DRAFT

CONCEPTUAL DESIGN REPORT FOR THE GROUNDWATER REMEDIATION SYSTEM AT THE BLACK & DECKER, INC. MANUFACTURING FACILITY HAMPSTEAD, MARYLAND

JUNE 1992

Prepared By:

ROY F. WESTON, INC.
One Weston Way
West Chester, PA 19380-1499

W.O. #2501-04-01

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1

INTRODUCTION

Black & Decker, Inc. has retained Roy F. Weston, Inc. (WESTON) to provide services to support the installation and operation of a groundwater remediation system at the Hampstead, Maryland facility. These services include engineering, permitting, construction support services, start-up assistance, and performance monitoring. This report presents WESTON's conceptual design, for Black & Decker review and approval. After receiving Black & Decker's comments and approval, WESTON will proceed with detailed design activities.

1.1 BACKGROUND

The 150-acre facility has operated since 1952, originally manufacturing power hand tools. Although the current focus of plant activities is distribution rather than manufacturing, continuing operations include manufacturing gears from powdered metal, heat treatment of the gears, and cleaning and treatment of power tool accessories for rust prevention.

The detection of chlorinated hydrocarbons in the groundwater at the site has led to the need for a groundwater remediation system. The project involves pumping groundwater from ten extraction wells and treating it to remove trichloroethylene (TCE) and perchloroethylene (PCE) using a new air stripper. The objective is to develop hydraulic barriers along the east and west sides of the Hampstead plant, which will minimize the potential for off-site migration of groundwater containing volatile organic compounds (VOCs) and lead to restoration of groundwater quality.

1.2 DESIGN INVESTIGATION RESULTS

The design investigation consisted of surface geophysics to identify likely fracture zones, test well installation, and pump testing. WESTON installed a total of ten extraction wells at locations most likely to create effective hydraulic barriers. Subsequent computer modeling based on the pump testing of these wells was used to determine the pumping rates required for effective capture and the maximum sustainable pumping rate, for each extraction well.

This data is presented in Table 1-1.

The anticipated extraction rate for effective capture is shown on Table 1-1. Under these anticipated or "normal" operating conditions, the system will pump and treat groundwater at 295 gallons per minute (gpm). The performance of the system as a whole is difficult to predict based upon individual well pump test data for fractured bedrock. Accordingly, WESTON has planned for the evaluation of hydrologic performance and contingency modification of pumping rates, as necessary. In designing the treatment system, the design maximum flow will be based on the most conservative contingency that all wells could be pumped at their maximum sustainable yield, resulting in flows up to a total of 553 gpm. Accordingly, the system will be designed with the capability to treat 553 gpm, although normal operation is planned to be 295 gpm.

TA[illegible]-1

BLACK & DECKER HAMPSTEAD, MD FACILITY
GROUNDWATER RECOVERY SYSTEM DESIGN BASIS

Train/ Extraction Well ID	Current Well ID	Well Casing Dia. (inch)	Well Coordinates		Maximum Sustainable Yield (gpm)	Anticipated Normal Pumping Rate (gpm)	Design TCE Conc. (µg/L)	Design PCE Conc. (µg/L)	Total Well Depth (ft)	Required Pump Installation Depth	Water Elevation (ft above MSL)		Top of Casing Elevation (ft above MSL)
											Static Water Level	Water Level at Normal Pumping Rate[3]	
EAST													
EW-1	RFW12	4	2,184	760	35	35	6,400	130	55	50	818	795	845
EW-2	PH3A	6			55	40	4,000[2]	15[2]	117	110	818	780	849
EW-3	PH1A	6	2,413	166	90	50	1,000	15	118	110	817	778	847
EW-4	PH4A	6			30	30	1,800[2]	100[2]	107	100	819	780	858
EW-5	PH2A	6	3,205	201	75	30	2,600	50	98	90	822	786	863
SUBTOTALS					285	185							
WEST													
EW-6	PH13	6	1,466	1,796	45	20	12	87	115	110	786	760	832
EW-7	RFW5B[1]	6	1,743	2,204	70	20	20	110	78	73	795	765	818
EW-8	PH10	6	2,136	2,281	80	25	7	170	98	93	802	766	811
EW-9	PH8	6	2,126	2,265	33	20	29	1,100	141	135	794	767	811
EW-10	PW-7[1] (existing Well 7)	8			40	25	22	3,100	240	110	794	773	804
SUBTOTALS					268	110							
TOTALS					553	295							

