PRELIMINARY DESIGN
ENGINEERING REPORT

GROUNDWATER REMEDIATION PROGRAM

AT THE

OLD BETHPAGE SOLID WASTE DISPOSAL COMPLEX

CONTRACT NO. TBI 86-400

PREPARED FOR:

TOWN OF OYSTER BAY
DEPARTMENT OF PUBLIC WORKS
SYOSSET, N.Y.

OCTOBER 1988

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TABLE OF CONTENTS

Engineering Report
For Groundwater Remediation Program at OBSWDC

4. The continuation of the collection and treatment of the groundwithin the plume until the monitoring program demonstrates that the groundwater has either met the specified groundwater criteria set forth in the Consent Decree, or has met the zero slope condition as described in the Consent Decree.

5. The installation, operation and maintenance of a post termination monitoring program to confirm the attainment of the groundwater criteria, or zero slope condition, before the GRP may be terminated.

SECTION 1

Introduction

This Engineer's Report describes the preliminary design of the Groundwater Remediation Program (GRP) at the Old Bethpage Solid Waste Disposal Complex (OBSWDC). The Groundwater Remediation Program is an integral portion of the OBSWDC Remedial Action Plan (RAP), whose implementation has been required by a Consent Decree in New York State v. Town of Oyster Bay et al. 83 Civ. 5357 ("Consent Decree").

The Groundwater Remediation Program, as indicated by the Consent Decree, consists of the following items:

1. The installation, operation, and maintenance of a system of groundwater recovery wells to effectively establish and maintain a consistent hydraulic containment of the contaminated groundwater plume.

2. The installation, operation and maintenance of a treatment facility to treat and discharge the collected groundwater from the recovery wells to comply with the air and water discharge criteria set forth in the Consent Decree.

3. The implementation of a groundwater monitoring program to demonstrate the plume is not migrating beyond the point of hydraulic containment in excess of the established groundwater criteria.

different VOC groupings within the landfill leachate plume indicates that part of the VOC contamination are not attributable to the landfill.

e. No significant mounding is occuring at the landfill. In addition, the proposed final capping of the landfill will minimize any potential for mounding.

2.2 Project Objectives

The overall project objective is to contain, capture and clean the landfill leachate plume, thereby, preventing further degradation of the groundwater aquifer. Specifically, the project objectives are to:

- Prevent, through the development of a hydraulic barrier, further migration of the landfill leachate plume.
- Capture and remove, through a series of extraction wells, the landfill leachate plume.
- Treat the captured groundwater leachate plume to meet groundwater quality requirements.
- Recharge the treated water to the local aquifer system.

SECTION 3

Authorization and Scope of Work

Lockwood, Kessler & Bartlett, Inc. (LKB) has been authorized by the Town of Oyster Bay, N.Y. to prepare the preliminary design plans for the Groundwater Remediation Program (GRP), at the Old Bethpage Solid Waste Disposal Complex (OBSWDC). The program consists of the installation, operation and maintenance of five groundwater recovery wells, a groundwater treatment plant and effluent discharge system to collect, treat and discharge groundwater contaminated by leachate from the Old Bethpage Landfill.

The project site encompasses an area which includes portions of the OBSWDC and the Bethpage State Park. The groundwater treatment plant and effluent discharge system will be located within the OBSWDC which is in eastern Nassau County, and is bordered by Round Swamp Road to the west, Winding Road to the east and Bethpage Sweet Hollow Road to the north. The groundwater recovery wells will be located within the Black Golf Course of the Bethpage State Park, located east of Winding Road and Round Swamp Road.

The work consists of five (5) groundwater recovery wells, each pumping at a rate of approximately 300,000 gallons per day (210 gpm) resulting in an approximate total flow of 1.5 million gallons per day (MGD) (1,050 gpm). The wells will pump to a common transmission line which will convey the flow to the proposed groundwater treatment plant. The plant will be able to contain three unit processes involving air stripping, filtration, and activated carbon adsorption, as required by each process. The treated effluent will then be discharged directly back to the groundwater through a series of diffusion wells located beneath the existing Recharge Basin No. 1 at the OBSWDC.

SECTION 2

Project Background and Objectives

2.1 Project Background

Previous groundwater investigations established the following:

a. The groundwater under the landfill flows in a south-south-easterly direction. Water-level data collected from the upgradient wells does not indicate components of groundwater flow to the north or west.

b. The landfill leachate plume is comprised of inorganic compounds and volatile (halogenated and non-halogenated) organic compounds (VOC's).

c. The lateral and vertical extent of the total organic plume.

d. The most dominant halogenated organics, in terms of concentration and distribution, are 1,2-dichloroethene, 1,1-dichloroethane, vinyl chloride, methylene chloride, trichloroethene and chloroethane. The non-halogenated organic compounds occur in a smaller area of the plume than do the halogenated compounds. The most dominant compounds of this group are benzene, toluene, ethyl benzene and isomers of xylene.

   Tetrachloroethene, although present at similar concentrations, has a different lateral distribution than the compounds cited above. In this regard, comparison of the distributions of the

The GRP also includes the initiation of a groundwater monitoring program to determine the effectiveness of the hydraulic containment of the plume and to monitor the quality of groundwater both within and beyond the plume. The GRP collection and treatment system will continue until such a time as the monitoring program demonstrates that the groundwater within the plume has either met the specified groundwater criteria or reached the zero slope condition.

SECTION 4

Treatment Unit Process Selection

4.1 General

The following goals have been identified in selecting the groundwater treatment process:

4.1.1 Treatment should meet or exceed the effluent quality requirements as set forth in the Consent Decree.

4.1.2 Operation should allow for easy visual monitoring, testing and maintenance, with automatic control of the principal pieces of equipment.

4.1.3 Aesthetics - The building design should blend in with the overall existing environment, and be self contained to eliminate the chance of contamination of the surrounding area from the untreated groundwater.

4.1.4 Schedule - Scheduling should allow for two phases of plant construction. The first phase will be constructed to accommodate only the air stripper to remove VOC contaminants and low iron and manganese concentrations in the groundwater. Based on the operation of the first phase construction, if the effluent limitations for VOC concentrations are not met, the second phase construction will include the carbon adsorbtion unit process only. If the effluent limitations for iron, manganese are not met, the second phase will contain the pressure filter units, and the related equipment only. If both the iron manganese and VOC concentrations exceed the effluent limitations, the second phase construction will include all the unit processes as shown on the drawings.

4.1.5 Cost-Effectiveness should also be considered when selecting the unit processes. The construction and annual operating costs should be carefully analyzed.

4.1.6 System Flexibility - Piping connections and valving of several unit processes should be provided to allow for changing or bypassing the process order, as well as providing flexibility within each process.

A typical example is indicated in the flow diagram incorporated in the plans. This flexibility will provide an inexpensive means by which maximum efficiency of the contaminant removal will be achieved.

4.1.7 Flow Measurement is necessary to provide good process control. Several flow meters have been provided at various locations in the system to monitor flow between the unit processes. Also, the flow meters will make it possible to balance out of the flows between the unit processes.

4.2 Treatment Unit Processes Available

4.2 1 General

The treatment process equipment chosen consists of the latest state of the art technology to treat the contaminated water to meet the established effluent criteria at the time of implementation. As indicated under "Design Parameters", the process selection was made to assure the removal of volatile organic compounds (VOC's), as well as iron and manganese, down to the requirements of the Federal, State and local Agencies. The process studied included the air stripping of VOC's, activated carbon adsorption for the removal of remaining VOC's and the chemical oxidation of the iron and manganese followed by manganese greensand filtration. The installation of various unit processes will be implemented based on the requirements to achieve the effluent limitations, as described in Section 4.1.4. It is anticipated that under normal operation of these three processes, iron removal will be accomplished prior to air stripping and activated carbon adsorption to ensure that iron precipitates will not clog the air stripper or activated carbon column.

4.2.2 Air Stripping

Air stripping is the unit process of choice for removing many different VOC's from groundwater. The required removal efficiency can be achieved by selecting the right combination of design parameters, including the air-to-water ratio hydraulic loading rate, and the height and type of packing material. The principal of air stripping is the transfer of VOC's from an aqueous solution into the gaseous phase, the rate of which is dependent on the mass transfer properties of the contaminants involved.

An optimum air-to-water ratio must be established to maximize the mass transfer rate and at the same time keep energy requirements within feasible limits. In order to optimize the mass transfer properties, the selection of packing material also plays an important role. By selecting the right packing and optimizing the appropriate parameters, the treatment objectives can be achieved for a determined effluent criteria to be met. For the purpose of this project, a pilot plant was operated to investigate the effects of varying the design parameters on a representative groundwater sample. The design parameters established during this test should be the most indicative for the groundwater in question. The air stripper will use a countercurrent flow scheme which has been proved to be an effective process for removing VOC's, to acceptable limits before recharging the water back into the ground. The VOC removal is expected to occur throughout the medium itself, performance as a function of medium depth.

