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FINAL BASIS OF DESIGN REPORT FOR THE HADNOT POINT INDUSTRIAL AREA SHALLOW AQUIFER GROUNDWATER TREATMENT SYSTEM

MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0134

N62470-92-B-2255

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1.0 INTRODUCTION

The United States Navy, Naval Facilities Engineering Command, Atlantic Division (LANTDIV), has directed Baker Environmental, Inc. (Baker) to conduct a treatability study and remedial design for an Interim Remedial Action (IRA) for the shallow aquifer at the Hadnot Point Industrial Area (HPIA) Operable Unit Site at Marine Corps Base (MCB), Camp Lejeune in Onslow County, North Carolina. This IRA has been documented in a Final IRA Record of Decision (ROD) for the site (Baker, September 17, 1992). The Navy/Marine Corps has obtained concurrence from the State of North Carolina and the United States Environmental Protection Agency (U. S. EPA) Region IV on this IRA.

In accordance with the project tasks identified in the Final Remedial Design Project Plans for the Shallow Aquifer at the Hadnot Point Industrial Area Operable Unit (Baker, January 1993), Baker has initiated the remedial design identified in the ROD.

1.1 Purpose of the Basis of Design Report

The purpose of this Basis of Design Report is to present final design information and drawings for the project.

As noted in Section 3.2.1 of LANTDIV's A&E Guide: "This submittal allows the activity to review and concur with the A&E's interpretation of the functional and organizational requirements of the project. Concurrently, LANTNAVFACENGCOM is reviewing to assure technical features comply with the Department of Defense and Navy policies and regulations."

1.2 Basis of Design Report Format

The basis of design information presented in this document is structured to address the major components of the remedial design, and include the following elements:

- Section 2: Site Background Information
- Section 3: Laboratory and Field Investigations
- Section 4: Conceptual Design
- Appendix A: Aquifer Characteristic Calculations and GWAP Program Data Sheets
- Appendix B: Outline Specifications (The complete set of specifications are bound separately).

- Appendix C: Preliminary Construction Cost Estimate
- Appendix D: Proposed Construction Schedule
- Appendix E: Design Calculations
- Appendix F: Manufacturers Catalog Data

2.0 SITE BACKGROUND INFORMATION

The following section provides site background information, and a description of the nature and extent of contamination found at the HPIA. Some of this information is based on that contained in the Interim Remedial Action Feasibility Study for the Shallow Aquifer at the Hadnot Point Industrial Area Operable Unit (Baker, April 1992).

2.1 Site Location

Camp Lejeune is a training base for the Marine Corps, located in Onslow County, North Carolina (see Figure 2-1). The base covers approximately 170 square miles and is bounded to the southeast by the Atlantic Ocean, to the northeast by State Road 24, and to the west by U.S. 17. The town of Jacksonville, North Carolina is north of the base.

The focus of this design is the shallow aquifer in the area of the HPIA. The HPIA is defined as Site 78 at MCB, Camp Lejeune. Site 78, along with Site 21 (Transformer Storage Yard) and Site 24 (Industrial Area Fly Ash Dump), comprise the HPIA Operable Unit at MCB, Camp Lejeune. The HPIA is bounded by Sneads Ferry Road to the north, Holcomb Boulevard to the west, Louis Road to the east, and Main Service Road to the south (see Figure 2-2 and Drawing T-1). Site 21 is also located within this boundary. Site 24 is located along Louis Road across from Site 78.

2.2 Site Description

The HPIA, constructed in the early 1940's was the first facility at MCB, Camp Lejeune. It was comprised of approximately 75 buildings and facilities including: maintenance shops, gas stations, administrative offices, commissaries, snack bars, warehouses, storage yards, and a dry cleaning facility. A steam plant and training facility occupy the southwest portion of the HPIA. A transformer storage yard (Site 21) and an industrial area fly ash dump (Site 24) are part of the overall HPIA Operable Unit. These two areas are not included in the scope of this design report but will be considered at a later time.

In addition to Sites 21 and 24, a fuel tank farm (Site 22) is located within the HPIA operable unit near the 1000 series buildings. The fuel farm is an underground storage tank site which is not being administered under CERCLA regulations. Therefore, Site 22 is not included as part of the HPIA Operable Unit.