[1]Open hole well construction (no PVC screen)
[2]Used isoconcentration contour map to estimate concentration
[3]Water level at maximum sustainable yield is approximately 5-feet above pump level

1117.cad

SECTION 2

CONCEPTUAL DESIGN SCOPE

This conceptual design effort was intended to develop a preliminary design for the entire system from well pumps through discharge, including necessary modifications to existing potable water and cooling water systems. The conceptual design includes a new groundwater extraction system; a new air stripper; and connection and modifications to the existing potable water and industrial cooling water systems. The development of the extraction well locations, flows and characteristics is documented in the Groundwater Appropriation Permit Application Hydrogeologic Report, dated June 1992. The major components of the Conceptual Design include:

- Well pumps, wellhead valves, controls, and buried piping to pump groundwater from ten existing wells, to a new air stripper.
- A new air stripper, sized to treat up to 553 gpm.
- Stripper outlet connections to both the industrial cooling water loop and potable water systems, with the appropriate control devices (i.e., sensors, controllers, control valves, alarms, and switches).
- A relocated pressure control valve/bypass system for the industrial cooling water loop.
- Evaluation of an alternative water pressure booster and surge supply system (e.g. use of a pressurized tank) to potentially replace the elevated potable water tank which is scheduled to be rehabilitated, if economically justified.
- A soda ash addition system to treat water exiting the stripper prior to entering the industrial cooling water loop to reduce corrosion.
- A reduced flow pumping system at the cooling water reservoir to complement the new supply to the cooling water loop from the stripper.
- Modifications to the reservoir overflow and outfall structures to accommodate the higher discharge flows which will result from operating the new groundwater

While the existing water supply wells and air stripper has been used to provide potable water, the new extraction wells and higher capacity stripper will supply potable water and a portion of the cooling water requirements. The existing cooling water reservoir will continue to be used to supply the balance of the cooling water requirements on demand. The increased input to the cooling water reservoir will result in an increase in the average discharge to surface water.

SECTION 3

CONCEPTUAL DESIGN BASIS

3.1 GROUNDWATER EXTRACTION AND TREATMENT

The system will be designed to handle a maximum (contingency) flow of 553 gpm, although normal operation is planned to be 295 gpm. The system will be started up in phases, first by pumping and treating only the wells comprising the east train (wells EW-1 through EW-5). This will result in a startup flow of 185 gpm. After system performance has been confirmed for the east train, the west train wells (EW-6 through EW-10) will be added, to establish the normal operating flow of 295 gpm.

Table 3-1 summarizes the critical influent design basis for the system under the three operating conditions; startup (east train only), normal operation (east and west trains at normal flows), and design maximum (all wells at maximum sustainable yield). Calculations used to develop the design basis, presented in Appendix A, were based upon the design TCE and PCE concentrations given in Table 1-1. These concentrations were selected based upon a review of the monitor well and pump test sample analysis data. The values selected were generally the highest historically observed unless the highest value was an "outlier" and not supported in repeat sample analysis results. This conservative approach was intended to ensure the adequacy of performance under all conceivable operating conditions. Actual concentrations may be lower because average concentrations are lower and because groundwater concentrations usually drop under pumping conditions. The values for EW-2 and EW-4 were estimated based upon isoconcentration diagrams because analytical data is not yet available for these wells.

Certain pumping wells were also sampled and analyzed for selected inorganic parameters which are used to evaluate the potential for iron, calcium and manganese fouling and corrosion. Table 3-2 presents these results. While iron concentrations up to 11.3 mg/l were reported, all samples which contained iron above the detection limit of 0.1 mg/l were also high in Total suspended solids (TSS). TSS values are often high during sampling but decrease rapidly in operating wells. Based upon the long history of groundwater use by Black & Decker without observing iron fouling and the high iron/TSS correlation, we have assumed that iron concentrations will be below 1 mg/l in the aggregate influent. Therefore, iron pretreatment will not be necessary.