4.2.3 Carbon Adsorption The activated carbon system, using granular activated carbon, as needed, is the most common adsorption process for the removal of organic contaminants. In general, and as used in this treatment process, better removal efficiency can be achieved by coupling air stripping with activated carbon adsorption for removal of VOC's.

There are actually three steps in the adsorption of contaminants by activated carbon. The first step is the transport of the solute to the surface of the carbon. Then the solute diffuses into the pores of the carbon. The final step is the adsorption of the solute on interior surfaces of the pores and in the capillary spaces of the carbon.

4.2.4 Iron & Manganese Removal

Iron and manganese removal is the process by which objectionable amounts of iron and manganese are removed from water either in one step or a series of steps. There are so many different methods that can be employed for iron and manganese removal that careful study is required to select a method most suitable to any individual case. Iron is frequently present in water in the ferrous or unoxidized state. An increase in pH in the absence of oxygen will precipitate ferrous hydroxide, but since ferrous hydroxide is more soluble than ferric hydroxide, complete iron removal requires oxidation of ferrous iron to the ferric state, with the precipatation of the highly insoluble ferric hydroxide.

For effective removal of iron and/or manganese, pH adjustment is required. For iron removal, pH should be maintained at 7.5. For manganese removal, pH should be adjusted to 9.5. The pH adjustment will be achieved by chemical treatment applied prior to filtration.

Methods of Iron Removal

a. Aeration-sedimentation-filtration
b. Coagulation-sedimentation-filtration
c. Lime and lime-soda softening
d. Ion exchange
e. Contact filtration
f. Aeration-filtration

Due to presence of both iron and manganese in the water to be treated, the processes considered should be contact filtration, and aeration-filtration. The other methods, as shown above, are either very expensive or very difficult from an operational point of view. In both processes, contact filtration and aeration-filtration, both iron and manganese are oxidized and their resulting precipitates are removed by a filtration process. Because of the amount of manganese to be removed, it is necessary to use the contact filtration process consisting of a combination of potassium permanganate addition and manganese greensand filtration. The aeration-filtration process is not used because manganese is not significantly oxidized below a pH of 9.5, so it is necesssary to use a strong oxidant.

The manganese greensand filtration, being the process selected for this treatment scheme, accomplishes the oxidation and filtration of iron and manganese in one step. For this process, the filter bed supplies the oxygen needed for oxidation of the two metals, and the oxygen must be periodically replenished by the use of a regenerant chemical (potassium permanganate). Addition of the potassium permanganate results in the precipitation of the higher oxides of manganese on the zeolite grains. The oxidation reaction occurs between the natural iron content of water and the manganese oxides, on the zeolite grains. Regeneration of the unit with potassium permanganate is required, as the oxidizing ability of the bed is consumed in the process of the iron and manganese removal. However, since the use of potassium permanganate ($KMnO_4$) is costly, an aditional less expensive chemical oxidant (sodium hypochlorite, NaOCL), is used to oxidize much of the iron before reaching the filter bed. A third chemical feed system is also used to raise the pH of the water to approximately 8.5 so that the oxidation reactions will commence more rapidly. The pH adjustment is performed first by the addition of caustic soda, followed by the addition of NaOCL and $KMnO_4$, respectively.

As mentioned previously, the iron and manganese removal can be accomplished by oxidizing the metals as much as possible by using air rather than chemical addition in order to reduce operation costs and a much more sophisticated process. The method which can be utilized is the in-line pressure aeration. This system must be installed upstream of the filtration and injects air under pressure into the influent causing oxidation of the iron prior to entering the filters. Because of several unknowns, in what level of iron and manganese removal can be achieved, and because these filtration systems, using air or chemicals prior the filters, the use of a pilot plant is essential in determining the most efficient and cost effective filtration unit process.

Several elements have to be determined within the filtration process; the underdrain system, the water backwash and air scouring, the disposal of the solids in the backwash water, as well as the most reliable control and instrumentation systems should be established before the filtration system is selected and before final design is begun.

4.3 Selected Process Description

4.3.1 General

The design has been developed for two phases of construction as follows:

Phase I Recovery wells (5), air stripper, air stripper pump station, and filter pump station (to be used as the treated water pump station during Phase I), and the discharge manhole and diffusion wells within the existing recharge basin.

Phase II will entail, as necessary, pressure filters, activated carbon columns, activated carbon pump station, and treated water pump station, chemical feed equipment and backwash equipment (including backwash holding tank, settling tank and filter press).

4.3.2 Operation

Phase I Reference is made to the Process Flow Diagram (Drawing No. 18A). The groundwater will be pumped from each of the five recovery wells through the transmission line toward the treatment plant. Flow from each well and the main header will be measured and transmitted to the main treatment plant for documentation and control purposes. Each well operates independently, and is controlled from the panel located in the control room at the treatment plant. The control system will allow various operational modes for the recovery wells. In addition, the wells will automatically be shut down if a high water level exists in the air stripper pump station or if the well pit float switch detects a presence of water. All remote control signals will be transmitted via telephone lines. The operation of the wells is regulated by the flow controller valves which can be manually opened or closed from inside the respective pump room, and used as shut off valves. The water will be pumped from the wells to the air stripper pump station. The flow can be controlled through the on/off valve located on the influent pipe.

The water is pumped from the wet well to the top of the air stripper. It flows down through the air stripper, while air is blown up and out the top of the air stripper. The effluent from the air stripper is discharged by gravity into the wet well of the filter pump station. The level in each wet well will be measured by use of a continuous level measurement device which provides a linear 4 to 20 mADC output signal. A pressure switch will be located on the discharge side of the blower for information of correct blower operation. In this stage of construction, the filter pump station will be used to pump the air stripper effluent toward diffusion wells located within the recharge basin.

A main control panel (MCP) will be provided and located in the Treatment Plant. The MCP will provide all required control logic to operate the five recovery well pumps, all pump station booster pumps and all automatic valves. In addition, the MCP will include the following:

- Annunciator for status indication of pumps and valves.

- Six pen recorder to record production well flows and main header flow.

- Totalizers to provide flow totals.

- Logic Control System for production wells and treatment plant operation.

- Telemetering equipment for comunication with the production wells.

Phase II If the Phase I operation of the plant does not provide adequate treatment of the groundwater, the construction of Phase II will allow for various modes of operations as indicated on the Flow Process Diagrams (Drawings No. 18 and 18A).

Two of the three pumps provided in the filter pump station will pump the water into the four horizontal pressure filters. During normal filtration operation, the flow will be evenly split among the filters. Each filter will be provided with a differential pressure switch. When the differential pressure for a given filter reaches a specific set point, the backwash operation will be initiated. During backwash operation, one unit is taken off-line. The remaining three filters continue under normal filtration mode.

The filtration process is aided by the addition of chemicals. Continuous regeneration involves the feeding of a predetermined amount of potassium permanganate, in combination with hypochlorite to the influent of the pressure filters. Caustic will also be added to the filter influent if pH adjustment is required.

The following chemical analysis equipment will be provided.

- Potassium Permanganate Color Monitor and Analyzer.
- pH Monitoring Control Station.
- Residual Chlorine Monitoring Control Stations.

Each of the above units shall provide control signals to the chemical feeders for adjustment as required.

During the backwash sequence, backwash water is discharged by gravity into the backwash holding tank. The water is then pumped out at a lower rate during the period between backwashes into the settling tank. The water level in the backwash holding tank is controlled by a level controller which activates closing of the control valve and the shut off of the backwash pumps.

The solids will be collected in the settling tank hoppers. The supernatant will overflow the weir and discharge into the main drain line flowing to the filter pump station.

When a 2% sludge concentration is achieved, it will be pumped into the filter press. The filter cake will be discharged into the dumpsters, while the filtrate will discharge into a drain pipe which conveys the filtrate to the backwash holding tank.

The treated effluent from the filters is discharged into the air stripper pump station. From here the water is pumped into the air stripper where the volatile organic compounds (VOC's) are removed. The air stripper effleuent flow then enters the activated carbon pump station where it is pumped into the activated carbon columns. These process units operate in either parallel or series.

During carbon replacement operations, one carbon filter will be taken off line by closing influent and effluent valves and removing the spent carbon and replacing it with regenerated carbon. Normal operation will then resume.

In both flow patterns, the effluent discharges into the treated water pump station containing two pump groups. One group has been sized to pump the final treated effluent toward the recharge basin and into the diffusion wells. The second group of pumps has been sized to provide the high rate backwash flow to one pressure filter at a time.

