Work Plan

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HAZARDOUS WASTE REMEDIATION
NYSDEC REGION 1

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

Nassau County Firemans Training Center
Bethpage, New York

Nassau County Department of Public Works

JULY 1989

PROJECT: 0726-20-1

MALCOLM PIRNIE

ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WORK PLAN

NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS
FIREMANS TRAINING CENTER

BETHPAGE, NEW YORK

JULY 1989

MALCOLM PIRNIE, INC.

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MALCOLM PIRNIE

NASSAU COUNTY FIRMEN'S
TRAINING CENTER REMEDIAL INVESTIGATION/
FEASIBILITY STUDY DRAFT WORK PLAN

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1.0 PROJECT OBJECTIVES

The Firemen's Training Center (FTC) in Bethpage, New York began operations in 1960. Over the years, a variety of contaminants associated with training activities entered the ground resulting in soil and ground water contamination. Nassau County became aware of the problem and initiated an exploratory investigation in 1985.

On March 21, 1988, New York State Department of Environmental Conservation listed the FTC in the Registry of Inactive Hazardous Waste Disposal Sites in New York as Site Number 130042, and subsequently ranked the FTC under Classification 2, indicating that it presents a significant threat to the public health or environment and remedial action is required.

In July 1987, Nassau County requested Malcolm Pirnie to initiate an investigation to evaluate soil and ground water contamination on, and downgradient, of the FTC. The investigation was focused on four areas of contamination, which were detected in previous investigations conducted by Nassau County:

- Two bodies of liquid product, identified as No. 2 heating oil, floating on the water table on the FTC property,
- Soil contaminated with adsorbed product in the vicinity of the floating product areas,
- Ground water occurring on the site contaminated with soluble fractions of liquid product and other dissolved solvents, principally acetone and methyl ethyl ketone,
- Ground water downgradient of the site containing dissolved organic chemicals.

NCDPW and Malcolm Pirnie jointly prepared a work plan for the investigation and for the selection of cost-effective remediation. Field work began in September, 1987, and was temporarily suspended in December, 1987. Four soil borings and two monitoring wells were completed on the FTC property and four monitoring wells were completed south of the property at that time. New data from other studies have revealed the presence of two small (or one large) areas of floating gasoline and the occurrence of dissolved organic chemicals in an off-site well (OBS-1) located 500 yards downgradient of the southern site boundary.

This work plan describes an RI investigation (RI) designed to collect sufficient data to support an evaluation of suitable remedial alternatives in the Feasibility Study (FS) as required under a Consent Order dated February 9, 1989. Remediation will be complicated by the number of sources and the large area impacted. Considerations will also be given to remedial facilities planned, or already constructed, on the Town of Oyster Bay Landfill, which is immediately adjacent to the FTC.

1.1 OBJECTIVES

Specific objectives for the Remedial Investigation/Feasibility Study (RI/FS) for the FTC site are to:

- Assess the extent and nature of liquid product and ground water contamination on the site,
- Assess the nature and extent of surface and subsurface soil contamination on the site,
- Assess the extent and nature of ground water contamination emanating from the site,
- Assess the potential impact of contamination on public health and the environment,
- Identify potential remedial action alternatives and evaluate their appropriateness and applicability,
- Recommend the most appropriate remedial alternatives,
- Prepare a conceptual design of the recommended remedial alternative(s).

1.2 PROJECT APPROACH

The project approach for the RI/FS at the FTC site includes:

- Existing Data Evaluation
- Field Investigations
- Analysis of Data
- Preliminary Remedial Technologies
- Pilot Studies
- Endangerment Assessment
- Development of Remedial Alternatives
- Screening of Remedial Alternatives
- Detailed Evaluation of Alternatives
- Preliminary Remedial Design

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2.0 BACKGROUND INFORMATION

2.1 SITE LOCATION

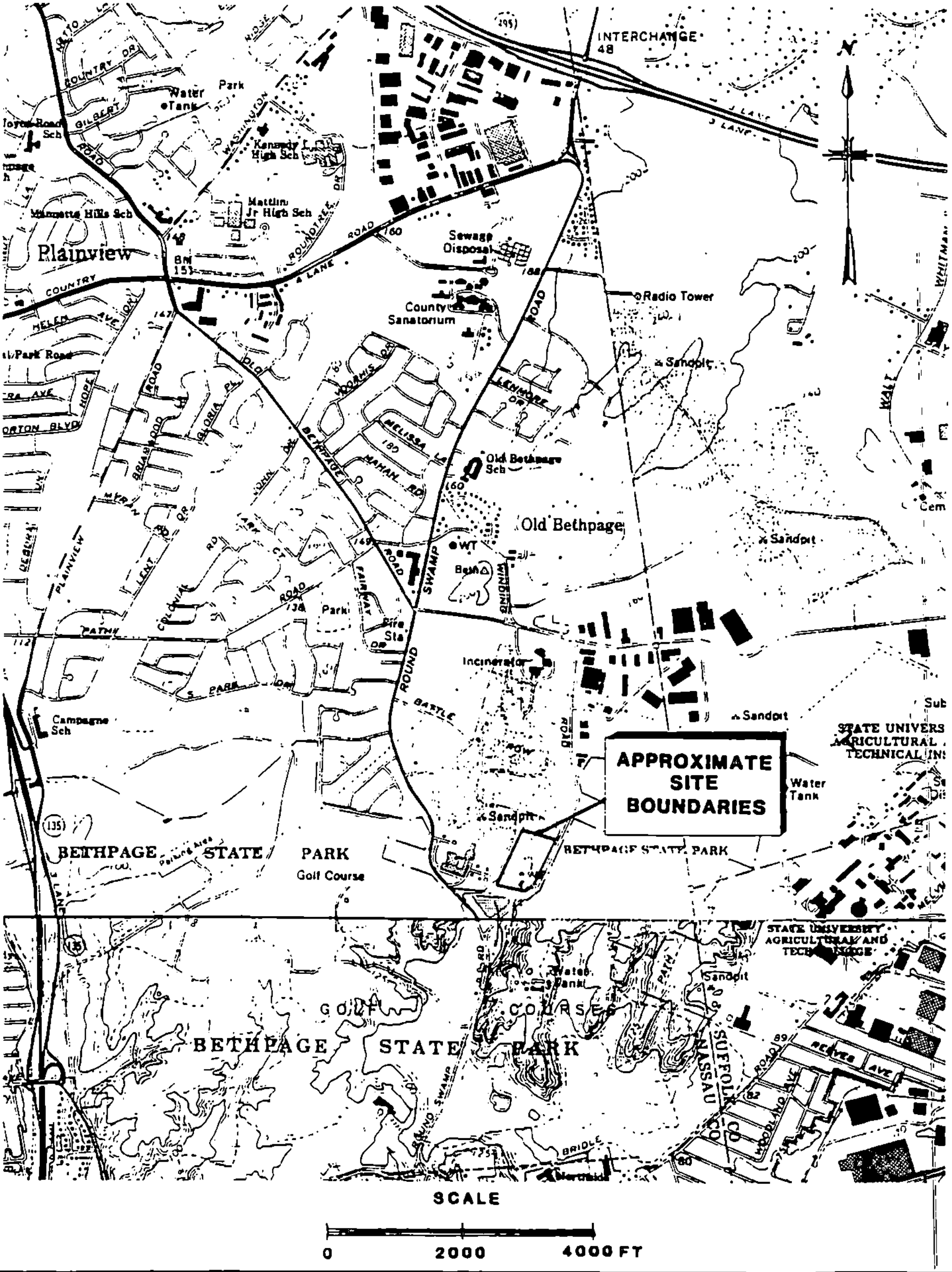
The FTC is located in Bethpage, New York, in southeastern Nassau County. It is situated on the west side of Winding Road, approximately 750 feet northeast of the junction of Winding Road and Round Swamp Road (Figure 2-1). The site is bounded on the east, south, and southwest by the golf courses and wooded areas of Bethpage State Park. The Town of Oyster Bay municipal landfill is located immediately northwest of the FTC. An industrial park is located approximately 2,000 feet northeast of the site and residential communities lie approximately 2,000 feet northwest and 4,000 feet south and southeast of the site.

2.2 SITE DESCRIPTION

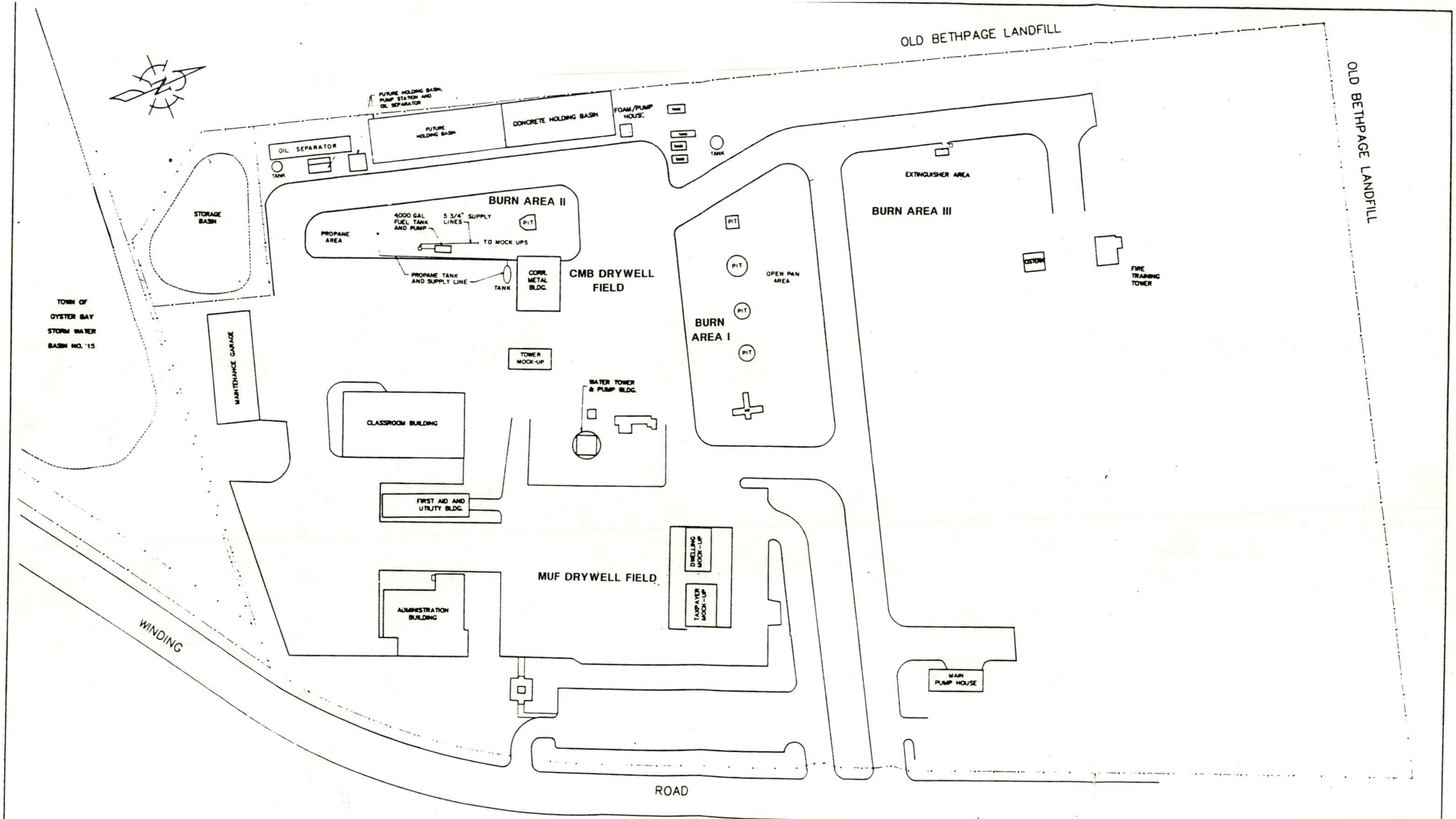
The FTC covers approximately 12 acres on a relatively flat parcel of land with surface elevations ranging from approximately 95 to 100 feet above mean sea level (MSL). The site is comprised of office and classroom buildings, mockup buildings used for test burns, an oil-water separator, open burn areas, and an undeveloped section. The facility plan is shown on Figure 2-2, with greater detail provided on Plate 1.

The southern portion of the site contains the administration building, which is used daily, and the classroom building, which is used during training sessions. A corrugated metal building is located near the center of the developed section of the FTC, which is used to test pumping equipment and other equipment used for training.

Three buildings referred to as "mock-ups" are used for burning during training exercises. Also located in the southern half of the site are several pumps and fuel tanks, which provide fuel for the test fires and an oil-water separator, which recieves the runoff from the burn areas. A fire training tower, located in the northeast corner of the site, is used for training fire fighters. The rest of the northern section of the site is presently unpaved and undeveloped.



MALCOLM PIRNIE	SITE LOCATION MAP FIREMEN'S TRAINING CENTER NASSAU COUNTY	MALCOLM PIRNIE, INC. FIGURE 2-1



MALCOLM PIRNIE	REVISIONS	DES / DWN / CKD	COUNTY OF NASSAU DEPARTMENT OF PUBLIC WORKS **FIREMANS TRAINING CENTER**	**FACILITY LAYOUT**	MALCOLM PIRNIE, INC. **FIGURE 2-2**

2.3 SITE HISTORY

Since 1960, the FTC has provided fire training for Nassau County firemen. Active training presently is given in three building mock-ups and three open burn areas (Plate 1). No. 2 fuel oil and gasoline are the primary sources of ignition. However, prior to 1980 various combustible organic solvents were mixed with the oil to promote burning. The fires are also fueled with wooden pallets and straw. The firemen use high pressure water hoses or chemical fire extinguishers to extinguish the fires. Training operations were suspended in 1987 because combustible gases were detected in several monitoring wells on the site. In order to better understand the potential for the accumulation of subsurface gases, a detailed monitoring program was developed, which resulted is the establishment of the Site Utilization Plan for all training facilities at the FTC. Training was resumed in 1988.

Unburned fuel and solvents have infiltrated into unpaved portions of the facility adjacent to the burn areas and have flowed, mixed with fire fighting and cleanup wash water, into nearby dry wells. The dry wells were constructed with unlined, permeable bottoms and provided conduits for migration of the liquids through the subsurface soils into the ground water. Additional sources of subsurface contamination may have originated from leaks in a network of shallow underground pipes which were used to supply fuel to some of the burn areas. These systems are no longer in service and new systems are being designed and will be constructed in the near future.

An additional dry well was discovered by Nassau County Department of Public Works (NCDPW) personnel in the corrugated metal building (Plate 1). The data indicates that this drywell may have been a source of some of the on-site ground water contamination.

2.4 TOPOGRAPHY AND DRAINAGE

2.4.1 Topography

The topography north and west of the site is generally flat, sloping gradually upward from an elevation of approximately 100 feet to 120 feet (MSL). Hills south and east of the site average 150 feet in elevation. Round Swamp Road, south of the FTC, is situated in a valley which separates the hills. A manmade topographic feature, the Town of Oyster Bay Landfill, rises above the gently sloping landscape immediately north of the FTC to an elevation of about 160 feet. The land surface on the FTC ranges from approximately 95 to 110 feet above mean sea level.

2.4.2 Drainage

Until 1984, storm runoff from the FTC was conveyed through underground pipes to a series of dry wells interconnected with a system of underground concrete basins and overflow pipes. Oil/water discharge from the mockup buildings and burn areas was channeled into the same dry wells through a system of drains surrounding the training facilities.

In 1984, the pipes leading to the dry wells were sealed and a new system of concrete drain pipes was installed throughout the site. The mock-up burn buildings and the open burn areas are surrounded by a system of drains that carry the water to an oil/water separator in the southwest corner of the site.

The dwelling and taxpayer mock-up buildings are connected by a common drain in the basement of each building. A pump in the taxpayer mock-up basement pumps the water/oil mixture from both buildings to an outside pump, where the mixture is then pumped to the oil/water separator.

2.5 GEOLOGY

2.5.1 Regional Geology

The FTC is underlain by approximately 1,100 feet of unconsolidated Coastal Plain sediments of Cretaceous, Tertiary and Quaternary age, which overlie igneous and metamorphic rocks of Precambian age (Isbister, 1966). The sediments dip generally to the southeast. The uppermost unconsolidated unit, which is Pleistocene in age, consists chiefly of outwash sediments deposited by meltwater streams from retreating glaciers. These deposits are generally stratified, moderate-to-well sorted sand and gravel. Some exposures, in on-site excavations reveal coarse stratified ice-contact deposits. In some places, the glacial deposits may consist of reworked and redeposited Cretaceous Age materials which are difficult, or impossible, to differentiate from the underlying Magothy Formation. The glacial deposits constitute the Upper Glacial Aquifer.

The Pleistocene sediments are underlain by the Magothy Formation which ranges from 0 to 800 feet in thickness in northeastern Nassau County (Isbister, 1966). The U.S. Geological Survey correlates the Magothy with the Matawan Group-Magothy Formation, undifferentiated of Cretaceous Age (McClymonds and Franke, 1972). It is a water-bearing geologic unit designated as the Magothy Aquifer.

The Magothy Formation overlies the Raritan Formation, which on Long Island, consists of an unnamed clay member and the Lloyd Sand member. The clay member underlies most of Nassau County, ranging in thickness in the northeastern section of the country from 0 to about 200 feet (Isbister, 1966). The unit is an aquitard and separates the Magothy Aquifer from the underlying Lloyd Aquifer. The Lloyd sand member is typically composed of interbedded gravel, sand, sandy clay and clay. In the vicinity of the site, the Lloyd sand member ranges in thickness from 200 to 250 feet.

2.5.2 Local Geology

Pleistocene age glacial outwash deposits range from 0 to 25 feet thick on the site. A continuous dense gray-brown clay lens is located in the western portion of the site. The lens extends approximately 700 feet in the north-south direction and ranges from approximately 2 to 15 feet in thickness. The east-west dimension of the clay is not known as the unit extends onto the adjacent Town of Oyster Bay property. However, boring information provided by the Town suggests that the clay lens may pinch out about 200 feet west of the FTC boundary. The top of the clay is at a depth of approximately 10 to 12 feet and extends to a depth approximately 25 feet. Coarse grained ice contact deposits were observed at the base of the clay in an excavation located on the western boundary of the property.