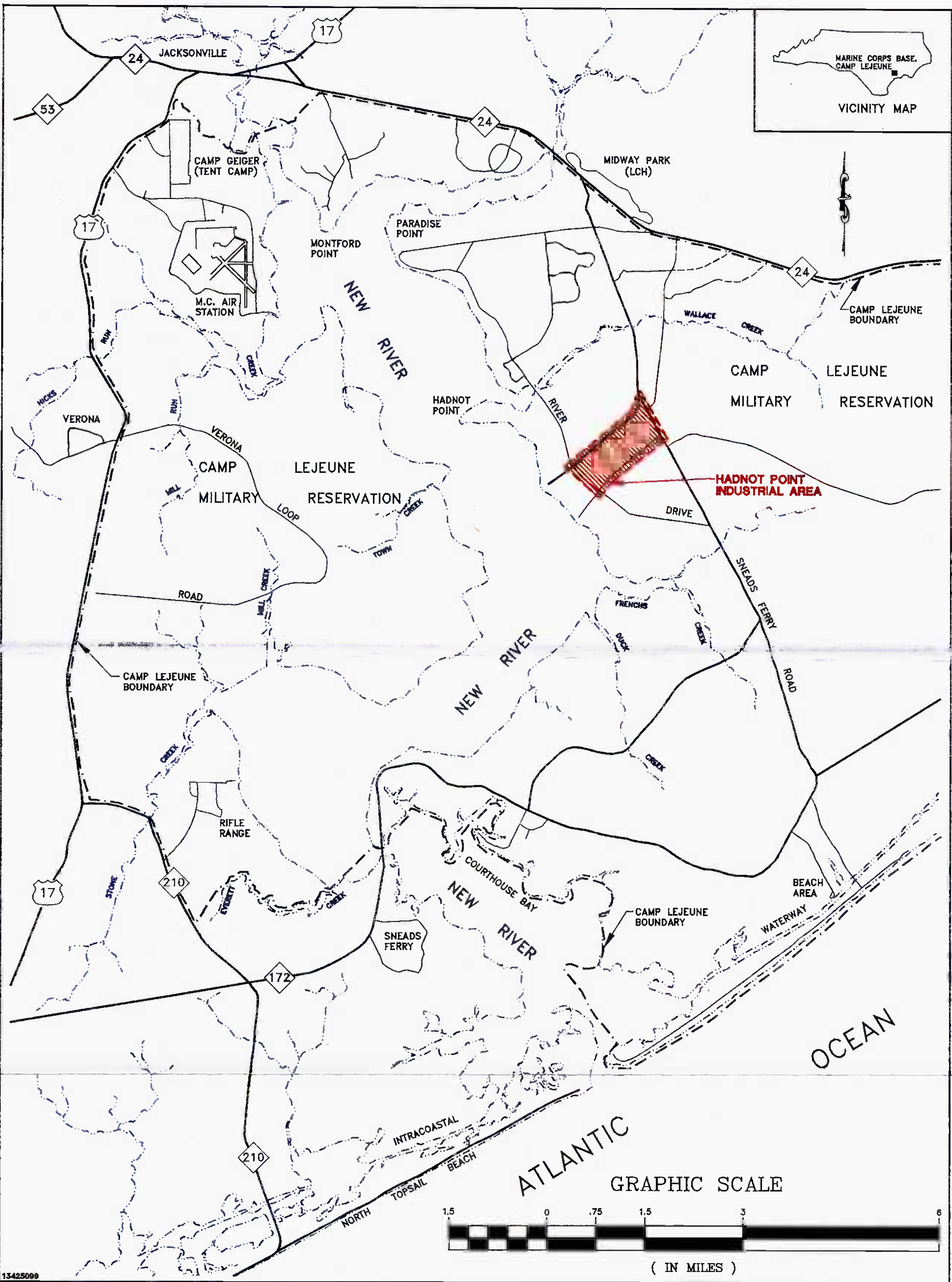

FIGURE 2-1
LOCATION MAP
HADNOT POINT INDUSTRIAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

SOURCE: U.S.G.S. WATER-RESOURCES
INVESTIGATIONS REPORT 89-4096

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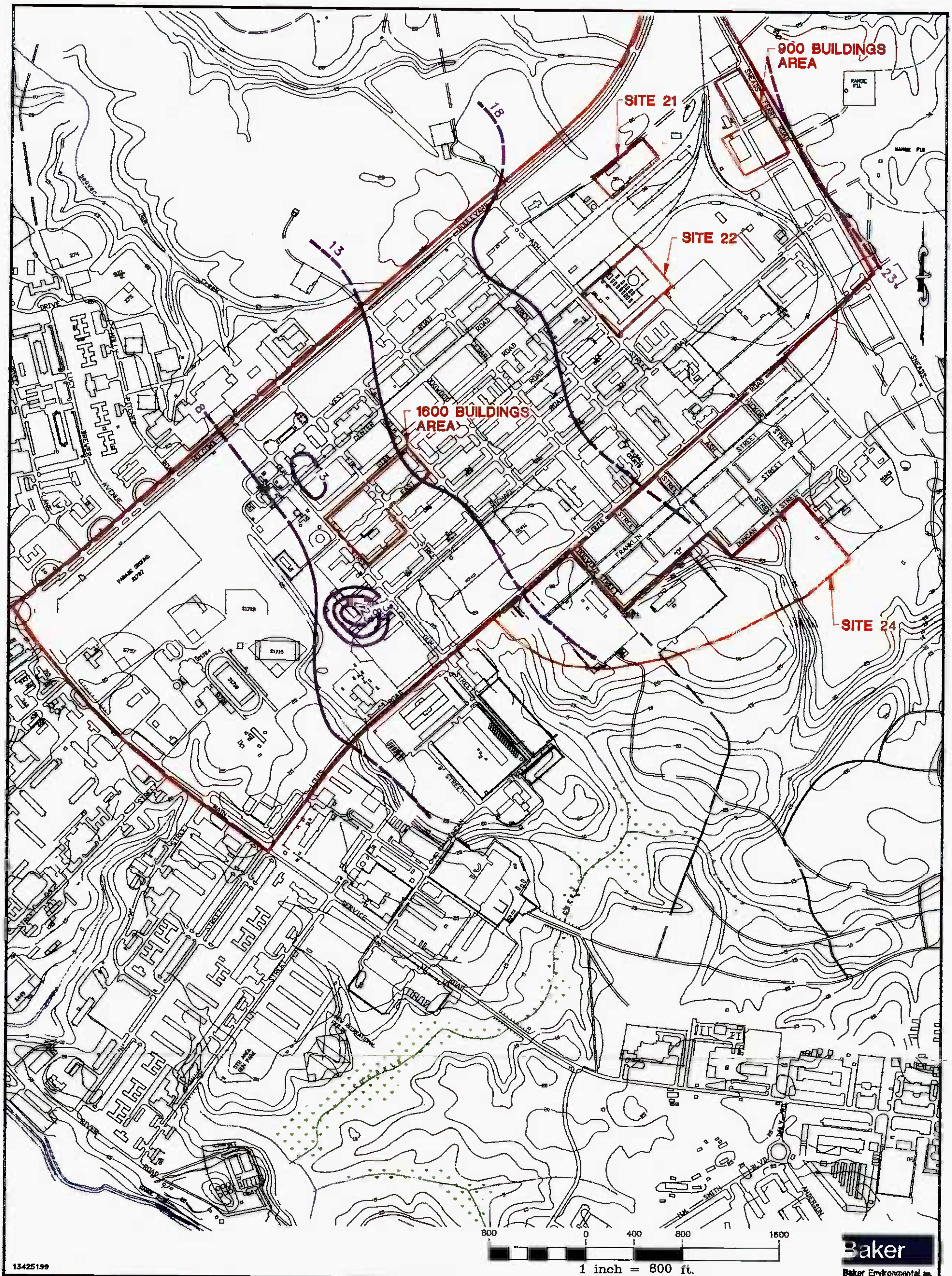

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8 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 2-2
SITE AND SHALLOW GROUNDWATER CONTOUR MAP (2/20/91)
HADNOT POINT INDUSTRIAL AREA
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

A fuel recovery/groundwater treatment system is currently being implemented at the tank farm.

Several areas at the HPIA have been investigated for potential soil and groundwater contamination due to Marine operations and activities resulting in the generation of potentially hazardous wastes. The investigations indicate that contamination has resulted at HPIA due to improper waste disposal, underground storage tank leakage, solvent spills, and sludge disposal.

2.3 Hydrology

The hydrologic system at MCB, Camp Lejeune consists of an unconfined (water table) aquifer and underlying semiconfined aquifers. The unconfined aquifer extends from the water table to the first significant confining layer, approximately 25 feet below land surface (bls).

The water table within HPIA was at an elevation ranging between 8.5 feet and 25.5 feet above mean sea level during January 1991. The depth to water table ranged from 6.7 to 23.2 feet bls. This variation in water table elevation is due to variations in water recharge throughout the area. This is caused by manmade features (parking lots, buildings, drainage ditches).

Groundwater flow in the shallow aquifer is predominantly to the southwest in the southern portion of HPIA and to the west-southwest in the northern and central portions of the site. There is some groundwater mounding in the southern corner of the site. Generally, the shallow groundwater flows toward the New River. Figure 2-2 shows a potentiometric surface map of the water table aquifer constructed from water level measurements taken in shallow monitoring wells on February 20, 1991 by Environmental Science and Engineering, Inc. (ESE). Water in the lower water bearing zones trends generally in the same direction (southwest) as that in the surficial.

As determined from February 1991 potentiometric surface maps, the horizontal hydraulic gradient in the shallow aquifer is approximately 0.003 feet per foot (ft/ft). The estimated gradient for the intermediate and deep zones are approximately 0.0015 ft/ft and 0.0021 ft/ft, respectively.

2.4 Nature and Extent of Contamination

Previous studies indicate that the shallow groundwater is contaminated primarily with fuel related compounds, benzene, 1,2-dichloroethene (1,2-DCE), trichloroethene (TCE), vinyl chloride, solvents, and metals, such as antimony, arsenic, beryllium, chromium, iron, lead, manganese, mercury, and nickel. Several compounds were detected at concentrations exceeding the Federal and North Carolina drinking water standards for groundwater.

Prior to the sampling conducted during the Treatability Study Pilot Test, the most recent shallow groundwater data was collected in January 1991 by ESE. This data is similar to the results of the earlier studies with the exception that the compound concentrations from the January 1991 data were generally lower than the concentrations identified in the earlier studies. There is no apparent reason why shallow groundwater concentrations were lower in 1991. However, deep groundwater quality showed an improving trend after the potable supply wells near the HPIA were shut down in the mid-1980s. Groundwater quality in the deep portion of the aquifer may have improved since contaminants from the shallow groundwater were no longer being drawn vertically by the pumping action of the supply wells.

Based upon the results of the January 1991 sampling, the following compounds were identified as potential contaminants of concern for the shallow aquifer at the HPIA: benzene, 1,2-DCE, TCE, antimony, arsenic, beryllium, chromium, iron, lead, manganese, mercury, and nickel. Table 2-1 presents a summary of the 1991 shallow aquifer groundwater data with respect to the contaminants of concern. Oil & grease data is not included on Table 2-1 due to the fact that this analysis was not conducted on any of the 1991 samples. The maximum concentrations of benzene (7900 µg/L) were detected in a monitoring well immediately adjacent to the fuel tank farm (Site 22). Maximum concentration of 1,2-DCE (42,000 µg/L) was detected in the northeast corner of the site (near the 900 series buildings) and the maximum concentration of TCE (14,000 µg/L) was detected in the southwestern portion of the site (near the 1600 series buildings), respectively. Metals concentrations were elevated throughout most of the site, especially near the fuel farm (lead).

Based on review of existing data, two major areas of contaminated groundwater (source areas) have been identified in the shallow aquifer at HPIA as shown on Figure 2-3 and Drawing T-1. The first area or plume is located northeast of Cedar Street near the 900 series buildings. The other plume is located southwest of Cedar Street near the 1600 series buildings.

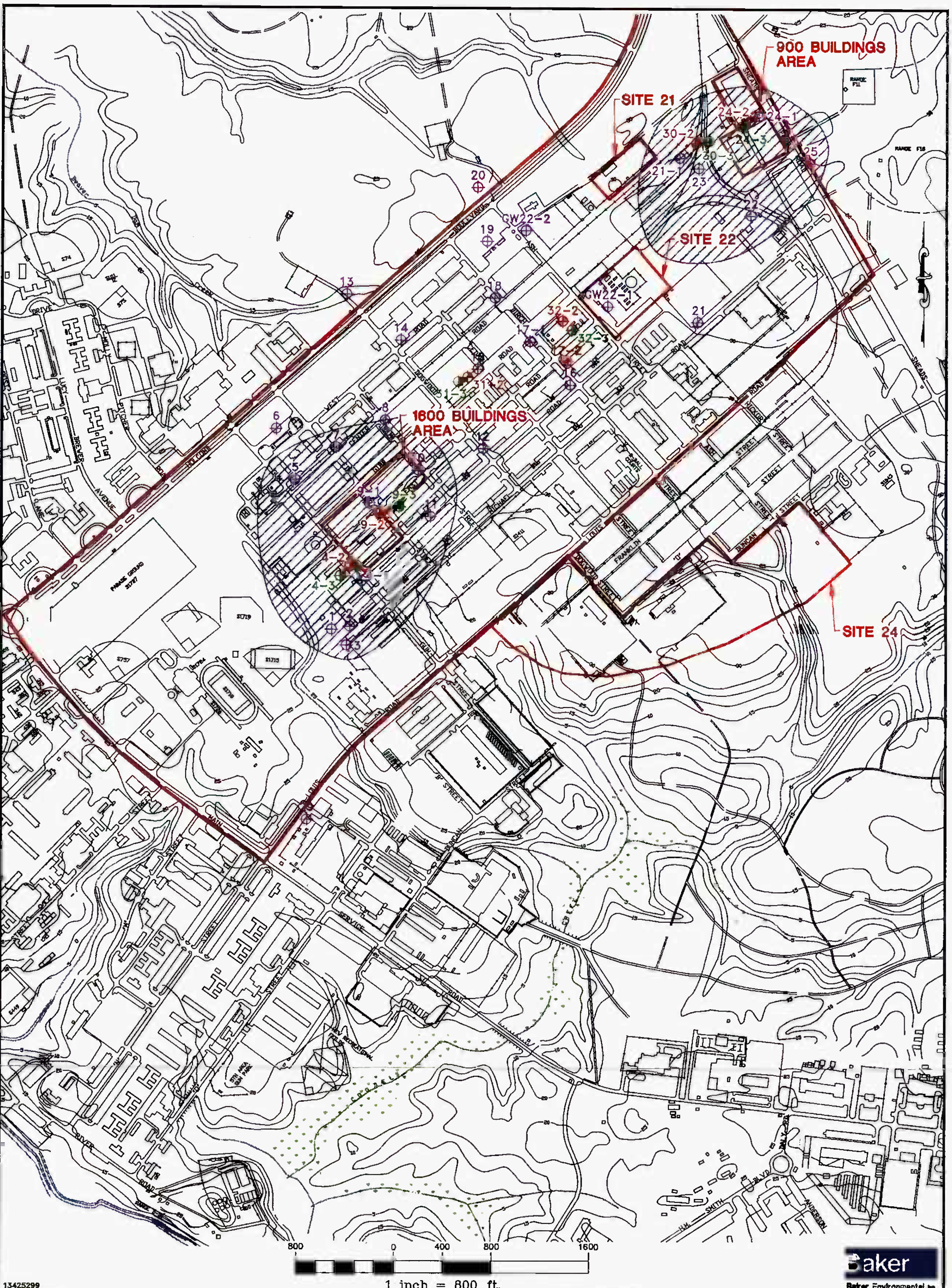
TABLE 2-1
SUMMARY OF CONTAMINANTS OF CONCERN DETECTED IN THE SHALLOW GROUNDWATER AQUIFER, JANUARY 1991

