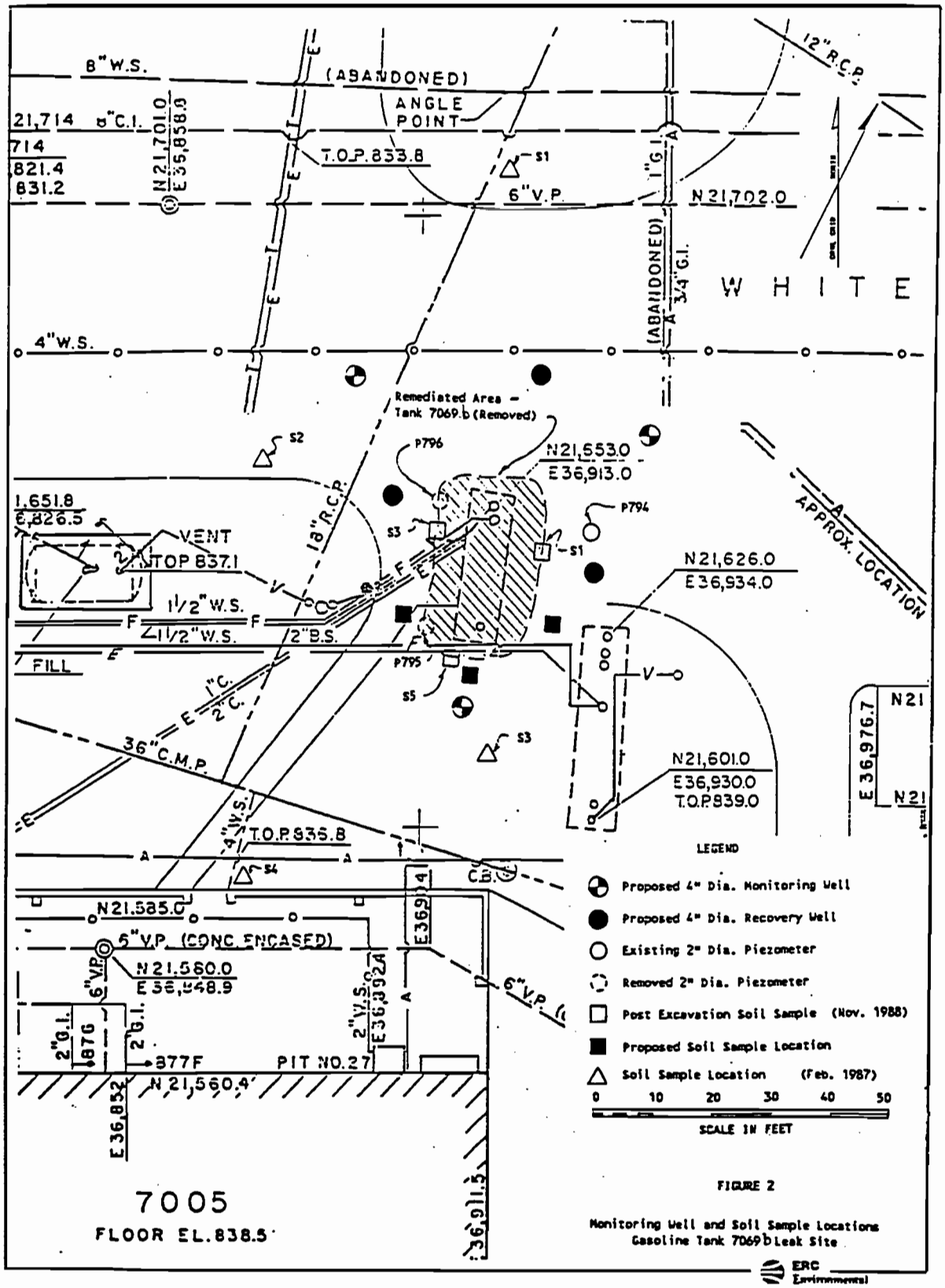

FIGURE 2

Monitoring Well and Soil Sample Locations
Gasoline Tank 7069b Leak Site

detected in the soil samples collected to the south of the tank; however, concentrations of BTX were detected in the samples collected to the north and west of the tank. These data indicate that gasoline constituents have remained localized, a conclusion that is consistent with the site hydrology discussed in the following section.

The underground storage tank was removed in November 1988. The soil in the immediate tank area was removed and aerated, and piezometers 795 and 796 were removed. Three soil samples and one water sample were collected from the excavation zone (see Fig. 2). Table 3 lists the results of these analyses. Petroleum hydrocarbons were detected in all samples. The area was subsequently backfilled with "clean" crushed stone.

2.2 SITE HYDROLOGY

The groundwater in the area is primarily a single aquifer system in which the upper regolith is in hydraulic communication with the bedrock, interbedded shale, and limestone of the Chickamauga Group. Permeabilities in the bedrock are low, and water flow is primarily through fissures oriented with the bedding planes that dip to the southeast. The upper portion of the aquifer resides in a brown silty clay approximately 12 ft thick at the site. The groundwater flows to the west and to the south forming a distinct divide through the 7000 Area of ORNL. The tank site lies on this groundwater divide. (Appendix A details the hydrologic data.)

The upper portion of the aquifer is significantly influenced by the surface topography draining to the west and by variations in soil permeabilities. The mean permeability calculated from 23 shallow piezometers in the area is 2.3×10^{-5} cm/s. Measurements in piezometers 794, 795, and 796 varied two orders of magnitude. The variation in permeability may partially explain the presence

Table 3. Summary of analyses from tank pit samples for gasoline tank 7069b leak site after tank removal (November 1988)

Hydrocarbon	Sample number[a]			
	S1	S3	S5	L1
Benzene, toluene, and xylene, ppb	6,480	5,830	388,200	2,400[b]

[a]S - soil sample, L - liquid sample.

[b]Analysis for benzene only.

of an anomalous gradient present at the tank site. Groundwater elevations collected monthly from each of the three local piezometers since December 1986 indicate a localized northerly gradient. The gradient shifted from the grid northeast in June 1987 to northwest in December 1987. The water table gradient is the single most important factor influencing the movement of floating hydrocarbons.

Within the Oak Ridge Reservation (ORR) the groundwater is not used as a drinking water supply. Potential groundwater users are located beyond the reservation boundary, which extends more than 2 miles in any direction from the tank site. The possibility of constituents migrating from the site in sufficient quantities to impact a user's supply are incalculably low.

2.3 REGULATORY REQUIREMENTS

In September 1988 the U.S. Environmental Protection Agency enacted regulations for underground storage tanks that store petroleum products.[2] The law requires that owners and operators initiate corrective actions when a leak is discovered and states that corrective action plans must provide adequate protection of human health and the environment as determined by the implementing

agency. Some of the factors to be taken into consideration include hydrogeologic characteristics of the site; proximity, quality, and current and future uses of nearby surface water and groundwater; and potential effects of residual contamination on nearby surface water and groundwater. In Tennessee the TDHE is expected to be the implementing agency.

The TDHE establishes methods of cleanup and action levels for BTX.[3] The action levels for these constituents in groundwater and soil are 5 ppb benzene and 10 ppm BTX, respectively, above a background of nondetection. However, revised cleanup standards have been defined under proposed Rule 1200-1-15 (see Table 4). The cleanup levels vary based on groundwater quality, aquifer yield, and groundwater use. Table 4 shows only the levels for soils having permeabilities of 10^{-4} to 10^{-6} cm/s because these values apply to site soils that have a mean permeability of 2.3×10^{-5} cm/s. If proposed Rule 1200-1-15 is accepted, less stringent limits may apply to the site if the groundwater is a TDHE-defined "non-drinking water supply."