Generally on the FTC, where the clay does not occur, the shallow materials are either a tan to cream, fine to medium sand, or a medium brown orange quartz sand. Overlying the glacial clay and this sand unit, is up to approximately 5 feet of fine to coarse, rounded to subrounded quartz sand and gravel with lenses of gray to orange silty clay. The sand and gravel underlies 5 to 7 feet of brown black quartz sand and fill material.

The Matawan Group - Magothy Formation, undifferentiated underlies the glacial deposits. The upper 100 to 120 feet of that formation generally consists of tan to cream fine to medium sand with occasional discontinuous lenses of fine to medium gravel, silt, and clay. Beneath this upper zone is a 10 to 40 foot thick bed that ranges from silty clay to clayey silt or sand. Below the clayey material, two borings penetrated 40 to 60 feet of tan to cream, fine to medium sand with discontinuous silty clay lenses. The clay lenses were more abundant towards the bottoms of the borings. None of the borings fully penetrated the Magothy Formation. The upper portion of the Magothy was reworked during the Pleistocene Epoch by glacial meltwater streams. The contact between the Magothy and the reworked Magothy is difficult, if not impossible to differentiate.

2.6 HYDROGEOLOGY

Ground water on the FTC occurs in the basal part of the Upper Glacial Aquifer and the Magothy Aquifer. The overall saturated zone is a thick sequence of sand with varying amounts of silt and clay. Locally, the numerous clay and silt layers, which are usually of limited areal extent, impede vertical ground water movement, resulting in semi-confined conditions which become more confined with increasing depth.

There is not, however, a continuous confining unit separating the water table zone from the deeper confined portions of the aquifer.

The water table on the FTC is approximately 40 feet below ground surface (60 feet above sea level). In October, 1987, water level measurements were made in the monitoring wells located on the FTC, wells located in Bethpage State Park, and selected monitoring wells surrounding the Town of Oyster Bay landfill. The water level measurements indicate that water in the shallow zone is generally moving to the south-southeast in the vicinity of the FTC, in an arcurate pattern away from the site and the adjacent landfill. A round of water level measurements in new wells located on the FTC in June confirms that the shallow ground water is generally flowing in a south-southeast direction.

The ground water elevations in wells screened approximately 80 to 100 feet below the ground surface indicate that to the east of the site, water in this deeper zone also flows generally to the south-southeast. However, on the FTC property, water in the 80 to 100 foot zone is generally flowing to the south-southwest. Comparisons of water levels in the shallow and deeper zones indicate a general downward vertical hydraulic gradient.

In the northwestern part of the site, a perched water body occurs above the glacial clay lens. The perched water is found approximately 10 feet below land surface and extends vertically to the upper surface of the clay, approximately 11 to 15 feet below grade.

2.7 HISTORICAL DATA

In 1985, the NCDPW,in conjunction with Environmental Resources Management (ERM), initiated the first exploratory investigation on the FTC. Three sources of soil contamination were identified during preliminary soil sampling. They included the Mock-Up Building Drywell Field (MUF), the Corrugated Metal Building Drywell Field (CMB), and the Burn Area I Drywell Field (BAF). These areas are shown on Plate 1. The NCDPW and ERM conducted a further soils investigation to characterize and assess the horizontal and vertical extent of soil contamination beneath, and adjacent to, drywells in each targeted area. The drywells ranged from 10 to 34 feet deep and the soil borings extended at least 16 feet below the bottom of each drywell. Selected borings were continued to the water table, which is approximately 38 feet below grade.

That investigation indicated that soils in the vicinity of the MUF and BAF dry well fields are generally contaminated with high levels of Total Petroleum Hydrocarbons (TPH) and benzene, toluene and xylene compounds (BTX) from the bottoms of the drywells down to the water table. The contaminated areas are shown on Plate 1. In the MUF area, TPH concentrations ranged from less than 100 parts per million (ppm) to 130,000 ppm, and BTX concentrations ranged from less than 100 parts per billion (ppb) to 7,830 ppb. In the BAF area, TPH concentrations ranged from 110 ppm to 19,000 ppm and BTX concentrations ranged from less than 100 ppb to 9,600 ppb. Contamination extends laterally approximately six feet from each MUF drywell, and about 12 feet from each BAF drywell. In the vicinity of the CMB area, soil contaminated with TPH and BTX generally extends to a depth of 8 feet below the bottoms of the drywells, and laterally approximately 8 feet beyond the walls of the drywells.

Between December, 1985, and January, 1987, NCDPW and ERM installed 33 monitoring wells, which are listed in Table 2-3. Their locations are shown on Plates 1 and 2. The locations and depths of the wells were selected to delineate the bodies of liquid product floating on the water table, ground water occurring on the site contaminated with soluble fractions of liquid product and dissolved solvents, and ground water downgradient of the site containing low concentrations of dissolved organic chemicals.

The water samples were collected in monitoring wells by both NCDPW and ERM on numerous occasions, and were analyzed for a variety of parameters, which included volatile organic compounds (VOCs), semi-volatile organic compounds (including Polynuclear Aromatic Hydrocarbons (PAHs)) associated with petroleum products and industrial solvents, and inorganic parameters (including metals). EcoTest Laboratories of North Babylon and the NCDPW lab at Cedar Creek, conducted the analyses.

TABLE 2-1

SUMMARY OF INORGANIC GROUND-WATER ANALYSES
FIREMEN'S TRAINING CENTER
NASSAU COUNTY, NEW YORK

	Chlorides (mg/l)	pH	Specific Conductivity umhos/cm	oT C	Sulfates as SO_4 mg/l	Ammonia as H mg/l		Iron mg/l	Manganese mg/l	Lead mg/l
Maximum * Ambient Level	12	6.2	79		28	.10	Metal Standard	0.3	0.05	.05
W-1		P R O D U C T		I N	W E L L					
W-2	37.5	6.2	460	17	24	2.4		130.0	11.5	.03
W-3	47.5	6.2	347	16.2	23	2.4		8.9	5.05	.10
W-4A	100	5.9	630	20.0	60	3.2		17.0	41.00	.03
W-4B	240	6.4	1600	19.0	100	7.2		0.3	9.80	BDL
W-5	68	5.4	430	18.8	100	1.2		0.3	NA	BDL
W-6	340	7.0	2200	36.0	100	0.8		5.6	NA	BDL
W-7A	30	5.9	310	15.3	28	1.2		0.2	NA	BDL
W-7B	23	6.3	546	16.0	14	21.2		10.3	BDL	.01
W-8A	20	5.9	304	17.0	38	0.8		0.2	NA	.03
W-8B	100	6.3	612	17.5	40	2.5		0.5	BDL	.02
W-9A	27	6.2	320	17.0	50	110		6.5	8.40	BDL
W-9B	25	63	410	16.0	30	4.5		1.5	1.80	.04
W-10	142.5	5.8	692		NA	NA		NA	NA	NA
W-11	NA	6.2	419		NA	NA		NA	NA	NA
W-12	NA	6.3	570		NA	NA		NA	NA	NA
W-13	17.5	6.1	510		NA	NA		NA	NA	NA
W-14A	17.5	6.3	651		NA	NA		NA	NA	NA
W-14B	NA	6.2	651		NA	NA		NA	NA	NA
W-15	425	6.2	414		NA	NA		NA	NA	NA
W-16	NA	6.1	492		NA	NA		NA	NA	NA
W-17	NA	NA	NA		NA	NA		NA	NA	NA
W-18	NA	NA	NA		NA	NA		NA	NA	NA
W-19	NA	NA	NA		NA	NA		NA	NA	NA
BP-1A	25	5.0	394		.79	.73		0.2	NA	.01
BP-1B	75	5.4	395		NA	3.08		0.2	NA	.01
BP-1C	93	6.0	557		1.48	1.80		0.3	NA	.03
BP-2A	BDL	6.0	346		NA	NA		NA	NA	NA
BP-2B	38	5.7	367		NA	NA		NA	NA	NA

NA = NOT ANALYZED
BDL = BELOW DETECTION LIMIT
* = LEVEL FROM NCDPW PHASE I REPORT

TABLE 2-2

SUMMARY OF VOLATILE ORGANIC COMPOUND GROUND-WATER ANALYSES (ppb)
FIREMEN'S TRAINING CENTER
NASSAU COUNTY, NEW YORK

	W-1	W-2	W-3	W-4A	W-4B	W-5	W-6	W-7A	W-7B	W-8A	W-8B	W-9A	W-9B	W-10	W-11
Benzene	164	232	955	113	BDL	57	3	5	2,693	28	35	3	BDL		1,700
Toluene	240	13	16,948	9	BDL	BDL	BDL	5	2,082	6	1	3	BDL		3,789
Xylenes	766	6	12,072	5	7	14	12	7	2,186	14	3	3	BDL		4,577
Ethylbenzene	126	20	2,174	11	BDL	BDL	5	1	867	3	BDL	5	BDL		934
Maximum Total Aromatic Hydrocarbons (BTX)	1,296	271	32,152	38	7	71	20	18	7,828	51	39	14	BDL	PRODUCT	11,000
Dichlorobenzene	BDL	82	1,845	NA	NA	BDL	NA	7	BDL	95	9	NA	3		1,356
1,2-Transdichloroethylene	16.2	83	764	BDL	9	78	37	132	910	6	17	37	8		1,575
1,1,1-Trichloroethane	BDL	2	39	BDL	BDL	2	BDL	4	3	BDL	BDL	BDL	5		17
Trichloroethylene	BDDL	6	204	.3	12	5	BDL	70	9	BDL	BDL	BDL	BDL		14
Tetrachloroethylene	BDL	BDL	321	BDL	BDL	16	BDL	207	21	BDL	1	BDL	1		31
Maximum Total Chlorinated Hydrocarbons (CHC)	16.2	184	4,011	40	37	114	42	439	1,020	101	49	39	15		2,998
Maximum Total Volatile Organics (TVOC)	1312.20	362	33,089	35	39	129	54	446	8,440	152	65	42	15		13,997
Total Polynuclear Aromatic Hydrocarbons (PAH)	NA	3,202	NA	NA	NA	NA	NA	BDL	35	BDL	BDL	NA	NA		BDL

	W-12	W-13	W-14A	W-14B	W-15	W-16	W-17	W-18	W-19	BP-1A	BP-1B	BP-1C	BP-2A	BP-2B	TU-3
Benzene	34	7	1,009	42	123	BDL	15	17	25	BDL	BDL	1	102	87	0.5
Toluene	5	BDL	1,114	3	19	2	4	22	3	BDL	BDL	3	6	1	BDL
Xylenes	11	7.5	2,489	81	103	BDL	66	148	13	BDL	BDL	BDL	5	6	2.5
Ethylbenzene	2	BDL	322	BDL	27	BDL	BDL	31	9	BDL	BDL	BDL	BDL	BDL	0.5
Maximum Total Aromatic Hydrocarbons (BTX)	52	15	4,934	126	172	2	85	223	50	BDL	BDL	4	113	94	3.5
Dichlorobenzene	NA	18	620	82	157	108	207	319	98	BDL	BDL	22	7	3	8
1,2-Transdichloroethylene	443	712	664	490	25	9	4	46	7	BDL	BDL	BDL	85	58	BDL
1,1,1-Trichloroethane	25	48	29	17	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Trichloroethylene	333	632	354	184	BDL	1	BDL	1	BDL	BDL	BDL	BDL	1	3	BDL
Tetrachloroethylene	981	1,773	1,254	504	BDL	1	BDL	1	BDL	BDL	0.4	1.4	1	BDL	BDL
Maximum Total Chlorinated Hydrocarbons (CHC)	1,809	3,204	2,922	1,277	182	122	212	367	105	0.5	2	24	97	103	9.5
Maximum Total Volatile Organics (TVOC)	1,862	3,219	7,855	1,406	628	120	310	584	155	0.5	2	27	206	172	19
Total Polynuclear Aromatic Hydrocarbons (PAH)	NA	NA	BDL	NA	BDL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 2-3

MONITORING WELLS

FIREMEN'S TRAINING CENTER

Well No.	Date Installed	Type of Well	Consultant
W-1	12/12/85	Water	NCDPW
W-2	12/13-15/85	Water	NCDPW
W-3	12/16-17/85	Water	NCDPW
W-4A	12/17-18/85	Water	NCDPW
W-4B	5/28/86-6/4/86	Water	NCDPW
W-5	5/20/86	Water	NCDPW
W-5S	5/31/88	Soil Gas	Malcolm Pirnie
W-6	5/19/86	Water	NCDPW
W-7A	5/21/86	Water	NCDPW
W-7B	6/16-17/86	Water	NCDPW
W-8A	5/22/86	Water	NCDPW
W-8B	6/13-15/86	Water	NCDPW
W-9A	5/23/86	Water	NCDPW
W-9B	6/9-10/86	Water	NCDPW
W-10	12/4-5/86	Water	NCDPW
W-10S	5/25/88	Soil Gas	Malcolm Pirnie
W-11	11/4-5/86	Water	NCDPW
W-12	10/28-29/86	Water	NCDPW
W-13	10/30-31/86	Water	NCDPW
W-14A	10/31/86-11/3/86	Water	NCDPW
W-14B	12/22-23/86	Water	NCDPW
W-15	12/5-6/86	Water	NCDPW
W-16	12/18-19/86	Water	NCDPW
W-17	12/29-30/86	Water	NCDPW
W-18	1/27-28/87	Water	NCDPW
W-19	1/30-31/87	Water	NCDPW
W-20A	6/22/87	Water	NCDPW
W-20B	6/8/87	Water	NCDPW
W-20C	11/5-6/87	Water	Malcolm Pirnie
W-20D	10/28/87	Water	Malcolm Pirnie
W-21A	6/3/87	Water	NCDPW
W-21B	5/29/87	Water	NCDPW
W-21C	11/18-20/87	Water	Malcolm Pirnie
W-21D	11/10-13/87	Water	Malcolm Pirnie
W-22	10/26-28/87	Water	Malcolm Pirnie
W-23	10/29/87	Water	Malcolm Pirnie
W-24	6/2/88	Water	Malcolm Pirnie
W-25	6/2/88	Water	Malcolm Pirnie
W-26	6/6/88	Water	Malcolm Pirnie
W-27	6/6-7/88	Water	Malcolm Pirnie
W-28	6/7/88	Water	Malcolm Pirnie
W-29	6/8/88	Water	Malcolm Pirnie
W-29S	6/8/88	Soil Gas	Malcolm Pirnie

TABLE 2-3

MONITORING WELLS (Continued)

FIREMEN'S TRAINING CENTER

Well No.	Date Installed	Type of Well	Consultant
W-30	6/8/88	Water	Malcolm Pirnie
W-31	6/8/88	Water	Malcolm Pirnie
W-32	6/9/88	Water	Malcolm Pirnie
W-33	6/9/88	Water	Malcolm Pirnie
BP-1A	1/7/87	Water	NCDPW
BP-1B	1/9/87	Water	NCDPW
BP-1C	3/13/87	Water	NCDPW
BP-2A	1/20/87	Water	NCDPW
BP-2B	1/22/87	Water	NCDPW
HSW-2	5/23/88	Soil Gas	Malcolm Pirnie
HSW-3	5/24/88	Soil Gas	Malcolm Pirnie
HSW-4	5/24/88	Soil Gas	Malcolm Pirnie
HSW-5	5/24/88	Soil Gas	Malcolm Pirnie
HSW-6	5/25/88	Soil Gas	Malcolm Pirnie
AQW-1	5/25/88	Soil Gas	Malcolm Pirnie
AQW-2	5/25/88	Soil Gas	Malcolm Pirnie
AQW-3	5/25/88	Soil Gas	Malcolm Pirnie
AQW-4	5/25/88	Soil Gas	Malcolm Pirnie
AQW-6	5/31/88	Soil Gas	Malcolm Pirnie
GW-1S	5/26/88	Soil Gas	Malcolm Pirnie
GW-1D	5/26/88	Soil Gas	Malcolm Pirnie
GW-2S	5/26/88	Soil Gas	Malcolm Pirnie
GW-2D	5/26/88	Soil Gas	Malcolm Pirnie
GW-4S	5/26/88	Soil Gas	Malcolm Pirnie
GW-4D	5/26/88	Soil Gas	Malcolm Pirnie
GW-5S	5/26/88	Soil Gas	Malcolm Pirnie
GW-5D	5/26/88	Soil Gas	Malcolm Pirnie
GW-6S	5/27/88	Soil Gas	Malcolm Pirnie
GW-6D	5/27/88	Soil Gas	Malcolm Pirnie
GW-7S	5/27/88	Soil Gas	Malcolm Pirnie
GW-7D	5/27/88	Soil Gas	Malcolm Pirnie
GW-8S	5/31/88	Soil Gas	Malcolm Pirnie
GW-8D	5/31/88	Soil Gas	Malcolm Pirnie
GW-9S	5/31/88	Soil Gas	Malcolm Pirnie
GW-9D	5/31/88	Soil Gas	Malcolm Pirnie
GW-10S	6/1/88	Soil Gas	Malcolm Pirnie
GW-10D	6/1/88	Soil Gas	Malcolm Pirnie
GW-11S	6/1/88	Soil Gas	Malcolm Pirnie
GW-11D	6/1/88	Soil Gas	Malcolm Pirnie
GW-12S	6/3/88	Soil Gas	Malcolm Pirnie
GW-12D	6/3-6/88	Soil Gas	Malcolm Pirnie

The chemical analyses indicated the presence of both aromatic and chlorinated hydrocarbons in the ground water on the FTC. Aromatic hydrocarbons (BTX) are associated with petroleum products, and chlorinated hydrocarbons (CHC) are typically used as industrial solvents. The aromatic hydrocarbons include benzene, toluene, xylenes and ethylbenzene. The chlorinated hydrocarbon compounds consistently detected in ground water at the FTC are dichlorobenzene, 1-2-transdichloroethylene, 1,1,1-trichloroethane, trichloroethylene and tetrachlororethylene. A summary of the inorganic and organic analyses is presented in Tables 2-1 and 2-2.