Table 3-1

Critical Design Basis Data

Operating Condition	Total Flow (gpm)	Flow-Weighted Average Influent Concentration to the Air Stripper		Total PCE and TCE Emissions from Air Stripper[1,2] (lb/hr)
		TCE (μg/L)	PCE (μg/L)	
Startup (East train only)	185	3,059	56	0.29
Normal Operation (East and West trains)	295	1,925	400	0.34
Design Maximum (all wells at maximum sustainable yield)	553	1,424	360	0.49

Notes:

[1] Assuming 100% removal efficiency. The actual target concentration for both TCE and PCE is 5 μg/L. A design target concentration of 1 μg/l (detection limit) was used to provide a safety factor since actual performance may differ slightly from design projections.

[2] Other VOCs have been detected at low concentrations in some planned extraction wells in the 8/27/90 and 3/17/92 sampling results. Of these, however, only 1,2 dichloroethene (1,2 DCE) was ever found above the detection limits of 5 μg/l. We can conservatively take the single highest observed extraction well concentration of 18 μg/l of 1,2 DCE and use it as the maximum possible concentration of other VOCs in the aggregate flow under pumping conditions. This would result in, additional VOC emissions of 0.0017 lb/hr, 0.0027 lb/hr, and 0.0050 lb/hr for 185 gpm, 295 gpm and 553 gpm flows respectively, an insignificant change vs. TCE and PCE estimates above.

Table 3-2

Summary of Inorganic Analyses

	PH-1A	PH-2A	PH-8	PH-8D	RFW-5B	RFW-12	Pre-Stripper	Post-Stripper	Cooling Water loop
Iron, total (μg/l)	100u	100u	1440	1580	11300	1050	100u	100u	156
Manganese, total (μg/l)	50.6	44.3	55.5	55.3	182	60.4	17.6	16.7	63.6
Sodium, total (μg/l)	54,900	9980	7240	7690	25500	22700	24,100	23,700	44,700
Total Alkalinity (mg/l) (pH =4.5)	38.0	2.5	38.0	38.0	52.0	20.0	21	22	41
m-Alkalinity (mg/l) (pH =3.8)	--	--	--	--	--	--	32	34	54
Chloride (mg/l)	118.0	17.0	9.2	9.2	62.6	47.6	--	--	--
Hardness, total (mg/l)	105.0	14.0	63.0	63.0	61.0	45.0	44.9	44.2	99.7
Ca-hardness (mg/l)	34.5	5.1	50.0	50.0	29.0	20.5	28	28	76
pH	5.4	6.0	5.8	5.8	5.4	5.5	5.5	6.7	7.2
Sulfate (mg/l)	2.5u	2.5u	3.0	11.8	2.5u	3.5	--	--	--
Specific conductance (μmhos/cm)	471	78.8	113	113	265	201	175	170	395
TDS (mg/l)	310.0	62.0	107	110	255	147	125	133	254
TSS (mg/l)	5u	5u	334	194	31.0	29.0	5u	5u	8

1117.cad

The overall design philosophy will be to size piping, electrical, and mechanical equipment which cannot be easily modified to accommodate the design maximum flow. Pumps and blowers in particular will be sized for the design maximum flow of 553 gpm, with the ability to be easily operated at the anticipated normal flow conditions (295 gpm). In this manner, capital costs can be minimized while providing the flexibility to operate at higher rates to meet remediation performance objectives. In certain cases where the difference in anticipated and design maximum flows is too large, it may be necessary to change out a well pump to achieve the design maximum flow to prevent excessive throttling of the well pump.

3.2 POTABLE AND COOLING WATER USE AND DISCHARGE

Treated water will be used for both potable water supply and cooling water. The design basis for the potable water supply from the new stripper is based on existing chart recordings provided by Black & Decker which show a continuous baseline flow of 25 gpm, a daytime average flow of approximately 70 gpm or less, and sudden peak flows up to 175 gpm for durations of approximately 1 minute or less each.