To be considered a nondrinking water supply, the groundwater must be excluded as a "drinking water supply." The TDHE defines a drinking water supply as "any aquifer or water source whose chemical characteristics meet the primary and secondary drinking water standards as defined under Rule 1200-5-1 (regulated by the Division of Water Supply) and that provides a yield of at least one-half gallon per minute. This shall also include any water supply used for drinking by the citizens of the state."

Under current policy, methods for treating or disposing the groundwater are not specified; however, methods for treating or disposing soil are limited by the policy. Soils containing 10 to 100 ppm of BTX may be landfilled (upon issue of a special waste approval letter), recycled, removed and aerated (if approved by the Division of Air Pollution Control), or treated in place. Soil containing 100 ppm of BTX or greater may be handled as a

Table 4. Proposed cleanup standards for groundwater and soils contaminated with gasoline

	Drinking water	Nondrinking water
	Groundwater cleanup level (ppb)[a]	
Benzene	5	70
	Soil cleanup level (ppm)[a,b]	
Benzene, toluene, and xylene	50	250

[a]Groundwater and soil cleanup levels apply to gasoline.

[b]Soil permeability of 10^{-4} to 10^{-6} cm/s.

Source: Tennessee Department of Health and Environment, Rule 1200-1-15.06, "Release Response and Corrective Action for UST Systems Containing Petroleum"; Rule 1200-1-15, Appendixes 3 and 4.

hazardous waste, recycled, or treated in place; however, removal and subsequent aeration is not allowed by the policy.

3. EVALUATION

Information collected to date indicates that environmental impacts are limited to the immediate tank area and that they are not a public health threat. However, both TDHE current policy and proposed regulations require remediation of gasoline constituents in the environment that are greater than the applicable cleanup levels. Results from piezometers (Table 1) indicate that the concentration of benzene in the groundwater exceeds the current TDHE limits of 5 ppb and the proposed non-drinking water limit of 70 ppb. Characterization and remediation of the groundwater therefore is required.

One postexcavation soil sample (see Table 3) indicates the presence of BTX in excess of the current 10 ppm cleanup limit and

the proposed 250 ppm nondrinking water cleanup limit for soil. All other soil samples collected did not exceed these limits. Limited soil sampling will be performed to ensure that this sample is not representative of the general soil conditions. Soils confirmed to contain BTX exceeding the action levels will be remediated.

4. FUTURE ACTIONS

Additional actions include investigations to delineate gasoline constituents in the groundwater and soil and remediation of the areas defined by the investigation. These activities are described below. Table 5 cites the objectives of the data collection activities. Estimates of schedule requirements and costs are provided later in this section.

Table 5. Data collection objectives for gasoline tank 7069b leak site

Objective	Groundwater sampling			Pump test	Soil sampling (BTX)[a]
	Benzene	Total petroleum hydrocarbons	Free product		
Constituent delineation	X	X	X		X
Regulatory threshold definition	X			X	X
Pump design requirements			X	X	
Treatment system requirements	X	X	X	X	
Soil remediation requirements					X

[a]BTX - benzene, toluene, and xylene.

4.1. INVESTIGATION

To collect the required information, six 4-in.-diam wells will be installed, and three soil samples will be collected at specific locations (Fig. 2). Table 6 summarizes sampling and analysis requirements. A pump test will be performed on at least one well to determine the "aquifer yield." The two wells installed nearest to the tank pit area will primarily be used to identify floating product. Additional wells will be used to assess plume migration. Existing piezometer 794 will not be used to monitor groundwater

Table 6. Summary of sampling and analysis for gasoline tank 7069b leak site

	Field screen[a]	BTX[b]		Total petroleum hydrocarbons (method 602)[c]
		Method 8020[c]	Method 602[d]	
Groundwater samples[e]			6	6
Soil samples at wells	6	6[f]		
Soil samples at south end of tank		3		

[a]Screen samples using a Photovac Tip calibrated to benzene or toluene.

[b]BTX - benzene, toluene, and xylene.

[c]"Environmental Protection Agency Methods for Evaluating Solid Wastes," SW 846.

[d]40 CFR Pt. 136, Appendix A.

[e]Samples are collected quarterly.

[f]Perform analyses if screening results are greater than 50% of the applicable cleanup level.

quality because the screen does not intercept the water table at all times - sampling and analysis results would probably be inconsistent.

The proposed wells (Fig. 2) have been located where preliminary groundwater results indicate the presence of petroleum hydrocarbons. These results are consistent with the site hydrology and behavior of gasoline. The flow rate of the aquifer is very low (i.e., 1 to 10 ft/year); this severely limits the effect of flow on the migration of the hydrocarbons. Migration of the hydrocarbons will be dominated by the spread of the floating product down gradient. Because of a localized anomaly, the gradient in the immediate tank area varied from the northeast to

the northwest where the hydrocarbons were detected. Groundwater samples will be collected from each of the newly installed wells for analysis prior to initiating remediation. These results will be evaluated to determine if the plume has been adequately characterized. Additional wells will be installed if the limit of migration has not been established for the appropriate benzene cleanup level.

To date 28 soil samples have been collected and analyzed. Samples were collected from various depths at ten locations surrounding the tank area. Eight soil samples were collected during the installation of the three piezometers, and three soil samples were collected following removal of the tank. Of these soil samples, BTX concentrations in only one (i.e., S5 at the south end of the tank pit) exceed the current 10 ppm cleanup level for BTX (Table 3). The proposed cleanup levels listed in Table 4 are also exceeded. Analysis results indicate that the primary impact of the gasoline leak has been limited to the soil in close proximity to the tank and that the majority of the impacted soils were removed and subsequently aerated during excavation of the tank. The remaining soils will be investigated as described below.

During installation of the monitoring wells, soil samples will be collected utilizing a split-spoon sampler. One soil sample will be collected in each well at approximately 6 in. above the water table. The sample will be screened with a portable organic vapor analyzer. If concentrations of BTX over 5 ppm (i.e., more than 50% of the applicable cleanup level) are detected, the sample will be submitted for laboratory analysis. In addition, three soil samples will be collected at the locations shown in Fig. 2. These samples have been located near the confirmatory soil sample S5 collected in November 1988 (Table 3). S5 is the only soil sample that has contained a BTX concentration that exceeds cleanup levels. The samples will be collected at approximately 6 in. above the water table and analyzed for BTX.

4.2. BASIS FOR PROPOSED CLEANUP ACTIONS AT OAK RIDGE NATIONAL LABORATORY

The groundwater within the ORR has not been and is not currently used as a drinking water supply. The reservation boundary extends more than 2 miles in any direction from the tank leak site. The isolated location of the site and the low permeability of the soil eliminate the possibility of any water supply used by citizens of the state being adversely affected by the tank leak. In addition to not being used as a drinking water supply, the aquifer in the area of the tank will have a low yield because of the low permeability of the soil. To verify this, the discharge of at least one well in the area of the tank will be measured. If the discharge is less than 1/2 gal/min, cleanup levels for nondrinking water supplies are proposed as the cleanup criteria for the site.