SECTION 5

Design Parameters

5.1 DESIGN FLOWS

5.1.1 Maximum (5 Wells Operating)	1.5 MGD (1050 GPM)
5.1.2 Minimum (2 Wells Operating)	0.6 MGD (420 GPM)

5.2 WATER CHARACTERISTICS

CONTAMINANTS (1)	INFLUENT (1)	EFFLUENT (2)	% REMOVAL REQ'D. (3)
- Inorganics, (mg/l)			
Iron	avg. 2-5	0.3	85-94
	max. 8	0.3	99
Manganese	0.5-1.0	0.3	92.5
Mercury	0.003	0.002	33
- Organics, ug/l			
Vinyl Chloride	68	1.0	98.5
1,1-Dichloroethane	178	50	72
1,2-Dichloroethane	8.7	0.8	91
1,1-Dichloroethene	1.2	0.07	94
1,2-Dichloroethene	273	50	82
Trichloroethylene	14.4	5	65
Benzene	90	Non-Detect.	98.9
Dichlorobenzene (Ortho & Para)	6.3	4.7	25
Ethylbenzene	272	50	82
Tetrachloroethene	4	0.7	82

(1) Indicates only those contaminants whose concentrations are expected to be above the acceptable groundwater criteria established by in the Consent Decree.

(2) Indicates effluent criteria established by the Consent Decree.

(3) Indicates the removal efficiency required in order to attain the effluent limitations established by the Consent Decree.

5.3. RECOVERY WELLS AND PIPING CONNECTIONS

5.3.1 Well No. 1

a. Well Characteristics:

Diameter = 10 in.
Depth = 245 ft.

b. Pump Characteristics:

Type = Submersible
Dia. = 4 in.
Flow Range = 180-220 GPM
T.D.H. = 130-160 ft.

5.3.2 Well No. 2

a. Well Characteristics:

Diameter = 10 in.
Depth = 270 ft.

b. Pump Characteristics:

Type = Submersible
Dia. = 4 in.
Flow Range = 205-260 GPM
T.D.H. = 110-145 ft.

5.3.3 Well No. 3

a. Well Characteristics:

Diameter = 10 in.
Depth = 270 ft.

b. Pump Characteristics

Type = Submersible
Dia. = 4 in.
Flow Range = 220-260 GPM
T.D.H. = 105-140 ft.

5.3.4 Well No. 4

a. Well Characteristics:

Diameter = 10 in.

Depth = 275 ft.

b. Pump Characteristics:

Type = Submersible
Dia. = 4 in.
Flow Range = 220-255 GPM
T.D.H. = 110-140 ft.

5.3.5 Well No. 5

a. Well Characteristics:

Diameter - 10 in.
Depth = 275 ft.

b. Pump Characteristics

Type = Submersible
Dia. = 4 in.
Flow Range = 225-245 GPM
T.D.H. = 120-135 ft.

5.3.6 Discharge Line (Typical)

Size = 4 in.
Material = P.V.C. Schedule 80 Type I
Joint = Threaded
Operating Pressure = 100 PSI

5.3.7 Transmission Line

Size = 4 to 10 in.
Material = P.V.C. Schedule 80 Type I
Joint = Slip on
Operating Pressure = 100 PSI

5.4. AIR STRIPPER PUMP STATION

5.4.1 Wet Well

Cycle Time = 15 min.
Volume Required = 4,000 Gal.
Water Depth = 8.10 ft. (min.)
Wet Well Dimensions (LxWxH.) = 15.5'x14.0'x11.5'
Volume Provided = 13,115 Gal.

5.4.2 Pumps

Number of Units = 3
Capacity (each) = 525 GPM
T.D.H. = 60 ft.
H.P. (each) = 15

5.5 AIR STRIPPER

Number of Units	1
Diameter	8'-0"
Tower Height	42'-0"
Inlet Pipe Elev.	184.5'
Hydraulic Loading	21 GPM/SF
Water Temperature	50 °

Air Blower

Air: Water Ratio	60:1
Air Flow Rate	8422 CFM
Number of Units	1

Packing Media

Packing Media Type	Jaeger
Packing Media Size	2" Dia.
Packing Media Depth	35'-0"

5.6. FILTERS PUMP STATION

5.6.1 Wet Well

Cycle Time = 15. min.
Volume Required = 4,000 Gal.
Water Depth (Min.) = 6.25'
Wet Well Dimensions (LxWxH.) = 17.25'x14.0'x11.5'
Volume Provided = 11,454 Gal.

5.6.2 Pumps

Number of Units = 3
Capacity (each) = 525 GPM
T.D.H. = 60 ft.
H.P. (each) = 15

5.7 PRESSURE FILTERS

No. of Units	4
Size (Dia. x Length)	8'-0"x30'-0"

Filter Media Depth	
Anthracite	21"
Manganese Greensand	15"
Filtration Rate	1050 GPM
All Filters Operating	1.3 GPM/SF
3 Operating & 1 Backwashing	1.7 GPM/SF
Backwash Rate (Low)	1250 GPM
Duration of Low Rate Backwash	1 MIN
Backwash Rate (High)	2500 GPM
Duration of High Rate Backwash	10 MIN
Air Scour Rate	0.8 SCFM/SF
Duration of Air Scour	3 MIN
Raw Water Rinse Duration	5 MIN
Air Blower	
No. of Units	1
Air Flow Rate (Each)	172 CFM
Pressure	5 PSI

5.8. CHEMICAL FEEDING SYSTEMS

5.8.1 Sodium Hydroxide (Na OH)

Use: pH Adjustment From 5.5 to 8.5

Application Rate	5 MG/l
Required Dosage	23.55 GPD
Storage Required (30 Days)	706 Gal.
No. of Metering Pumps (Diaphragm Type)	1

5.8.2 Sodium Hypochlorite (NaOCL)

Use: Iron Oxidation

Application Rate	5 MG/l
Required Dosage	54.75 GPD
Storage Required (30 Days)	1,642 Gal.
No. of Metering Pumps (Diaphragm Type)	1

5.8.3 Potassium Permanganate (KMn04)

Use: Filter Bed Regeneration

Application Rate	9-14 mg/l

Required Dosage	240-375 GPD
Storage Required (30 Days)	3,390 Lbs.
No. of Metering Pumps (Diaphragm Type)	1

5.9. BACKWASH PUMPS

5.9.1 Wet Well:

Cycle Time = 15 min.
Volume Required (for cycle) = 9,375 Gal.
Volume Required (for backwash) = 14,500 Gal.
Water Depth (min.) = 8.0'

Dimensions: (LxWxH.) = 20.75'x14.0'x11.5'
Volume Provided = 17,384 Gal.

5.9.2 Pumps:

Number of Units = 2
Capacity (each) = 1,250 GPM
T.D.H. = 70 ft.
H.P. (Each) = 30

5.10 BACKWASH HOLDING TANK

5.10.1 Volume Required

Partial Tank Drainage			=	1,400 Gal
Low Rate Backwash	@ 1,250 GPM	for 1 Min.	=	1,250 Gal
High Rate Backwash	@ 2,500 GPM	for 10 Min.	=	25,000 Gal.
Raw Water Rinse	@ 263 GPM	for 5 Min.	=	1,315 Gal.
		Total Volume Required	=	28,965 Gal.
		Safety Factor		x 1.20
				34,758 Gal
				(4,647 CF)

Number of Units	1
Water Depth	10'-0"
Area Required	465 SF
Tank Size (wxl)	16'-0"x30'-0"
Total Tank Depth	12'-0"

5.10.2 Transfer Pumps

Number of Units	2
Capacity (Each)	300 GPM
T.D.H.	30 FT

Motor HP (Ea.)	5

5.11 SETTLING TANK

5.11.1 Tank Design

Flow	100 GPM
Overflow Rate	0.33 GPM/SF
Area Required	300 SF
Number of Units	1
Size Required (wXl)	12'-0"x25'-0"
Detention Time	180 MIN
Side Water Depth	8'-0"
Freeboard	1'-6"

5.11.2 Sludge Pump

Type: Air Powered-Double Diaphragm

Number of Units	1
Capacity	0-135 GPM
Pressure (Max.)	125 PSI

5.12 FILTER PRESS

Number of Units	1
Filtration Area	524 SF
Filtration Volume	24 CF
Maximum Pressure	100 PSIG
Maximum Hydraulic Pressure	3,000 PSIG
No. of Chambers	31
Cake Removal By	Removable Cake Trays

5.13 ACTIVATED CARBON PUMP STATION

5.13.1 Wet Well

Cycle Time = 15 Min.
Volume Required = 4,000 Gal.
Water Depth = 6.25'
Dimensions (LxWxH) = 14.25'x14.0'x11.5'
Volume Provided = 11,454 Gal.

5.13.2 Pumps

Number of Units = 3
Capacity (each) = 525 GPM
T.D.H. = 130 Ft.