Whatever water is not used for potable water supply will be fed to the cooling water system to provide a baseline cooling water flow. Additional cooling water will be supplied by the existing cooling water pumps at the cooling water reservoir. Based on conversations with Black & Decker facility personnel, the existing 400 gpm pumps at the cooling water reservoir are already oversized for most time periods. Since the stripper would provide an adequate and relatively constant daytime cooling water flow of about 225 gpm (295 gpm minus an average of 70 gpm to the potable water system), the reservoir pumps can be operated as a backup only, potentially activated by cooling water low system pressure. One reservoir pump would be modified to reduce flow from 400 gpm to approximately 200 gpm, by removing one or more vertical turbine stages. This would reduce power consumption, both for baseline cooling water needs and for responding to peak demands. The remaining two pumps can remain as high capacity backups for periods of extremely high demand.

The reservoir outfall structures will be modified to accommodate the additional flow from the groundwater remediation system. According to plant personnel, the average existing outflow from the reservoir is 30 to 50 gpm. The maximum flow which can be recorded is 250 gpm. Since the outfall has reportedly overflowed during large storms, it is proposed that the weir and chart recorder be sufficiently increased in size to handle both the increase in baseline flow from the extraction wells and stormwater surges. If the design maximum extraction well flow of 553 gpm is added to the current maximum recorder capacity of 250 gpm a total flow of 800 gpm results. In order to provide additional capacity for storms as well, Black & Decker indicated that the weir should be modified to handle 1,000 gpm. Since the design capacity of 553 gpm is provided as a contingency, the additional capacity for storm surges will probably be more than adequate.

Pertinent assumptions used in the design which were provided by Black & Decker include:

- Potable water demand and use patterns would remain as depicted in representative flow charts.

- Some transient short term decreases in water pressure are tolerable.

- Manual and mechanical-only controls are preferable to automatic monitoring and control to reduce maintenance cost, where possible.

- The cooling water supply loop and return loop sizing is more than adequate to handle the new groundwater flows.

- A cooling water loop pressure of 60 to 80 psig is adequate to supply existing cooling equipment.

- The current potable water system pressure is 50 to 55 psig at maximum. A potable water target pressure of 40 to 60 psig is adequate, although slightly higher pressure may be desirable.

- The existing soda ash demand is 3.5 to 4.0 mg $Na_2\ CO_3$ (dry weight basis) per liter of water to raise the pH of stripper outflow to 8.5. We assume this would apply to the future aggregate flow.

Black & Decker should verify these assumptions prior to the final system design.

SECTION 4

CONCEPTUAL DESIGN

4.1 GROUNDWATER EXTRACTION SYSTEM

The groundwater extraction system will consist of the extraction wells which have already been installed and pump tested. The pump test and modeling results, presented in the Groundwater Appropriation Permit Application Hydrogeologic Report, dated June 1992, indicate that pumping these ten wells will provide sufficient hydrologic control at a total pumping rate of 295 gpm. However, higher flow rates may need to be employed, depending upon actual performance, up to the maximum well yield. Therefore, well pumps will be sized to deliver up to the maximum well yield, when feasible. Each well will be fitted with piping, instrumentation, and controls to adjust and monitor flow, including:

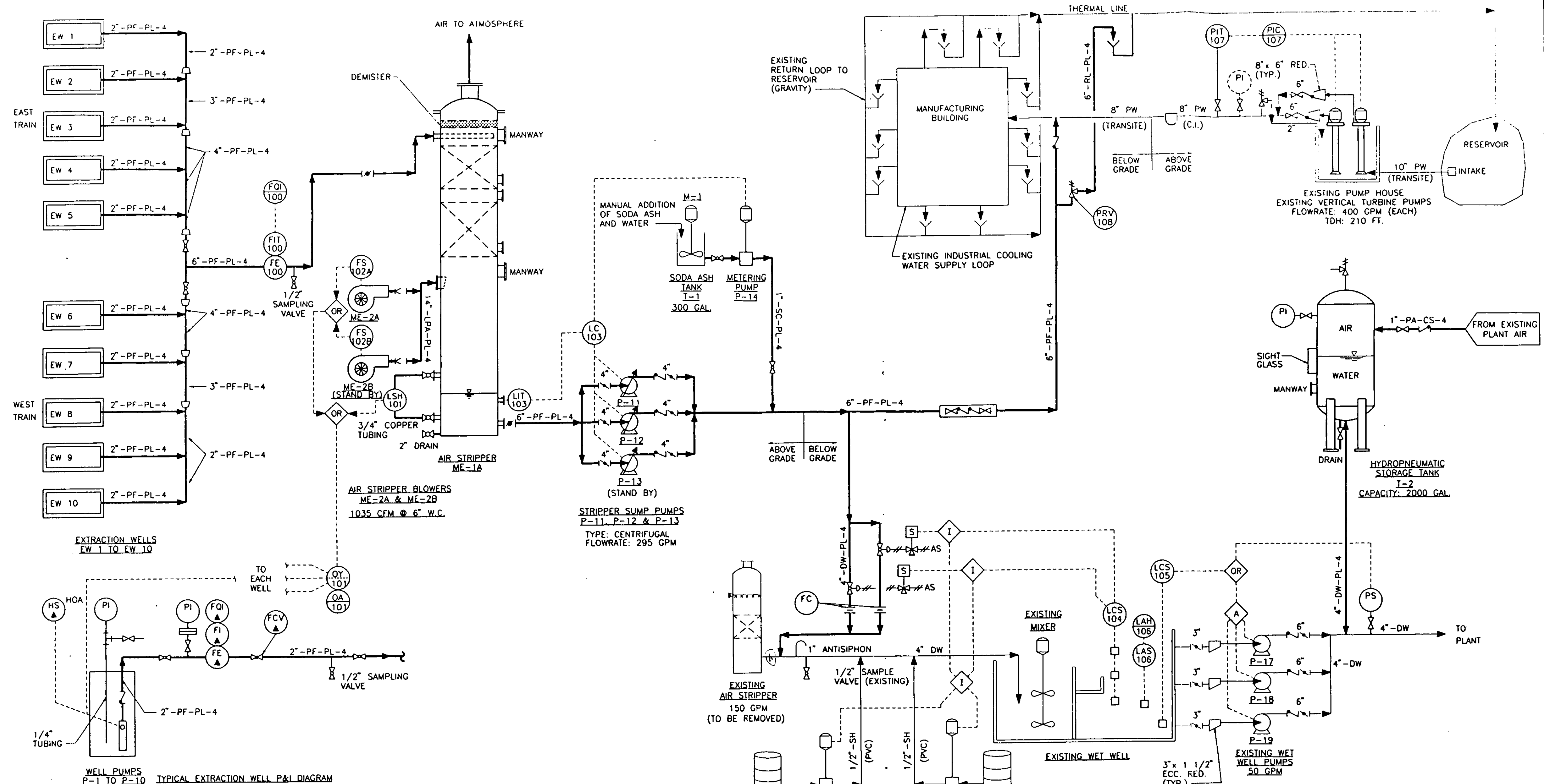
- An analog turbine meter with a simple local mechanical flow reading and flow totalizer.

- A self contained flow control valve that can be used easily for minor flow adjustments and can be easily modified to change flow range by changing the flow measurement orifice.

- A sampling valve.

- A simple water level measurement system consisting of a PVC riser pipe, plastic tubing, and a pressure gauge. The operator will use a portable pump (e.g. foot pump) to inject air until the pressure stabilizes and will then get the pressure reading. A simple table will be used to convert pressure to water depth for each well based upon the depth of the tube.

The piping and instrumentation for the entire system is presented in Figure 4-1. The basic pump sizing information is presented in Appendix B - Major Equipment List. The pumps will be started-up with centrally located panel mounted hand switches. Interlocks will be provided to shutdown each well pump on low water level (to protect the pumps) and to shutdown all wells on low air flow to the stripper and high stripper sump water level. A



WELL	PUMP	DESIGN FLOW (GPM)	NORMAL FLOW (GPM)	▲
EW 1	P-1	35	35	001
EW 2	P-2	55	40	002
EW 3	P-3	90	50	003
EW 4	P-4	30	30	004
EW 5	P-5	75	30	005
EW 6	P-6	45	20	006
EW 7	P-7	70	20	007
EW 8	P-8	80	25	008
EW 9	P-9	33	20	009
EW 10	P-10	40	25	010