Potential Contaminants of Concern	HPGW1	HPGW2	HPGW3	HPGW4-1	HPGW5	HPGW6	HPGW7	HPGW8	HPGW9-1	HPGW10	HPGW11	HPGW12	HPGW13	HPGW14	HPGW15
VOC (µg/L)															
Benzene	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <	5 <
1,2-Dichloroethene	73	10 <	10 <	5 <	5 <	5 <	5 <	5 <	1200	5 <	5 <	5 <	5 <	5 <	7
Trichloroethene	91	5 <	5 <	0.9 J	5 <	5 <	5 <	2 J	14000	5 <	5 <	5 <	5 <	5 <	4 J
Inorganics (µg/L)															
Chromium	87	64.3	16.7	187	3.6 B	1590	313	91.8	66.4	310	140	25.5	48.9	127	21.4
Iron	64100	34800	10400	100000	3100	265000	65700	40900	19800	119000	31800	5600	33500	87200	4800
Lead	16.6	29.4	11.4	66.6	13.6	60.7	112	54.1	128	186	45.2	15.7	9	66.5	16.6
Manganese	168	77	53.9	425	162	487	136	46.5	45	255	103	18.3	30.3	80	18.3
Antimony	13.3 <	15.6 B	46.5 B	21.9 B	13.3 <	13.3 <	22 <	22	17.6 B	22 <	22 <	22 <	13.3 <	13.3 <	22 <
Arsenic	8 B	24.1	15.6	15.5	1.5 <	31.5	18.3	28.4	3 B	39.9	9.1 B	1.8 <	47	45.6	1.8 <
Beryllium	6	1.7 BG	1.2 B	6.7	0.86 B	20	4.8 B	2.1	0.79 B	5.6	2.1 <	2.1 <	0.59 B	2.7 B	2.1 <
Mercury	0.1 <	0.1 <	0.1 <	0.1 <	0.1 <	1.4	0.25	0.13	0.1 <	0.82	0.1 B	0.1 <	0.1 <	0.26	0.1 <
Nickel	31.3 B	16.9 B	12.1 B	57	5.2 <	161	50.7	25.2	15.1 B	92.2	23.6 B	11 <	21.2 B	41.6	11 <

Potential Contaminants of Concern	HPGW16	HPGW17-1	HPGW18	HPGW19	HPGW20	HPGW21	HPGW22	HPGW23	HPGW24-1	HPGW25	HPGW26	HPGW29	22GW1	22GW2	North Carolina Water Quality Criteria	Federal Drinking Water MCLs
VOC (µg/L)																
Benzene	5 <	5 <	N/A	5 <	5 <	5 <	5 <	24	3 J	5 <	5 <	5 <	7900	5 <	1	5
1,2-Dichloroethene	5 <	5 <	N/A	0.8 J	5 <	5 <	5 <	8900	42000 D	5 <	5 <	5 <	5 <	5 <	70	70
Trichloroethene	5 <	5 <	N/A	2 J	5 <	3 J	5 <	3700	180	5 <	5 <	5 <	5 J	5 <	2.8	5
Inorganics (µg/L)																
Chromium	209	37	N/A	13.8	424	45	79.8	76.3	26.3	205	13	179	457	26.3	50	100
Iron	47200	10500	N/A	36200	2E+05	56600	24400	23300	19200	46600	19000	76200	1E+05	16200	300	--
Lead	100	23.7	N/A	31.7	20	49.4	39.4	45	21.4	71.6	9	29.1	307	16.2	50	15
Manganese	98.3	31.3	N/A	79	217	136	94.1	68.8	54.8	118	10.6 B	236	284	763	50	--
Antimony	22 <	22 <	N/A	13.3	21.9B	13.3 <	24.6 B	24.6 <	22 <	13.3 <	13.3 <	13.3 <	20.9 B	13.3	--	6
Arsenic	17.3	1.8 <	N/A	5 B	49.4	12.1	7.2 B	6.6 B	4.2 B	13.2	1.5 <	25.6	50.3	11	50	50
Beryllium	5.3	2.1 <	N/A	2.3 B	9.5	3.7 B	0.6 B	1 B	2.1 <	2.8 B	0.5 <	8.7	5.8	0.5	0.5	4
Mercury	0.13 B	0.1 <	N/A	N/A	0.5	0.1 <	0.1 <	0.1 <	0.1 <	0.1 <	0.1 <	0.1 <	0.35	0.1	1.1	2
Nickel	41	11.9 B	N/A	7.3 B	168	30.8 B	23.2 B	33.2 B	14 <	39.2 B	5.2 <	93.5	186	17	150	100

Notes: < = Compound was analyzed, but not detected at the listed detection limit
J = Value is estimated
B = Reported value is < contract required detection limit (CRDL), but > instrument detection limit (IDL)
D = Compound identified in an analysis at a secondary dilution factor

N/A = Not Analyzed
-- = Not established
MCL = Maximum Contaminant Level



LEGEND

APPROXIMATE SOURCE AREA OF GROUNDWATER CONTAMINATION IN THE SHALLOW AQUIFER

20 EXISTING SHALLOW MONITORING WELL

24-2 EXISTING INTERMEDIATE MONITORING WELL

24-3 EXISTING DEEP MONITORING WELL

SOURCE: LANTDIV, FEBRUARY 1992

FIGURE 2-3
APPROXIMATE AREA OF GROUNDWATER CONTAMINATION IN THE SHALLOW AQUIFER
HADNOT POINT INDUSTRIAL AREA
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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2.4.1 Results of VOC Sampling, May 1993

In May 1993, groundwater samples were taken by Baker personnel from the monitoring wells in the HPIA. Preliminary results for VOCs from this sampling event are presented in Table 2-2. It should be noted that this data has not been validated.

The maximum concentration of 1,2-DCE detected was 14,190 µg/L from HPGW23. The highest concentration of 1,2-DCE previously detected from HPGW23 was 8,900 µg/L in January 1991.

The maximum concentration of TCE detected was 440 µg/L from HPGW23. The highest concentration of TCE previously detected from HPGW23 was 3,700 µg/L in January 1991.

TABLE 2-2

SUMMARY OF VOC CONTAMINANTS OF CONCERN DETECTED IN THE SHALLOW GROUNDWATER AQUIFER, MAY 1993

Potential Contaminants of Concern	HPGW2	HPGW3	HPGW4-1	HPGW5	HPGW6	HPGW7	HPGW8	HPGW9-2	HPGW9-3	HPGW10	HPGW11	HPGW13
VOCs (µg/l): Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	1.2	ND	ND	ND	ND	ND	ND	ND	2.0	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	1.4	ND	ND	2.0	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	6.0	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	1.5	ND	ND	ND	ND	ND

Potential Contaminants of Concern	HPGW14	HPGW15	HPGW16	HPGW17-1	HPGW17-2	HPGW19	HPGW20	HPGW21	HPGW22-1	HPGW22-2	HPGW23	HPGW24-1
VOCs (µg/l): Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	1.6
Bromomethane	1.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.6	6.7
Trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	190	140
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14,000	3400
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.2	ND
Methylene Chloride	1.4	1.4	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.3	1.5
Total Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28	1.4
Trichloroethene	ND	1.4	ND	ND	ND	1.4	ND	1.6	ND	ND	440	51
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	97
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: ND = Not Detected

3.0 LABORATORY AND FIELD INVESTIGATIONS

This section summarizes the laboratory and field activities conducted in support of the remedial design. These activities included: laboratory bench-scale treatability testing for oil, grease and metals removal, an aquifer pump test, and field pilot-scale treatability testing for volatile organic compounds (VOCs) removal with air stripping and activated carbon.

The objectives of these tests were to evaluate the remedial technologies' performance in meeting the site-specific clean-up goals for this site. The cleanup goals include Federal and North Carolina Groundwater MCLs, as shown on Table 3-1. These goals have been defined by the USEPA Region IV and the North Carolina DEHNR. A more detailed description of the objectives and procedures used in these activities is provided in the Remedial Design Work Plan (Baker, January 1993).

The results of the bench-scale and pilot-scale treatability tests have provided data to support the design of pretreatment components (e.g., metals removal, oil separation) and the air stripping treatment unit. Additionally, the pilot-scale test provided data to evaluate whether liquid phase carbon adsorption is required as part of the groundwater treatment system in order to meet cleanup goals.

The data obtained from the bench-scale and pilot-scale tests supported initial design assumptions regarding gravity oil/water separation and gravity settling of suspended metals. However, because the influent VOC concentrations detected during the pilot test were less than other historical data, alternative methods of predicting VOC removal rates were necessary. These methods are noted in Section 3.3.

The treatability study results were presented in a separate Treatability Study Report which has been submitted to LANTDIV and the Activity.

The following subsections provide a brief description of the laboratory and field activities, and a summary of their results.

TABLE 3-1

FEDERAL AND STATE CRITERIA FOR THE CONTAMINANTS OF CONCERN IDENTIFIED FOR THE SHALLOW AQUIFER

Contaminant of Concern	North Carolina* Water Quality Criteria for Groundwater (µg/L)	Federal Drinking Water MCLs (µg/L)	North Carolina* Water Criteria for Fresh Surface Water (µg/L) Class C Waters	North Carolina* Water Quality Criteria for Tidal Salt Waters (µg/L) Class SC Waters
TCE	2.8	5	92.4 (4)	92.4 (4)
1,2-DCE	--	70	--	--
Benzene	1	5	71.4 (4)	71.4 (4)
Antimony	--	6	--	--
Arsenic	50	50	50 (1)	50 (1)
Beryllium	--	4	.117 (4) 6.5 (1)	.117 (4)
Chromium	50	100	50 (1)	20 (1)
Iron	300	--	1000 (5)	--
Lead	50	15(3)	25 (1)	25 (1)
Manganese	50	--	--	--
Mercury	1.1	2	0.012 (1)	.025 (1)
Nickel	150	100	88 (1)	--

* From NC Administrative Code 15A NCAC 2B.0200
(1) Protection of aquatic life.
(2) -- = No standard established.
(3) MCL is action level for public water supply systems.
(4) Protection of Human Health through consumption of fish/shell fish.
(5) NC Action Level for discharge to fresh waters.