H.P. (Each) = 25

5.14 ACTIVATED CARBON COLUMNS

Number of Units = 3
Vessel Dimensions: 10 ft. dia.x15 ft.H.
Operating in Parallel
Overflow Rate = 4.46 GPM/ft ^{2}
Flow Rate/Unit = 350 GPM
Total Flow Rate = 1,050 GPM
Contact Time = 15 Min.
Carbon Bed Depth = 12.5'

5.15 DISCHARGE PUMPS

5.15.1 Wet Well

Cycle Time = 15 Min.
Volume Required = 4,000 Gal.
Water Depth = 8.10'
Dimensions (LXWXH) = 20.75'x14'x11.5'
Volume Provided = 17,384 Gal.

5.15.2 Pumps

Number of Units = 2
Capacity (Each) = 1,050 GPM
T.D.H. = 46 Ft.
H.P. (Each) = 20

5.16 DISCHARGE MANHOLE

Number of Manholes	1
Size	4'-0" Dia.x8'-0" Deep

5.17 DIFFUSION WELLS & DISTRIBUTION PIPING

Number of Wells	10
Size	10'-0" Dia. x 24'-0" Deep
Distribution Piping	12" Dia. Porous Pipe

SECTION 6

Description of the Recovery Wells

6.1 General

Reference is made to Sections 5 and 10 of this report which contain technical data pertaining to groundwater recovery system, particularly, design parameters and outline specifications.

6.2 Purpose

The Groundwater Recovery System refers to a series of groundwater recovery wells and a transmission line which were designed to accomplish the following purposes:

a. Provide hydraulic containment of the groundwater plume whose water quality was affected by contamination from the Old Bethpage Landfill. The recovery system will maintain sufficient drawdown to create a hydraulic barrier which will prevent further migration of the groundwater plume.

b. Convey the captured groundwater to the treatment plant for removal of contaminants and recharged to ground through diffusion wells.

The operation of the groundwater recovery system will continue until the groundwater monitoring system demonstrates that either the Specified Groundwater Criteria is met, or the Zero Slope Condition is reached as described in the consent decree.

6.3 Description and Location

The groundwater recovery well system consists of five groundwater recovery wells and a transmission force main conveying the captured groundwater to the treatment plant. The five wells are located at the leading edge of the contaminant plume within the Bethpage State Park Black Golf Course (BSPGC), and are situated to create a hydraulic barrier to prevent any further plume migration. The recovery wells are designed to withdraw a total of 1.5 mgd, or 0.30 mgd from each well. Each individual well consists of a 10" pipe and screen, 10 H.P. or 15 H.P pump and motor, equipped with a check valve, a 4" discharge pipe with a control valve, a pressure gauge flow meter and control panel. The control facilities are located in an underground reinforced concrete structure with the top slab at the ground level. Other details and individual well characteristics are shown on Drawing No. 21.

The conveyance system through the golf course generally follows existing pathways and clearing so as to cause minimum disturbance of the existing environment and to minimize potential impacts on park activities, both during the construction and operation phases. The actual locations of the wells and piping system through the golf course as presented on the drawings was reviewed and tentatively approved by the representatives of the New York State Park Commission.

The conveyance system consists of 4", 6", 8" and 10" P.V.C. pipes provided with vacuum and air release valves at the high points and drains at the low points. Restrained joints and/or thrust blocks will also be provided as necessary. A back pressure sustaining valve is provided to accommodate for low pumpage rates and negative pressures in the system.

The power supply for the wells is taken from the existing LILCO aerial service pole at the intersection of Round Swamp Road and the BSPGC Maintenance Road, as shown on Drawing 11. A 15 KV, buried cable connects the service pole with the transformer located adjacent to the existing BSPGC Well and Pump Station No. 3. From the transformer, individual, 480V feeders supply wells Nos. 1 through 5 following the piping alignment once it reaches Well No. 1. The telemetry and control system also follows the piping alignment beginning at the wells and terminating at the groundwater treatment plant control panel.

6.4 Operation and Control

The operation of the groundwater recovery system is intended to create and maintain a hydraulic barrier to prevent further migration of the groundwater plume, as well as collect and transfer captured groundwater for treatment. The anticipated flow required to maintain hydraulic containment from the five recovery wells is 1.5 mgd. This design flow and its corresponding resultant water table drawdown were estimated from the groundwater modeling studies and confirmed through the pilot pump test. However, to ensure that the groundwater recovery system will maintain hydraulic containment over a range of possible operating conditions, the following design assumptions were made prior to well pump selection:

a. The normal mode of operation assumes all five wells operating at 210 gpm (0.30 mgd) each for a total flow of 1050 gpm (1.5 mgd).

b. The total maximum pumping capacity of the system is 1.76 mgd or 220 gpm.

c. Wells operating individually have a capacity of up to 290 gpm.

d. To account for seasonal water table fluctuations, as well as the possible lowering of the water table over the duration of the project, the pumps have been located an additional ten feet below the anticipated drawdown depth.

6.5 Transmission Line Leak Detection

Detection of leakage of the conveyance system is accomplished by monitoring both the flow rates of the individual extraction wells measured at the well sites and measuring the total flow delivered at the Groundwater Treatment Plant. The control panel in the treatment plant will be equipped with a totalizer to total the flow from the five wells. This total flow will continually be compared to the flow measured at the influent line at the treatment plant. Once the difference in these flows exceeds a predetermined limit, the recovery wells will automatically be shut off and a visual and audible alarm will be triggered. The actual location of the leak will be determined by the system's maintenance crew and the pipe repaired.

6.6 Ground-Water Monitoring Program

In order to demonstrate the effectiveness of the remedial actions, a groundwater monitoring program will be implemented. It will consist of two elements: hydraulic monitoring and groundwater quality monitoring, as described below:

a. The hydraulic containment and the effects of potential mounding will be demonstrated by measuring water levels in adjacent monitoring wells.

b. Groundwater quality monitoring will be initiated after the recovery system has been installed but prior to the commencement of pumping. Samples will be taken from down gradient, and upgradient wells. The groundwater monitoring program will continue until the Termination Criteria is met. This will be demonstrated by the Termination and Post-Termination Monitoring Program.

SECTION 7

Description of the Treatment Facilities

7.1 Building and Grounds

The proposed treatment facilities will be housed in a building designed to blend in with the styling of the surrounding buildings. Salient features of the building, its layout and the surrounding area are as follows:

Dimensions

- Treatment area 72'-0" x 73'-8"
- Chemical Room 24'-8" x 35'-6"
- Control Room 24'-8" x 35'-6"
- The building slab will be provided with a gas proof membrane to prevent gas migrated from the landfill to penetrate the building.
- 3'-6" to 4'-6" walkways around all unit process, with 12'-0" central walkway.
- 4,000 CFM ventilation system for the treatment area
- 150 CFM ventilation system for the control room
- 3,000 CFM ventilation for the chemical room

- Heating system for the treatment area and control room to maintain a temperature of 65 ^{o} F.

- Heating system for the chemical room to maintain a temperature of 60 ^{o} F.

- The floor drainage throughout the building will discharge into the air stripper and/or filter pump station.

- Cold water will be supplied from the existing 6" water main.

- Sanitary sewer will discharge into the existing 15" sanitary sewer on Winding Road.

- The site drainage system is integrated with the TOBSWDC Master Plan.

7.2 Unit Processes

7.2.1 Air Stripper Design

The air stripper design was based on a pilot plant study and empirical data used for mass transfer modeling for the removal of volatile organic compounds (VOC's) from the captured groundwater. The pilot plant study was performed on a groundwater sample from an existing off-site groundwater monitoring well cluster. The pilot plant tested several liquid loading rates and air flow rates to determine the most accurate mass transfer coefficients for the contaminants in the groundwater sample. In applying the results of the pilot test to full scale design a balance was sought between capital and operating costs in selecting tower size, packing height and air blower performance. Table 7-1 lists the design parameters of the proposed air stripper.

TABLE 7-1

Air Stripper Design Parameters

No. of Units	1
Tower Diameter	8'-0"
Tower Height (aboveground)	42'-0"
Tower Material	Stainless Steel
Packing Media Type	2" Jaeger Tri-Paks
Packing Media Depth	35'-0"
Design Flow	1,050 gpm
Hydraulic Loading Rate	21 gpm/sf
Water Temperature	50 ^{o} F
Air: Water Ratio	60:1
Air Flow Rate	8,422 cfm

The eight foot diameter counter current air stripper column is made of stainless steel and has a total height of 45 feet (42 feet above ground). The column is completely self-supported and anchored to an 18 inch thick concrete base located three feet below grade for structural stability. The tower will be provided with sufficient connections for the rectangular flanged air influent duct work, an eight inch flanged influent nozzle, a ten inch effluent nozzle, three flanged manways as sized and located on the plans, four inch flanged nozzles for level probes, base anchor rings, lifting lugs, and support brackets for ladders and piping.