4.3. PROPOSED REMEDIATION

The preliminary data indicate that environmental impacts are limited to the immediate tank area and are significantly inhibited by the natural soil conditions. The proposed remediation plan is structured around this assumption. Following the collection and analysis phase, the data will be evaluated to determine the accuracy of this assumption. Should the preliminary data not accurately reflect the current site conditions, the site remediation plan may require significant modification. Should the assumptions remain valid, the area will be remediated as described below.

The limited aerial extent of constituents and site conditions (i.e., low permeability and shallow water table) are conducive to remediation by pumping and treating the groundwater. Free product identified on the groundwater surface will be removed by down-hole scavenger pumps placed in the 4-in.-diam wells next to the tank pit (identified as recovery wells in Fig. 2). The product and groundwater will be removed from the wells concurrently to promote flow of the product into the well. The product will be pumped to an above-grade tank for recycling or disposal. The water will be

treated with an air stripper or carbon filter and discharged to the sewer. Appendix B contains the conceptual design of the system.

The treatment system may be adjacent to the site or located remotely. Water will be collected and transported to the remote location if necessary. The groundwater recovery system will be sized in accordance with the expected well production derived from the measured aquifer characteristics. Wells will be added as necessary to remediate the impacted groundwater properly. The groundwater treatment system will be adequate to treat the recovered groundwater to limits for discharge into the storm sewer (i.e., 2.13 ppm total petroleum hydrocarbons). Groundwater treatment will continue until samples collected from the three monitoring wells (Fig. 2) contain contaminants in concentrations smaller than the cleanup levels (i.e., 5 ppb benzene for drinking water or 70 ppb for nondrinking water). The groundwater samples will be collected and analyzed on a quarterly basis. Effluents will be sampled and analyzed weekly for the first 4 weeks and quarterly thereafter.

Three soil samples will be collected and analyzed from the south end of the tank pit. If BTX concentrations do not exceed the applicable cleanup level (i.e., 10 ppm BTX for drinking water or 250 ppm BTX for nondrinking water), no additional actions will be taken. If BTX concentrations exceed the applicable cleanup level, the soil will be excavated and aerated. The excavated surface will be surveyed with a portable organic vapor analyzer to ensure that all impacted soil is removed. Four confirmatory samples will be collected - two from the resulting pit and two from the aerated soil - to demonstrate that cleanup has been achieved.

4.4. SCHEDULE

Figure 3 charts the sequence and duration of activities. Approximately 9 months are required from project approval to operation of the recovery and treatment system. The project may be delayed a minimum of 4 months if a review of the collected data indicates that significant changes in the remediation plan are required. The estimated duration of the recovery and treatment

```
ACTIVITY                                          MONTHS
                                  ....1....2....3....4....5....6....7....8....9..........33
TDHE Approval                     -
ORNL Planning (ADM. etc.)          ---
Procure Contractor                    ----------
Install Monitoring Wells                        -
Collect and Analyze Samples                         ----
Perform Pump Test                                    -
Evaluate Results(a)                                     ----
Design GW System                                            --
Review Design                                                --
Procure Materials                                              ------------
Install System                                                             --
Operate System                                                               -------------
```

(a) If results require significant modification of the remediation plan, a minimum delay of 4 months may be experienced for ORNL through TDHE reviews.

FIGURE 3

SCHEDULE OF ACTIVITIES FOR REMEDIATION OF UST GASOLINE LEAK SITE

process is 2 years. This projected schedule presumes that the plume has remained localized and excludes regulatory and administrative delays.

4.5. COST

Table 7 provides an estimate of project costs; however, the cost of implementation may vary considerably as a result of unanticipated conditions. The costs shown reflect the assumption that six wells will be installed and that the plume has remained confined to the immediate area of the tank pit.

For estimating purposes the following assumptions have been made:

- The cost of each 4-in.-diam well is $10,000.[4]

- The cost for each analysis is $225. Sampling cost is equal to analysis cost.

- The equipment costs are based on vendor quotes and catalog prices. These costs have been doubled to include costs associated with government procurement. The labor costs for installation are equal to the total equipment cost.

- Providing necessary utilities to the site will cost $5000.

- The cost for reporting is based on submitting three reports requiring an average preparation time of 40 h each at $50/h and one Action Description Memorandum at 80 h and $50/h.

- Disposal of 1200 lb of waste carbon materials is $3.25/lb.[5] This assumes that three units are used at 400 lb each to treat 200,000 gal of water at 50 ppm BTX. Decontamination water will be treated with the system.

- Engineering is 25% of the total equipment and labor costs for the treatment system. Excavation and backfill contractor cost is $100/yd. The cost is doubled to include health and safety,

Table 7. Conceptual cost summary for remediation of gasoline tank 7069b leak site

Groundwater investigation and remediation	
Installation of six 4-in.-diam wells	$ 60,000
Sampling and analysis of six wells quarterly for 2 years (40 samples)	18,000
Groundwater recovery system - three pumps, piping, and controls	34,000
Product separator, equalization tank, carbon filters, and high-water alarm	18,800
Utilities	5,000
Effluent water sampling - weekly for 4 weeks, quarterly for 2 years	5,400
Operation and maintenance	3,000
Waste disposal	3,900
Reporting	10,000
Engineering	13,200
Soil investigation and remediation	
Collect 11 samples for analysis	5,000
Excavation (5 yd)	1,000
Subtotal	$177,300
ORNL general overhead (40%)	70,900
Total	**$248,000**

security, etc. A maximum of 5 yd^3 will be excavated. ORNL general overhead is assumed to be 40% of the overall cost.

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1. Contamination Assessments of the Gasoline Leak Site at Oak Ridge National Laboratory, Environ. Compliance and Health Protection Div., Martin Marietta Energy Systems, Oak Ridge Natl. Lab., 1988.

2. 10 CFR Pt. 280 (specifically 280.66).