No. 2 fuel oil floating on the ground water was detected near the the MUF and BAF drywells fields (Plate 1). However, the lateral extent of these product bodies was not delineated.

2.8 PRELIMINARY REMEDIAL INVESTIGATION

A summary of the work and the data generated in the Preliminary Remedial Investigation is presented in this section. The proposed scope of work for the Remedial Investigation is given in Chapter 3.0 and is based on the fulfillment of data needs to determine the extent of soil, product, and ground water contamination on the FTC.

2.8.1 Hydrogeological Investigations

2.8.1.1 Initial Field Program

In September, 1987, NCDPW retained Malcolm Pirnie, Inc. to conduct a Preliminary Remedial Investigation at the FTC.

The initial phase of field work conducted from September to December, 1987, consisted of several tasks: drilling soil borings adjacent to the free liquid product areas; installing ground water monitoring wells; and sampling soil, ground water and liquid product for chemical analysis.

2.8.1.2 Soil Borings and On-Site Monitoring Wells

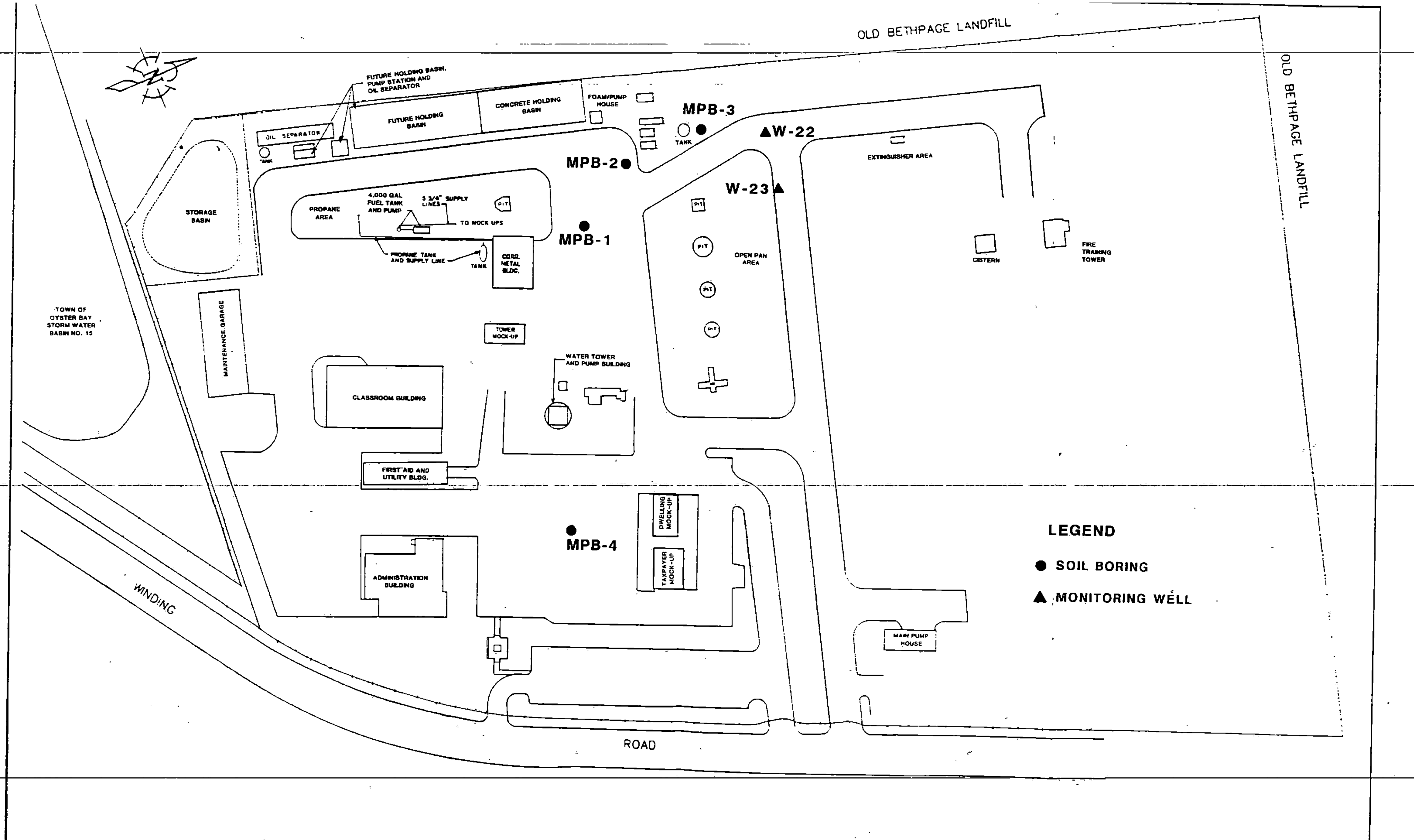
Six soil borings designated MPB-1 through MPB-4, W-22 and W-23 were drilled on the FTC between October 26 and November 4, 1987, as shown on Plate 1 and Figure 2-3. The borings were drilled in the vicinity of the product areas to obtain information on the depth and areal extent of product and contaminated soil, and to identify potential locations for remedial facilities to recover mobile product.

Borings MPB-1, MPB-2, MPB-3, W-22, and W-23 are located adjacent to the floating product area associated with the Burn Area I drywell field (BAF). Boring MPB-4 is located adjacent to the floating product associated with the Mock-Up Building drywell field (MUF).

The borings were drilled with a hollow stem power auger. Split-spoon samples were collected at 5-foot intervals until areas of visible soil contamination were reached. Below that depth, continuous split-spoon samples were collected. Borings MPB-1, MPB-2 and MPB-3 were terminated at the clay layer which occurs 11 to 15 feet below the surface in the BAF area.

One split-spoon sample was selected for chemical analysis from the zone of contamination in each boring. The selected sample from each of the MPB-1, MPB-2 and MPB-3 borings was the one having the highest HNu photoionization reading immediately after sampling. The selected sample from each of the MPB-4, W-22 and W-23 borings was collected from immediately above the water table. Samples were analyzed for full volatile organic chemical fraction plus fifteen and base neutrals (including PAH's) plus fifteen. The parameters were selected based on a review of the existing data. The samples were collected in accordance with procedures outlined in the QAPP and sent to Envirotest Laboratories in Newburgh, NY for analysis.

Borings W-22 and W-23 were completed as monitoring wells. The wells were constructed with 20 feet of 4-inch inside diameter (I.D.) stainless steel well screen with a slot size of 0.020 inches and 4-inch I.D. black steel casing. A summary of all wells installed on the FTC is given in Table 2-3. Stainless steel well screen and black steel casing were used because nearby wells constructed with PVC casing and screen have been deteriorated because of reactions between the chemicals in the



MALCOLM PIRNIE

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APPROXIMATE SCALE IN FEET

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LOCATIONS OF
SOIL BORINGS AND MONITORING WELLS
DRILLED
OCTOBER 26 THROUGH NOVEMBER 4, 1987

MALCOLM PIRNIE INC

FIGURE 2-3

ground water and the PVC materials. The well screen in each well extends 5 feet above the water table, so the casing is never in contact with the groundwater.

The wells are screened across the water table. The well screens are 20 feet long and extend from a minimum depth (top of screen) of 35 feet to a maximum depth (bottom of screen) of 56 feet below ground surface. The annular space was filled with a mixture of Jessie Morie No. 1 and No. 2 gravel pack to 6 feet above the top of the well screen. A seal consisting of 2 feet of bentonite pellets was added to the annular space above the gravel pack, and the remaining annular space was filled with a low permeability cement-bentonite grout to the surface.

Each well was developed using a submersible pump for approximately 2 hours, until the water was visually clear and free of sediment. The water from the development process was discharged into the oil/water separator located on the site.

2.8.1.3 Off-Site Monitoring Wells

Four monitoring wells designated W-20C, W-20D, W-21C, and W-21D were installed southeast of the FTC between October 27 and November 20, 1987, as shown on Plate 2. The purpose of these wells, together with existing monitoring wells, is to provide information on the areal extent and depth of contaminated ground water on and immediately south of the FTC.

Wells W-20C and W-20D are installed adjacent to wells W-20A and W-20B to complete a cluster of four wells each screened at a different depth. In the same way, wells W-21C and W-21D are located adjacent to wells W-21A and W-21B.

The boreholes for each well were drilled using a truck-mounted mud rotary rig. The C wells and the D wells are 160 and 240 feet deep, respectively. The D wells in each cluster were drilled before the shallow wells to provide geologic information. Split-spoon samples were collected every 5 feet starting from 40 feet below ground surface. Data from land surface to 40 feet were available from the drilling of the B wells by the NCDPW in the earlier investigation. The split-spoon samples were used to characterize the geologic materials so that the well screens would be installed in sandy material rather than in silt or clay.

Each well is constructed with 20 feet of 4-inch I.D. stainless steel screen with a slot size of 0.020 inches and 4-inch I.D. black steel casing. The annular space was filled with a mixture of Jessie Morie No. 1 and No. 2 gravel pack to 6 feet above the top of the screen. A 2-foot granular bentonite seal was placed on top of the gravel pack, and the remaining annular space was filled with a cement-bentonite grout to land surface. The wells were completed with a locking cap at grade in curb boxes.

Each well was developed with compressed air for approximately 2 hours, until the water was visually clear and free of sediment. The water was collected in drums for disposal.

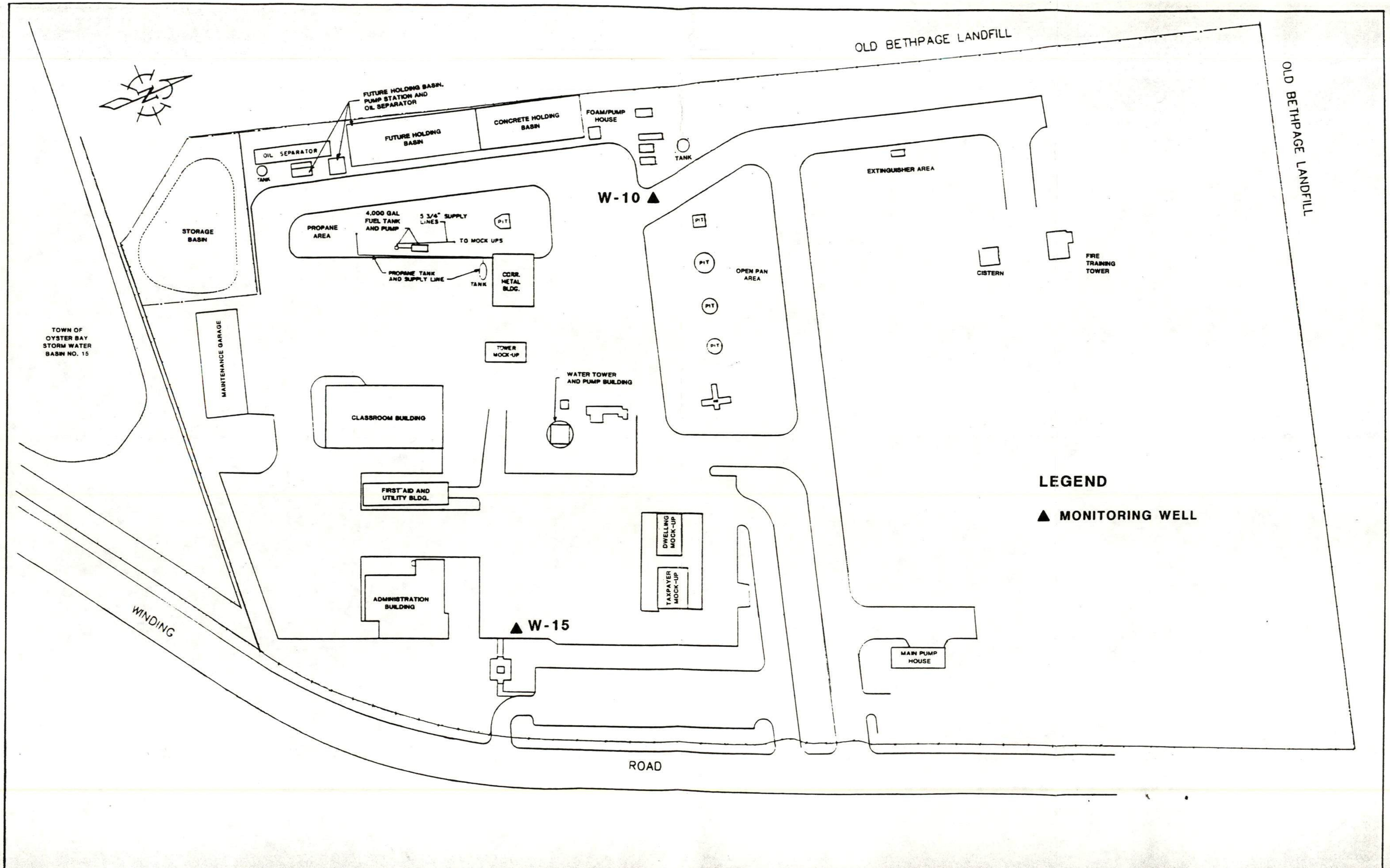
2.8.1.4 Floating Product Sampling

Samples of floating product were collected in wells W-10 and W-15 on September 25, 1987. Well W-10 is located in the center of the BAF product area and well W-15 is in the middle of the MUF product area. The locations of the wells are shown on Figure 2-4.

A teflon bailer was used to collect the product in each well. Before each use, the bailer was disassembled and decontaminated by scrubbing with Alconox and rinsing with distilled water. The bailer was lowered twice into each well to collect the product sample. Each sample was placed in a labeled laboratory prepared container. The samples were delivered to Envirotest Laboratories to identify the product and analyze it for dissolved volatile organic chemicals, base neutral compounds and acid extractable compounds. The samples were also analyzed for total petroleum hydrocarbons using NYSDOH Method 310.13 and an EPA/NIH/NBS library search of non-priority pollutant compounds.

2.8.1.5 Bailer Tests

Bailer tests were conducted on wells W-10 and W-15 on October 8, 1987, to obtain information on the thickness and mobility of the floating product. The volume of product in each well was determined by measuring the depth to water and the depth to product with a sonic



MALCOLM PIRNIE

100 0 100

APPROXIMATE SCALE IN FEET

COUNTY OF NASSAU
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FIREMANS TRAINING CENTER

FLOATING PRODUCT SAMPLING AND BAILER TESTS

SEPTEMBER 25 AND OCTOBER 8, 1987

MALCOLM PIRNIE INC

FIGURE 2-4

interface detector. Before the tests began, product was 4.02 feet thick in well W-10 and 1.95 feet thick in well W-15. Liquid product was removed from each well using a teflon bailer until at least one full casing volume of product was recovered. The product was placed in a 3-gallon bucket to measure the quantity and was then discharged to the oil/water separator.

Immediately after bailing, the depth to water and the depth to product were again measured. The product layer was approximately 1.18 feet thick in well W-10 and 0.64 feet thick in well W-15. The product thickness in the ground was estimated to be between 1.18 and 4.02 feet in well W-10 and 0.64 and 1.95 feet thick in well W-15.

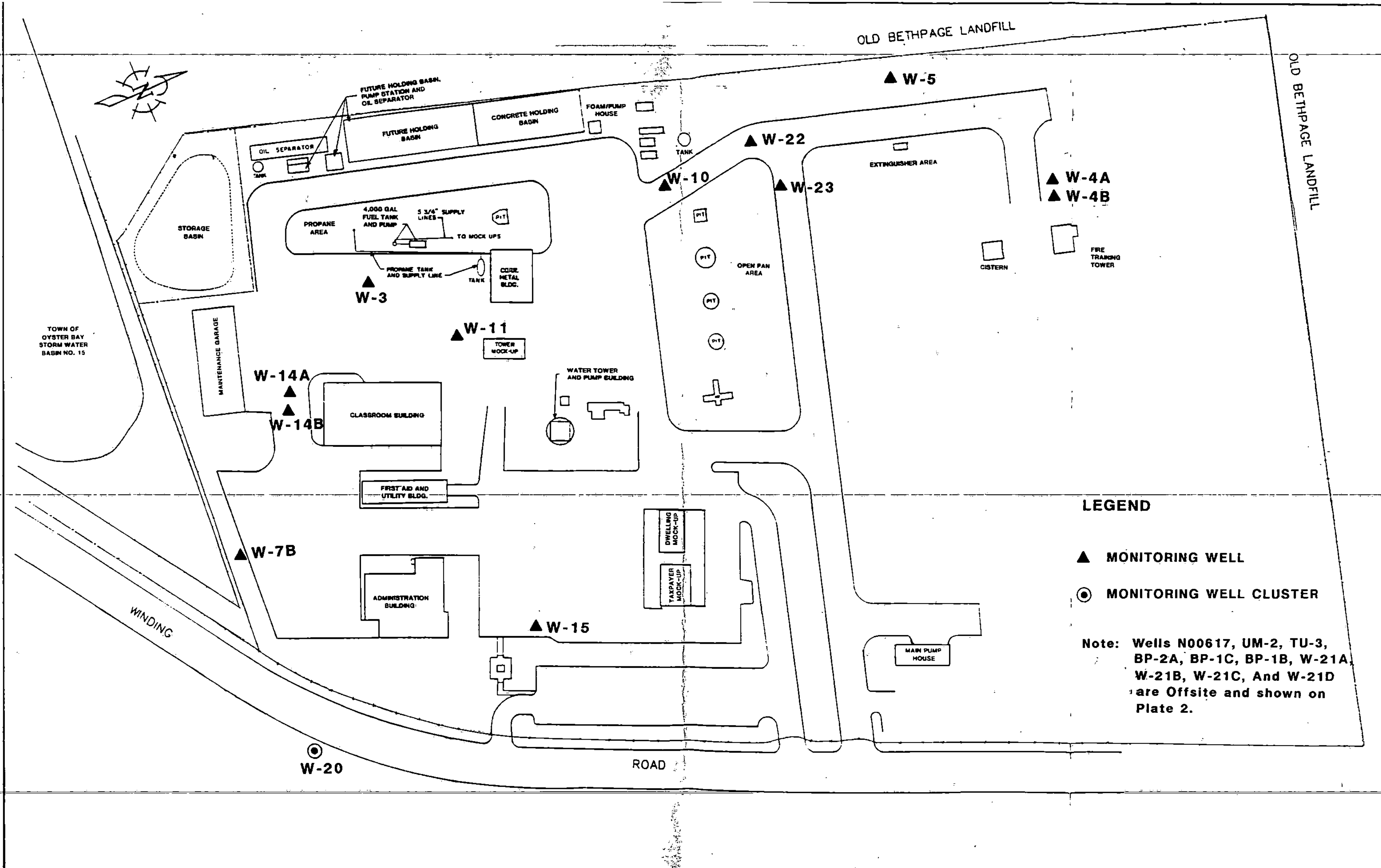
2.8.1.6 Ground Water Sampling

Between September 17 and December 3, 1987, water samples were collected in selected monitoring wells installed by NCDPW and from all the new monitoring wells. The well locations are shown on Figure 2-5 and Plates 1 and 2. The water samples were collected to confirm the results of earlier analyses in the older wells, and to provide data for assessing the extent of ground water contamination.