The air stripper design investigated the required packing depths needed to remove the influent VOC's to the acceptable effluent criteria. The design parameters included a water temperature of 50 ^{o} F to account for the effects of winter conditions on exposed piping. Comparing the results of the pilot plant study with mass transfer modeling data, including the individual Henry's constants for each constituent, it appears that the limiting contaminant will be 1,2-Dichloroethane. The required packing depth for its removal is 35 feet. All remaining VOC's which require shorter packing depths should, therefore, be removed to levels below the effluent criteria.

The packing media will be 2 inch diameter spherical polypropeylene packing with a surface area of approximately 43 square feet/ cubic foot and 90 percent void space. The pressure drop, under the operating condition of 8,422 cfm of air and 1,050 gpm of water will not exceed .07 inches of water/foot of packing. One packing support plate will be provided. The support plate will be designed and supported so that the maximum deflection in the tray is less than one quarter inch when supporting the maximum load.

A distributor tray is provided to uniformly distribute the water flow over the surface of the packing and uniformly collect the exhaust air. The distributor tray will be complete with influent velocity breaker, air exhaust stacks, and distributor orifices. The air exhaust stacks will be sized to provide a gas velocity not exceeding 25 feet per second. The distributor orifices will be sufficient in number to provide even distribution and sized to retain a static head of water in the tray over the full range of liquid flow rates anticipated. The bottom of the tray will be stiffened to withstand the maximum hydrostatic head anticipated without excessive deflection. The structural design shall conform to the standards of the AISC.

Liquid redistribution rings are provided at even intervals throughout the height of packing, as required for efficient packing performance. A minimum of four redistributors will be provided.

A moisture separation system is provided which will eliminate water droplets in the exhaust air stream consisting of a polypropylene mesh-type mist eliminator. All air inlet and outlet openings will be provided with 24 mesh insect screens.

The air blower will be capable of delivering 8,640 scfm at 3.5 inches water air static pressure. The blower will be in accordance with standards adopted by AMCA for industrial fans. The blower housing will be heavy gauge steel with continuous airtight welds and suitably braced to resist vibration or pulsation. The air blower motor will be squirrel cage induction type electrical motor, totally enclosed, fan cooled, of a high efficiency and energy conserving design, manufactured in accordance with NEMA specifications.

A caged safety ladder/work platform will be included in final design for access to--and inspection of--the tower internals. The ladder and platform are intended to provide reasonably easy access to the upper manway on the tower. The ladder and platform should be constructed to bolt onto the brackets that are welded to the tower shell or to be welded directly to the tower shell. The ladder/platform will be provided as part of the packed tower by the tower manufacturer.

7.2.2 Manganese Greensand Filtration

The purpose of the Manganese Greensand Filters is the removal of iron and manganese from the captured groundwater. This is accomplished by oxidizing the iron and manganese to form their respective hydroxide precipitates, and settling the precipitates out on the dual media filter bed.

The manganese greensand pressure filters consist of a dual media bed of anthracite and manganese greensand. The anthracite is used as a buffer to remove any previously formed precipitates prior to contact with the manganese greensand. The greensand is a manganese-treated zeolite exchange medium capable of exchanging electrons and thereby oxidizing the iron and manganese. However, the oxidation capacity of the greensand is limited and must be regenerated. This is accomplished by a continuous feed system of potassium permanganate ($KMnO_4$) prior to the pressure filters. While this operation is effective, the use of potassium permanganate is costly. Therefore, chlorine is used as a less expensive oxidant prior to the $KMnO_4$ to oxidize much of the iron and lower the amounts of $KMnO_4$ required.

Chemical Feed Systems

Three chemical feed systems are provided prior to the greensand filters. The first consists of a pH monitoring station connected to a caustic (NaOH) feed system. The pH of the groundwater is expected to be approximately 5.5. Sufficient caustic soda must be added to raise the pH to 8.5 so that oxidation will progress rapidly.

The second chemical feed system adds sodium hypochlorite (NaOCL) to the groundwater to begin iron oxidation. The chlorine addition reduces the amount of potassium permanganate needed to oxidize the iron and manganese. Since potassium permangate is costly, this step decreases operating costs substantially.

Potassium permanganate is added immediately prior to the pressure filters to oxidize iron and manganese and regenerate the greensand filter media. The continuous regeneration process ensures that the exchange capacity of the manganese greensand is not exhausted. In addition, the hydroxides of iron and manganese deposited on the exchange medium have a large sorption capacity for soluble iron (Fe^{+2}) and manganese (Mn^{+2}) which aides in their removal.

Pressure Filters

Four horizontal pressure filters (8' dia. x 30' long) have been provided for iron and manganese removal. Table 7-2 lists the pressure filter design parameters. The filters are operated in parallel at a filtration rate of 1.3 gpm/sf. The process has been designed to treat 8 mg/l of iron and 1 mg/l of manganese. Each filter contains an influent distributor/backwash collector, dual media bed of anthracite (21") and manganese greensand (15"), air wash distributer, gravel bed (with retaining screen) and underdrain system.

TABLE 7-2

Manganese Greensand Filter Design Parameters

Number of Units	4
Filter Type	Horizontal Pressure Filter
Filter Size (Dia. x Length)	8'0"x30'-0"
Filter Media Depth	
Anthracite	21"
Manganese Greensand	15"
Filtration Rate	
All 4 Filters Operating	1.3 gpm/sf
3 Operating, 1 Backwashing	1.7 gpm/sf
Backwash Rate (Low)	1,250 gpm
Duration	1 min.
Backwash Rate (High)	2,500 gpm
Duration	10 min.
Air Scour Rate	0.8 scfm/sf
Duration	3 min.
Raw Water Rinse Duration	5 min.
Air Blower	
No. of Units	1
Air Flow Rate (ea.)	172
Pressure	5 psi

The influent distribution and backwash collection system of the filter will be arranged to accommodate backwashing at the rate of 12 gallons per minute per square foot of filter surface. Backwash will be accomplished by use of filtered water. Each unit will begin its backwash cycle with an initial backwash at a rate of 1,250 gpm for a period of approximately 1 minute, accompanied by an air wash scour at 172 cfm.

Supplemental air/water scour is supplied to ensure that the filter bed is effectively cleaned of iron and manganese precipitates. Air discharged from a lobe-type air blower is used in conjunction with a simultaneous upflow water wash immediately prior to the full volume backwash. The design air rate is 0.8 CFM/sq.ft. The simultaneous upflow wash will be maintained at 6 gpm/sq. ft. to provide the optimum air/water scour combination.

A gravel retaining screen is provided to secure the gravel supporting bed without hindering the necessary service or backwash flow distribution. The underdrain system is a header-lateral system which performs the dual function of backwash distribution and filtered water collection.

All valves will be of the butterfly wafer type. The inlet, effluent and backwash valves will be electrically actuated, automatic valves and the drain valve will be a manual valve. A pressure relief valve is provided on each filter. An automatic air release valve is provided on each filter. Sample valves will be provided on the inlet and discharge of each filter, and shown on the plans in final design. A sight glass will be located in the common backwash line.

Each filter operates under normal conditions, collecting the iron and manganese precipitate deposited on the filter media. Once the filter media becomes clogged to a certain point and the pressure drop through the system reaches a predetermined limit, the normal filtration operation is stopped and the backwash sequence begins. Controls will be interlocked so that only one filter can backwash at a time. The controls will allow for manual override of the automatic backwash initiation and time delay. After the backwash cycle is complete, the controls will place the filter system back into operation. The time of backwash will be capable of being varied, and a backwash cycle counter will be mounted on the face of the control panel. During the backwash sequence, the iron and manganese precipitate within the filter bed is removed and transported to the backwash holding tank.

Backwash Holding Tank, Settling Tank and Filter Press

The backwash holding tank is an underground reinforced concrete structure located in the treatment plant building, between the pressure filters and the activated carbon columns. As each filter is backwashed, the backwash water enters the holding tank at a rate of 2,500 gpm, and is temporarily stored while it is transferred to the settling tank at 100 gpm. This slower rate is required in the settling tank in order for the iron and manganese percipitate to settle out and be collected in the settling tank sludge hoppers. When the sludge in the hoppers reaches a 2 percent concentration, a sensor will activate an air powered, double diaphragm sludge pump which will transfer the sludge to the filter press. The filter press then consolidates the sludge into cakes which drop below the press into carts for removal. During the filter press operation, the filtrate drains to the backwash holding tank. Table 7.3 lists the design parameters of the backwash holding tank, the settling tank and the filter press.

TABLE 7-3

Backwash Holding Tank

Volume Required	29,000 gal.
Volume Provided	35,000 gal.
Design Water Depth	10'-0"
Tank Dimensions	16'-0"Wx30'-0"Lx12'-0"D
Freeboard	2'-0"

Settling Tank

Flow Rate	100 gpm
Overflow Rate	0.33 gpm/sf
Tank Dimensions	12'-0"Wx25'-0"L
Side Water Depth	8'-0"
Freeboard	1'-6"
Detention Time	3.0 hrs.