Figure 4-1 P&ID

NOTES: 1.) ALL INSTRUMENTATION IS NEW EXCEPT AS NOTED.
2.) ——— EXISTING PIPING
3.) ——— NEW PIPING

PRELIMINARY CLIENT REVIEW

A 6/19/92 ISSUED FOR CONCEPTUAL DESIGN-FOR CLIENT REVIEW ONLY

BLACK & DECKER, INC.
HAMPSTEAD MARYLAND

WESTON

CHECKED
DES. ENG. RGT/HFE/PSP 6/5/92
PROJ. ENG. CWB 6/5/92
PROJ. MGR. RLM 6/5/92
APPROVED

GROUNDWATER REMEDIATION SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM

DRAWN M.HANSEN DATE 4/14/92 DWG NO. 101 REV NO. 0
SCALE NONE W.O. NO. 2501-04-01

PLOTTED 06/19/92 10:54 am FILE NO. 0401101 panel mounted strip chart recorder will be provided to continuously record the flow rate into the stripper and a totalizer will read out total cumulative flow.

4.2 AIR STRIPPER

Several process options were considered for treatment by air stripping. These included:

- Use of the existing air stripper for all flows.
- Use of the existing air stripper for potable water supply and installation of a new separate stripper for cooling water supply.
- Installation of a new stripper for all flows.

The first option was evaluated and the stripper was found to have an insufficient diameter and height of packing to meet the treatment objectives. The second option was eliminated due to the complexity of operating two strippers and little or no long-term cost advantages over the third option. Therefore, a new stripper which can meet all performance objectives and processing the maximum design flows was the selected option.

The primary compounds of concern for design are TCE and PCE. Other VOCs are present at very low levels in some of the wells. The target performance objectives for the discharge from air stripper were set at drinking water Maximum Contaminant Levels (MCLs) of 5 μg/L for both TCE and PCE. However, in order to provide a safety factor between theoretical and actual performance, a 1 μg/L design discharge criterion was set for both TCE and PCE. This safety factor is equivalent to providing a safety factor of more than 30% on the packing height necessary to achieve a concentration of 5 μg/l.

The stripper design was evaluated using the AIRSTRIP™ computer model. This model uses the Onda correlation to determine overall gas/liquid mass transfer coefficient. TCE was found to be the constituent controlling the design packing height in all cases because it is present at higher concentrations and is slightly less "strippable" than PCE. Given the design capability for removing TCE, all other VOCs will be removed to below the detection limit of 1 μg/L. Based on existing stripper performance and the inorganic analysis results presented in Section 3, inorganic constituents are not present at concentrations which will result in severe fouling. Long-term fouling will be monitored by observing blower discharge pressure trends.

Maryland air toxics emissions regulations require emission control for sources exceeding 0.5 lb/hr of air toxics. The air stripper emissions are projected to be below this level at normal, and even design maximum conditions. However, the Maryland Department of the Environment (MDE) sometimes requires temporary emission controls for groundwater treatment by air strippers with projected emissions near that limit. Alternatively, emissions could potentially be higher than estimated if unexpectedly high groundwater concentrations occur under pumping conditions. Since, in these cases, the use of air emission controls could be required by the State of Maryland, the air stripper design has been optimized to minimize the capital and O&M costs for vapor phase granular activated carbon (GAC) treatment, if required.

The contingency GAC system would consist of two GAC units placed in parallel, along with a supplemental blower to accommodate the pressure drop across the GAC units and an in-line duct heater to reduce the relative humidity to below 40%. The duct heater will raise the air temperature from 55°F to 85°F.

The air stripper design evaluation considered a range of liquid loading rates, air to water ratios and packing sizes. The optimum design was selected to minimize overall cost including contingency air emission control. The cost of air emission control is directly dependent on air flow rate. The optimum design minimized air flow rate. This resulted in a slightly larger packing height. The diameter was selected to provide reliable operation in the full range of water flows possible, 185 to 553 gpm. A 5-foot diameter provided a high enough liquid loading rate at 185 gpm to ensure complete wetting of the packing and a liquid loading rate at 553 gpm that was still well below a flooding condition.