Before sampling each well, the depth to water was measured from a permanent reference point using a steel tape. The total depth of each well was also measured so that the volume of standing water could be calculated. Prior to each use, the tapes were cleaned with distilled water.

The wells were purged (pumped) until measurements of pH, specific conductance and temperatures stabalized (3-5 volumes of standing water) were evacuated or until the well was pumped dry. Ten-foot lengths of 1.5 inch diameter PVC pipe were attached to the suction hose of the purging pump. The pipe was steam-cleaned between each use. The water was discharged on the ground if readings made with a photoionization indicator (HNu) were not above ambient atmospheric background levels; if the readings were above background levels, the water was placed in drums for disposal.

Measurements of pH, specific conductance and temperature were made in the field at each well. The pH meter was calibrated before each



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FIREMANS TRAINING CENTER

GROUND WATER SAMPLING

SEPTEMBER 17 THROUGH DECEMBER 3, 1987

MALCOLM PIRNIE INC

FIGURE 2-5

measurement. Appropriate instrument settings were selected based on the water temperature before the specific conductance readings were made.

Once the water level in the well had recovered after purging, water samples were collected using 2-foot long, 2-inch diameter stainless steel bailers. The bailers were decontaminated by steam cleaning between each well.

Samples designated for inorganic analyses were field filtered through a 0.45 micron membrane filter before being placed in laboratory prepared sample containers. Other samples were placed in similarly prepared containers and sent to Envirotest Laboratories for analysis of priority pollutant organics plus forty, acetone, methyl ethyl ketone, landfill leachate parameters, PCBs and total petroleum hydrocarbons.

Trip blanks and field blanks were also analyzed for quality assurance and quality control. A chain-of-custody record was prepared at the point of origin for all samples. The samples were hand delivered to the laboratory where the sample custodian immediately checked each sample against the chain of custody record and returned a signed copy of the record to the sampling team. All sampling procedures were conducted in accordance with the procedures given in the QAPP. Analytical parameters and procedures are summarized in Table 2-4 and Table 2-5. All analytical data were validated according to procedures given in the QAPP.

The chemical quality data confirmed that ground water onsite and immediately south of the FTC is contaminated with soluble fractions of liquid product (benzene, toluene, chlorobenzene, ethylbenzene and xylenes) and various solvents (principally acetone, methyl ethyl ketone (2-butanone), carbon disulfide and various chlorinated hydrocarbons. Some of the dissolved solvents have migrated off the site to the south and southeast. In these areas they were detected at lower concentrations than were found on the FTC.

The highest concentrations of contaminants occurs in the shallow ground water in the vicinity of the BAF area and the corrugated metal building extending south-southeast to Winding Road. Downgradient of the property, low concentrations of tetrachloroethene and trans-1,2-dichloroethene were detected at greater depths as far south as N-0617.

TABLE 2-4

ANALYTICAL PARAMETERS - GROUND WATER SAMPLES

Areas of Concern and Associated Samples	TCL[1] VOC's	TCL[1] BNA's	TCL[1] Pest/PCB's	TCL[1] Inorganics	Volatile Organics[2] Method 502.1,502.2	TPH[3]	Landfill[4] Leachate Parameters	Waste[5] Classification
A) Burn Area Drywell Field								
W-22	X	X	X	X		X	X	
W-23	X	X	X	X(6)		X	X	
W-30	X	X	X	X		X	X	X
W-37	X	X	X	X		X	X	
W-38	X	X	X	X		X	X	
B) Mock-Up Building Drywell Field								
W-24	X	X	X	X		X	X	
W-25	X	X	X	X(6)		X	X	X
W-26	X	X	X	X		X	X	
W-27	X	X	X	X(6)		X	X	X
W-33	X	X	X	X		X	X	
W-40	X	X	X	X		X	X	
C) Corregated Metal Building Drywell Field								
W-28	X	X	X	X(6)		X	X	X
W-29	X	X	X	X		X	X	
W-31	X	X	X	X(6)		X	X	X
W-32	X	X	X	X		X	X	
W-35	X	X	X	X		X	X	
W-36	X	X	X	X		X	X	

TABLE 2-4 (Continued)

ANALYTICAL PARAMETERS - GROUND WATER SAMPLES

Areas of Concern and Associated Samples	TCL[1] VOC's	TCL[1] BNA's	TCL[1] Pest/PCB's	TCL[1] Inorganics	Volatile Organics[2] Method 502.1,502.2	TPH[3]	Landfill[4] Leachate Parameters	Waste[5] Classification
D) Solvent Plume								
W-34	X	X	X	X		X	X	
W-7C	X	X	X	X(6)		X	X	
W-7D	X	X	X	X(6)		X	X	
E) Offsite Dissolved Constituent Plume								
W-39	X	X	X	X		X	X	
BP-3A,B,C,D	X	X	X	X	X	X	X	
BP-4A,B,C,D	X	X	X	X	X	X	X	
BP-5A,B,C,D	X	X	X	X	X	X	X	
BP-6A,B,C,D	X	X	X	X	X	X	X	
BP-7A,B,C,D	X	X	X	X	X	X	X	
BP-8A,B,C,D	X	X	X	X	X	X	X	
F) Additional Samples								
Drilling Water -								
BP-3	X							
BP-4	X							
BP-5	X							
BP-6	X							
BP-7	X							
BP-8	X							
W-7D	X							

TABLE 2-4 (Continued)

ANALYTICAL PARAMETERS - GROUND WATER SAMPLES

Areas of Concern and Associated Samples	TCL[1] VOC's	TCL[1] BNA's	TCL[1] Pest/PCB's	TCL[1] Inorganics	Volatile Organics[2] Method 502.1,502.2	TPH[3]	Landfill[4] Leachate Parameters	Waste[5] Classification
G) QA/QC Samples								
Field Blanks (up to 6)	X	X	X	X		X	X	
Trip Blanks (up to 14)	X	X	X	X		X	X	

Notes:

1. Target Compound List (TCL) Volatile Organic Compounds (VOC's), Base/Neutral/Acid Extractables (BNA's), Pesticide/PCB's, and Inorganics are the NYSDEC CLP List as given in the most recent protocol.

2. Downgradient wells BP-3 through BP-8 are anticipated to have low concentrations of VOC's. Wells which have concentrations below the CLP method 601/602 detection limits will be resampled and analyzed using methods 502.1 and 502.2 so that detection limits will be sufficiently low for comparison to the revised 10 NYCRR Part 5 drinking water standards.

3. TPH = Total Petroleum Hydrocarbons.

4. Landfill leachate parameters include alkalinity (USEPA 310.1), Ammonia (USEPA 350.2), BOD (USEPA 405.1), COD (USEPA 410.4), Chloride (USEPA 325.1), Chromiun VI (USEPA 218.5), Color (USEPA 110.2), Hardness (USEPA 130.2), Phenols (USEPA 420.1), MBAS (USEPA 425.1), Nitrates (USEPA 353.2), Odor (USEPA 140.1), Sulfate (USEPA 375.4), TDS (USEPA 160.1), Total Kjeldahl-N (USEPA 351.2), TOC (USEPA 415.2).

5. Free petroleum product in the indicated wells will be analyzed for characteristics required for disposal. These include reactivity, corrosivity, ignitability, toxicity, total PCB's, total organic carbon, specific gravity, and any other analyses that may be required by the waste hauler.

6. All CLP metals analyses will be condcuted for total metals (unfiltered samples). In addition, selected samples will also be analyzed for dissolved metals (filtered samples) using non-CLP protocol. This determination is outside the scope of EQBA Title 3.

TABLE 2-5

ANALYTICAL PARAMETERS - SOIL SAMPLES

Areas of Concern and Associated Samples	TCL, VOC's, BNA's[1] Pest/PCB's, Inorganics	TPH[2]	Dioxins/Furans[3]
A) Burn Area Drywell Field			
W-37	X	X	X
W-38	X	X	X
B) Mock-Up Building Drywell Field			
W-40	X	X	X
C) Corregated Metal Building Drywell Field			
W-35	X	X	X
W-36	X	X	X
D) Solvent Plume			
W-34	X	X	X
W-7D	X	X	X
E) Offsite Dissolved Constituent Plume			
W-39	X	X	
BP-3	X	X	
BP-4	X	X	
BP-5	X	X	
BP-6	X	X	
BP-7	X	X	
BP-8	X	X	

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TABLE 2-5 (Continued)

ANALYTICAL PARAMETERS - SOIL SAMPLES

Areas of Concern and Associated Samples	TCL, VOC's, BNA's[1] Pest/PCB's, Inorganics	TPH[2]	Dioxins/Furans[3]
F) QA/QC Samples			
Field Blanks (one per day)	X	X	
Trip Blanks (one per day)	X (VOC's only)		

Notes:

1. Target Compound List (TCL) Volatile Organic Compounds (VOC's), Base/Neutral/Acid Extractables (BNA's), Pesticide/PCB's, and Inorganics are the NYSDEC CLP List as given in the most recent protocol.

2. TPH = Total Petroleum Hydrocarbon.

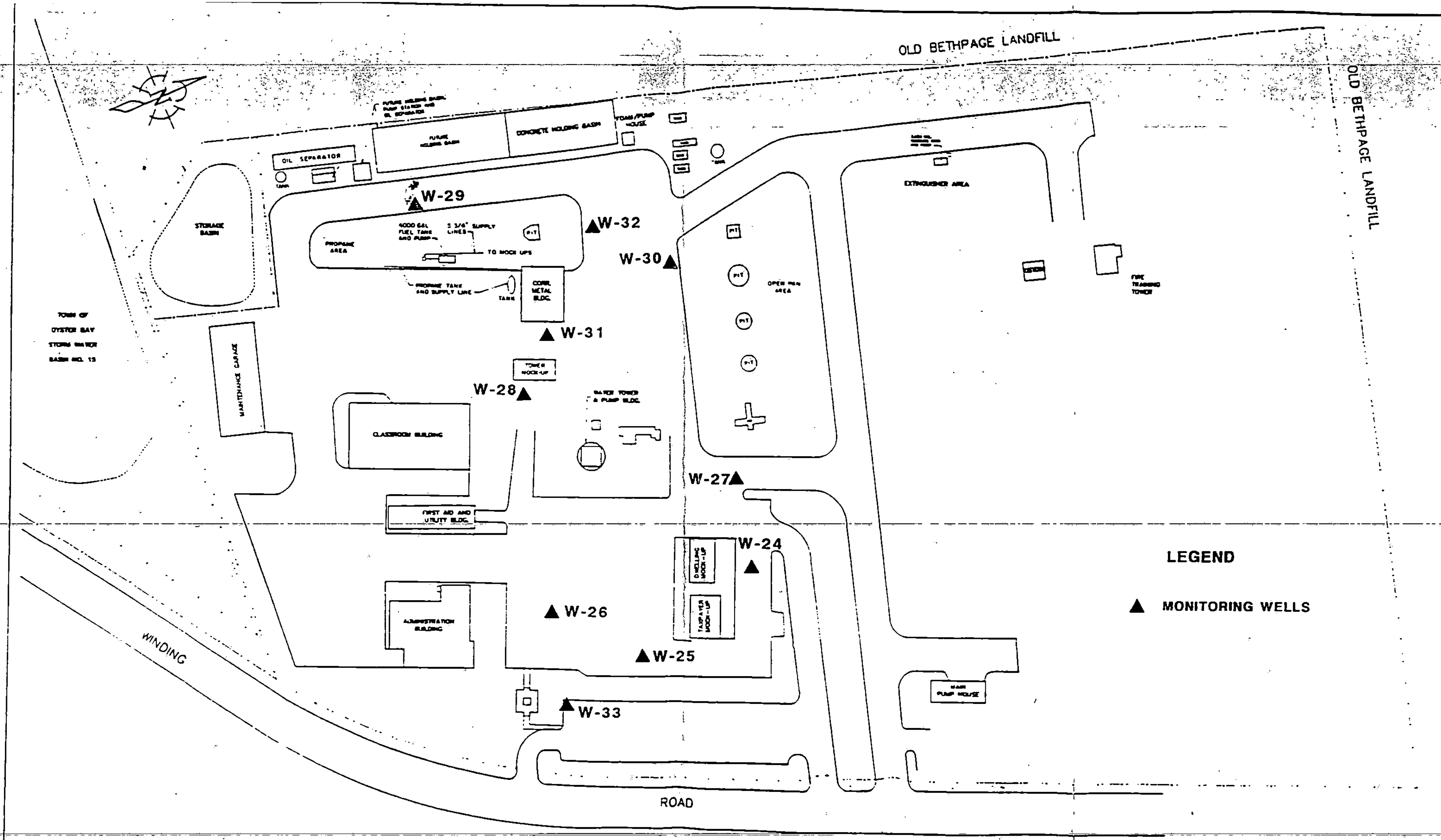
3. Dioxins/Furans - Polychlorinatd Dibenzo - P - Dioxins and Polychlorinated Dibenzofurans - Method 8280.

2.8.1.7 New Monitoring Well Installations

Ten additional monitoring wells were installed on the FTC in June, 1988, to more fully delineate the floating product bodies in the MUF and BAF drywell areas and to determine if a floating product body exists downgradient of the CMB drywell field. The well locations (W-24 through W-33) are shown on Plate 1 and Figure 2-6. One split spoon soil sample from each boring was selected for analysis of landfill leachate parameters, TPH, and Target Compound List (TCL) volatile organics, base/neutral and acid extractable compounds, and a library search for non-TCL compounds and priority pollutants plus 40. Collection of geologic samples and well installation were conducted in the same manner described above and detailed in the QAPP. The wells were screened across the water table.

During the drilling of the new wells, two additional bodies, or one large body, of floating product (gasoline) were identified south of the new holding basin and southeast of the CMB drywell field. The locations of these bodies are delineated on Plate 1.

Bailer samples of floating product were collected from wells GW-5D, W-27, W-28 and W-30 for analyses. The laboratory results have confirmed the product in wells GW-5D, W-28, and W30 to be gasoline and in well W-27 to be number 2 fuel oil. The results have been submitted to the NYSDEC and the N.Y. Attorney General's Office.



MALCOLM PIRNIE

APPROXIMATE SCALE: 1"=100'

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
FIREMANS TRAINING CENTER

MONITORING WELLS
JUNE 1988

MALCOLM PIRNIE INC
FIGURE 2-6

MALCOLM PIRNIE

3.0 REMEDIAL INVESTIGATION

The purpose of the Remedial Investigation (RI) is to further delineate the bodies of floating oil and gasoline and the extent of on-site and off-site plumes of contaminated ground water, and to provide other pertinent data needed to support the Feasibility Study (FS). The RI consists of nine tasks:

Task 1 - Description of Current Investigation
Task 2 - Plans and Management
Task 3 - Site Investigation
Task 4 - Site Investigation Analysis
Task 5 - Laboratory and Bench Scale Studies
Task 6 - Pilot Studies and Interim Remedial Measures
Task 7 - RI Report
Task 8 - Endangerment Assessment
Task 9 - Community Relations Support

3.1 TASK 1 - DESCRIPTION OF CURRENT SITUATION

A history of the FTC, and compilation of pertinent information has been prepared and presented in reports including the Site Utilization Plan and the Quality Assurance Project Plan (QAPP). Information will be extracted from these and other documents pertaining to the FTC and compiled into a single volume which will include:

- Site Background
- Nature and Extent of Problem
- History of Previous Investigations
- Site Description
- Site Map Showing Boundaries and Pertinent Features
- Site Office

3.2 TASK 2 - PLANS AND MANAGEMENT

Plans necessary for the completion of the RI will be prepared. A scope of the proposed work is included in this document. A Quality Assurance Project Plan (QAPP) has been prepared, which contains details of the proposed work including sampling objectives, equipment, and sampling protocols. Information contained in this Work Plan and the

QAPP are comprehensive. A separate Sampling Plan and Data Management Plan are not considered necessary.

As part of this task, monthly progress reports and task specific deliverables will be prepared. Monthly progress reports will summarize the progress made during the reporting period (wells completed, samples taken, work begun, etc.) and identify problems encountered or solved and changes in the work scope or personnel.