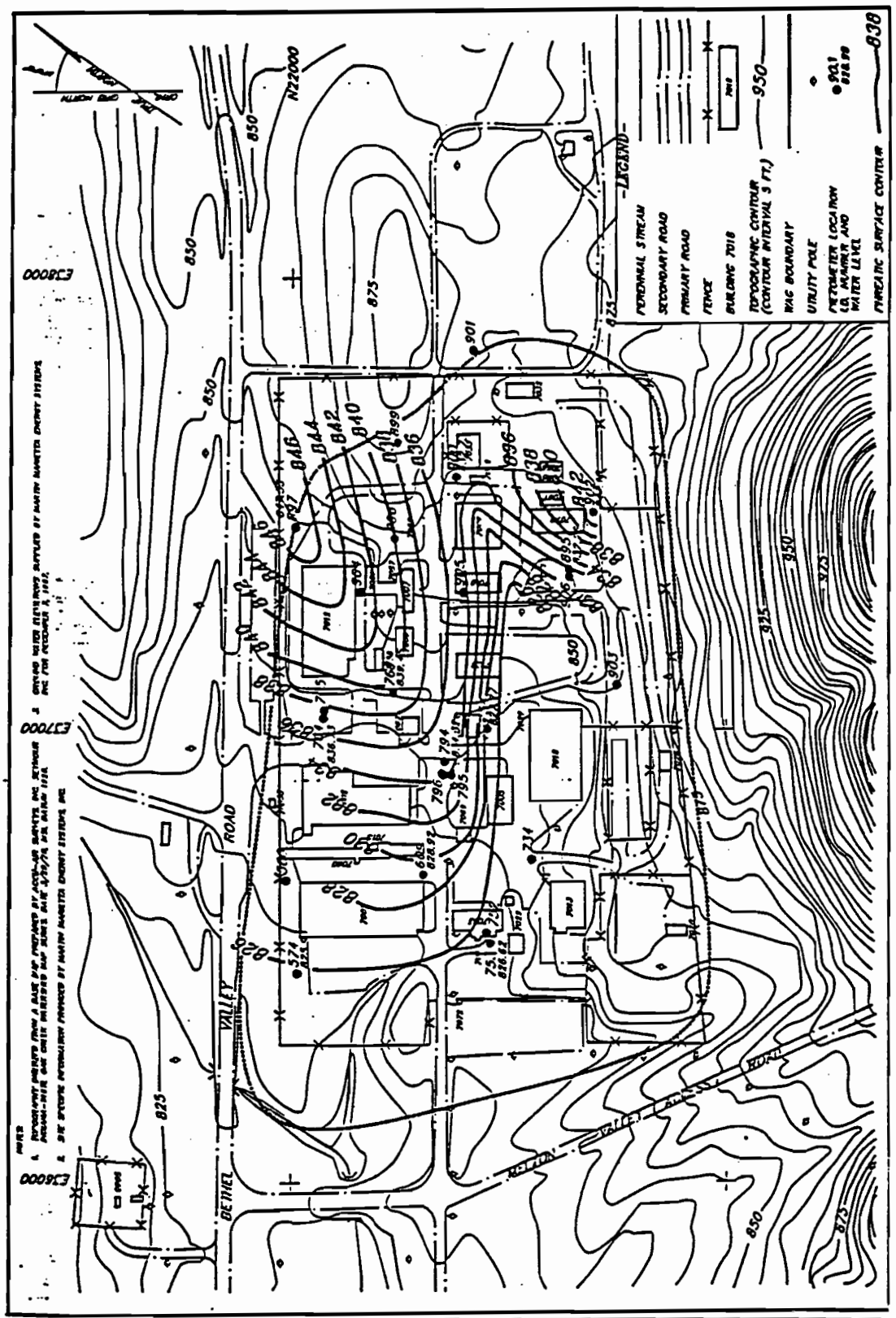
3. Policy on Cleanup Levels for Gasoline and Other Petroleum Hydrocarbons in Ground Water, Policy UST 001-1, Tenn. Dept. of Health and Environment, Div. of Groundwater Protection, Knoxville, Tenn., 1987.

4. J. Autrey, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., personal communication to G. Mandry, Remedial Action Program, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., 1989.

5. G. Mandry, Remedial Action Program, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., personal communication to B. Frederick, ERC Environmental and Energy Services Company, Inc., Oak Ridge, Tenn., 1989.

Appendix A

GEOHYDROLOGIC DATA



WAG 17 PHREATIC SURFACE
BASED ON SHALLOW PIEZOMETERS
MARTIN MARIETTA ENERGY SYSTEMS
SCALE: 1" = 200'

EDGe Engineering, Design & Geosciences Group, Inc.
723 Pellissippi Parkway
P.O. Box 22770 Knoxville, Tn 37933-0770

SUMMARY OF CONSTRUCTION DETAILS FOR PIEZOMETERS IN WAG 17
Excerpted From The EDGe Group's Piezometer Construction File
Distances Are In Feet From Ground Surface
Elevations Are In Feet Above MSL

Piezometer Number	Base of Screen (ft.)	Screen Length (ft.)	Top of Sandpack (ft.)	Measuring Point El.	Ground Surface El.	Depth to Top of Rock (ft.)
574	14.20	10.00	3.20	831.75	830.00	14.50
586	41.70	10.00	30.00	836.33	834.60	7.50
609	33.20	10.00	21.50	836.74	834.90	11.00
734	58.00	10.00	47.00	842.50	842.50	11.00
752	65.00	10.00	53.00	836.02	835.90	5.00
753	32.20	10.00	20.00	838.02	836.13	8.00
754	34.00	10.00	24.00	841.63	839.65	11.00
764	22.20	10.00	9.00	844.03	842.30	4.00
765	72.00	10.00	61.00	845.01	843.07	4.00
769	31.00	10.00	19.00	848.50	846.49	8.00
794	12.00	7.00	4.00	840.92	841.08	11.00
795	11.50	5.00	5.50	839.74	840.04	NA
796	12.50	5.00	7.00	839.92	840.08	10.00
895	25.70	10.00	14.50	860.04	858.36	26.00
896	67.20	10.00	55.00	861.22	859.37	6.50
897	22.00	10.00	11.00	851.99	850.30	7.00
899	70.00	10.00	58.50	872.66	870.86	6.00
900	35.70	10.00	25.00	859.94	858.20	16.00
901	53.20	10.00	42.50	867.14	865.30	8.00
902	21.70	10.00	10.00	866.18	864.38	7.00
903	62.20	10.00	51.00	860.50	858.60	7.50
904	45.00	10.00	34.00	849.42	847.56	4.00
905	41.70	10.00	30.70	858.78	856.89	16.00
906	47.00	10.00	35.00	860.05	857.91	26.00

WAG 17

GROUND WATER LEVEL ELEVATIONS FOR DECEMBER 7, 1987

Piezometer No.	Water Level Elevation In Feet Above Mean Sea Level
574	825.93
586	830.23
609	828.92
734	824.75
752	825.52
753	826.62
754	827.77
764	836.73
765	839.46
769	839.46
794	834.32
795	833.99
796	832.92
895	832.26
896	834.68
897	847.35
899	836.00
900	832.73
901	842.14
902	843.18
904	838.17
905	831.95
906	827.98

WAG 17

HYDRAULIC CONDUCTIVITY VALUES

(Excerpted From The WAG 17 Environmental Data Package)

Well No.	Hydraulic Conductivity (Meters/Day)
574	0.021
586	---
609	0.027
734	0.20
752	0.57
753	0.0013
754	0.049
764	0.031
765	0.023
769	0.037
794	0.0001[a]
795	0.0069
796	0.59
895	0.0048
896	0.0016
897	0.030
899	0.023
900	0.036
901	0.0093
902	0.0029
903	0.032
904	0.64
905	0.22
906	0.00056
Geometric mean	0.020

[a] Data value near zero and too small for accurate determination.