3.1 Bench-Scale Treatability Tests

Laboratory bench-scale treatability tests were conducted to determine if oil/water separation and metals removal would be required in the full size treatment system. Groundwater characterization samples collected from monitoring well HPGW 24-1 were used for these tests.

This monitoring well was selected based on a review of the January 1991 sampling data that indicated a high concentration of 1,2-DCE (42,000 µg/L). Because the treatability study also considered VOCs, a location was selected which had previously shown both VOC and metals contamination. In addition, this monitoring well is located in an area that was accessible for the pilot test.

3.1.1 Oil/Water Separation

As reported in the Treatability Study Report, oil and grease concentrations for samples taken from HPGW 24-1 and the recovery well (RW-1) were all less than 10 mg/L, which is generally accepted as the minimum effluent concentration achievable with a slant rib type oil/water separator. Results of the oil/water separation tests on the sample from HPGW 24-1 showed these concentrations were reduced from 6 mg/L to less than 3 mg/L after the sample settled for approximately 30 minutes. Note that these concentrations are all less than the contract detection limits for oil and grease, which is 3 mg/L. It appears that conventional oil/water separation techniques will remove oil and grease to levels below detection limits. In addition, an oil/water separator will remove some of the suspended solids from the groundwater. Table 3-2 shows the results of the oil/water separation test.

3.1.2 Solids Settling

Based on the groundwater characterization sample analyses, it was determined that chemical treatment (metals precipitation jar tests) were not required because the metals of concern were primarily associated with the suspended solids. Table 3-3 shows the results of the total and dissolved metal characterization sample. Therefore, bench-scale solids settling tests were conducted to determine if gravity settling will provide sufficient physical treatment to remove the suspended metals to levels that will meet discharge criteria. The results of these tests are presented in detail in Section 5.0 of the Treatability Study Report.

TABLE 3-2

OIL/WATER SEPARATION BENCH-SCALE TEST ANALYTICAL RESULTS

Time (minutes)	Oil and Grease (mg/L)	Sample Temp. (°C)
0	6	NA
15	<3	28
30	4	28
60	<3	28

TABLE 3-3
HPIA GROUNDWATER SAMPLE CHARACTERIZATION ANALYSES: TOTAL AND DISSOLVED METALS

Parameter	Total Metals (ug/L)	Dissolved Metals (ug/L)	Primary/Secondary Drinking Water MCLs (ug/L)	NC Ground-Water Criteria (ug/L)	NC Surface Water Criteria (3) (ug/L)
Aluminum	25900	35.0 B	50 to 200	--- (2)	---
Antimony	20 U (1)	20.0 U	6	---	---
Arsenic	9.7 B (1)	2.0 U	50	50	50
Barium	78.0 B	146 B	2000	1000	---
Beryllium	1.0 B	1.0 U	4	---	65
Cadmium	5.0 U	5.0 U	5	5	2
Calcium	18600	15000	---	---	---
Chromium	32.0	10.0 U	100	50	50
Cobalt	8.0 U	8.0 U	---	---	---
Copper	14.0 B	2.0 U	1300	1000	7
Iron	26400	31.0 B	300	300	1000
Lead	22.4	1.0 U	15 (4)	50	25
Magnesium	3100 B	1530 B	---	---	---
Manganese	84.0	24.0	50	50	---
Mercury	0.20 U	0.20 U	2	1.1	0.012
Nickel	22.0 B	20.0 U	100	150	88
Potassium	2330 B	830 B	---	---	---
Selenium	1.5 B	1.0 U	50	10	5
Silver	3.0 U	3.0 U	100	50	0.06
Sodium	8620	9910	---	---	---
Thallium	2.0 U	2.0 U	2	---	---
Vanadium	73.0	4.0 U	---	---	---
Zinc	40.0	57.0	5000	5000	50

NOTES:

(1) CONCENTRATION QUALIFIERS:

B = entered if the reported value was obtained from a reading that was less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

U = entered if the analyte was analyzed for but not detected, quantitation limit reported.

(2) "---" = No standard established.

(3) Protection of Aquatic Life.

(4) MCL is action level for public water supply systems.

After qualitative tests were conducted to determine an adequate polymer and optimum dosage rate, settling tests were conducted using both a raw groundwater sample and groundwater sample that had 2 mg/L of anionic polymer (Armstrong APS) added. The results of these tests are presented in Tables 3-4 and 3-5. Table 3-4 shows that the sample with the polymer increased the settling rate when compared with the raw sample. After 30 minutes of settling, the polymer enhanced sample had a 75 percent suspended solids removal, as compared with a 48 percent suspended solids removal in the raw sample.

Samples were taken for metals analyses (aluminum, arsenic, chromium, iron, and lead) after 60 minutes of settling for the raw sample and 30 minutes for the polymer enhanced sample. These analyses are presented in Table 3-5. This data shows that polymer addition can be used to aid in metals removal, if gravity settling alone does not reduce the metals concentrations to a level that meets discharge requirements. It should be noted that two raw influent samples collected during the pilot-scale test had total suspended solids levels of less than 10 mg/L (as compared with a TSS concentration of 62 mg/L for the bench-scale sample). A description of the pilot test is provided in Section 3.3. Additional information on solids settling can be found in Section 5.1.3 of the Treatability Study.

It was also noted that the metals concentrations in the raw sample used for the bench-scale test were less than many of the sampling results presented in Table 2-1. Because of the quality control procedures used to collect these samples, Baker believes that the samples used for the bench-scale test are representative of actual site conditions at the HPIA. These samples show groundwater conditions in the area that the sample was collected (near HPGW 24-1). This assumption is supported by the fact that the raw sample concentrations for the metals listed in Table 3-5 compare favorably with the concentrations of untreated groundwater collected during the pilot test (see Tables 5-14, 5-16, and 5-17 in the Treatability Study).

One sample, lead, showed an increased concentration after 30 minutes of settling when polymer was added. This results could be due to a reaction between the lead and the polymer. After considering the results of the bench-scale and pilot-scale tests, a solids removal system made up of polymer addition, flocculation, and gravity settling will provide adequate metals removal.

TABLE 3-4

SOLIDS SETTLING TESTS: SUSPENDED SOLIDS CONCENTRATION AS A FUNCTION OF TIME

Settling Time (minutes)	Total Suspended Solids (mg/L)	
	Raw Sample	Sample with Polymer at 2 mg/L
0	62	62
5	--	28
10	48	27
15	--	20
20	35	--
30	32	16
60	25	--

TABLE 3-5

SOLIDS SETTLING TESTS: TOTAL METALS AND TSS CONCENTRATIONS

Parameter	Units	Concentration		
		Raw Initial Sample	Raw Sample After 60 Min. Settling	Sample with Polymer at 2 mg/L after 30 Min. Settling
Aluminum	µg/L	2780	2290	282
Arsenic	µg/L	<4.0	<4.0	<4.0
Chromium	µg/L	20	14	<10.0
Iron	µg/L	8930	6400	2310
Lead	µg/L	4.4	3.2	11
TSS	µg/L	62	25	16

3.2 Aquifer Pump Test

A shallow aquifer pump test was conducted in the area of the 900 series buildings within HPIA. The purpose of the aquifer pump test was to evaluate aquifer characteristics (hydraulic conductivity, transmissivity, and storativity) and to determine optimum flow rates and recovery well zones of influence in the area.

A 6-inch diameter groundwater recovery well (RW-1) and two 2-inch diameter piezometers (P-1 and P-2) were installed near the southeast corner of Building 902. This location was selected on the basis of its location (near the center of the northern contaminant plume) and the results of previous groundwater sampling activities,which had detected a high concentrations of 1,2-dichloroethene and trichloroethene in monitoring wells HPGW 23-1 and HPGW 24-1. Well construction and boring logs for RW-1, P-1, P-2, HPGW 24-1, HPGW 24-2, and HPGW 24-3 are provided in Appendix L of the Treatability Study Report.

A step drawdown test conducted by Baker on February 1, 1993 determined that the maximum sustainable pumping rate for RW-1 was 1.5 gpm. For comparison, pump tests conducted at the Hadnot Point Fuel Farm (Site 22), produced pumping rates of 2 to 3 gpm. (O'Brien & Gere, 1990). Therefore, Baker does not believe that the 1.5 gpm pumping rate was due to poor well installation or development, but that this rate is representative of the lithology in this area. When the recovery wells are installed, flow rates of 1 to 5 gpm would be expected (see Section 4.1 for a discussion of recovery well installation).

The 72-hour pump test was started on February 2, 1993. During this test the shallow aquifer was pumped at a rate of 1.2 gpm and transducers were used to measure and record the drawdown in the recovery well, piezometers and nearby existing monitoring wells. At the completion of the pump test, the recovery rate of RW-1, P-1, P-2, and the other monitoring wells was recorded.

3.2.1 Aquifer Characteristics

Using the data collected during the pump test, aquifer characteristics were calculated using the "Graphical Well Analysis Package (GWAP)" program designed by Groundwater Graphics of Oceanside, California. Using the Neuman Method for unconfined aquifers with an elastic response, GWAP calculates aquifer transmissivity, hydraulic conductivity, and storativity.

Summary pages for the GWAP calculations are provided in Appendix A. The average value of these aquifer characteristics, based on the GWAP program, are as follows:

Transmissivity (T)	450 gpd/ft
Hydraulic Conductivity (K)	12 gpd/sq ft
Storativity (S)	0.05067

Using the Theis nonequilibrium well equation, at a boundary drawdown of 0.25 feet, various pumping radii were calculated:

Flow rate (gpm)	Pumping time (days)	Radius (feet)
1.5	30	250
1.5	60	350
3.0	30	330
3.0	60	470

After reviewing this information, Baker is recommending that the initial group of recovery wells be placed 400 feet apart (200 foot radius), in a configuration along the leading edge of the plume. The wells will be located to insure coverage of the downgradient edge of each plume, with sufficient overlapping of the well capture zones. This recovery well spacing should provide adequate coverage of the plume in the case that pumping rates do not exceed 1.5 gpm.