Task specific deliverables will be prepared after each of the following tasks:

Task 4 - Site Investigation Analysis
Task 5 - Laboratory and Bench Scale Studies
Task 6 - Pilot Studies
Task 8 - RI Report
Task 13 - Feasibility Study

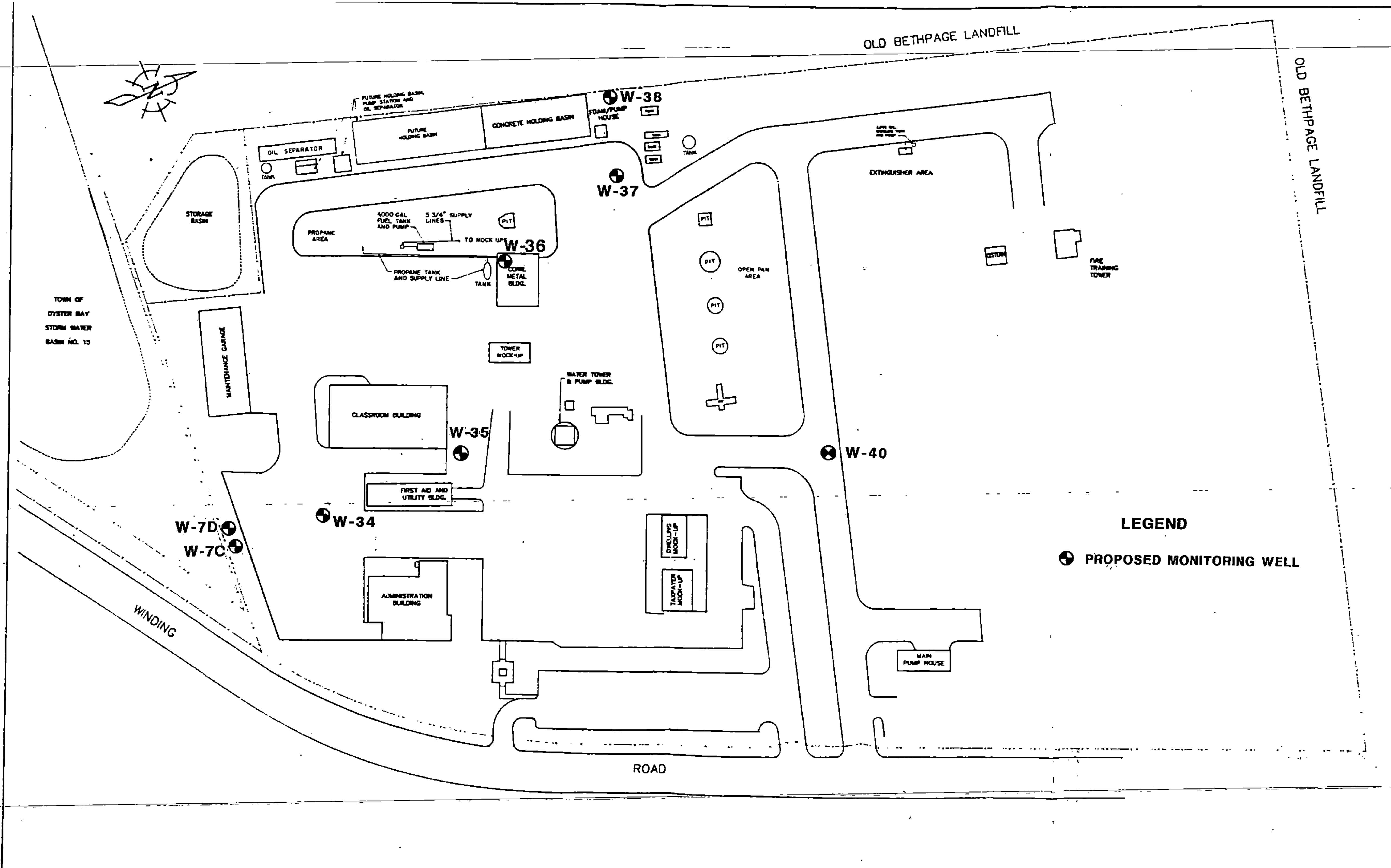
A detailed Health and Safety Plan (HASP) has been prepared for the investigation. The plan was prepared by a Certified Industrial Hygienist (who fulfills the state requirement of being a certified Health and Safety Specialist) and will address applicable regulatory requirements. It will also detail personnel responsibilities, protective equipment, procedures and protocols, decontamination, training and medical surveillance.

3.3 TASK 3 - SITE INVESTIGATION

The site investigation will include field studies needed to supplement the existing data base and provide additional information needed to assess the extent of soil contamination and the extent of the bodies of floating product and plumes of contaminated ground water. The investigation will provide data to support the development and evaluation of remedial alternatives during the Feasibility Study.

3.3.1 On-Site Monitoring Wells

The construction of up to eight monitoring wells is proposed on the FTC, at the locations shown on Figure 3-1 and Plate 1. Two wells, W-7C and 7D, located adjacent to wells W-7A and W-7B, will be screened from



MALCOLM PIRNIE	APPROXIMATE SCALE: 1"=100'	COUNTY OF NASSAU DEPARTMENT OF PUBLIC WORKS **FIREMANS TRAINING CENTER**	**PROPOSED MONITORING WELLS**	MALCOLM PIRNIE INC FIGURE 3-1

140 to 160 feet and from 220 to 240 feet below ground surface, respectively to complete that cluster. Chemical analysis of water samples from these two wells will provide information on the depth of the plume contaminated with dissolved petroleum hydrocarbons and chlorinated hydrocarbons. The cluster will also be used to determine the direction of the vertical hydraulic gradient and to confirm if there is a southwest component of flow. The deeper well will be drilled as a boring for geologic information using a truck mounted mud rotary drill rig as described in Section 3.3.2. Split spoon core samples will be collected at 20 foot intervals except in the probable well screen intervals of each well. In these intervals, 140-160 and 220 to 240 feet, split spoon samples will be collected at five foot intervals to assure that the well screen is placed in a sand layer rather than a silt or clay layer. One split spoon sample from W-7D will be analyzed for the parameters listed in Table 3-2. The wells will be completed with 20 feet of 0.020 inch slot, four-inch I.D. stainless steel well screen and four-inch ID stainless steel casing through the saturated zone. Black steel casing will be used above the water table in the unsaturated zone. Well W-7D will be gamma ray logged to provide additional information on the subsurface geology.

Well W-34, will be drilled near the southeast corner of the classroom building to delineate the downgradient and leading edge of the floating gasoline plume(s). Well W-35 will be drilled if contamination is not detected in well W-34. Well W-35 will be installed next to the northern side of the classroom building approximately 60 feet south of well W-28. Wells W-37 and W-38 will be drilled north and northwest of the Corrugated Metal Building to delineate the upgradient edge of the floating gasoline plume(s). Well W-36 will be drilled inside the drywell that is located in the southwest corner of the Corrugated Metal Building. This well will be drilled to collect data that may identify the origin of the high concentrations of dissolved acetone and MEK that are found in the ground water on the site. The well will also help define the leading edge of the floating gasoline plume(s). Well W-40 will be installed to obtain information on the upgradient edge No. 2 fuel oil floating product plume associated with the mock-up field.

Wells W-34 through W-38 and W-40 will provide geologic and product information, and will be drilled using a truck mounted 6-inch ID hollow stem auger drill rig. Borings will be drilled to a depth of approximately fifteen feet below the water table. Split spoon samples will be collected at five foot intervals until visual evidence of soil contamination is identified, after which continuous split spoon sampling will be conducted to the water table. Below the water table, split spoon samples will be collected every 5 feet to the bottom of the boring or until field conditions do not permit further sampling. Each boring will be completed as a monitoring well with 20 feet of four inch I.D. 0.020 inch slot stainless steel well screen bridging the water table and four inch black steel casing. Fifteen feet of each well screen will be set below the water table with the remaining 5 feet in the vadose zone. One split spoon sample from each boring will be sent to a NYSDEC CLP laboratory to be analyzed for the parameters listed in Table 2-4. Upon completion, each well will be gamma ray logged to provide additional information on the subsurface geology. The extent of soil contamination will be mapped, based on the soil sampling results and the extent of product contamination. Additional monitoring wells will be proposed if the data is insufficient to fully delineate the extent of contamination.

3.3.2 Off-Site Monitoring Wells

Six well clusters (BP-3, 4, 5, 6, 7 and 8), each consisting of up to four wells screened at different depths, are proposed south of the site at the approximate locations shown on Plate 2. An additional well (W-39) is proposed west of the Town of Oyster Bay Landfill on Round Swamp Road.

The purpose of the six offsite well clusters is to provide information on the depth and southern extent of the plume containing dissolved organic compounds and to measure the vertical head gradient at each cluster location. Well clusters BP-3, 4, 5 and 6 are believed to be downgradient of the leading edge of the off-site plume. Well clusters BP-3 and BP-5 will define the eastern and western boundaries of the plume, respectively. Well cluster BP-4 is located just south of the downgradient limit of the plume. The plume is not believed to have migrated past the location of BP-4 because BSP-1, a public supply well now abandoned due to contamination, should have prevented further migration of the plume to the south. Well BSP-1 was shut down in 1980. If the data from these well clusters indicate that the plume has moved past them, additional downgradient wells will be proposed.

The purpose of well clusters BP-6 and BP-8 is to determine if contaminants have migrated in a southwesterly direction away from the site. A southwesterly ground water flow direction has been reported in the 80-100 foot zone on the site.

Well cluster BP-7 will be installed west of the FTC in Bethpage State Park. The purpose of the well cluster is to detect contamination emanating from the Town of Oyster Bay landfill and/or the FTC and moving toward the new New York State Public Supply Well (N10457) located in Bethpage State Park before it reaches the public supply well.

Initially, at each of the proposed downgradient cluster locations, a 400 foot deep formation testhole will be drilled using the mud rotary method with Wyoming bentonite based drilling mud mixed with potable water. Split-spoon samples of the subsurface materials will be collected at 20 foot intervals from the ground surface to the bottom of the hole. Gamma ray logs will be made in the completed borehole to provide supplementary information on the geology at each cluster location. Upon completion of the geophysical logging, the borehole will be abandoned and backfilled with cement bentonite grout for the entire depth. The grout will be tremied in place from the bottom of the hole up to the ground surface. The grout will be a mixture of Type I Portland cement (94 lbs.) and powdered bentonite (Wyoming Bentonite) (5 lbs.) for each 8 gallons of potable water.

The information from the testhole will be used to design the well cluster at each location. The data will include the driller's log and other pertinent information he records while drilling the hole. The geologist will describe the split-spoon samples and although they are of limited value, the flume samples. His field notes will also include such information as rate of drilling, amount of mud mixed, quantity of water added to the mud, Hnu readings from the split-spoon samples, loss of mud while drilling, caving of the borehole while drilling and other data to be used in preparing a geologist's log of the borehole.

Each cluster will consist of 4 wells in close proximity to the testhole and to each other. The well identification numbers will be suffixed with a letter designating the general depth zone as follows:

A Well - Well screened from 10 feet above to 10 feet below the water table

B Well - Well screened from approximately 180 to 200 feet

C Well - Well screened from approximately 280 to 300 feet

D Well - Well screened from approximately 380 to 400 feet

The A well will be installed using a truck mounted power auger. The hole will be drilled to the designated depth using 6-inch I.D. hollow stem auger flytes. The well will be constructed with 4-inch I.D., 0.020 inch slot, stainless steel wire wrapped well screen set across the water table as described in Section 3.3.1. As the well casing (riser) will not be in contact with the ground water, 4-inch diameter, black steel pipe will be used. The annular space surrounding the well will be packed with No. 2 gravel to a depth 5 feet above the top of the well screen. A 2-foot thick bentonite pellet seal will be emplaced on top of the sand pack and the remaining annular space will be backfilled with a cement bentonite grout tremied in place from the bottom of the borehole to the ground surface. A 6-inch diameter steel protective casing will be installed (with locking steel cap), and a cement collar will be constructed to divert surface runoff away from the well. The A well, and the other wells in each cluster, will be constructed in conformance with any applicable NYSDEC standards not specifically described in this workplan.

The B, C and D wells in each cluster will be drilled using the hydraulic mud rotary method. The drilling mud will be a Wyoming bentonite mixture with no additives. Potable water will be used to mix the mud. Quantities of bentonite and water used will be logged and losses to the subsurface formations will be estimated and recorded together with the depth. In each well, a 10-inch diameter borehole will be drilled to a depth 20-feet above the top of the selected screen interval. At this depth, drilling will be stopped and an 8-inch diameter steel outer casing with welded joints will be set in the hole from ground surface to the bottom of the hole. This casing will be pressed or driven a few inches into the bottom of the hole to achieve a seal and the annulus outside the casing will be filled with cement bentonite grout tremied in place from the bottom of the borehole to the ground surface. This casing will be finished 36 inches above grade and will be used as the protective casing for the completed monitoring well.

After the grout has set for 24 hours, the drilling mud will be removed, and the inside of the 8-inch diameter casing washed to remove residual mud. The borehole will then be drilled to the bottom of the proposed screen interval (40 feet) using only potable water as the drilling fluid. The monitoring well will be constructed with a 20-foot length of 0.020 inch slot, stainless steel, wire wrap well screen and 4-inch diameter, stainless steel casing (riser) set with stainless steel centering guides, inside the 8-inch diameter outer casing. The stainless steel riser will extend 10 feet above the water table and black steel pipe will be used from the top of the stainless steel pipe to the top of the well. The sand pack, bentonite seal and grout will be installed as described above.

The potable water for all drilling will be obtained from the Plainview Water District. A sample of the water used for drilling will be collected at each cluster for chemical analysis. Samples of the dry (unmixed) bentonite from each well will be collected but not tested; the samples will be stored for future analysis if a question arises when interpreting the ground water chemical quality information.

Each well will be developed by surging and/or pumping to open the screen to the formation water and to minimize turbidity. If possible, the turbidity will be reduced to a level of 50 NTU's (Nephelometric Turbidity Units). Data from other monitoring wells indicate that this level should be possible. However, the Cretaceous Age deposits that will be tapped by the proposed cluster wells are known to contain a large percent of clay sized particles both in thin seams and layers and as interstitial clay. Occasionally, wells designed and constructed for large public and industrial supplies suffer turbidity problems. A reasonable effort will be made to achieve the requested level of turbidity in the monitoring wells. However, if after 3 hours of developing, measurements made with a nephelometer or turbidimeter show that the turbidity is not improving, developing will be stopped and the Malcolm Pirnie and NYSDEC Project Quality Assurance Officers will be notified. Additional well clusters will be proposed downgradient of these clusters if these wells are contaminated and the leading edge and depth of the plume can not be delineated based on data from these wells.

Well W-39 will be drilled on the west side of the Oyster Bay Solid Waste Disposal Complex along the west side of Round Swamp Road. The boring will be drilled with a truck mounted 6-inch I.D. Hollow Stem Auger. Split Spoon core samples will be collected at 5 foot intervals. The boring will be completed by installing 4-inch I.D. black steel casing and 20 feet of 0.020 slot, 4-inch I.D. stainless steel screen. The screen will bridge the water table with 15 feet set in the saturated zone and 5 feet set above the water table. The purpose of well W-39 is to provide water quality information and water level measurements in the shallow ground water on the western side of the landfill. One split-spoon sample will be sent to a NYSDEC CLP laboratory to be analyzed for Target Compound List (TCL) plus thirty, landfill leachate parameters, and total petroleum hydrocarbons.

3.3.3 Ground Water Sampling

Ground water samples will be collected from selected wells installed through June 1988 (W-22 through W-33) and from the wells drilled for this investigation. The well locations are chosen to provide data on the extent of the bodies of liquid product and the dissolved volatile organic compound plumes. The water samples will be analyzed for landfill leachate parameters, TPH, and TCL plus thirty. Additional sampling in existing wells may be required, if results from the sampling indicate the need for confirmatory analyses.

Initially, wells will be purged until three to five volumes of standing water are evacuated or until the well is pumped dry. The volume of water removed from each well that will not be pumped dry, is dependent upon the field measurements of pH, temperature and specific conductance. When all three of these parameters are stabilized, the volume of water will be recorded and the well sampled. The purge water will be discharged into the oil-water separator located on the site.

Once purged, the ground water samples will be collected using a stainless steel bailer which has been decontaminated by steam cleaning. Bailers will be lowered slowly into the well to assure that dissolved volatile compounds are not driven off. Samples will be transferred from the bailer to laboratory clean sample containers.

Field measurements of pH, specific conductance, and temperature will be made in each well. Both the pH and the specific conductivity meters will be calibrated for water temperature before they are used and the pH meter will be calibrated prior to each use. All field measurements will be recorded on the sample logs.

3.3.4 Measurement of Ground Water Levels

Synoptic water level measurements will be collected once a month for a period of one year. This data will help define the direction(s) of ground water movement and to assess if seasonal changes in the direction of water movement occur. An effort will be made to coordinate the measurement periods with the Town of Oyster Bay's consultant so that water level measurements in the Town's monitoring wells north and east of the site can be obtained at the same time.

Water level measurements will be made more frequently than once a month, when possible, at times when Malcolm Pirnie personnel are present on the site. In addition, data will be obtained from the NCDPW for nearby public water supply and observation wells which they monitor on a regular basis.

3.4 TASK 4 - SITE INVESTIGATION ANALYSIS

Remedial technologies will be identified prior to the completion of field work to ensure that the data base developed from the RI is adequate for the evaluation and the selection of remedial alternatives in the FS. Technologies for both source control and management of contaminant migration will be reviewed.

The preliminary list of remedial technologies is initiated by identifying General Response Actions (GRA's). The GRA's are broad categories or types of responses that can be implemented for site remediation. Potentially applicable remedial technologies will be identified for each GRA. The data collected in the field investigations will be evaluated and compared to the preliminary list of remedial technologies. Data deficiencies, if any are identified, will be addressed. This process ensures that sufficient data will be collected to conduct the FS. A list of potential GRA's and associated remedial technologies is given in Table 3-1.

3.5 TASK 5 - LABORATORY AND BENCH SCALE STUDIES

Laboratory studies will be conducted to assess the need for Remediation of contaminated soil and, if needed, to provide data for selection of a suitable method. Undisturbed samples of contaminated soil will be collected and sent to a laboratory for column studies. Data that will be generated on the soil columns will include the leaching characteristics of the soil, the effect of flushing the soil with water (hot water or water containing a detergent), and the potential effectiveness of biodegradation as a remedial measure.

3.6 TASK 6 - PILOT STUDIES AND INTERIM REMEDIAL MEASURES (IRM)

Pilot studies will be conducted to determine design characteristics for recovery of liquid product, recovery of contaminated ground water, and treatment of contaminated ground water. The free product recovery pilot test will be extended for the duration of the program to provide interim remediation in the most highly contaminated areas. This program, the IRM, will limit the migration of contaminants and will remove contaminants from the subsurface on the FTC.