GEOTEK
ENGINEERING COMPANY

MONITOR WELL INSTALLATION DATA

Date Completed: 6/14/86 Drillers: Williams & Lewis

Monitor Well No. 794 Geologist/Engineer: Bill Stanley

Drilling Method: 8" Auger No Sample

Drilling Fluid: N/A

Monitor Well Screen: 7'. #10 Slot. 2" PVC

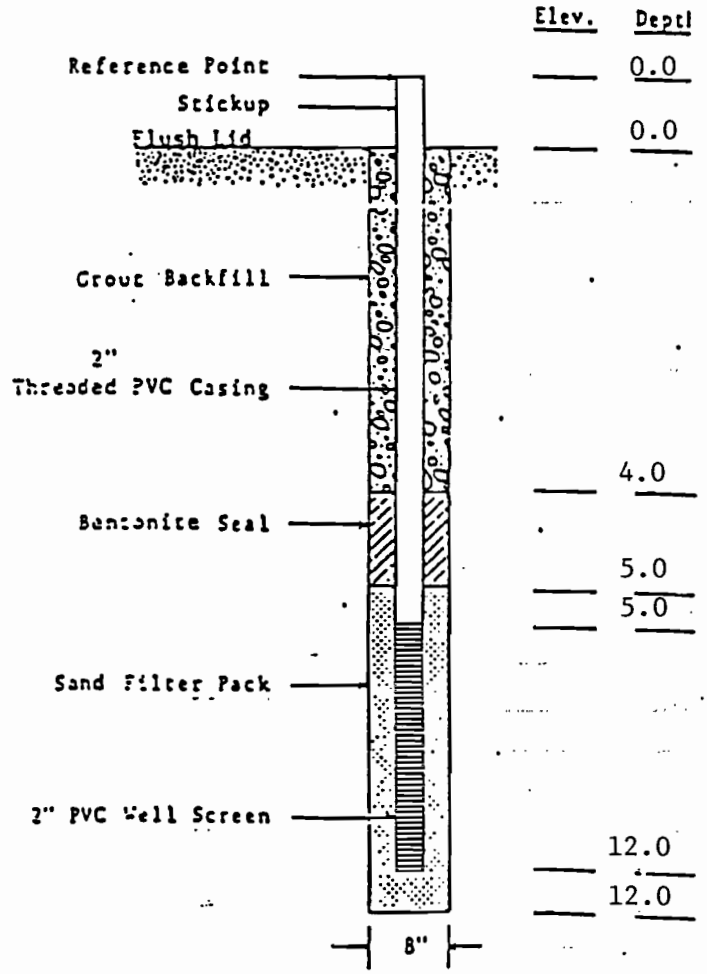
Method of Development: N/A

STRATIGRAPHY

Soil/Rock	Depth

WATER LEVEL READINGS

Date	Depth Below Reference Point	Elev.



Comments:

A-12

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GEOTEK
ENGINEERING COMPANY

Log Of Boring

Job No. 83-1370

Client Martin Marietta

Project Gas Storage Tank-X-10 Plant

Location of Boring:

Water Level	
Time	
Date	

Boring No. 794 Date 6/14/86 Sheet 1 of 1

Type of Boring 8" Auger Rig Mobile 8-56

Casing used Yes Size 2" Drilling mud used

Boring begun Boring completed

Ground Elevation referred to

Date

Field Party: Williams & Lewis

Rock Data						Soil Data						
Length cored ft	Recovery ft.	% Recovery	Drilling Time, min.	% Drill Water Return	RQD %	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
										0		6" Asphalt
										1		Limestone Gravel
										2		
										3		
										4		Reddish Brown Silty Clay
										5		
										6		
										7		
										8		
										9		
										10		
										11		Weathered Thin limestone layers
										12		Auger Refusal @ 12.0'. End of Bore
										13		
										14		
										15		
										16		
										17		
										18		
										19		

WATER LEVEL MEASUREMENTS (Field) **Measured by A.E. Hunley ***
Location of Project - Gas Tank 7000 area
Well No. 796

DATE	HOUR	DEPTH TO WATER (FT)**	REMARKS
12-16-86	13:02	3.19	tape
12-30-86	11:15	3.40	tape
1-13-87	12:57	5.08	tape
1-29-87	10:37	3.35	tape-rechecked
2-17-87	9:27	4.27	tape
3-3-87	13:06	3.06	tape
3-18-87	10:32	3.67	tape
4-15-87	10:16	3.71	tape
4-28-87	13:03	4.03	tape
5-19-87	13:10	5.57	tape
6-16-87	14:00	6.41	tape
7-21-87	10:38	6.05	tape
8-25-87	10:20	7.88	tape-rechecked
9-23-87	14:40	8.07	tape
10-28-87	9:09	8.51	tape
11-16-87	13:17	7.47	tape
12-7-87	12:57	7.00	tape
1-5-88	13:53	4.09	tape-rechecked
2-1-88	13:09	4.00	tape
2-29-88	10:43	4.31	tape
4-5-88	10:28	4.22	tape
5-2-88	13:32	4.85	tape
6-6-88	10:03	5.95	tape

*** recopied from original data sheet**

**** Measurement (datum) is 0.16 ft below land surface**

GEOTEK
ENGINEERING COMPANY

MONITOR WELL INSTALLATION DATA

Date Completed: 6/14/86 Drillers: Williams & Lewis

Monitor Well No. 795 Geologist/Engineer: Bill Staley

Drilling Method: 8" Auger No Sample

Drilling Fluid: N/A

Monitor Well Screen: 7'. #10 slot. 2" PVC

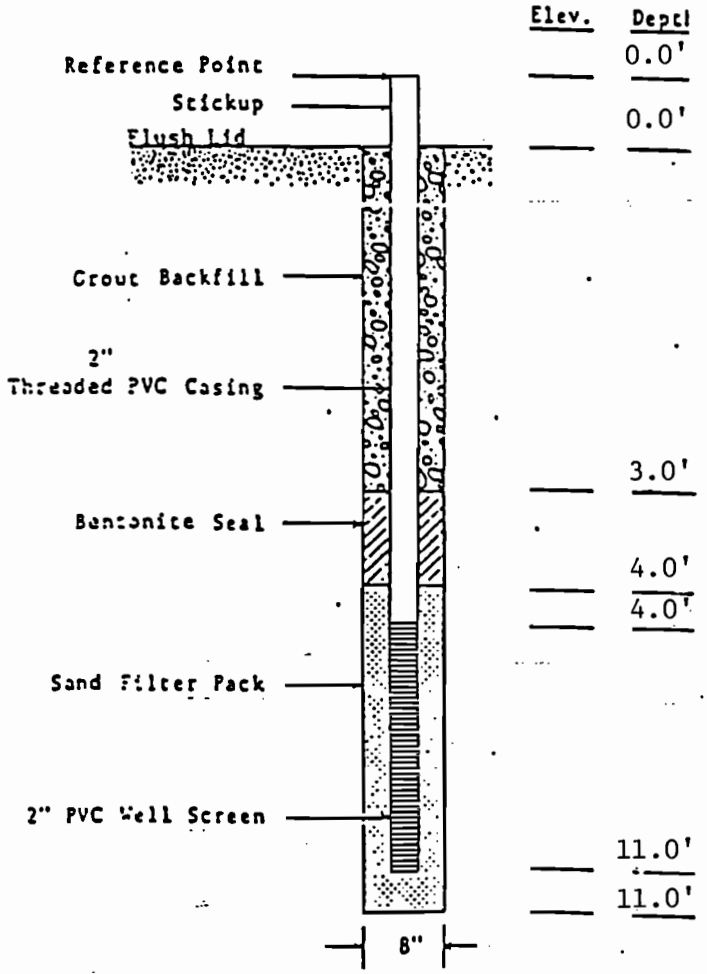
Method of Development: N/A

STRATIGRAPHY

Soil/Rock	Depth

WATER LEVEL READINGS

Date	Depth Below Reference Point	Elev.