3.3 Pilot Test

All groundwater extracted during the 72-hour pump test was pumped through an on-site pilot-scale treatment system before being discharged to the sanitary sewer system. The pilot-scale system consisted of: an oil/water separator, surge tank, low profile tray type air stripper, and activated carbon contractor. The objectives of the pilot test were to evaluate the remedial technologies' performance in meeting the site-specific clean-up goals for this site.

Samples were collected every 12-hours from three locations on the pilot-scale system during the test: influent to the air stripper, effluent from the air stripper, and the effluent from the activated carbon unit. A total of seven samples (plus one duplicate) was collected at each of these locations. These samples were analyzed for VOCs and metals. In addition, samples collected at the beginning and at the end of the test were analyzed for the following conventional parameters: oil and grease, ammonia, bicarbonate, carbonate, chlorides, total dissolved solids, total suspended solids, hardness, and nitrate/nitrites. One set of samples collected prior to and after the activated carbon unit were tested for whole effluent toxicity.

The analytical results of the pilot test samples demonstrated that an air stripper can effectively remove the VOCs of concern, at the concentrations detected during the test, from the groundwater. The sampling results are presented in Section 5.0 of the Treatability Study Report. In addition, a table will be included in Section 4 that summarizes the VOC sampling data used to design the air stripper.

To address concerns about the ability of the air stripping system to remove higher VOC concentrations, modeling data was obtained from manufactures to predict the removal capabilities of the air stripper system. This information is presented in Section 4.0.

4.0 CONCEPTUAL DESIGN

The new treatment system to be installed for remediation of the shallow aquifer at the HPIA site includes: groundwater recovery, treatment, and discharge to the Hadnot Point STP. There will be two on-site treatment systems, each capable of treating up to 80 gpm of groundwater from two separate grids of recovery wells. Details of the three major components of the system (groundwater recovery, groundwater treatment, and treated effluent discharge) are provided in the following subsections and a schematic is shown on Figure 4-1. In addition, Table 4-1 is a summary of the Basis of Design information for the new treatment system. Appendix E contains design calculations and Appendix F contains the manufacturer's catalog information for the major equipment items for the groundwater recovery and treatment system.

Following a reviewing of the treatability and pilot test information, and discussions with LANTDIV, USEPA and North Carolina DEHNR, it was determined that additional data was needed to supplement the pilot test data in order to determine the air stripper design parameters. In addition, liquid phase carbon polishing was determined to be necessary as a final treatment step. Therefore, the sampling data presented in Table 2-1 was analyzed to determine maximum, 95th percentile, and average anticipated VOC influent concentrations. Using this information, effluent concentrations from the air stripper were determined using vendor modeling programs. This information is summarized on Table 4-2 and shows that the air stripper should be capable of removing the maximum VOCs detected from previous sampling.

The 95th percentile calculation was based on USEPA's "Supplemental Guidance to RAGS: Calculating the Concentration Term" (USEPA, Publication 9285.7-081, May 1992). The 95th percentile is calculated as follows:

$$\mu_{95} = \bar{x} + t_{n-1,\,0.95}\left(s/\sqrt{n} \right)$$

Where:
- μ_{95} = 95th percentile
- $\bar{x}$ = mean of the data
- s = standard deviation
- t = Student-t statistic (e.g., from table published in Gilbert, 1987)
- n = number of samples

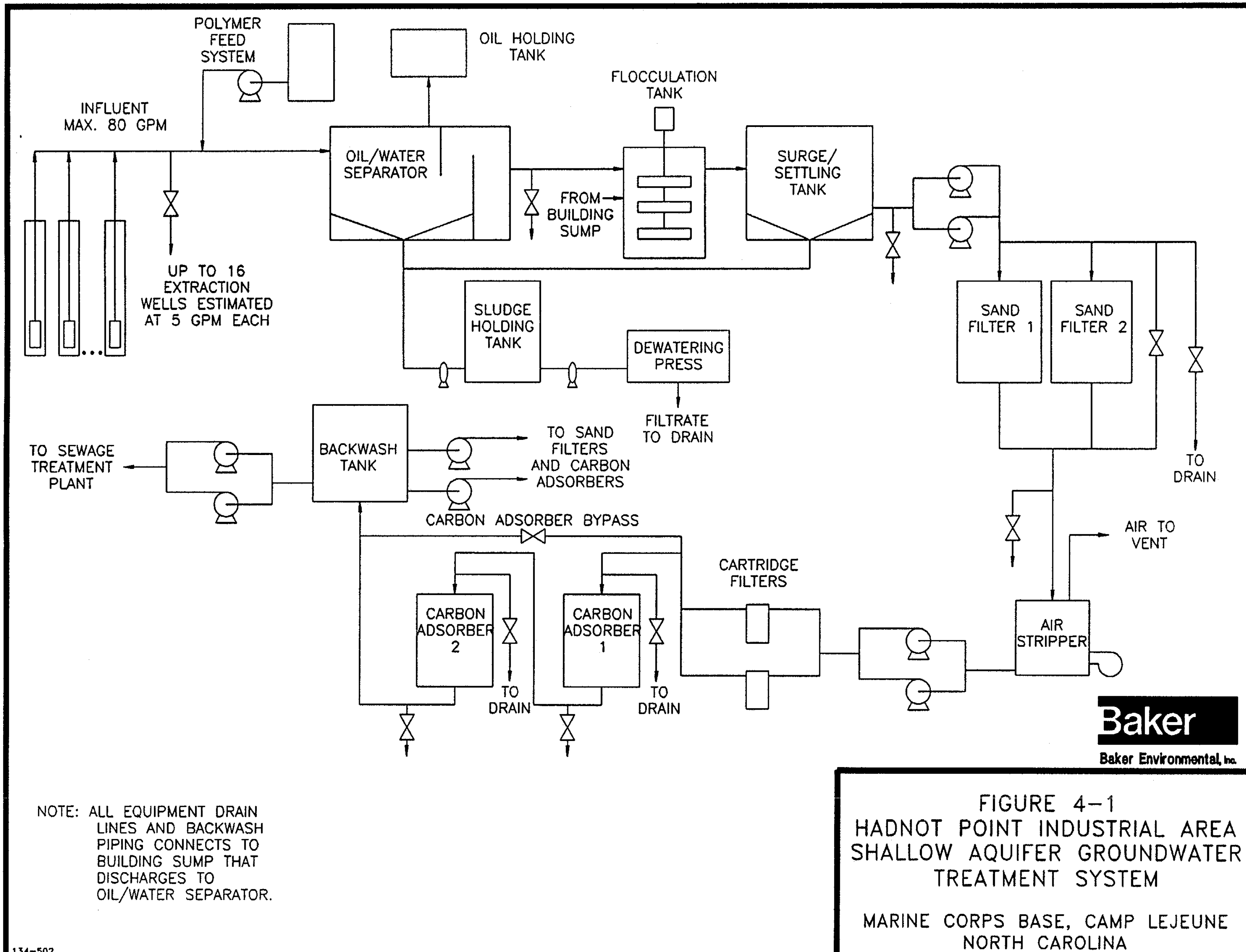


FIGURE 4-1
HADNOT POINT INDUSTRIAL AREA
SHALLOW AQUIFER GROUNDWATER
TREATMENT SYSTEM

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

TABLE 4-1

BASIS OF DESIGN INFORMATION
INTERIM REMEDIAL DESIGN FOR THE SHALLOW AQUIFER AT THE HADNOT POINT INDUSTRIAL AREA OPERABLE UNIT

I. GENERAL SYSTEM DESCRIPTION

Two 80 gpm on-site groundwater treatment systems designed for the removal of TCE, DCE, and benzene. Each system will consist of: groundwater recovery wells with individual groundwater pumps (five wells at southern area, four wells at northern area); polymer feed system, oil/water separator; flocculation tank, solids settling tank, multi-media sand filters, low profile air stripper; and related transfer pumps and controls for automatic operation; cartridge filters; carbon adsorbers. The sludge handling system at each site will consist of a solids holding tank, with supernatant drawoff; and a plate and frame dewatering press.

II. GROUNDWATER RECOVERY SYSTEM

1. Recovery Wells

Minimum Number:	4
Minimum Diameter:	6 inches
Depth:	35 feet

2. Pumping System

Type:	Pneumatic Ejector
Components:	Groundwater Recovery Pump (1/well) Remote Air Valve Assembly (1/well) Duplex Air Compressor with ASME Stamped Air Tank
Well Enclosure:	Below Grade Concrete Wellhead Vault

3. Piping System

Components:	Schedule 80 PVC Casing Pipe with Schedule 40 HDPE Carrier Pipe

III. GROUNDWATER TREATMENT SYSTEM

1. Polymer Feed System

Number:	1
Capacity:	0.01 to 1.0 gallon per hour

2. Oil/Water Separator

Number:	1
Capacity:	80 gpm
Type:	Slant Rib Coalescing
Coalescing Area:	Approx. 1500 square feet

3. Flocculation Tank

Number:	1
Capacity:	1,200 gallons
Accessories:	Adjustable Speed Mixer/Agitator

TABLE 4-1
BASIS OF DESIGN INFORMATION
PAGE 2

4. Recovered Product Storage Tank

Number:	1
Capacity:	250 gallons
Accessories:	Product Level Gage

5. Influent Surge/Settling Tank

Number:	1
Capacity:	2,500 gallons
Accessories:	Level Control Floats

6. Air Stripper

Number:	1
Capacity:	80 gpm
Type:	Low Profile
Material of Constr:	Stainless Steel
Accessories:	2, 40 gpm Feed Pumps; and 2, 40 gpm Discharge Pumps; 7-1/2 HP, 900 SCFM Blower, Control Panel with Pump Level Controls; Alarm Interlocks; Motor Starter

7. Multi-Media Sand Filters

Number:	2
Capacity:	100 gpm
Accessories:	Backwash Controls

8. Carbon Adsorbers

Number:	2
Capacity:	100 gpm @ 100 psi
Carbon Capacity:	2,500 lb/unit
Accessories:	Backwash Controls

9. Solids Holding Tank

Number:	1
Capacity:	2,500 gallons
Accessories:	Level Control Floats, Supernatant Decanting Piping