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TABLE 3-1

IDENTIFICATION OF POTENTIALLY APPLICABLE GENERAL RESPONSE ACTIONS (GRAs) AND REMEDIAL TECHNOLOGIES FOR THE FIREMAN'S TRAINING CENTER SITE

General Response Action	Potentially Applicable Remedial Technologies
Ground Water Controls	Ground Water Pumping Product Removal Subsurface Drains Subsurface Barriers Vacuum Extraction
Removal	Excavation and Removal of Contaminated Soils
Direct Waste Treatment	Mechanical Separation Air Stripping Activated Carbon Biological Treatment Oxidation Solids Treatment Solidification/Stabilization Incineration Gaseous Waste Treatment
In-Situ Treatment	Bioreclamation Chemical Treatment
Off Site Disposal	Disposal of Product Reclamation of Product Temporary Storage
Air Pollution Controls	Gas Collection Fugative Dust Suppression
Surface Water Controls	Capping Grading Diversion

3.6.1 Pilot Liquid Product Recovery System

The removal of free phase oil and gasoline will be conducted as an IRM. The goal of the IRM is to remove as much of the free phase product as possible prior to remedial action while obtaining information on product recovery.

Several alternatives will be investigated to accomplish the IRM goals. They include an automatic bailing device such as the R.E. Wright Autoskimmer or a product recovery pump such as the QED Pulse Pumps. These products will remove predominantly free phase hydrocarbons without removing a large volume of ground water.

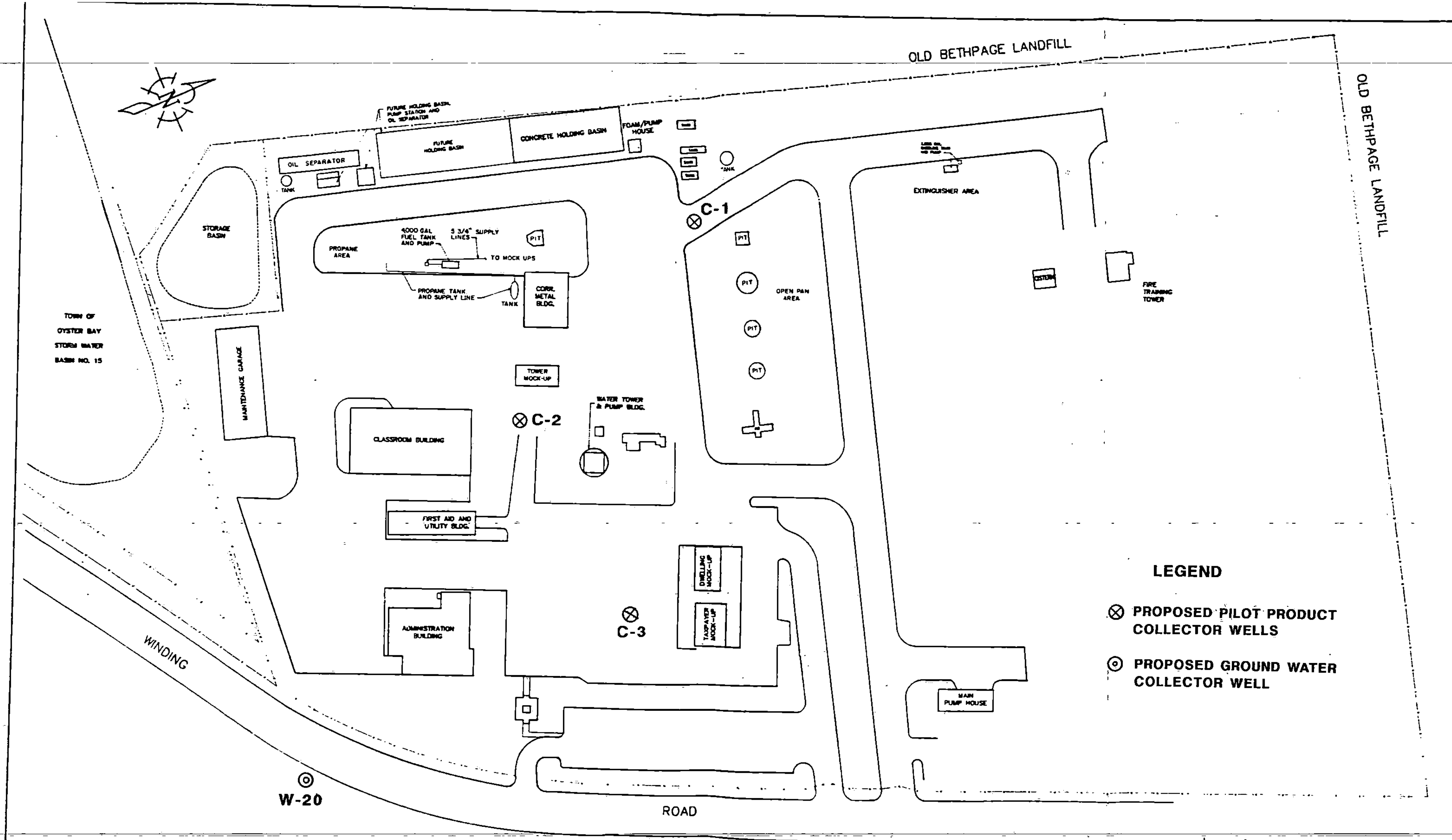
As a preliminary plan for the IRM, product removal will be conducted in wells W-33 and W-27 in the MUF No.2 oil plume, W-28 in the CMB gasoline plume, and W-30 in the BAF No.2 oil plume. Product will be stored on-site temporarily prior to its removal from the site for disposal.

The amount and rate of product removal, and the recovery rate, will be recorded and product/water level changes in nearby monitoring wells will be measured. Analysis of these data will provide information on the mobility of the product and the feasibility of this type of remediation.

3.6.2 Pilot Collector Well

If the information developed from the IRM is promising and the pumping of product and water warrants further evaluation, pilot collector wells will be constructed in the gasoline plume (Well C-2) and in the No. 2 fuel oil plumes located in the BAF area (C-1) and in the MUF Area (C-3) as shown in Figure 3-2. The pilot collector wells will be used to assess the effectiveness of pumping at the product/ground water interface and to test some of the equipment specifically made for this purpose. The results will be used to determine the number and locations of wells that will be needed in each product area to collect the product, and to conceptually design the recovery wells and final removal system.

The pilot wells will be designed and pumped so that a drawdown of approximately five feet below static water level will be maintained. This pumping will create a cone of depression in the ground water which



MALCOLM PIRNIE	APPROXIMATE SCALE: 1"=100'	COUNTY OF NASSAU DEPARTMENT OF PUBLIC WORKS FIREMANS TRAINING CENTER	PROPOSED PILOT TEST WELLS	MALCOLM PIRNIE INC FIGURE 3-2

slopes towards the pumping well and causes liquid product to move toward the well for recovery.

One type of recovery system will consist of two pumps. One pump will be submerged in the ground water while the intake of the second pump will be placed at the ground water/floating product interface. The floating product will be collected separately and pumped to a tank where the product will be separated from any water present. Periodically, the product will be removed from the tank and drummed for proper disposal. Alternatively, a floating skimmer may be used to recover the product. Contaminated water removed during the tests will be diverted to the oil water separator or a temporary on-site treatment system before discharge or disposal.

Although this method of collection has been used to recover floating oil, the amount of recovery is frequently small because of the viscosity of the oil and the capacity of soil to absorb product. Consequently, the testing will also include some method of enhancement, such as the recharge of heated and/or detergent enriched clean water to increase the mobility of the oil in the subsurface. This technique may also have application in flushing contaminated soil above the floating product.

For extraction of the gasoline product, a combination of pumping and vacuum extraction may be employed. Vacuum Extraction is a remediation approach that has been used for removal of VOC's and volatile hydrocarbons in the unsaturated, or vadose zone. It removes contaminants by lowering the gas pressure in the contaminated soil mass above the floating product. Extraction wells connected to vacuum pumps provide the means for extacting the gasoline by inducing volatilization. Vacuum pumps draw air through the soil, changing equilibrium conditions. The moving air entrains and removes contaminants that exist in the vapor phase and causes further volatilization of contaminants in the liquid phase. Continuation of this process can result in essentially complete removal of the volatile contamination.

The floating product collector wells will be constructed of 10-inch diameter black steel casing and stainless steel well screen unless the collection equipment selected requires a larger diameter well. The screen slot opening and gravel pack size will be determined from mechanical analyses of split spoon core samples collected in the proposed screen interval.

The length of the well screen in the collector wells will be determined based on estimates of the static and pumping water levels and water level changes that can be expected due to seasonal changes and possible landfill capping effects that can be expected during the life of the wells. Recharge of treated water by the Town of Oyster Bay on the north end of the adjacent landfill property may also be a factor. To accommodate fluctuations in water levels, the screens in the collector wells will be designed and installed to allow for at least 20 feet of variation in water level so that the ground water/liquid product interface will always lie within the screen interval.

To assess the response of the aquifer to pumping, estimates of drawdown were made using existing data. The average recharge rate for Long Island of one million gallons per day per square mile and a storativity value of 0.01 were used in the analysis. The effects of pumping were evaluated using permeability values of 400 and 800 gallons per day per square foot (gpd/ft^2). The lower value was taken from McClymond and Franke's report (1972) on the water transmitting properties of aquifers on Long Island, New York. The higher value was used by Geraghty & Miller (1987) to design a nearby system of collector wells to intercept a plume of dissolved volatile organic chemicals originating in the Town of Oyster Bay Landfill.

Based on a permeability of 400 gpd/ft^2, the preliminary calculations indicate that each FTC collector well would need to be pumped at approximately 50 gallons per minute (gpm) to maintain a drawdown of about five feet in the well. With a higher permeability of 800 gpd/ft^2, a pumping rate of about 100 gpm is estimated in each well to maintain the required drawdown.

Testing will consist of pumping water from the well at varying rates for periods of up to at least several days. During the pumping, water level measurements will be collected from nearby monitoring wells to assess the extent zone of influence. Several recovery systems will be tested in the wells to assess their ability to remove product at various pumping rates. The results will be used to estimate:

- The number of collector wells required to remediate each product body.
- The locations of the collector wells.
- The pumping rate and schedule required to maintain the appropriate drawdown in each well.
- The recovery equipment which will be most effective in recovering liquid product.
- The need for recharge to enhance product migration to the collector wells.

3.6.3 Pilot Dissolved Volatile Organic Compound Plume Recovery System

A pilot study consisting of the installation and testing of a cluster of collector wells is proposed to provide information for designing recovery system to control the contaminated plume. The purpose of the pilot study is to assess the aquifer characteristics in the vicinity of the collection area(s) and to evaluate the locations number of wells (clusters) that will be required to remediate the plume.

The Remedial Action/Feasibility Study recently completed for controlling the plume originating from the Town of Oyster Bay Landfill will be used in a preliminary assessment of the FTC pilot recovery wells. The Town's proposed system reportedly will consist of five 200 gpm collector wells, each screening 300 feet of the aquifer. The collector well system proposed for recovery of the FTC ground water plume will operate in conjunction with the collector system proposed for the Town of Oyster Bay Landfill and the combined operation of the two systems will have to be evaluated.

Clusters of wells are proposed for the FTC rather than single well with an excessively long screen, because one long screen potentially would allow downward migration of contaminated ground water to occur in the wells when the wells are not being pumped. Longer screens may also present problems both in developing the wells and in well maintenance.

The proposed location of the pilot well cluster will likely be in the vicinity of W-20 which is shown on Figure 3-6.

The number of wells in the proposed cluster and the depth of the deepest well will be determined when field work is completed, based on the thickness and depth of the plume at the proposed location. Contamination occurs in the deepest wells in the vicinity of the proposed collector wells at depths of 180 feet. However, the maximum depth and leading edge of the plume still need to be assessed to confirm the optimum locations for the long term recovery wells.

3.6.4 No. 2 Oil and Ground Water Recovery Systems

Recovering floating No. 2 oil from a ground water system is a complex procedure which is dependent on factors such as:

- Composition and texture of the subsurface materials;
- Transmissivity of the subsurface material;
- Attenuative properties of the aquifer;
- Properties of the oil such as viscosity, solubility and affinity to clay minerals;
- Physical and chemical reactions due to exposure of the oil to water, air or other chemical compounds; and
- Temperature changes.

These factors will be considered when evaluating a recovery system. The effects of oil and possible dissolved organic chemicals on the component parts of the system also need to be considered as they vary depending on the nature of the product and the design of the system.

The potential high yield of the subsurface materials at the FTC site should be amenable to use of a dual pump recovery system. The dual pump recovery system employs one ground water pump per recovery well to create a depression in the water table around the recovery well. The gradient of the water table in the cone of depression causes the oil to migrate toward the recovery well. A second pump or floating skimmer designed to remove the product is installed in the well so that the intake is at the oil/water interface. Sensors activate the product pump when sufficient product accumulates in the well or alternatively its operation can be timed. The oil is pumped to a product/water separator and then to a tank storage. The ground water removed from the well is either treated and returned to the ground or taken away.

The dual pump recovery system usually requires well diameters of 10 inches or larger to accommodate the pumps and sensing probes. Recovery well(s) are strategically placed within the area of product so that a minimum pumping rate will capture the bulk of the recoverable product. The cone of depression caused by pumping should extend far enough beyond the well(s) to capture all of the floating product, but not too far beyond the the limit of the floating product, which would result in pumping more water than is necessary. The water level should not be drawn down deeper than necessary to minimize the possibility of new soil contamination.

A number of the available floating product recovery systems have been reviewed for possible use at the FTC in terms of their operation and maintenance requirements and costs. Some systems consist of both a product recovery pump and a water pump. Other systems consist of only a product pump with the water pump supplied by a separate vendor. This preliminary review was not meant to be an exhaustive study of all systems available or all possible combinations of components. The purpose of the review was a preliminary assessment of representative systems, which are currently available and sufficiently tested.

3.6.4.1 System Components

Due to the nature of the subsurface materials at the FTC, only recovery systems that utilize dual pump designs were considered. Some variation exists in the design of systems available from different manufacturers.

3.6.4.1.1 Water Pumps

Several different pump designs are employed to create the cone of depression needed to accumulate the product in the well. The appropriate design depends on the depth to water in the well and the quantity of water to be pumped.

Centrifugal surface-mounted pumps are the simplest type of pump to install and maintain. However, they are limited to pumping water from depths no greater than about 20 feet and are not suitable for use at the FTC.

Centrifugal submersible pumps are installed near the bottom of the well and are powered electrically. These pumps are typically low maintenance units designed to pump ground water which contains dissolved hydrocarbons or other contaminants. However, the water must be relatively free of sediment that could clog the pump. Maintenance of these units requires the pump assembly to be removed from the well. Since the water pump would be installed below the product recovery pump, this would be time consuming unless large diameter well casings are used.

Pneumatic submersible pumps operate with a pneumatic power source on the surface, although the pump is installed in the well in a fashion similar to the centrifugal submersible pump discussed above. Although part of the pump apparatus is located at the land surface, making maintenance on that portion simpler, a pneumatic control is considerably more complex than an electrical control. Pneumatic pumps are typically used where a source of compressed air is readily available or where the danger of fire or explosion precludes the use of electrical devices.

3.6.4.1.2 <u>Product Recovery Pumps</u>

Several types of product recovery pumps are available. Some are similar in design and operation to the water pumps discussed above. In addition, there are peristaltic pumps, automatic bailers and skimming by preferential attraction.

Peristaltic pumps operate by rotating roller drums which continuously squeeze and move product through a flexible tube, usually made of silicone rubber. The pump assembly is located at the land surface with a suction line located in the product. This is typically a low maintenance pump, only requiring a change of tubing at regular intervals. However, it is a low yield pump which is limited to about 20 feet of lift.

Automatic bailers are devices that remove product from the well by bailing. The bailer is lowered mechanically into the well and when the bailer is full, it is raised to the surface and dumped automatically into a product storage container. These devices are complex and have low yields. Therefore, they are suitable only for low (product) yield wells. However, an automatic bailing system such as the auto skimmer may be suitable at the FTC for a preliminary evaluation of the depth and extent of the product plumes. The auto skimmer could also be used for recovery of gasoline.

Another type of recovery system works on the principle of preferential attraction of oils to materials such as flexible acrylic plastics (Tygon). A continuous loop of tubing is passed through the product so that the product adheres to the outside surface of the tubing. The tubing is then passed over a product storage tank were the oil is rubbed off and collected. The cleaned tubing is once again lowered into the product. This type of pump is a low yield system typically used for recovery of oils from surface impoundments. It may not be suitable for use in a well.

3.6.4.1.3 Sensors

The purpose of the sensor is to turn on and off the appropriate pumps or valves to control the water level in the well or to pump the product into a storage container. The design of the sensors varies depending on their application.

Conductivity type sensors, which are the simplest, work on the principle of conductivity differences between water and air and water and non-polar liquids (oils). One or more metal probes are suspended into the water or the product. To control water level drawdown, two probes are used, a lower "pump-off" probe and an upper "pump-on" probe. For a two pump system, the water level must be maintained at a constant depth so that the product recovery pump intake is always within the accumulated product. Other sensors are used to detect the accumulation of product and to turn on the recovery pump. Conductivity probes may malfunction because of accumulations of films on their surface and require frequent maintenance.

Float sensors work on the principle of varying specific gravity in the well column. The sensor is able to detect the difference between the specific gravity of water and a lighter-than-water floating product. These sensors are electro-mechanical and are not as sensitive to surface films as are the conductivity type probes. However, as with all mechanical devices, parts can wear with time and sensitive bearings can be damaged by components of the ground water or the floating product.

Pneumatic bellows sensors also work on the principle of density variations within the well. However, those differences are detected pneumatically rather than mechanically.