Comments:

A-15

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ENGINEERING COMPANY

Log Of Boring

Job No. 83-1370

Client Martin Marietta

Project Gas Storage Tank-X-10 Plant

Location of Boring:

Water Level	
Time	
Date	

Boring No. 795 Date 6/14/86 Sheet 1 of 56

Type of Boring 8" Auger Rig Mobile 8-56

Casing used Yes Size 2" Drilling mud used —

Boring begun 200 Boring completed 330

Ground Elevation — referred to — Date

Field Party: Williams & Lewis

Rock Data						Soil Data						
Length cored Ft	Recovery Ft.	% Recovery	Drilling Time, min.	% Drill Water Return	RQD %	Sample Type	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
										0		6" Asphalt
										1		Brown Silty Clay w/Purple
										2		& Green Sheen
										3		
										4		
										5		Brown Silty Clay
										6		
										7		
										8		Weathered Limestone Mixed
										9		with Brown Clay
										10		
										11		Auger Refusal @ 11.0'. End
										12		of Bore
										13		
										14		
										15		
										16		
										17		
										18		
										19		

WATER LEVEL MEASUREMENTS (Field) **Measured by A.E. Hunley ***
Location of Project - Gas Tank 7000 area
Well No. 795

DATE	HOUR	DEPTH TO WATER (FT)**	REMARKS
12-16-86	13:05	3.00	tape
12-30-86	11:17	2.93	tape
1-13-87	12:55	4.48	tape
1-28-87	10:41	2.88	tape-rechecked
2-17-87	9:24	3.55	tape
3-3-87	13:08	2.77	tape
3-18-87	10:34	3.26	tape
4-15-87	10:18	3.21	tape
4-28-87	13:05	3.03	tape
5-19-87	13:12	4.82	tape-rechecked
6-16-87	14:05	5.54	tape
7-21-87	10:41	5.31	tape
8-25-87	10:23	7.04	tape-rechecked
9-23-87	14:44	6.98	tape
10-28-87	9:11	8.73	tape-rechecked
11-16-87	13:19	6.28	tape
12-7-87	13:00	5.75	tape
1-5-88	13:55	3.24	tape-rechecked
2-1-88	13:11	3.67	tape
2-29-88	10:45	3.57	tape
4-5-88	10:30	3.66	tape
5-2-88	13:34	3.97	tape
6-6-88	10:06	5.28	tape

*** recopied from original data sheet**

**** Measurement (datum) is 0.30 ft below land surface**

GEOTEK
ENGINEERING COMPANY

MONITOR WELL INSTALLATION DATA

Date Completed: 6/17/86 Drillers: Williams & Lewis

Monitor Well No. 796 Geologist/Engineer: Bill Stanley

Drilling Method: 8" Auger No Samples

Drilling Fluid: N/A

Monitor Well Screen: 5'. #10 Slot. 2" PVC

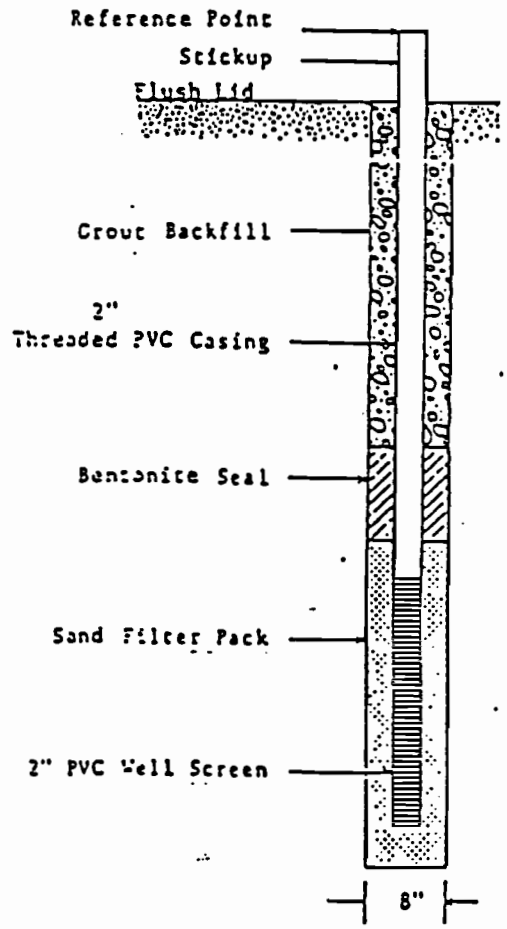
Method of Development: N/A

STRATIGRAPHY

Soil/Rock	Depth

WATER LEVEL READINGS

Date	Depth Below Reference Point	Elev.



Elev.	Depth
	0.0
	0.0
	6.0
	7.0
	7.0
	12.0
	12.0

Comments:

A-16

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GEOTEK
ENGINEERING COMPANY

Log Of Boring

Job No. 83-1370

Client Martin Marietta

Project Gas Storage Tank-X-10 Plant

Location of Boring:

Water Level

Time

Date

Boring No. 796 Date 6/17/86 Sheet 1 of 1

Type of Boring 8" Auger Rig Mobile B-56

Casing used Yes Size 2" Drilling mud used

Boring begun 2:00 Boring completed 3:00

Ground Elevation referred to

Date

Field Party: Williams & Lewis

Rock Data						Soil Data						
Length cored ft	Recovery ft.	% Recovery	Drilling Time, min.	% Drill Water Return	RQD %	Sample Type*	Sample No	Blows per 6" Drive	N-Value	DEPTH IN FEET	GRAPH	Description of soil or rock & notes on drilling operation
										0		6" Topsoil
										1		Limestone Gravel Mixed w/Brown Silty Clay
										2		
										3		
										4		
										5		Brown Silty Clay
										6		Wet Below 5.5'
										7		
										8		
										9		
										10		
										11		
										12		Weathered, Thin Limestone Layers
										13		
										14		
										15		Refusal @ 12.0' End of Boring
										16		
										17		
										18		
										19		

WATER LEVEL MEASUREMENTS (Field) **Measured by A.E. Hunley ***
Location of Project - Gas Tank 7000 area
Well No. 794

DATE	HOUR	DEPTH TO WATER (FT)**	REMARKS
12-16-86	13:00	4.37	tape
12-30-86	11:15	4.06	tape
1-13-87	13:00	4.83	tape
1-28-87	13:20	4.66	tape
2-17-87	9:22	4.35	tape
3-3-87	13:04	3.83	tape
3-18-87	10:29	3.80	tape
4-15-87	10:14	3.83	tape
4-28-87	12:59	4.03	tape
5-19-87	13:08	5.12	tape
6-16-87	13:58	7.94	tape-rechecked
7-21-87	10:35	7.57	tape
8-25-87	10:17	7.14	tape
9-23-87	14:37	7.59	tape
10-28-87	9:07	6.43	tape
11-16-87	13:15	6.81	tape
12-7-87	12:54	6.60	tape
1-5-88	13:51	6.01	tape
2-1-88	13:06	5.00	tape
2-29-88	10:41	4.88	tape
4-5-88	10:25	5.01	tape
5-2-88	13:29	3.98	tape
6-6-88	10:00	5.34	tape