10. Dewatering Press

Number:	1
Type:	Plate and Frame
Capacity:	3.3 cubic feet
Accessories:	Automatic Sludge Feed Controls and Sludge Feed Pump

TABLE 4-2
SUMMARY OF SAMPLING DATA FOR VOC CONTAMINANTS OF CONCERN DETECTED IN THE SHALLOW GROUNDWATER AQUIFER

	Benzene	1,2-DCE	TCE	Vinyl Chloride
NC Water Quality Criteria for GW (ug/l)	1	--	2.8	0.015*****
Federal Drinking Water MCLs (ug/l)	5	70	5	2
Minimum Conc. Detected (ug/l) (Jan. 1991 Data)	<5	<5	<2	270*
Average Conc. (ug/l) (Cal. From Jan. 1991 Data)	288	1868	646	325*
95th Percentile** Value (ug/l) (Cal. From Jan. 1991 Data)	856	4932	1677	***
Maximum Conc. Detected (ug/l) (Jan. 1991 Data)	7900****	42000	14000	360*
Estimated Effluent Conc. From Air Stripper Based On Ave. Influent Conc.(ug/l)	<1	<1	<1	<1
Estimated Effluent Conc. From Air Stripper Based On 95% Influent Conc.(ug/l)	<1	<1	<1	<1
Estimated Effluent Conc. From Air Stripper Based On Max. Influent Conc.(ug/l)	2	<1	<1	<1
Estimated Effluent Conc. From Carbon Unit Based On Max. Influent Conc.(ug/l)	<1	<1	<1	<1

* Feb. 1993 Sample
** 95th percentile value was calculated from 28 samples taken in Jan. 1991, and is based on "Supplemental Guidance to RAGS : Calculating the Concentration Term" (USEPA, May 1992).
*** 95th percentile not calculated
**** This concentration detected at Site 22, which is a UST site
***** Note that GW criteria for vinyl chloride cannot be detected, use 1 ug/l as GW criteria

Preliminary data from samples collected May 1993 was also reviewed to verify that the air stripping system should be capable of removing the maximum concentrations detected, since these concentrations were less than those previously detected.

4.1 Groundwater Recovery and Pumping System

Initially, the system will be designed to extract groundwater from four recovery wells installed into each of the two contaminant plumes. Based on the results of the pump test and pilot test, the radius of influence was determined to be approximately 250 feet for the installed recovery well. Therefore, it is proposed to locate four recovery wells in the north plume and five recovery wells in the south plume in a configuration that is located along the leading edge of the plume, at a spacing of 400 feet, as shown on Drawings C-1 and C-3 of the Contract drawings. These well field configurations will provide for recovery of contaminated groundwater from each of the two plumes as the plumes migrate to the southwest, and will prevent the plumes from migrating further in the direction of the hydraulic gradient. These proposed recovery well locations also allow for construction of the initial wells and the collection piping in locations where fewer conflicts with other utilities would be encountered.

Each of the recovery wells will be a minimum of 6-inches in diameter and will be installed to a depth of approximately 35 feet below the ground surface. The bottom 25 feet of each well will be screened with 20 slot wire wrap stainless steel screen. The added depth of the recovery wells (35 feet versus the pilot test well depth of 25 feet) is intended to improve the groundwater recovery rate of the wells. The design will include provisions for installing additional recovery wells based on the results of monitoring conducted after the system is operating.

An air operated pump with an individual pump controller will be installed in each recovery well. The recovery pump will lift the contaminated groundwater from the well and pump it through a 2-inch HDPE header to the treatment system. This header and the associated air supply tubing will be placed in a PVC casing pipe, which will be installed approximately 3 feet below grade and located to avoid other underground utilities.

4.2 Groundwater Treatment System

A treatment system will be located within the area of each plume (See Drawings C-1 and C-3). Each treatment system will be designed for an ultimate flow capacity of 80 gpm, assuming a maximum of 16 recovery wells (at 5 gpm per well). The treatment systems are designed to produce an effluent that meets NC groundwater standards, as listed in Table 3-1. Each treatment system will consist of the following components:

The groundwater will flow to an oil/water separator for the removal of any floating oils, and settleable solids or oily wastes that are heavier than water. The oil/water separator system will include a 250 gallon holding tank for the storage of the extracted free product. Settled solids will be transferred to a sludge holding tank.

A chemical feed system consisting of a polymer feed pump and a flocculation tank will be used to form a floc to aid in solids and suspected metals removal.

The effluent from the flocculation tank will flow to a surge/settling tank with a capacity of approximately 2,900 gallons. This tank will have a circular divider wall which will separate the tank into a center settling zone and a perimeter holding zone to provide surge storage. The tank will have a sloped or conical bottom to allow for the removal of additional solids that will settle in this tank. Based on the results of the bench-scale tests, this arrangement should provide sufficient detention time for suspended metals removal.

The air stripper influent pumps will transfer groundwater from the surge/settling tank through two multi-media filters, then to the low profile, tray type air stripper for removal of volatile organic contaminants. The low profile air stripper is sized to remove the VOCs of concern at the maximum influent concentrations detected in previous sampling. Table 4-2 shows the minimum and maximum VOC concentrations detected, and the estimated effluent concentrations from the air stripper.

Two air stripper effluents pumps will pump groundwater to two cartridge filters that are designed to remove any suspended solids prior to the liquid phase carbon adsorbers.

Two liquid phase carbon adsorbers will be installed to operate in parallel. Each carbon unit will have a capacity of 80 gpm, and will have a backwash system. The two liquid-phase carbon adsorption units are designed with bypass piping so that the units do not have to run continuously. In normal operations, the carbon system will be bypassed and effluent from the air stripper will be pumped through the cartridge filters to the backwash tank. The carbon units will only be used if routine testing shows that effluent concentrations for the contaminants of concern exceed North Carolina groundwater standards, or Federal drinking water MCLs, or are above detection limits, if no standard exists.

Solids generated during the treatment process will be pumped to a conical bottom 2,500 gallon sludge holding tank. The sludge will be dewatered with a plate and frame press; the filtrate water will be pumped back to the head of the treatment system.

4.3 Discharge to Hadnot Point STP

The treated groundwater from each system will be pumped to the sanitary sewer for discharge to the existing biological treatment system at the Hadnot Point STP. The capacity of the existing sewers was evaluated by Baker (see the Treatability Study Report), and was found to have sufficient capacity to carry the additional maximum flow of 80 gpm from each treatment system.

4.4 Dewatered Sludge and Waste Oil Disposal

The dewatered sludge will be tested via the Toxicity Characteristic Leaching Procedure (TCLP) to determine if the sludge is considered a hazardous waste. If the sludge passes the TCLP test, it will be sent to a licensed nonhazardous waste landfill. If the sludge fails the TCLP test and is, therefore, considered hazardous, it will be transported to a licensed hazardous waste landfill for proper disposal.

Collected waste oil will be sent to a waste oil recycling or reclamation facility.

Appendix A
Aquifer Characteristic Calculations and GWAP Program Data Sheets

S.O. No. 19134-50-SRN

Subject: DETERMINING RADIUS OF INFLUENCE

Sheet No. 1 of 2

Drawing No.

Computed by DPJ Checked By RPA 3/17/93 Date 3-9-93

Baker

USING THE PUMP TEST DATA, THE FOLLOWING AQUIFER PARAMETERS WERE CALCULATED:

	TRANSMISSIVITY (T) gpd/ft	STORATIVITY (S)	HYDRAULIC CONDUCTIVITY (K) gpd/sf
RW-1	1.429×10^{2}	6.267×10^{-2}	5.718
P-1	7.001×10^{2}	4.156×10^{-2}	2.8×10^{1}
P-2	3.591×10^{2}	9.508×10^{-4}	1.436×10^{1}
24-1	5.07×10^{2}	4.78×10^{-3}	2.03×10^{1}

USING THE THEIS EQUATION → $s = \frac{114.6\, Q\, (W(u))}{T}$

s = drawdown in ft
Q = pumping rate in gpm
T = Transmissivity in gpd/ft
$W(u)$ = well function of u

SOLVING THE THEIS EQUATION FOR $W(u)$ → $= \frac{(s)(T)}{114.6\,(Q)}$

ASSUMPTIONS:

1. Drawdown (s) = 0.25' = boundary
2. Transmissivity (T) = AVE T of RW-1, P-1 & 24-1
   $= 4.5 \times 10^{2}$
3. $Q = 1.5$ gpm

SOLVING FOR $W(u) = \frac{0.25\,(4.5 \times 10^{2})}{114.6\,(1.5)}$

$W(u) = 6.54 \times 10^{-1}$

FROM APPENDIX 9.E – Groundwater and Wells, 2nd Ed; Driscoll,

$u = 4.3 \times 10^{-1}$

S.O. No. 19134-50-SEN

Subject:

Sheet No. 2 of 2

Drawing No.