3.6.4.1.4 Enclosures

Two basic types of enclosures, weather tight and explosion proof, are used to house the control units and motors for all the systems described above. The use of either is dictated by site conditions. Weather tight enclosures are used when the unit will be exposed to the weather. Explosion proof enclosures, or the less sophisticated intrinsically safe enclosures, are used where the danger of flammable or explosive gases may be present. These enclosures are also weather tight.

3.6.4.1.5 Evaluation of Floating Product Recovery Systems

Nine floating product recovery systems were selected for preliminary evaluation, and are presented on Table 3-2, which contains specific information on each system, including approximate costs. A number of systems were eliminated from consideration as indicated at the bottom of the table.

3.6.5 Pilot Ground Water Treatment System

Ground water pumped from the collector wells located both in the free product areas on the FTC and downgradient of the site will be piped to a treatment facility. To select the appropriate treatment method, the types of contaminants and their concentrations will be further evaluated. Based on the specific problem identified, the optimum treatment process can be selected.

As previously discussed, free oil and gasoline product is floating on the ground water surface in four areas of the FTC, and the ground water is contaminated with volatile organic compounds:

TABLE 3-2

TYPICAL FLOATING PRODUCT (HYDROCARBON) RECOVERY SYSTEMS

Item	1A.Emtek Collectron 200	1B.Emtek Collectron 100	2.Ges GRS-Dual Pump	3A.Grndwtr Tech Probe Scavenger
Type of System	Dual Surface Pump System	Dual Submersible Pump System	Dual Submersible Pump System	Dual Submersible Pump System
Well Size	4"+	6"+	4"+	8"+
H_2O Pump		Grundfos	Grundfos	
Type	Vacuum	Submersible	SPO	
Flow/head		/100'	5 - 20 gpm/	40/60 - 70/50
HP		3	2	2
Power			230 VAC	230 VAC 11 AMPS
Power Cord				
Discharge			Rigid Pipe 316 SS Smooth Fl	
HC Pump				
Type	Vacuum	Submersible		
Flow/head			0.5 gpm/	35 gpm/
HP		3/4 - 1-1/2		3/4
Power			12 VAC	230 VAC 5 AMP
Power Cord				
Discharge		3/4" Hose	3/8" Polyprop	
Multiwell System			Optional	Yes
Costs		Product Pump 6,900 H_2O Pump 5,300	Dual Pump 10,000 H_2O pump 5,400	Product Pump 6,750 H_2O Pump 5,500
Contact	Ray Ditz	Ray Ditz	Brian Beahan	Linda Herbert
Preliminary Evaluation	NA due to low water table in aquifer & high pump head limitations	Requires manual adjustment of water level		

TABLE 3-2

FLOATING PRODUCT (HYDROCARBON) RECOVERY SYSTEMS (Continued)

Item	3B. Grndwtr Tech Comb. Dual Pump	4. NEPCCO Petropurge Sys	5. Ejector Systems ESI Ejector	6. QED Pulse Pump	7. R.E. Wright Auto Skimmer
Type of System	Dual Subm Combo Pump System	Dual Submersible Pump System	Pneumatic Pump System	Pneumatic Pump System	Automated Mech Bailing System
Well Size	4"+	6"+	2" and 4"+	2"+	2" and 4"+
H_2O Pump	Modified Grundfos	SS W/Tfe HP-75	Need Other	Need Other	Need Other
Type		Submersible			
Flow/head	35 gpm/160'	70 gpm/90'	15-50 gpm/		
HP		5			
Power		230 VAC			
Power Cord		3 Phase			
Discharge					
HC Pump		AL/Oil Resist		C1301 SS	
Type		Submersible		Pneumatic	
Flow/head			0.25 - 1 gpm/	1 gpm/60'	
HP		1/3 - 1-1/2			
Power		230 VAC		115 VAC	15 AMP
Power Cord					
Discharge					
Multiwell System		Yes	Yes	Up to 6 wells within 200'	
Costs	12,000	16,000	7,490 Product system	2,500 H_2O pump not included	
Contact		Paul Winter	Jim Fairchild	Ken Byrnes	David Brown
Preliminary Evaluation	NA	Conductivity sensor can have coating problem due to oil viscosity, especially at low temperatures	No mixing of water and product during pumping	Considered for IRM and remedial action	Considered for IRM

Vinyl Chloride	Trichloroethene
Methylene Chloride	Benzene
Acetone	Tetrachloroethene
1,1-Dichloroethene	Toluene
1,1-Dichloroethane	Chlorobenzene
Trans-1,2-Dichloroethene	Ethylbenzene
2-Butanone	Xylenes
1,1,1-Trichloroethane	

Physical treatment of the free product floating on the ground water is proposed by separating the product from the water with an oil/water separator. Subsequently, both the water coming from the oil/water separator and water pumped from the downgradient collector wells will be treated for VOC removal.

The type of VOC treatment system will be selected based on the following considerations:

- Cost effectiveness;
- Compliance with specific environmental programs, if appropriate;
- Removal effectiveness;
- Operation and maintenance requirements;
- Reliability;
- Compliance with appropriate regulations;
- Identification of temporary storage requirements, if required; and
- Compliance with safety requirements during remedial implementation.

The selected treatment system will need to address the following objectives:

- Assure that remediation results in permanent treatment or destruction of the wastes or limits the potential for future release of contaminants to the environment;

- Demonstrate that the treatment process has the ability to conform to more stringent regulations in the future; and

- Meet site-specific engineering considerations.

3.6.5.1 <u>VOC Water Treatment Technologies</u>

Based on the contaminants detected to date, aeration and adsorption appear to be the most appropriate technologies. Other treatment technologies will be examined during the FS. Pilot testing is proposed for these two technologies. If other treatment technologies are also determined appropriate in the FS, additional pilot testing may be necessary. It will be necessary to divert the air from the aeration units through activated carbon to meet air emission standards.

3.6.5.1.1 Aeration Treatment Techniques (Air Stripping)

Air stripping is a unit process in which water and air are brought into contact with each other and volatile substances are transferred from water to the air. Aeration equipment for water treatment can be classified into two general categories: diffused aerators and packed column aerators.

3.6.5.1.2 Diffused Aeration

Air stripping is accomplished in the diffused-air type equipment by injecting bubbles of air (usually compressed air) into the water by means of submerged diffusers or porous plates. Bubbles of air pass through the water, thereby providing contact between the air and water which provides a transport mechanism to transfer the VOCs from the water to the air.

Diffused aeration is less commonly used by industry than packed column aeration for VOC removal. Diffused aeration requires a longer contact time between the air and water for effective removal of contaminants, limiting the rate at which water can be treated.

3.6.5.1.3 Packed Column Aeration

In contrast to diffused aeration, packed column aeration provides continuous and thorough contact of water and air, promoting efficient transfer of contaminants between these two phases. Packing materials in the column provide high void volumes and high surface area which break down water into thin films to provide for adequate contact of the air and water. This design results in continuous and thorough contact of the water with the air and minimizes the thickness of the water layer on the packing, thereby promoting efficient mass transfer of the VOCs from the water to the air.

The water is pumped to the top of the air stripper. Air is then blown up through the column to provide a countercurrent flow of air and water. Treated water is collected in a clearwell located directly under the column. Booster pumps are used to pump the water to a discharge point.

The sizing of the air stripper column diameter is dependent upon the flow rate of the liquid. The column height is dependent upon the maximum residual concentration of VOCs. The packing height required to achieve a desired removal percentage is dependent upon the air to water ratio; the required packing height decreases with increasing air to water ratio.

3.6.5.1.4 Adsorption Techniques

Three adsorption techniques were considered for removal of organics from ground water:

- Powdered activated carbon (PAC),
- Synthetic resins, and
- Granular activated carbon (GAC).

PAC traditionally is used in U.S. water treatment plants for removing trace organic compounds associated with taste and odor problems. Few studies have been conducted on the use of PAC for removing organics in ground water supplies primarily because preliminary data indicated that very large quantities of PAC would be necessary to achieve satisfactory removal efficiencies.

Synthetic resins can effectively adsorb low molecular weight organics from water. The major disadvantages of using synthetic resins are the high cost of the resins and the unproven technology associated with regenerating the resins in-situ with low temperature steam. In addition, producing synthetic resins on a commercial scale has been very difficult.

The effectiveness of GAC for treating ground water systems depends on the types and concentrations of volatile organic compounds in the ground water. Also, the presence of other synthetic or natural organics may reduce the effectiveness of the GAC to remove VOCs.

In GAC treatment, raw water is pumped to the GAC contactor where the activated carbon adsorbs VOCs from the water. The treated water is then sent to a discharge facility. The GAC contactor configuration (gravity versus pressure) depends upon the characteristics of the pumping system. Gravity GAC contactors allow water to filter through the carbon under gravity to a clearwell, which then requires pumping the treated water to its final destination. In contrast, pressure contactors pump the raw water through the contactor under pressure, and the same pressure moves the treated water to the distribution system.

An important economic consideration regarding the use of a GAC treatment system is regeneration or replacement of the carbon. Manufacturers of GAC indicate that on-site regeneration is not economical at carbon usage rates of less than 2,000 pounds per day. Carbon life is dependent upon the types and concentrations of the VOCs and the desired removal percentage.

The most feasible treatment techniques for removing VOCs from the FTC are packed column aeration and GAC adsorption. The selection of one technique over the other, or the use of both techniques, depends on operational considerations (concentrations of VOCs present and percent removal required) and economic considerations.

Before treatment facilities can be properly designed, a pilot-scale testing program will be conducted to evaluate removal efficiencies. The results of this testing program would then be used to develop design criteria for a full-scale treatment facility.

The pilot testing program for packed column aeration would be conducted using a pilot aeration column at one or more of the wells on-site. The rate at which a volatile organic compound is removed from water by aeration depends on several factors:

- Hydraulic loading rate (water flow rate),
- Air flow rate,
- Air to water ratio (A:W),
- Available surface area for mass transfer,
- Temperature of the water and air, and
- Physical chemistry of the compound.

During testing, the air flow rate, water flow rate and A:W ratio will be varied. The A:W ratio is dependent upon the air and water flow rates. By monitoring VOC removal efficiencies under these various conditions, data for developing the mass transfer relationship for each VOC will be obtained. In addition, mass balance calculations will be used to determine the emission rates of the removed VOCs into the surrounding air to determine compliance with emission standards. The results of the testing program will be used to establish process design criteria, such as:

- Maximum water flow rate and loading rate,
- Water temperature,
- VOC identification,
- Maximum influent and effluent concentrations,
- Mass transfer coefficient, and
- A:W ratio.

3.7 TASK 7 - REMEDIAL INVESTIGATION REPORT

The Remedial Investigation report will contain the data collected during the RI and assess the lateral and vertical extent of contamination present. In addition, the hydrogeology will be evaluated and characteristics of the waste contaminants for treatability. The RI report, at a minimum, will contain the following:

- Site Description and History
- Background Information
- Soil Quality Investigations
- Hydrogeologic Investigations
- Water Table and Potentiometric Contour Maps
- Geologic Cross Sections and a Map of the Clay Layer Under the Northern End of the Site
- Ground Water Quality
- Waste Characteristics (Treatability Test Results)
- Preliminary Evaluation of Remedial Alternatives
- Conclusions

3.8 TASK 8 - ENDANGERMENT ASSESSMENT

An endangerment assessment will be conducted to provide justification for the remedial action recommended. Guidance for this task is the "Superfund Public Health Evaluation Manual" (USEPA/540/1-86/060) October 1986. The endangerment assessment determines whether harm may be associated with the site and includes:

- Hazard Identification
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

Hazard identification presents information on hazardous chemicals which are present on the site. Indicator chemicals representative of the types of contamination known to be present at the site are then selected for evaluation. Since previous study at the FTC has indicated that there is a limited number of compounds found at the site, the selected indicator compounds will be the complete set of organic and inorganic contaminants found to date.

The exposure assessment addresses the question of how and where human and environmental receptors may contact indicator chemicals. The chemical and physical properties of the indicator chemicals are reviewed to determine potential for release and transport from the site. All potential exposure pathways will be evaluated for each contaminated medium at the site. For exposures for which there are no established ARAR's, a quantitative risk assessment will be completed for each exposure. The exposure assessment will characterize the potential risk of site contaminants to fish and wildlife in the area. Exposure pathways will also be evaluated for fish and wildlife receptors.

The toxicity assessment provides a critical evaluation and interpretation of toxicological data for the indicator chemicals as well as determination of the potency of the indicator chemicals.

The final component of the endangerment assessment process is the estimation of adverse public health and environmental impacts under the conditions of exposure previously outlined. Four separate categories of risk are typically evaluated:

- Carcinogenic human health risk
- Non Carcinogenic human health risk
- Risk to public welfare; and
- Environmental risk

In summary, the Endangerment Assessment will follow an orderly progression: the site data will be subject to critical evaluation; indicator chemicals will be selected; the probable transport and fate of those chemicals described, potential receptors identified, exposure levels estimated, the toxicity and potency of the chemicals assessed, and conclusions regarding potential human health, welfare and environmental impacts reached.

3.9 TASK 9 - COMMUNITY RELATIONS SUPPORT

Nassau County is required under the Consent Order to prepare a Citizen Participation Plan which will provide for effective citizen participation and comments at key stages of the RI/FS and remedy selection process. Malcolm Pirnie will provide technical support and will attend meetings as requested by the County. Copies of monthly progress reports which are submitted to the DEC and the Attorney General's Office will be sent to the project document repository, where they will keep the public apprised of the project's progress. Such reports will summarize the progress made during the reporting period (wells completed, samples taken, work begun, etc.) and identify problems encountered or solved and changes in the scope of work or personnel.

4.0 FEASIBILITY STUDY

The Feasibility Study (FS) uses the findings and conclusions of the RI and the endangerment assessment to develop and evaluate remedial alternatives. The overall feasibility process is illustrated on Figure 4-1 with the components discussed below.

The FS will use the data obtained during the RI. Emphasis will be placed on results obtained from the pilot recovery well tests and the pilot treatability tests.

The process by which the most feasible remedial alternatives will be selected for the site involves:

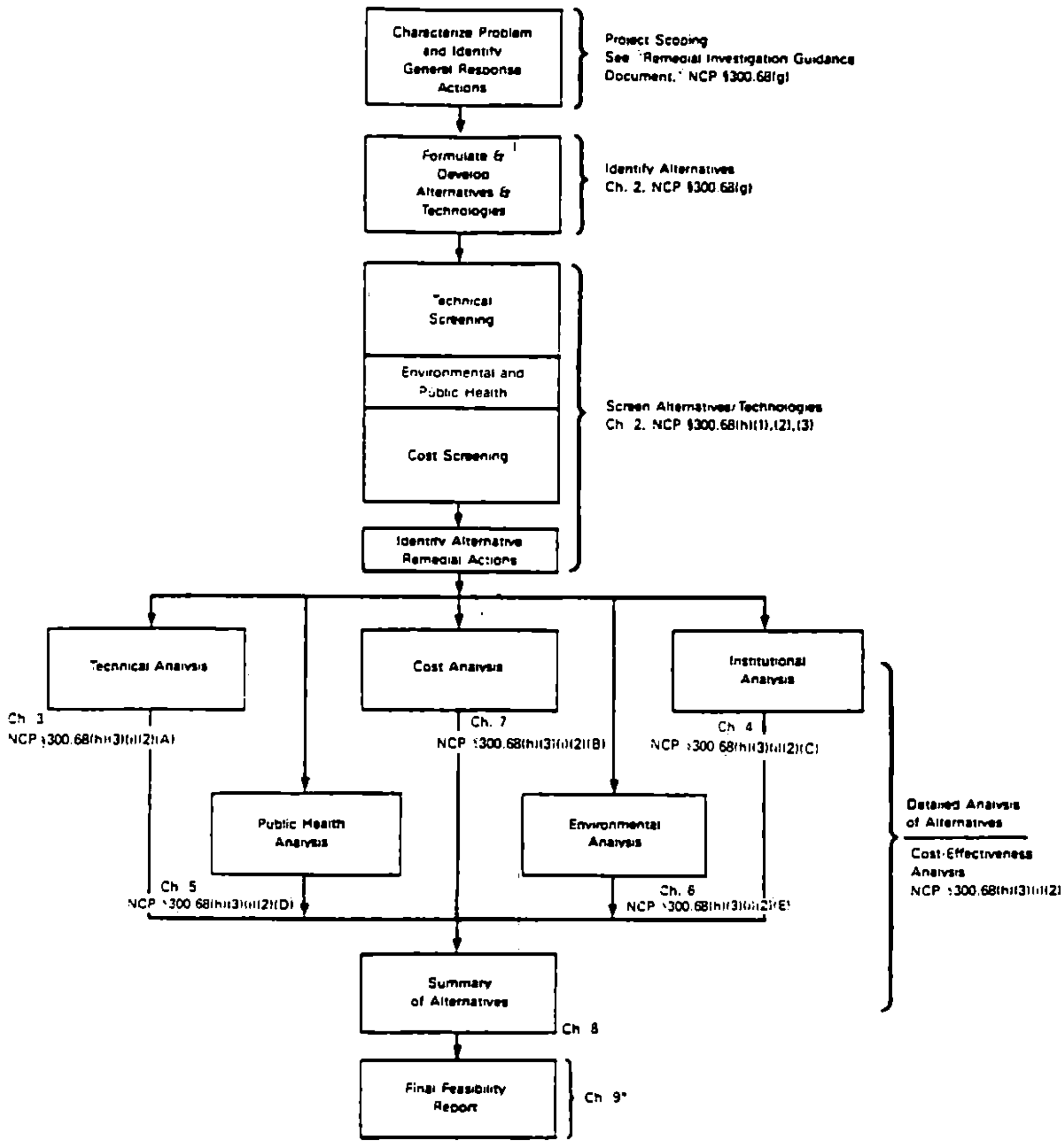
- Development of Remedial Alternatives
- Screening of Remedial Alternatives
- Detailed Evaluation of Alternatives

The FS is complicated by the existence of several contaminated areas, i.e. four floating product areas, an on-site contaminated ground water plume, and a possibly extensive downgradient contaminated plume that may have originated when the FTC first began operations in 1960. The presence of the Town of Oyster Bay Landfill and its associated contamination and remedial facilities further complicates the selection and operation of FTC remedial operations. The FS evaluations, therefore, will require the integration of these relevant factors.