*** recopied from original data sheet**

**** Measurement (datum) is 0.16 ft below land surface**

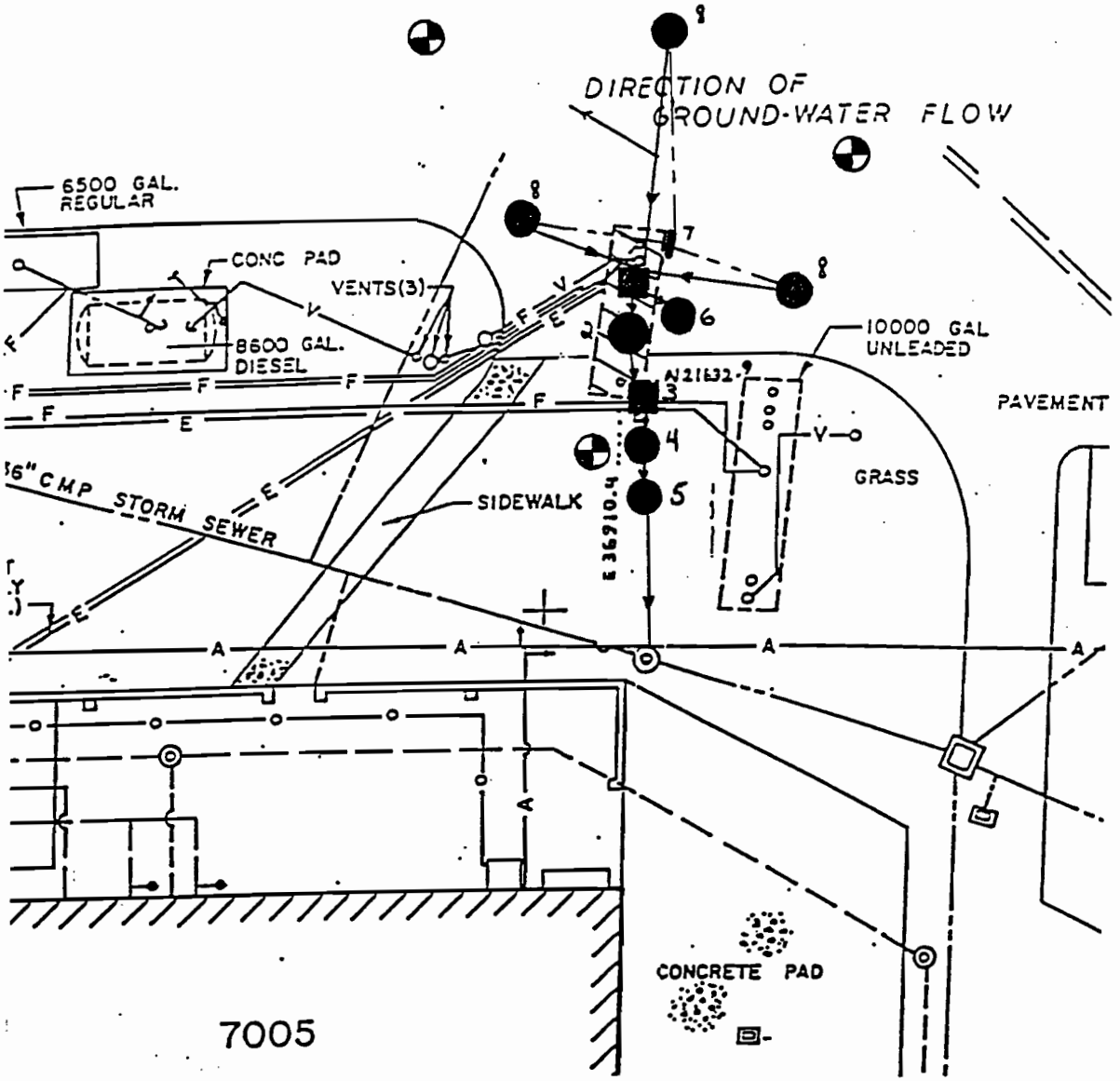
REFERENCES

1. Bechtel National, Inc., CH^2M Hill, EDGe, and PEER, Remedial Investigation Plan for Waste Area Grouping 17, ORNL/RAP/Sub-87/99053/20, Martin Marietta Energy Systems, Oak Ridge Natl. Lab., 1988.

2. Engineering, Design & Geosciences Group, Inc., Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 17 and Lower WAG 2, ORNL/RAP/Sub/87-SB189/2, Martin Marietta Energy Systems, Oak Ridge Natl. Lab. 1988.

APPENDIX B

DESIGN DATA



LEGEND

1 - Oil/Water Separator
2 - Storage Tank
3 - Prefilter
4 & 5 - Carbon Filter
6 - Product Drum
7 - Control Unit
8 - Recovery Well

Note: The plan layout is conceptual. The system may be located in a remote area and the effluent collected and transported to the remote location.

PLAN

Groundwater Treatment System
Wells & Piping Schematic
ORNL Gasoline Tank 7069b Leak Site

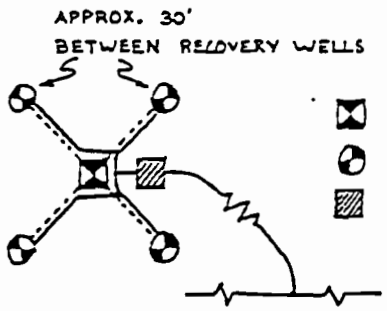
SUBJECT....EARTH RESOURCES CONSULTANTS
BRIAN FREDERICK

PROJECT NUMBER.....

PHASE..... TASK.....

BY JPM.....DATE 06-16-89. CHECKED BY.....DATE.....

SHEET NUMBER ..... OF.....



4002-04 CONTROLLER
2030-4-DA TOTAL FLUIDS PUMP
SRCM-4 SLANT RIB COALESCING OIL/WATER SEPARATOR

----- AIR & SENSOR LINES
—— PUMP DISCHARGE LINES
-W- SEPARATOR DISCHARGE LINE
-∿- SANITARY SEWER

AIR SUPPLY SHOULD BE CAPABLE OF 6 CFM AT 80 PSI. FOR .5 GPM PUMP FLOWS.

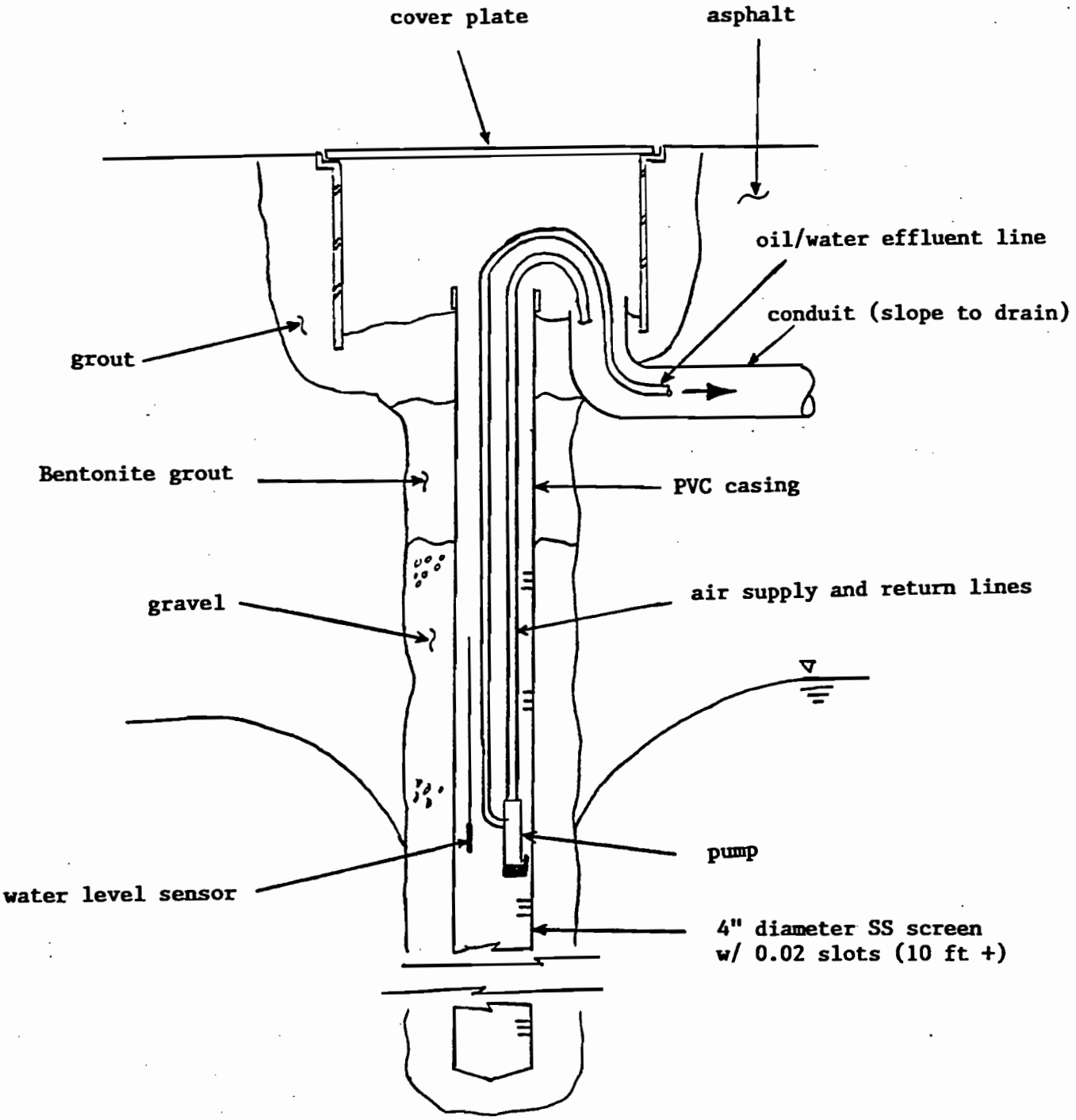
CONTROLLER	#4002-04	$ 4240.00	
PUMPS	#2030-4-DA	$ 1233.00 EACH	x(4) $4932.00
SEPARATOR	#SRCM-4	$ 1700.00 FRP CONSTRUCTION	