Filter Press

Filtration Area	524 SF
Filtration Volume	24 CF
Maximum Pressure	100 PSI
Maximum Hydraulic Pressure	3,000 PSI

7.2.3 Activated Carbon

The activated carbon columns are provided to remove any residual VOC's which are not removed in the air stripping process. Three columns were designed to operate in parallel, each accepting 350 gpm and providing a contact time of 15 minutes. Table 7-4 summarizes the design parameters. The columns are 10 feet diameter vertical tanks with a straight shell height of 15 feet. Each column contains 20,000 lbs. of activated carbon which, under constant usage, should last a minimum 4-6 months, depending on the VOC loading. Once the carbon capacity in each column is exhausted, the column will be taken off-line and the carbon will be replaced with regenerated carbon which will be delivered. While one column is off-line for carbon replacement, the remaining two columns will be operated at 525 gpm with a contact time of 10 minutes.

The activated carbon vessels consist of the following major assemblies: influent distribution, effluent collection, access ladder, vessel assembly with support legs, and all required connection piping and nozzles.

The system is designed to operate in a downflow mode. The cyclindrical vessels have a straight shell height of 15 feet with flanged and dished heads. The upper head is equipped with an access manhole. The bottom head is equipped with a nozzle for withdrawal of spent carbon. A ladder will be provided for access to the top of the vessel.

The influent distribution system is designed to evenly distribute the inlet water over the entire area of the carbon bed. The distribution system consists of an inlet pipe and distributor baffle.

TABLE 7-4

Activated Carbon Columns Design Parameters

No. of Units	3
Type of Operation	Parallel
Vessel Dimensions	10 ft. dia. x 15 ft. H
Overflow Rate	4.46 gpm/ft ^{2}
Flow Rate/Unit	350 gpm
Total Flow Rate	1050 gpm
Contact Time	15 min.
Carbon Bed Depth	12.5 ft.

The effluent collection system is designed to evenly collect the effluent from the carbon contactor while retaining the carbon media. The system consists of filter nozzles installed in a header-lateral piping system at the bottom of the vessel.

An automatic combination air/vacuum release valve is provided to release an amount of air equal to the design flow rate of the column and to automatically release air accumulated during operation of the system. Additionally, the valve will allow air to flow back into the vessel while it is being drained.

Influent and effluent valves are wafer type, butterfly valves. Valves used in lines transferring carbon slurries are full port ball valves. All carbon transfer and vessel drain valves are equipped with a manual level operation. The remaining valves are automatically controlled. All piping is as shown on the plans.

The activtaed carbon media is made from coal and is steam activated at high temperature (1650-1800 ^{o}F). The carbon is milled, compacted and sized such that at least 88 percent will pass through a No. 12 screen and be retained on a No. 40 screen. The wetted particle density must be approximately 1.35 gr. cm ^{3} in order to provide an expansion of the carbon bed of no more than 10 percent at a flow rate of 5 gpm/sq. ft. and a temperature of 68 ^{o}F. The pore structure of the carbon is controlled to facilitate the adsorption of both high and low molecular weight organic compounds from the water.

A flowmeter will be provided to measure the total flow to the inlet of the carbon transport system. The flowmeter will be of the orifice plate by-pass design consisting of a base socket with integral orifice plate that can be installed directly in the main pipeline. A variable area gauge calibrated to provide a direct reading of the total flow rate will also be provided.

A stub out will be provided at the bottom of the contactor vessels to remove spent carbon. The piping is sized as shown on the drawings and will be furnished with a ball valve and quick-disconnect fittings. A twenty foot length of hose will be furnished with quick disconnects at each end.

A stub out will be provided near the top of the contactor vessels to add virgin or regenerated carbon. A ball valve will be provided on the stub out. Piping, sized as shown on the drawings, will be furnished terminating approximately five feet from the base pads of the support legs. The pipe will have quick disconnect fittings. A twenty foot length of hose will be furnished for connection of the fill pipe to the carbon columns.

7.3 Monitoring

7.3.1 Process Monitoring

Several parameters will be monitored throughout the treatment process to ensure proper operation. These include flow metering, pH, residual chlorine and potassium permanganate monitoring, as well as water quality monitoring throughout the process units.

Flow will be metered at various points in the treatment process including plant influent, effluent and points between process units for overall process control.

Prior to the greensand pressure filters, pH will be measured and adjusted accordingly for optimum iron and manganese removal. Chlorine and potassium permanganate dosages will be controlled by monitoring the residual chlorine and potassium permanganate in the filter effluent.

Water quality will be monitored at the treatment plant influent and effluent piping, before and after each process unit, and at some points within each process unit using sample taps which will be shown on the contract drawings in final design.

7.3.2 Air Quality Monitoring

The remedial action plan for removing groundwater contaminants from the leachate plume emanating from the Old Bethpage Solid Waste Disposal Complex entails using an air stripping tower. As specified in the DEC consent order operation of the air stripper must assure compliance with applicable state air discharge requirements and Air Guide No. 1 for the Control of Toxic Air Contaminants.

This will be accomplished by reviewing the quarterly laboratory results of water samples obtained from the stripping tower influent and effluent. The difference in analytical results between the two samples will yield an accurate value of the volatile organic compounds (VOC's) being stripped from the groundwater. These values along with the tower design parameters, will then be used to calculate emission rates for VOC's which can be compared to VOC emission limits set forth in NYS DEC Title 6, Part 231 (New Source Review in Nonattainment Areas and Part 212 (Process and Exhaust and/or Ventilation Systems). The comparison will determine if acceptable VOC emissions are being met and if control technology is needed.

The calculated emission rates will also be compared to previously modeled maximum expected VOC emission rates (RTP Environmental Associates Report, 9:87). The results of this dispersion air modeling showed that the New York State Ambient Air Level (AAL) concentrations of VOC's would not be exceeded even under the extremely conservative modeling assumptions used. Also, the current proposed height of the stripping tower is five (5) feet higher than the value used in the modeling. Therefore, greater dispersion, and subsequent lower AAL concentrations, of contaminants than that previously estimated would be expected.

7.4 Discharge System

The treatment plant discharge system consists of a 10 inch discharge force main, discharge manhole, 10 inch gravity discharge line and diffusion well field.

The 10 inch force main conveys the treated effluent water from the treated water pump station to the 6-ft. diameter discharge manhole located at the high point between the treatment plant and recharge basin. The discharge force main alignment begins at the treatment plant and continues in a westerly direction towards the landfill Haul Road where it makes a 90 ^{o} bend and continues southerly adjacent to the Haul Road to the discharge manhole at Station 10+38.

A 10 inch gravity discharge line continues along the Haul Road alignment from the discharge manhole to the diffusion well field located in existing Recharge Basin No. 1. A total of ten diffusion wells are needed beneath the bottom of the recharge basin to dispose of the 1.5 mgd flow. The diffusion wells are 10 feet in diameter and 24 feet deep. They are of reinforced concrete construction, and contain rectangular leaching holes throughout the diffusion well side walls. Each diffusion well is surrounded by a 2 foot wide gravel collar. The diffusion wells are arranged along the bottom of the recharge basin in a circular formation, with a distribution well in the center. They are interconnected by 12 inch perforated pipe to maintain even distribution of the flow. Each diffusion well is raised four feet above the bottom of the recharge basin leaving the remaining 20 feet below the basin floor. The top four feet is surrounded by permeable fill material to allow flow to enter from the recharge basin and to prevent silt and sediment from entering the diffusion well.

SECTION 8

Estimated Costs

The costs were developed based on manufacturer's quotations, past and current bid data upgraded for inflation, and certain assumptions as follows:

8.1.1 The cost of the equipment for the unit processes is based on quotations from the manufacturers, including F.O.B. shipping points. For installation, 30-50 percent of the material cost has been added.

8.1.2 The cost of the piping, fittings and valves is based on prices received from several suppliers. The installation cost has been estimated to be between 25-40 percent of the material cost.

8.1.3 Some of the costs have been established based on existing construction bid data in LKB's file. These costs are basically connected to site work, concrete and cost of building.

8.1.4 A ten percent allowance for contingencies, and a ten percent allowance for engineering and administration has been included. The cost estimates do not include the cost of land for the treatment plant, for the recovery wells and interest during construction.