Computed by DPJ Checked By RPA 3/17/93 Date 3-9-93

Baker

In the w(u) well function, $u = \frac{1.87 r^2 S}{Tt}$

r = radius in ft from center of pumped well to a point where drawdown is measured

S = Storativity

T = Transmissivity

t = time since pumping started, in days

solving the above equation for $r = \sqrt{\frac{u(T)(t)}{1.87(S)}}$

ASSUMPTIONS:

T = AVERAGE T FOR RW-1, P-1, & 24-1
$= 4.5 \times 10^{2}$

S = AVERAGE S FOR RW-1, P-1, & 24-1
$= 5.067 \times 10^{-2}$

THEREFORE, SOLVING FOR RADIUS r @ 1.5 gpm & t = 30 d

$$r = \sqrt{\frac{4.3 \times 10^{-1} (4.5 \times 10^{2})(30)}{1.87 (5.067 \times 10^{-2})}}$$

r = 247' @ 30 days

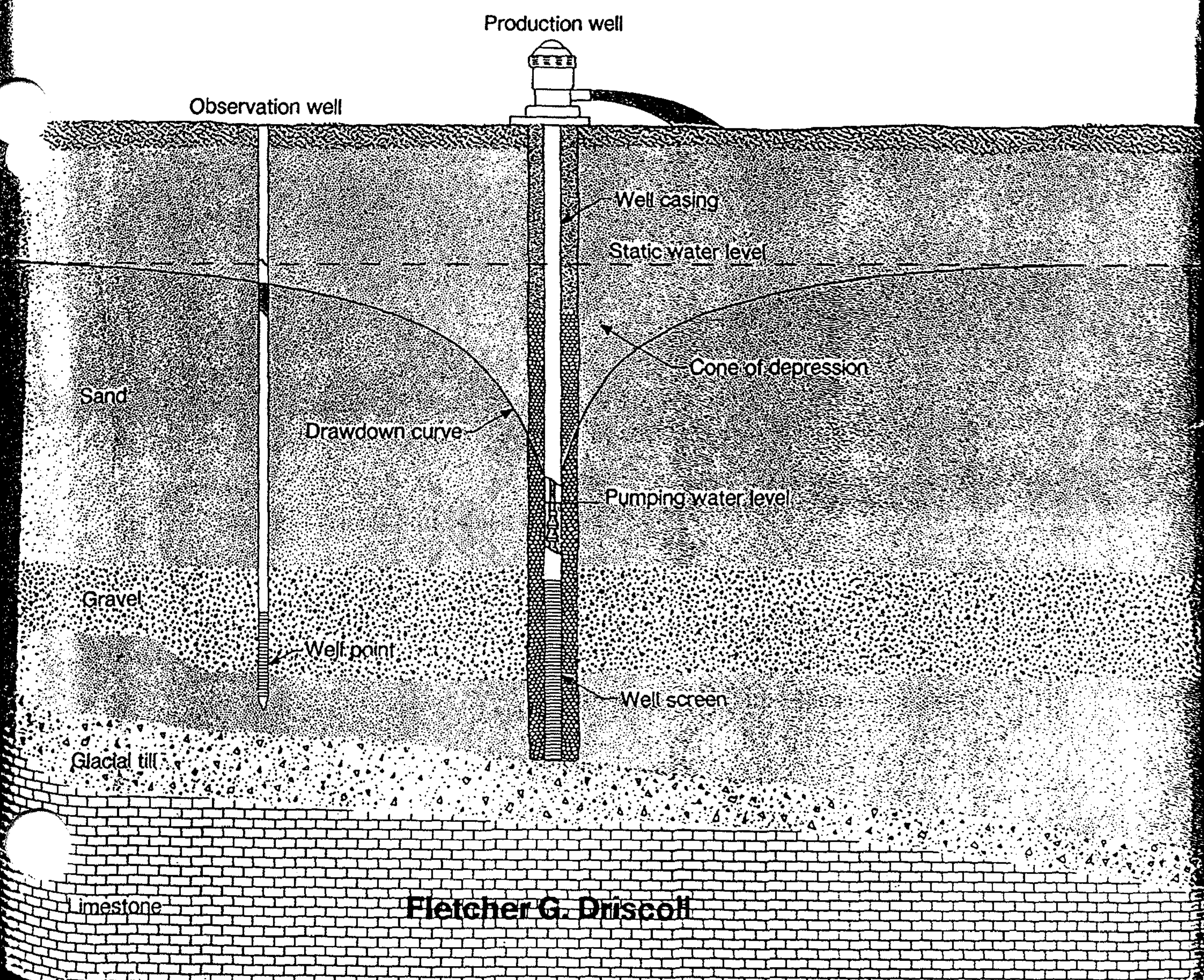
SET-UP: A TABLE FOR VARIOUS FLOW RATES & PUMPING TIM

Q (gpm)	W(u)	u	t (days)	r (ft)
1.5	6.54×10^{-1}	4.3×10^{-1}	30	250
1.5	6.54×10^{-1}	4.3×10^{-1}	60	350
3.0	3.27×10^{-1}	7.7×10^{-1}	30	330
3.0	3.27×10^{-1}	7.7×10^{-1}	60	470

Groundwater and Wells

Second Edition

A comprehensive study of groundwater and the technologies used to locate, extract, treat, and protect this resource.



Fletcher G. Driscoll

NONEQUILIBRIUM WELL EQUATION

Theis developed the nonequilibrium well equation in 1935. The Theis equation was the first to take into account the effect of pumping time on well yield. Its derivation was a major advance in groundwater hydraulics. By use of this equation, the drawdown can be predicted at any time after pumping begins. Transmissivity and average hydraulic conductivity can be determined during the early stages of a pumping test rather than after water levels in observation wells have virtually stabilized. Aquifer coefficients can be determined from the time-drawdown measurements in a single observation well rather than from two observation wells as required in Equations 9.3 and 9.4.

Derivation of the Theis equation is based on the following assumptions:

1. The water-bearing formation is uniform in character and the hydraulic conductivity is the same in all directions.
2. The formation is uniform in thickness and infinite in areal extent.
3. The formation receives no recharge from any source.
4. The pumped well penetrates, and receives water from, the full thickness of the water-bearing formation.
5. The water removed from storage is discharged instantaneously when the head is lowered.
6. The pumping well is 100-percent efficient.
7. All water removed from the well comes from aquifer storage.
8. Laminar flow exists throughout the well and aquifer.
9. The water table or potentiometric surface has no slope.

These assumptions are essentially the same as those for the equilibrium equation except that the water levels within the cone of depression need not have stabilized or reached equilibrium.

In its simplest form, the Theis equation is:

$$s = \frac{114.6\, Q\, W(u)}{T} \qquad\qquad s = \frac{1}{4\pi}\frac{Q}{T}W(u) \qquad (9.5)$$

where

s = drawdown, in ft, at any point in the vicinity of a well discharging at a constant rate

Q = pumping rate, in gpm

T = coefficient of transmissivity of the aquifer, in gpd/ft

$W(u)$ = is read "well function of u" and represents an exponential integral

where

s = drawdown, in m, at any point in the vicinity of a well discharging at a constant rate

Q = pumping rate, in m^3/day

T = coefficient of transmissivity of the aquifer, in m^2/day

$W(u)$ = is read "well function of u" and represents an exponential integral

In the $W(u)$ function, u is equal to:

$$u = \frac{1.87 r^2 S}{Tt} \qquad\qquad u = \frac{r^2 S}{4Tt} \qquad (9.5a)$$

where

r = distance, in ft, from the center of a

where

r = distance, in m, from the center of a

pumped well to a point where the drawdown is measured
S = coefficient of storage (dimensionless)
T = coefficient of transmissivity, in gpd/ft
t = time since pumping started, in days

pumped well to a point where the drawdown is measured
S = coefficient of storage (dimensionless)
T = coefficient of transmissivity, in m^2/day
t = time since pumping started, in days

The well function of u [$W(u)$] originated as a term to represent the heat distribution in a flat plate with a heating element at its center. Theis recognized that this same concept could be applied to the regular distribution of the groundwater head around a pumping well even though water flows toward the point source rather than away from it. The mathematical principles remain the same.

Analysis of pumping test data* using the Theis equation can yield transmissivity and storage coefficients for all nonequilibrium situations. In actual practice, however, the Theis method is often avoided because it requires curve-matching interpretation and is somewhat laborious. In fact, the work of applying the Theis method can be avoided in most cases. For example, if the pumping test is sufficiently long or the distance from the well to where the drawdown is measured is sufficiently small, the $W(u)$ function can be replaced by a simpler mathematical function which makes the analysis easier. The Theis method is developed at the end of this chapter, but at this point the simplified version is examined because it serves well in most cases.

MODIFIED NONEQUILIBRIUM EQUATION

In working with the Theis equation, Cooper and Jacob (1946) point out that when u is sufficiently small, the nonequilibrium equation can be modified to the following form without significant error:

$$s = \frac{264Q}{T}\log\frac{0.3\ Tt}{r^2S} \qquad s = \frac{0.183Q}{T}\log\frac{2.25\ Tt}{r^2S} \qquad (9.6)$$

where the symbols represent the same terms as in Equation 9.5 and 9.5a.

For values of u less than about 0.05, Equation 9.6 gives essentially the same results as Equation 9.5. The value of u becomes smaller as t increases and r decreases. Thus, Equation 9.6 is valid when t is sufficiently large and r is sufficiently small. Equation 9.6 is similar in form to the Theis equation except that the exponential integral function, $W(u)$, has been replaced by a logarithmic term which is easier to work with in practical applications of well hydraulics.

For a particular situation where the pumping rate is held constant, Q, T, and S are all constants. Equation 9.6 shows, therefore, that the drawdown, s, varies with log t/r^2 when u is less than 0.05. From this relationship, two important relationships can be stated:

1. For a particular aquifer at any specific point (where r is constant), the terms s and t are the only variables in Equation 9.6. Thus, s varies as log C_1t, where C_1 represents all the constant terms in the equation.

2. For a particular formation and at a given value of t, the terms s and r are the

*The performance of newly completed wells is often checked by pumping tests. During the test, the drawdown in the pumping well and observation wells is measured at a constant discharge rate. When properly conducted, these tests yield information on transmissivity and storage capability. See Chapter 16 for a detailed analysis of pumping test procedures.

APPENDIX 9.E.