The FS will consist of 11 tasks:

Task 10 - Establishment of Remedial Response Objectives
Task 11 - Identification of ARAR's
Task 12 - Identification of Potential Remedial Technologies
Task 13 - Development of Remedial Alternatives
Task 14 - Screening of Remedial Alternatives
Task 15 - Detailed Development of Alternatives
Task 16 - Technical Evaluation of Alternatives
Task 17 - Institutional Analysis of Alternatives
Task 18 - Public Health and Environmental Impacts of Alternatives
Task 19 - Cost Analysis of Alternatives
Task 20 - Feasibility Study Report
Task 21 - Modeling

FIGURE 4-1 Feasibility Study Process



Note: NCP sections identified refer to those cited in the Federal Register, July 16, 1982.

*Not specified sections of the NCP

4.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The process by which remedial alternatives are developed for each contamination area will be completed as a four-step process which includes:

- Establishing site specific remedial response objectives and criteria.
- Identification of potential treatment technologies that address site problems and meet remedial goals and objectives.
- Screening of technologies for suitability based on site and waste limiting characteristics as well as the technical reliability of the technology.
- Assembling the suitable remedial technologies into operable alternatives.

The development of remedial alternatives is based on the site conditions and public health and environmental concerns that will be discussed in the Remedial Investigation Report and the Endangerment Assessment Report. The intent of the development of alternatives is to satisfy the remedial response objectives and Applicable or Relevant and Appropriate Requirements (ARARs) as required under the Superfund Amendments and Reauthorization Act (SARA). Each step in the development of alternatives process is outlined below.

4.1.1 Task 10 - Establishment of Remedial Response Objectives

The first step in the development of alternatives is to establish site-specific remedial response objectives and criteria for each contamination problem. Response objectives will be developed for source control measures (measures designed to minimize migration of hazardous substances from the source), and management of migration measures (measures designed to mitigate the impact of contamination that has migrated into the environment).

The response objectives will be based on the results of the RI public health and environmental concerns established in the endangerment assessment, and the requirements of other applicable federal, state and local standards. Response objectives will be developed during the RI.

Remedial objectives will address areas of contaminated soil, the floating product bodies and contaminated ground water, including:

Source control objectives:

- Prevent the further release of contaminants to the surrounding environmental media.

- Eliminate or minimize the threat posed to public health, welfare and the environment from the source area.

Management of migration objectives:

- Minimize or prevent the further migration of contaminants beyond their current extent.

- Minimize threats posed to public health, welfare and the environment from the current extent of contamination.

Based on these response objectives, preliminary cleanup criteria will be developed in consultation with Nassau County and the New York State Department of Environmental Conservation.

4.1.2 Task 11 - Identification ARAR's

Applicable, relavent and appropriate requirements (ARAR's) will be identified to assure that all remedial alternatives comply. Appropriate ARAR's will be considered - including federal, state, and local requirements. A preliminary list of ARAR's will include:

Federal
RCRA
SDWA
TSCA
SARA

NYSDEC
Part 370 Hazardous Waste Management
Part 700 Groundwater Quality Regulations
Part 200 Air Emission Requirements

NYSDOH
Part 5 Drinking Water Supples
Part 170 Water Supply Sources

4.1.3 Task 12 - Identification and Screening of Potential Remedial Technologies

A list of remedial technologies will be compiled to identify techniques that are potentially capable of addressing the remedial response objectives. The technologies will include those pertaining to a contaminated site listed in the USEPA Handbook, "Remedial Action at Waste Disposal Sites," 1985 and other appropriate documents. Technologies will be screened during the RI.

Remedial technologies which meet the response objectives will be screened to eliminate those that are clearly infeasible or inappropriate. A summary of some of the criteria which will be used in the technology screening is given in Table 4-1.

4.1.4 Task 13 - Development of Remedial Alternatives

Acceptable technologies will be assembled to meet the source control or management of migration objectives. The alternatives will range from those which exceed the applicable cleanup standards to those which minimally attain the standards but acceptably reduce the probability of present or future threat from the contamination. The "no action alternative" will be developed to serve as a baseline for comparison.

Potential remedial alternatives will include, but will not be limited to, technologies addressing problems in each of the contaminated areas:

- Contaminated soil removal
- Product and removal and disposal
- Ground water extraction with treatment
- Oil/water separation and air stripping of contaminated ground water
- Biodegradation
- No action

4.1.5 Task 14 - Screening of Remedial Alternatives

The initial screening of remedial alternatives involves analysis of each alternative, based on environmental and public health effects, technical feasibility, and order-of-magnitude cost estimates.

The purpose of the screening step is to reduce the number of alternatives for a more detailed evaluation, at the same time preserving a range of options. Alternatives that are not effective in providing adequate protection of public health and the environment, are not implementable, or are significantly more costly than others and provide similar results will be eliminated from further consideration.

4.1.5.1 Effectiveness and Implementability Screening

In the screening of remedial alternatives for effectiveness in public health protection, consideration is given to the following:

- Which alternatives will minimize or prevent exposure?
- Will contaminant releases be minimized or prevented by the remedial action?
- Over what period of time will chemical concentrations be reduced at receptor locations?
- Is exposure expected during the remedial action?
- Will ARARs be satisfied?

In the screening of remedial alternatives for effectiveness in environmental protection, consideration is given to the following:

- Will the alternative improve environmental quality?
- Will the alternative cause an increase in airborne emissions?
- Will the alternative cause a new discharge to surface or ground water?
- Will the alternative cause an increase in the loading of the receiving waters?
- Will the alternative result in a known or expected significant adverse effect on the environment or human use of environmental resources?

Each alternative is also evaluated for implementability through the following factors:

- Performance
- Reliability
- Implementability
- Safety

4.1.5.2 Cost Screening

Costs are presented in the initial screening section to eliminate alternatives that are significantly greater in cost than other alternatives and provide similar environmental or public health benefits or greater reliability.

Capital costs and present worth O&M costs will be estimated. Actual costs are likely to be within the range of 50 percent less to 100 percent more than the estimates. Some of the cost data for the screening will be taken from the "Compendium of Cost of Remedial Technologies at Hazardous Waste Sites, Final Report" (ELI, 1985). Other sources of cost information include standard cost indices such as the "Means Guide" and previously estimated costs.

Capital costs where applicable, will include equipment costs, construction expenses, labor costs, contingency allowances (15 percent), engineering (15 percent), disposal costs and costs of anticipated health and safety requirements during construction. Operation and maintenance costs, where applicable, will include operating labor costs, maintenance material costs, administrative costs, and service costs. In the present worth analysis of O&M costs, a 10 percent discount rate will be used. The lifetime of each alternative for the purpose of the estimate will be assumed to be 30 years.

4.2 DETAILED EVALUATION OF ALTERNATIVES

A detailed description and evaluation of each of the remedial alternatives that pass the initial screening is the next step in the FS process. Included in the detailed development of alternatives are the factors necessary to conduct the detailed analysis of technical feasibility, institutional requirements, public health and environmental concern, and costs.

The technical feasibility analysis discusses each alternative in terms of its performance, reliability, implementability, and safety. The institutional analysis analyzes the alternatives with respect to their compliance with ARARs so that primary consideration can be given to those alternatives that attain ARARs. The public health and environmental analysis examines the beneficial and adverse effects anticipated with the implementation of each alternative. The cost analysis presents estimates of capital and O&M costs for each alternative. Estimates are expected to be in the range of +50 to -30 percent of actual costs.

4.2.1 Task 15 - Detailed Development of Alternatives

Using information such as material requirements, preliminary design criteria, and disposal requirements, each of the alternatives will be described in detail to provide a basis for the detailed analysis and subsequent recommendation of the preferred alternative. The description will include:

- Objective of the alternative
- Figures, plans and/or maps, as appropriate, to present the major features of the alternative
- Key cost components and features of the alternative
- Extent to which alternative satisfies response objectives
- Additional studies or testing required prior to design
- Site preparation requirements
- Permits, contracts, interagency agreements required to implement alternative
- Operation, maintenance, and monitoring requirements
- Disposal and transportation plans for any waste products generated, if applicable
- Temporary storage requirements, if applicable
- Health and safety requirements for remedial implementation
- A description of how implementation could be phased to improve the environment or decrease costs

4.2.2 Task 16 - Technical Evaluation of Alternatives

The technical feasibility of each alternative will be evaluated in terms of its performance, reliability, implementability and safety. Performance is based on the effectiveness of the alternative to achieve its intended function and useful life, or length of time that the alternative will achieve this function. The evaluation of reliability of an alternative involves the demonstration of reliability of the alternative at similar sites, and on operation and maintenance requirements. Implementability is based on the ease of installation in terms of constructability and time required for the construction. Safety of the alternative involves identification of the short-term and long-term threats to the safety of nearby communities as well as site workers during construction. Specific criteria that will be included in the analysis are:

- Performance, effectiveness, and useful life;
- Reliability and probability of failure;
- Operation and maintenance requirements;
- Established technology;
- Suitability;
- Risks to construction and operation of personnel health and safety;
- Constructability and operability in light of any unique site conditions;
- Time required for implementation and ultimate completion;
- Transportation and disposal capacity requirements;
- Permanent treatment of destruction of waste
- Potential for future release.

4.2.3 Task 17 - Institutional Analysis of Alternatives

In the institutional analysis, remedial alternatives are evaluated for compliance with Federal Applicable and Relevant and Appropriate Requirements (ARARs) and New York State requirements. It is a requirement of SARA that in selecting remedial actions, primary consideration be given to remedies that attain federal and state ARARs. Specific criteria that will be included in the analysis are:

- Implementation and permit requirements under Federal, State, and local laws, regulations, and policies, as addressed in the

"Summary of Institutional Requirements" in the USEPA CERCLA Guidance;

- Impact on rights and conservation requirements of users, both currently and in the future;

- Community concerns and desires;

- Need for coordination with other agencies;

- Necessary strategies to implement alternatives, considering rights, authorities, and responsibilities of other agencies and existing water users.

4.2.4 Task 18 - Public Health and Environmental Impacts of Alternatives

The beneficial and adverse public health and environmental effects achieved by each alternative are also evaluated. Public health impacts are examined for both long and short term effects. The evaluation of environmental impacts examines beneficial and adverse effects both during construction and operation and after remediation. Specific criteria that will be included in the analysis are:

Beneficial Effects:

- Estimate change in migration of contaminants.
- Estimate changes in release to contaminants.
- Estimate improvements in biological environment.
- Improvement to aquifer
- Improvement to resources.
- Describe improvements in water quality.

Adverse Impacts

- Estimate impact on air quality.
- Estimate short term impacts during construction.
- Develop and evaluate measures to mitigate adverse impacts.

Also, for each alternative it will be determined whether applicable environment standards will be attained at potential exposure points. The following standards will be included:

Water

- USEPA and NYDEC drinking water standards

Air

- NYDEC Standards
- USEPA - Clean Air Act

4.2.5 Task 19 - Cost Analysis of Alternatives

Each of the alternatives will undergo a cost analysis to further refine the cost estimates to the accuracy of -30 to +50 percent. In developing the detailed cost estimates, the following steps are used:

- Estimation of capital and operation and maintenance costs.
- Present worth analyses - calculation of annual costs and present worth for each remedial action alternative using a 10 percent interest rate factor over a 30 year period.

4.2.5.1 Capital Costs

Capital costs for each remedial alternative are estimated using the following components, if applicable:

- Construction costs: Costs of materials, labors, and overhead and profit.
- Equipment Costs: Cost of remedial action equipment.
- Services Costs: Utility costs, disposal costs and the costs of purchased services.
- Engineering Expenses: Costs of administration, design, construction supervision and drafting.
- Legal fees and permit costs.
- Start-up and shakedown costs.
- Contingency allowances.

4.2.5.2 Operation and Maintenance Costs

Operation and maintenance costs are estimated using the following components if applicable:

- Operation Labor Costs: Wages, training, overhead and benefits associated with the labor needed for post-construction operations.
- Maintenance Costs: Cost for labor, parts, and other resources required for routine maintenance.
- Materials and Energy: Costs of such items as activated carbon and electricity for plant operation.
- Purchased Services: Sampling costs, laboratory fees.
- Administrative Costs

- Insurance, Taxes, Licensing Costs: Cost of such items as liability, real estate taxes, permit renewal, etc.
- Contingency Funds
- Monitoring Costs.

4.2.6 Task 20 - Feasibility Study Report

The Consent Order requires Nassau County to submit the FS Report to the State within 90 days after their approval of the RI Report (designated Appendix D in the Consent Order). The FS will be consistent with CERCLA, NCP and USEPA guidance documents. The report will address soil contamination on-site, the areas of floating product, on-site ground water contamination and the down gradient off-site plume of contaminated ground water based on the work descriptions described in Tasks 10 through 19.

4.3 TASK 21 - MODELLING

A ground water model may be employed to predict the impact and interaction of the remediation measures employed at the site in addition to interaction with other facilities (Town of Oyster Bay (TOB) Landfill, Claremont Industrial Park, the pumping of nearby wells). The Prickett-Lonnquist Aquifer Simulation Model could be used for this purpose. Existing regional models, such as the USGS model are sufficiently detailed to accurately represent this complex area. The model would input data obtained from the USGS, FTC investigation and the modelling effort conducted in connection with remediation of the TOB Landfill.

5.0 PROJECT SCHEDULE

The project schedule for the RI/FS at the FTC is given on Plate 3. The schedule is intended only for a rough approximation to the length of time required for each task. The time required for items such as review by state agencies and Nassau County are not known and are not included in the schedule. Refinement of the schedule will be necessary prior to the onset of field activities.

SITE MAP

FIREMANS TRAINING CENTER
OLD BETHPAGE, N.Y.

PLATE 1

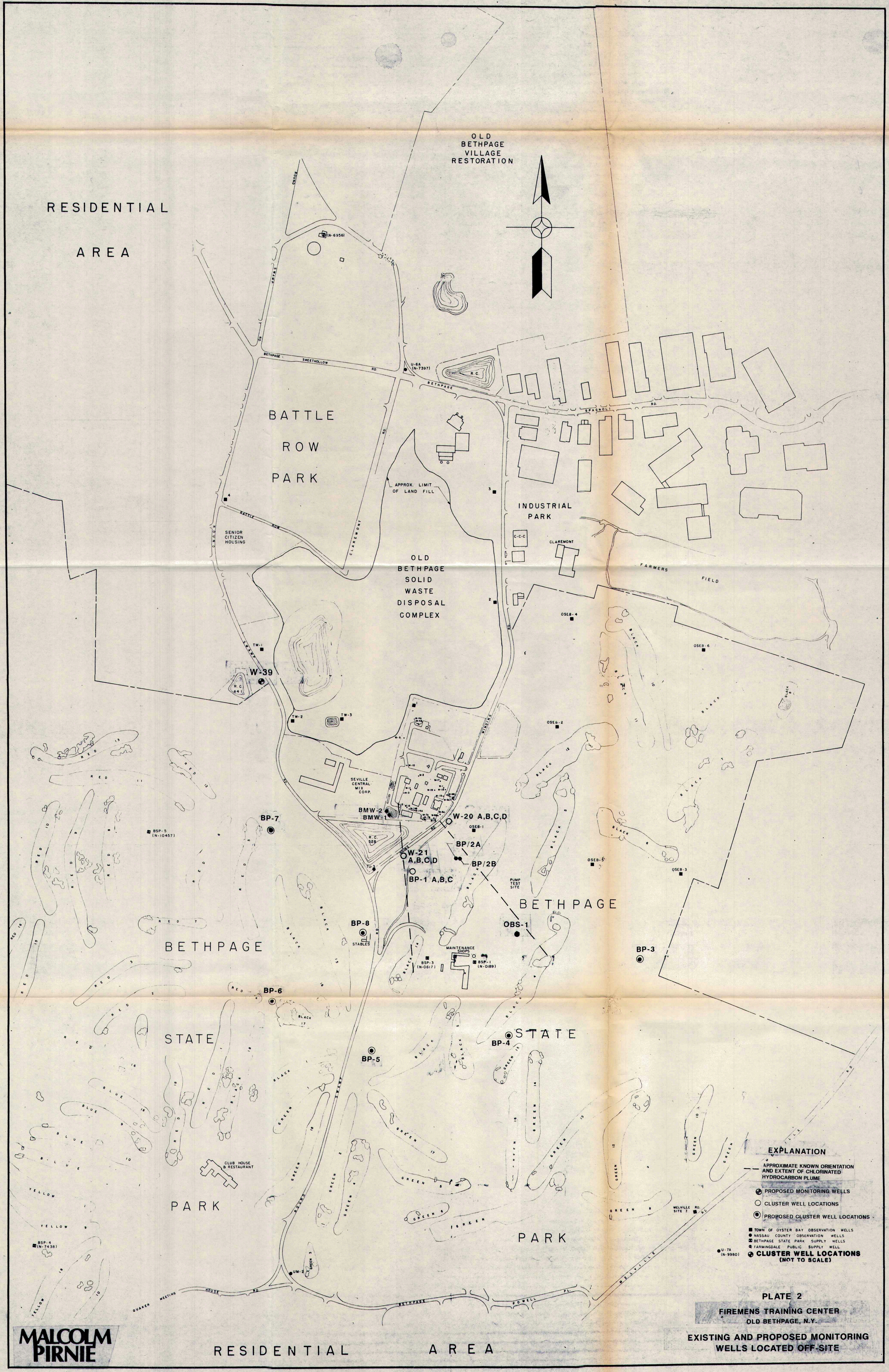


PLATE 2
FIREMENS TRAINING CENTER
OLD BETHPAGE, N.Y.
EXISTING AND PROPOSED MONITORING WELLS LOCATED OFF-SITE

NASSAU COUNTY FIREMANS TRAINING CENTER PROJECT SCHEDULE

* PERIODS OF STATE RESPONSE AS PROVIDED BY THE CONSENT ORDER

PLATE 3