8.1.5 Construction costs include the cost of the explosion proof equipment.

Engineer's Estimate
For
Project Costs

DESCRIPTION	PHASE I	PHASE II ALT. 1 A/C ONLY	PHASE II ALT. 2 P/F ONLY	PHASE II ALT. 3 A/C & P/F	TOTAL PHASE I & II
SITE WORK					
Recovery Wells	13,000	---	---	---	13,000
Treatment Plant	320,000	240,000	240,000	240,000	560,000
CONCRETE					
Recovery Wells	25,000	---	---	---	25,000
Treatment Plant	90,000	940,000*	940,000*	940,000*	1,030,000*
BUILDING	50,000	200,000	200,000	200,000	250,000
MECHANICAL					
Recovery Wells	450,000	---	---	---	450,000
Treatment Plant	240,000	378,000	395,000	773,000	1,013,000
PIPING & VALVES					
Transmission Line	900,000	---	---	---	900,000
Treatment Plant	37,000	63,000	120,000	183,000	220,000
Discharge to Diffusion Wells	193,000	---	---	---	193,000
DIFFUSION WELLS	250,000	---	---	---	250,000
CHEMICAL EQUIPMENT	--	---	20,000	20,000	20,000
ELECTRICAL	225,000**	25,000	70,000	95,000	320,000**
PLUMBING	10,000	20,000	20,000	20,000	30,000
H.V.A.C.	15,000	25,000	25,000	25,000	40,000
INSTRUMENTATION & CONTROLS	175,000**	25,000**	120,000**	145,000**	320,000 **
SUBTOTAL	2,993,000	1,916,000	2,150,000	2,641,000	5,634,000
CONTINGENCIES @ 10% ±	299,000	192,000	215,000	264,000	563,000
SUBTOTAL CONSTRUCTION COST	$3,292,000	$2,108,000	$2,365,000	$2,905,000	$6,197,000
ENGR. & DESIGN FEES	735,000	735,000	735,000	735,000	735,000
TOTAL EST. PROJECT COSTS ***	$4,027,000	$2,843,000	$3,100,000	$3,640,000	$6,932,000

* Includes Allowance For Special Foundation $ 600,000
** Includes Explosion Proof Equipment
*** Includes Complete Design of Phase I & II (Based on the Consent Decree)

A/C - Activated Carbon
P/F - Pressure Filters

SECTION 9

Estimated Annual Costs

The estimated annual costs are based on system operation for 365 days per year and include operation and maintenance, cost of chemicals and power.

These costs are based upon the following assumptions:

a. Phase II construction is implemented in its entirety.

b. Maintenance being three percent of mechanical equipment cost, two percent of electrical and instrumentation and one percent of piping cost.

c. Labor at $25,000 per man year, including overhead and benefits.

d. Unit cost of chemicals are:
Sodium Hypochlorite - $0.15/lb.
Potassium Permanganate - $1.65/lb.
Caustic Soda - $0.15/lb.

e. Cost of KW-Hr. @ $0.15, cost of power has been considered for the number of hours of operation for each piece of equipment, i.e, for each piece of equipment, i.e., for pump. The operating hours have been 8,760 hrs. per year (365 days per year) - backwash pumps only a few hours per day as well as the equipment connected to backwash handling and solid disposal.

I. OPERATING COSTS

a. Labor @ $25,000 per man year, including overhead and benefits.

6 Men @ $25,000	150,000

b. Maintenance

- Mechanical Equipment (3% of Equipment costs)

0.65 x 1,533,000 x 0.03 =	30,000

- Electrical & Instrument (2% of Equipment Costs)

$640,000 x 0.02	13,000

- Piping & Valves (1% of Material Cost)

(1,313,000 x 0.01) =	13,000

c. Power	135,000
d. Chemicals	50,000
II. MONITORING COSTS	53,000
*TOTAL ANNUAL COSTS	$ 444,000

*Does not include cost of interest

SECTION 10

OUTLINE SPECIFICATIONS

10.1 PIPING, VALVES AND ACCESSORIES

10.1.1 Outside piping shall be PVC Type I Schedule 80 rated at minimum 100 psi working pressure with solvent Schedule 80 cemented joints, and shall be in conformance with the latest ASTM D-1785. Fitting for pipes shall be injection molded of PVC Schedule 80, and shall be in conformance with the latest ASTM D-1784.

10.1.2 Inside piping shall be PVC Type I Schedule 80, threaded joint type. Fittings for pipes shall be PVC Schedule 80, and shall be threaded type, and shall conform to Standard ANSI B2.1. and ASTM 2464. Victaulic couplings shall be used for easy disassembly.

10.1.3 Vacuum and air release valves shall be installed at the highest points along the transmission line. The valves shall have a cast iron body and a stainless steel float.

10.1.4 Drain valves shall be installed at the lowest points of the transmission line. The 3-inch gate valve shall be double disc type having non-rising stem and "O" ring seals.

10.1.5 Thrust blocks shall be provided at all bends and tees. Thrust blocks shall be sited for a testing pressure of 150 psi. Concrete for thrust blocks shall have a minimum strength of 3000 psi after 28 days.

10.1.6 Check valves, shall be silent type, cast iron body, bronze seat, stainless steel spring, and shall comply with ASTM Class 125.

10.1.7 Automatic shut-off valves, shall be butterfly type and shall conform to the latest AWNA C504. All valve bodies shall be cast iron, disc shall be of cast iron, seats shall be natural rubber. Operator shall be solenoid pilot.

10.1.8 Meters shall be turbine type, iron body, bronze counter housing, body coating-styrene polymer, and shall comply to the latest AWWA C701.

10.2 MECHANICAL EQUIPMENT

10.2.1 Well Pumps

10.2.1.1 Well submersible pumps shall be made of stainless steel, multi-stage centrifugal, and shall be supplied with direct coupled, water-lubricated motors. A 304SS check valve built into the top of the pump shall prevent the backflow.

10.2.1.2 The submersible motor shall be specifically designed for underwater services and shall be of can-type squirrel-cage design.

10.2.1.3 The 431 stainless steel shaft shall be mounted in two water lubricated radial bearings. All bearings shall be water lubricated.

10.2.2 Air Stripper shall include packed tower complete with internals, packing, air blower and ductwork. The tower shell shall have a maximum 8 foot inside diameter and maximum 40 foot height to the center line of the influent pipe. The column shall be constructed entirely of 304 stainless steel, shall be self supporting and anchored in a concrete base. Adequate high efficiency packing, which depth and sizes shall be established based on contaminant removal efficiency.

A distributor tray shall be provided to uniformly distribute the water over the surface of the packing. The blower shall be capable of delivering the amount of air, at a 60:1 air to water ratio. Air strippers shall be provided with all the intervals and accessories, as well as piping inlet, outlet, etc., for a complete operational unit.

10.2.3 Pressure Filters The filtration system shall consist of pressure horizontal or vertical vessels, filter media, intervals, piping connections, valves and controls. Backwash system shall consist of pumps, backwash holding tank, settling tank and sludge drying device (filter press).

10.2.3.1 Filter shell shall be structural grade steel plate, rolled in the shape of a cylinder. The steel plate shall be of sufficient strength to assure structural integrity to withstand the operating pressure as well as the pressure test. Each cell shall be equipped with filter media, selected to secure removal of iron and manganese, as per design criteria. Also the cell shall have an underdrain system to collect the filter water and to distribute the backwash water. The sizes of the vessel shall be based on providing an area for a filtration rate between 2.0 to 3.0GPM/$ft.^2$, when all vessels are in operation.

10.2.3.2 Pumps and Motors All pumps shall be vertical, submersible type, sized to provide flow requirements against a head determined based on hydraulic design of the system.

- o Backwash pumps (2) shall be sized to deliver an average backwash rate of 15 GPM/SF of filter surface area. The head shall be determined based on needs to clean the media and head losses through the piping and valves.

- o Backwash transfer pumps (2) shall be sized such that it will be capable of pumping the tank down at a rate that will allow the tank to be ready to receive next backwash.

10.2.3.3 Air scour shall be supplied by a blower unit, sized to supply an average of 1.0 CFM/SF of filter surface area, at a pressure no higher than 5 PSIG.

10.2.3.4 The piping system (pipes and fittings) shall be PVC Schedule 80, and shall be installed using PVC solvent weld compound.

10.2.3 5 Valves shall be automatic butterfly, on the influent and effluent, and backwash influent and effluent, and gate valves on the drain lines.

10.2.3.6 Settling Tank

- The tank shall consist of a steel outer wall, settling influent assembly, sludge collector mechanism, effluent launder and influent baffle, sludge drawoff and supernatant overflow lines.

- The unit shall be mounted at the factory.

- The sludge shall be moved toward the two hoppers, by means of a collector mechanism consisting of two endless strands of chain and scrapping flights, attached thereto, and passing over a pair of sprockets. The collector shall be driven through a single motorized speed reducer.

- The tank shall have the sizes, as shown on the drawings.

10.2.3.7 Filter press shall be of steel construction with side bar wear strips and complete with the following:

- Two (2) 20 inch stroke, double-acting hydraulic cylinders to automatically open and close the press.

- One (1) enclosed hydraulic closing panel compete with selector switches, indicator lights and pressure gauges.

- Piping for feed and discharge connections.

- Fully mechanized plate shifting unit designed to automatically separate the chamber to allow the cakes to be discharged.

- A plate stack incorporating the number of chambers required, recessed to form the cakes.