The air stripper design parameters are summarized in Table 4-1. The air stripping tower will include a weir or orifice top distributor and a similar redistributor at the middle of the packed zone. Additional features provided will include automatic shutdown of the air stripper feed due to blower failure and level controls for the stripper sump as shown on Figure 4-1. The stripper discharge pumps and soda ash metering pump will automatically be shutdown on low level in the sump.

Table 4-1

Air Stripper Design Parameters

Maximum (Design) Water Flowrate	553 gpm
Air Flow Rate	1035 cfm
Air to Water Ratio	14
Stripping Factor	3.7
Influent Water Temperature	55° F
Packing Type	Plastic Jaeger Tripacks (2-inch diameter)
Packing Height	42 feet
Total Tower Height	52 feet (approximate)
Column Diameter	5 feet
Liquid Loading Rate	28.1 gpm/ft^2
Air Pressure Drop	<2.5 inches w.c. for packing 6 inches w.c. maximum

Design Case	Influent Characteristics			Treatment Objectives
	Startup	**Normal**	**Design Max.**	
Flows	185 gpm	295 gpm	553 gpm	
Trichloroethylene (TCE)	3060 μg/l	1925 μg/l	1424 μg/l	< 5*
Perchloroethylene (PCE)	56 μg/l	400 μg/l	360 μg/l	< 5*
Total PCE and TCE	3116 μg/l	2325 μg/l	1784 μg/l	

* Effluent objectives are drinking water MCLs of 5 μg/L. The stripper was designed to achieve 1 μg/L to provide a safety factor to ensure that actual concentrations are below the MCL.

4.3 CONNECTION AND MODIFICATIONS TO THE INDUSTRIAL COOLING WATER LOOP

Figure 4-1, the piping and instrumentation diagram (P&ID), shows the planned modifications to the cooling water loop to achieve the design objectives of energy efficient reuse of water to the maximum practical extent. Each area to be modified is discussed below.

4.3.1 Stripper Sump/Cooling Water Delivery Pumps

The treated water will be conveyed from the bottom of the air stripper to both the potable and cooling water systems using up to two operating pumps. An installed spare pump will also be provided. The pumps will each be sized to individually deliver 295 gpm, the anticipated normal flow. Two pumps operating together will be designed to deliver higher flows up to the design maximum of 553 gpm. A stripper sump level controller will be used to maintain the water level between a depth of 1.5 and 3.5 feet by adjusting the pump speed. The controller will shut down these and the soda ash metering pump at low sump level. The pump discharge pressure will be at or above 80 psig, the upper end of the 60 to 80 psi cooling water loop pressure objective of Black & Decker, at design flows.

4.3.2 Soda Ash Addition System

Presently there is corrosion problem with steel pipe in the cooling water supply loop. The tendency for corrosion depends upon concentrations of calcium relative to saturation, oxygen, carbon dioxide and galvanic effects. The most easily controllable factor is calcium corrosion/scaling tendencies. Calcium scaling or corrosion depends on a variety of factors including temperature, pH, alkalinity, calcium hardness and total dissolved solids. Samples were recently taken for analysis of these parameters before and after the stripper. Based on the results presented on Table 3-2, the Langelier Saturation Index was calculated to be -3.6 and -2.5 for pre-stripper and post-stripper samples. The negative values indicate a tendency to dissolve calcium carbonate, minimizing the ability to prevent corrosion. The Ryzner's Stability Index was calculated to the 12.8 and 11.6. A value above 8.0 indicates a high probability for corrosion. With both indices for the post-stripper sample confirming the corrosion tendency, the post-stripper pH of 6.7 should be raised to approximately 8.5 so the water will have a tendency to be less corrosive. Increasing the pH to 8.5 will result in Langelier and Ryzner's Indices of approximately -0.55 and 9.6, respectively. Increase beyond this range will result in further improvement but there are drawbacks of the effect on potable water quality (e.g., sodium levels) and reductions in the effectiveness of chlorination. The pH increase can be achieved by adding soda ash downstream of the stripper.