SUPPLY/EXHAUST AIR TUBING WITH TEFLON SENSOR WIRE.... $2.40/FT. APPROX. 130 FT. REQUIRED FOR ABOVE SENARIO...$312.00

PRODUCT DISCHARGE HOSE, 3/8" ID $1.20/FT. FROM PUMP TO SEPARATOR, APPROX. 130 FT. $156.00

PUMP SUPPORT CABLE, 1/8" STAINLESS STEEL $1.20/FT. FROM PUMP TO WELL HEAD, APPROX. 48 FT. $57.60

APPROX SYSTEM TOTAL # 11,397.00



TYPICAL GROUND WATER EXTRACTION WELL INSTALLATION

CANSORB® *MODULAR ADSORBERS FOR WATER POLLUTION CONTROL, PROCESS LIQUID PURIFICATION*

- Waste Water/Wash Water
- Radioactive Waste Water
- Laboratory Wastes
- Process Streams/Solvents
- Spill Control
- Protect IX, RO Units

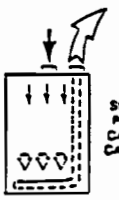
Models C15, C15 XP, C20, C25, C50, C100

Part of the selection of CANSORB Modular Activated Carbon Adsorbers is shown at right. Model numbers give maximum recommended GPM for water and other low viscosity liquids. Maximum flow may be lower for viscous liquids or for removing impurities with low adsorption potential, or to obtain ultralow impurity levels by maximizing adsorbent:liquid contact time. Units employ a proprietary* liquid collection system that promotes even flow distribution for effective purification, maximum adsorbent utilization efficiency and low flow resistance.

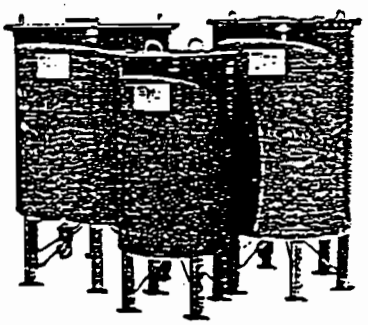
Construction is double epoxy/phenolic or double phenolic lined steel as standard. The C15 XP vessel is cross-linked, high density polyethylene with PVC and fiberglass internals for highly corrosive duty. Standard units have full open heads for replacing adsorbent, but can be provided in closed head versions as needed.

For disposal of hazardous wastes, the saturated C15 converts to a D.O.T. 5B drum. Conversion capability is of interest with non-carbon sorbents as well, for example in nonregenerable uses of ion exchange materials to isolate radioactive wastes.

Left to right: (Foreground) C15, C15 XP; (Middle) C20, C25, (Rear) C50. The larger C100 is not shown.



Standard Flow Pattern — All CANSORB and CANSORB HDS Units



Left to right: CANSORB C50 HDS, C25HDS, C35 HDS, C75 HDS, C100 HDS, and C200 HDS, not pictured, are similar units of successively larger size.

CANSORB HDS Models C25, C35, C50, C75, C100, C200

Units at left are designed for permanent installation/reuse and extra convenience in refilling. Liquid underdrains are designed with unique* collectors as described above, with similar effectiveness in flow geometry and low pressure drop. Model number refers to maximum water viscosity GPM per unit. (Also see contact time comment above.)

Standard construction is heavy steel shell with bolted flange top, completely lined with 1/4 inch thick high density polyethylene. Adsorber tops and bottoms are reinforced as needed to suppress flexing in service. Internals are stainless steel, PVC and fiberglass. Separate fittings allow adsorbent discharge and replacement without disconnecting liquid piping or removing top. Short legs assist in positioning and accommodate a bottom-mounted, side-discharging ball valve for removing spent adsorbents.

See Specifications and Properties page for details on CANSORB and CANSORB HDS models.

*U.S. PATENT 4,375,750
CANADA PATENT 1,157,075

CAUTIONS

MIXTOX liners are normally entirely trouble free in use. However, certain adsorbed materials can undergo oxidation, polymerization, or other chemical reactions with, or in the presence of, activated charcoal (active carbon), often with the liberation of heat. The use of MIXTOX liners to control substances such as ozone, methylethyl ketone (MEK), and concentrated oxygen streams such as oxygen and chlorine is not recommended for these reasons. If there is any doubt concerning the compatibility of activated charcoal with your air or gas stream, TIGG Corporation will be happy to comment or to supply a laboratory sample of its adsorbent for adsorption tests. In the event the MIXTOX unit is to be connected to a storage tank or other source of combustible material, the precautionary use of a suitable flame arrester in the connection line is recommended.

If CANSORB liner piping should be pressure removed, particularly if the adsorbers are fed by a positive displacement pump or other potential sources of high system pressure in upset conditions. Similarly, CANSORB units should be vented during extended shutdowns, to remove gases that might result from biological action on adsorbates.

ENVIROSORB LAB SENTRY, BENCH SENTRY and DOOR MAGNET liners are designed to reduce concentrations of adsorbable odors and other undesirable adsorbable gases and vapors. This simple atmospheric purpose is not intended to substitute for good safety or ventilation practices, nor to substitute for devices such as individual respirators or liners designed to remove poorly adsorbed substances such as carbon monoxide.

WARRANTY

TIGG Corporation warrants these products to be in acceptance with specifications and descriptions herein. Due to the wide variety of possible applications and conditions of use, no additional express or implied warranty is made for performance, safety, or suitability for particular purposes.

ACRONYMS AND INITIALISMS

BTX	benzene, toluene, and xylene
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
TDHE	Tennessee Department of Health and Environment

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39. ER-Central Files
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41-42. Laboratory Records, RC
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