- Polypropylene filter media, with latex edges, installed on the plate.

- An air driven, self compensating hydraulic pumping unit, complete with all valves, fittings, hoses and oil reservoir.

10.2.4 ACTIVATED CARBON

10.2.4.1 The vessels shall be rated for a total flow of 1050 GPM when operated at a flow rate of 4.5 GPM/SF, operated in parallel. The vessel shall be 10 ft.-0 inch in diameter and a sidewall height of 15 ft. Pressure drop across the vessel at start up shall not exceed 3 PSI above the static water pressure.

10.2.4.2 The circular steel contactor tanks shall be ASTM-A36 steel with a minimum thickness of 1/4 inch designed to withstand a full hydrostatic interval loading of a minimum of 50 PSI. Tank shall consist of the following components: influent distribution, effluent collection, access ladder, tank assembly with support legs, cover with manhole, all required connection nozzle, and required volume of activated carbon.

10.2.4.3 The system shall be designed to operate in a downflow mode and also allowing the reversing of the flow.

10.2.4.4 The conical bottom shall be provided with the slope of the sides, to promote the even withdrawal of spent carbon. The top of the vessel shall be equipped with conical roof. The ladder shall be provided for access to the access manhole located at the top of the vessel.

10.2.4.5 The influent distribution system shall be designed to evenly distribute the inlet water over the entire area of the carbon bed. The effluent collection system shall consist of a circular trough around the interior periphery of the vessel. All piping shall be PVC Schedule 80 and the valves shall be water type butterfly valves. As shown on the drawings, some valves shall be automatic operating, while others shall be with a manual level operator.

10.2.4.6 The activated carbon media shall be made from coal and be steam activated at high temperatures. The carbon shall be milled, compacted and sifted such that at least 88 percent will pass through a No. 12 screw. The wetted particle density shall be approximately 1.35 GR CM ^{3} . The pore structure of the carbon shall be controlled to facilitate the adsorption of both high and low molecular weight organic compounds from the water.

10.2.5 PROCESS PUMPS AND MOTORS

10.2.5.1 The circulation of the water to and from process units shall be done by using pumps located in several wet well type pump stations.

10.2.5.2 This chapter shall indicate the characteristics of all the pumps docated in the air stripper, filter, activated carbon and treated water pump stations. All pumps characteristics shall be as indicated in the design criteria. All pumps shall be water lubricated, vertical turbine pump.

10.2.5.3 The pump head shall be of high grade cast iron and shall accommodate the mounting of the motor, with an above-floor flange discharge outlet and a companion flange threaded.

- The pump column assembly shall be furnished in interchangeable sections not over ten feet in length. The column shall have bronze bearing retainers threaded into the pipe couplings.

- The pump bowls shall be close grained cast iron having a minimum tensile strength of 30,000 pounds per square inch. Bowls shall be coated inside with a smooth vitreous enamel, for reduction of friction losses and better efficiency. The impleller shaft shall be a stainless steel of not less than 12 percent chrome. The impeller shall be of cast iron, accurately machined and finished. Each bowl shall have an impeller seat ring to prevent slippage of water between bowl and impeller.

- All pumps shall be supplied with a motor, 480 volt, 3 phase, 60 cycle, not more than 1,800 RPM, and shall be of proper size to drive the pump continuously under the total head specified, with a temperature rise of not more than 40 ^{o} C, above the ambient temperature.

- The motor thrust bearing shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers.

- The motor shall be of the full voltage starting, vertical, hollow shaft, squirrel cage induction type.

10.3 CHEMICAL FEED EQUIPMENT

10.3.1 Three (3) chemicals shall be used to augment the oxidation and removal of iron and manganese: potassium permanganate, hypochlorite and caustic soda.

10.3.2 The metering biaphragm type pumps shall be capable of delivering solution based on the calculation for each chemical supply. Pump construction shall include a PVC head with kynar valve poppets, TFE faced diaphragm, cast aluminum housing, fiber glass pump. In addition, each pump shall be powered by a 1/4 HP, 115/230 volt, 1 phase 60 Hz, open drip drive motor. Each pump shall have a stand, which also accommodate a 50 gallon polyethelene tank. Other system components include: liquid level switch, pressure relief valve, corporation cock main connection, foot valve-stroking combination, sight flow indicator.

10.3.3 Storage tanks with different capacities and transfer pumps to circulate the chemicals from storage tanks to active tanks.

10.3.4 Piping connecting the metering pumps with the filters influent pipe, which sizes are indicated on the drawings.

10.4 ELECTRICAL

10.4.1 The entire electrical installation shall be in strict accordance with the National Electrical Code and the rules and regulations of all authorities having jurisdiction.

Obtain all required permits, insurance, bonds, etc. as required. Upon completion of the work, an inspection certificate from the Board of Fire Underwriters shall be submitted. All electrical equipment being installed shall be UL approved and labeled.

All electrical equipment, including instrumentation installed within the Water Treatment Plant, will be explosion proof.

10.4.2 The Contractor shall furnish all labor, materials, equipment, transportation, services and appliances necessary for receiving, installing, testing and adjusting of electrical equipment and wiring, for a complete and functionally installation as shown on the drawings and as specified herein. The following items of work are to be included:

1. Incoming electric service;
2. Switchboards, panelboards, feeders;
3. A system of lighting with switching as indicated;
4. A complete system of power and branch circuit wiring, including installation of motors, starters and miscellaneous equipment connections;
5. Wiring of all heating ventilation air conditioning and plumbing equipment;
6. Process telemetry and control;
7. Operational testing; and
8. Temporary light and power.

10.4.3 Wiring, Conduit and Boxes, Grounding

All wiring shall be run in conduit except where run underground, which shall be direct burial. Wire shall be copper, #12 AWG minimum except for control and telemetry. Conduit shall be heavy wall aluminum or rigid galvanized steel, boxes shall be cast aluminum or iron. Ground entire installation per National Electrical Code.

10.4.4 Lighting Fixtures

The Contractor shall provide, install and connect all lighting fixtures complete with lamps, hangers, fittings, etc., in accordance with fixtures indicated on the drawings.

10.4.5 Panel, Disconnect Switches

Panels and disconnect switches shall be as manufactured by Square D, Cutler Hammer, ITE GE or Westinghouse. Panels shall be 20 inch wide minimum, with separate ground bus, bolt-on circuit breakers and be UL labeled, switches shall be fusible type with fusetrons, except for safety disconnect which may be non fuse type.

10.4.6 Connection of Equipment

The Contractor shall connect each item of electrical equipment, whether furnished by him or not and leave it in operable condition.

10.4.7 Wiring Devices

All wiring devices shall be "Specification Grade" as manufactured by Hubbell, AH&H or Leviton. Switches shall be 20 ampere quiet type, receptacles shall be 15 ampere duplex or 20 ampere single. Plates shall be stainless steel.

10.4.8 Indentification

All feeder cables, control and telemetry wires shall be tagged at terminal points and in all boxes. Safety switches, remote starting control equipment, shall have lamacoid name plates describing function, purpose or equipment controlled. Panelboard directories shall be completely typewritten indicating loads served.

10.4.9 Grounding

Ground system per code and UL requirements, each panel feeder shall include a ground conductor size per NEC Table 250-95.

10.4.10 Temporary Light and Power

Provide a system of temporary lighting and convenience receptacles throughout the building conforming to NEC and OSHA requirements. All temporary wiring shall be removed when permanent systems are operable.

APPENDIX "A"

Summary of Horse Power Requirements at Treatment Plant

Motor Location	No. of Motors Operating	No. of Motors Stand By	Capacity-Each (HP) Operating	Capacity-Each (HP) Stand By	Total HP Operating	Total HP Stand By
A/S Blower	1	0	7.5	0	7.5	0
A/S P. Sta.	2	1	15	15	30	15
Filter Pump Sta.	2	1	15	15	30	15
Filter Air Blower	1	0	15	0	15	0
A/C P. Sta.	2	1	30	30	60	30
Treated Water Pump Sta. Backwash Pumps	2	0	25	0	50	0
Discharge Pumps	1	1	20	20	20	20
Backwash Holding Tank Transfer Pumps	1	1	5	5	5	5
Air Compressor Sludge Pump	1	0	15	0	15	0
Filter Press	1	0	1/2	0	1/2	0
Chem. Feed Pumps	3	0	1/4	0	3/4	0
Chem. Transfer Pump	2	0	1/4	0	1/2	0
Elect. Heaters	7	0	10	0	70	0
Elect. Heater	1	0	2	0	2	0
Heat Pumps	2	0	7.5	0	15	0
Heat Rec. Fans	4	0	1/4	0	1	0
Exhaust Fans	2	0	1.5	0	3	0
Exhaust Fans	1	0	1/8	0	1/8	0
Exhaust Fans	1	0	1	0	1	0
Exhaust Fans	1	0	1/4	0	1/4	0