Values of *W(u)* Corresponding to Values of *u* for Theis Nonequilibrium Equation

N \ u	$N \times 10^{-15}$	$N \times 10^{-14}$	$N \times 10^{-13}$	$N \times 10^{-12}$	$N \times 10^{-11}$	$N \times 10^{-10}$	$N \times 10^{-9}$	$N - 10^{-8}$	$N \times 10^{-7}$	$N \times 10^{-6}$	$N \times 10^{-5}$	$N \times 10^{-4}$	$N \times 10^{-3}$	$N \times 10^{-2}$	$N \times 10^{-1}$	N
1.0	33.9616	31.6590	29.3564	27.0538	24.7512	22.4486	20.1460	17.8435	15.5409	13.2383	10.9357	8.6332	6.3315	4.0379	1.8229	0.2194
1.1	33.8662	31.5637	29.2611	26.9585	24.6559	22.3533	20.0507	17.7482	15.4456	13.1430	10.8404	8.5379	6.2363	3.9436	1.7371	.1860
1.2	33.7792	31.4767	29.1741	26.8715	24.5689	22.2663	19.9637	17.6611	15.3586	13.0560	10.7534	8.4509	6.1494	3.8576	1.6595	.1584
1.3	33.6992	31.3966	29.0940	26.7914	24.4889	22.1863	19.8837	17.5811	15.2785	12.9759	10.6734	8.3709	6.0695	3.7785	1.5889	.1355
1.4	33.6251	31.3225	29.0199	26.7173	24.4147	22.1122	19.8096	17.5070	15.2044	12.9018	10.5993	8.2968	5.9955	3.7054	1.5241	.1162
1.5	33.5561	31.2535	28.9509	26.6483	24.3458	22.0432	19.7406	17.4380	15.1354	12.8328	10.5303	8.2278	5.9266	3.6374	1.4645	.1000
1.6	33.4916	31.1890	28.8864	26.5838	24.2812	21.9786	19.6760	17.3735	15.0709	12.7683	10.4657	8.1634	5.8621	3.5739	1.4092	.08631
1.7	33.4309	31.1283	28.8258	26.5232	24.2206	21.9180	19.6154	17.3128	15.0103	12.7077	10.4051	8.1027	5.8016	3.5143	1.3578	.07465
1.8	33.3738	31.0712	28.7686	26.4660	24.1634	21.8608	19.5583	17.2557	14.9531	12.6505	10.3479	8.0455	5.7446	3.4581	1.3098	.06471
1.9	33.3197	31.0171	28.7145	26.4119	24.1094	21.8068	19.5042	17.2016	14.8990	12.5964	10.2939	7.9915	5.6906	3.4050	1.2649	.05620
2.0	33.2684	30.9658	28.6632	26.3607	24.0581	21.7555	19.4529	17.1503	14.8477	12.5451	10.2426	7.9402	5.6394	3.3547	1.2227	.04890
2.1	33.2196	30.9170	28.6145	26.3119	24.0093	21.7067	19.4041	17.1015	14.7989	12.4964	10.1938	7.8914	5.5907	3.3069	1.1829	.04261
2.2	33.1731	30.8705	28.5679	26.2653	23.9628	21.6602	19.3576	17.0550	14.7524	12.4498	10.1473	7.8449	5.5443	3.2614	1.1454	.03719
2.3	33.1286	30.8261	28.5235	26.2209	23.9183	21.6157	19.3131	17.0106	14.7080	12.4054	10.1028	7.8004	5.4999	3.2179	1.1099	.03250
2.4	33.0861	30.7835	28.4809	26.1783	23.8758	21.5732	19.2706	16.9680	14.6654	12.3628	10.0603	7.7579	5.4575	3.1763	1.0762	.02844
2.5	33.0453	30.7427	28.4401	26.1375	23.8349	21.5323	19.2298	16.9272	14.6246	12.3220	10.0194	7.7172	5.4167	3.1365	1.0443	.02491
2.6	33.0060	30.7035	28.4009	26.0983	23.7957	21.4931	19.1905	16.8880	14.5854	12.2828	9.9802	7.6779	5.3776	3.0983	1.0139	.02185
2.7	32.9683	30.6657	28.3631	26.0606	23.7580	21.4554	19.1528	16.8502	14.5476	12.2450	9.9425	7.6401	5.3400	3.0615	.9849	.01918
2.8	32.9319	30.6294	28.3268	26.0242	23.7216	21.4190	19.1164	16.8138	14.5113	12.2087	9.9061	7.6038	5.3037	3.0261	.9573	.01686
2.9	32.8968	30.5943	28.2917	25.9891	23.6865	21.3839	19.0813	16.7788	14.4762	12.1736	9.8710	7.5687	5.2687	2.9920	.9309	.01482
3.0	32.8629	30.5604	28.2578	25.9552	23.6526	21.3500	19.0474	16.7449	14.4423	12.1397	9.8371	7.5348	5.2349	2.9591	.9057	.01305
3.1	32.8302	30.5276	28.2250	25.9224	23.6198	21.3172	19.0146	16.7121	14.4095	12.1069	9.8043	7.5020	5.2022	2.9273	.8815	.01149
3.2	32.7984	30.4958	28.1932	25.8907	23.5881	21.2855	18.9829	16.6803	14.3777	12.0751	9.7726	7.4703	5.1706	2.8965	.8583	.01013
3.3	32.7676	30.4651	28.1625	25.8599	23.5573	21.2547	18.9521	16.6495	14.3470	12.0444	9.7418	7.4395	5.1399	2.8668	.8361	.008939
3.4	32.7378	30.4352	28.1326	25.8300	23.5274	21.2249	18.9223	16.6197	14.3171	12.0145	9.7120	7.4097	5.1102	2.8379	.8147	.007891
3.5	32.7088	30.4062	28.1036	25.8010	23.4985	21.1959	18.8933	16.5907	14.2881	11.9855	9.6830	7.3807	5.0813	2.8099	.7942	.006970
3.6	32.6806	30.3780	28.0755	25.7729	23.4703	21.1677	18.8651	16.5625	14.2599	11.9574	9.6548	7.3526	5.0532	2.7827	.7745	.006160
3.7	32.6532	30.3506	28.0481	25.7455	23.4429	21.1403	18.8377	16.5351	14.2325	11.9300	9.6274	7.3252	5.0259	2.7563	.7554	.005448
3.8	32.6266	30.3240	28.0214	25.7188	23.4162	21.1136	18.8110	16.5085	14.2059	11.9033	9.6007	7.2985	4.9993	2.7306	.7371	.004820
3.9	32.6006	30.2980	27.9954	25.6928	23.3902	21.0877	18.7851	16.4825	14.1799	11.8773	9.5748	7.2725	4.9735	2.7056	.7194	.004267
4.0	32.5753	30.2727	27.9701	25.6675	23.3649	21.0623	18.7598	16.4572	14.1546	11.8520	9.5495	7.2472	4.9482	2.6813	.7024	.003779
4.1	32.5506	30.2480	27.9454	25.6428	23.3402	21.0376	18.7351	16.4325	14.1299	11.8273	9.5248	7.2225	4.9236	2.6576	.6859	.003349
4.2	32.5265	30.2239	27.9213	25.6187	23.3161	21.0136	18.7110	16.4084	14.1058	11.8032	9.5007	7.1985	4.8997	2.6344	.6700	.002969
4.3	32.5029	30.2004	27.8978	25.5952	23.2926	20.9900	18.6874	16.3848	14.0823	11.7797	9.4771	7.1749	4.8762	2.6119	.6546	.002633
4.4	32.4800	30.1774	27.8748	25.5722	23.2696	20.9670	18.6644	16.3619	14.0593	11.7567	9.4541	7.1520	4.8533	2.5899	.6397	.002336
4.5	32.4575	30.1549	27.8523	25.5497	23.2471	20.9446	18.6420	16.3394	14.0368	11.7342	9.4317	7.1295	4.8310	2.5684	.6253	.002073
4.6	32.4355	30.1329	27.8303	25.5277	23.2252	20.9226	18.6200	16.3174	14.0148	11.7122	9.4097	7.1075	4.8091	2.5474	.6114	.001841
4.7	32.4140	30.1114	27.8088	25.5062	23.2037	20.9011	18.5985	16.2959	13.9933	11.6907	9.3882	7.0860	4.7877	2.5268	.5979	.001635
4.8	32.3929	30.0904	27.7878	25.4852	23.1826	20.8800	18.5774	16.2748	13.9723	11.6697	9.3671	7.0650	4.7667	2.5068	.5848	.001453
4.9	32.3723	30.0697	27.7672	25.4646	23.1620	20.8594	18.5568	16.2542	13.9516	11.6491	9.3465	7.0444	4.7462	2.4871	.5721	.001291
5.0	32.3521	30.0495	27.7470	25.4444	23.1418	20.8392	18.5366	16.2340	13.9314	11.6289	9.3263	7.0242	4.7261	2.4679	.5598	.001148
5.1	32.3323	30.0297	27.7271	25.4246	23.1220	20.8194	18.5168	16.2142	13.9116	11.6091	9.3065	7.0044	4.7064	2.4491	.5478	.001021

Appendix 9.E. Continued

N \ u	$N \times 10^{-15}$	$N \times 10^{-14}$	$N \times 10^{-13}$	$N \times 10^{-12}$	$N \times 10^{-11}$	$N \times 10^{-10}$	$N \times 10^{-9}$	$N \times 10^{-8}$	$N \times 10^{-7}$	$N \times 10^{-6}$	$N \times 10^{-5}$	$N \times 10^{-4}$	$N \times 10^{-3}$	$N \times 10^{-2}$	$N \times 10^{-1}$	N
5.2	32.3129	30.0103	27.7077	25.4051	23.1026	20.8000	18.4974	16.1948	13.8922	11.5896	9.2871	6.9850	4.6871	2.4306	.5362	.0009086
5.3	32.2939	29.9913	27.6887	25.3861	23.0835	20.7809	18.4783	16.1758	13.8732	11.5706	9.2681	6.9659	4.6681	2.4126	.5250	.0008086
5.4	32.2752	29.9726	27.6700	25.3674	23.0648	20.7622	18.4596	16.1571	13.8545	11.5519	9.2494	6.9473	4.6495	2.3948	.5140	.0007198
5.5	32.2568	29.9542	27.6516	25.3491	23.0465	20.7439	18.4413	16.1387	13.8361	11.5336	9.2310	6.9289	4.6313	2.3775	.5034	.0006409
5.6	32.2388	29.9362	27.6336	25.3310	23.0285	20.7259	18.4233	16.1207	13.8181	11.5155	9.2130	6.9109	4.6134	2.3604	.4930	.0005708
5.7	32.2211	29.9185	27.6159	25.3133	23.0108	20.7082	18.4056	16.1030	13.8004	11.4978	9.1953	6.8932	4.5958	2.3437	.4830	.0005085
5.8	32.2037	29.9011	27.5985	25.2959	22.9934	20.6908	18.3882	16.0856	13.7830	11.4804	9.1779	6.8758	4.5785	2.3273	.4732	.0004532
5.9	32.1866	29.8840	27.5814	25.2789	22.9763	20.6737	18.3711	16.0685	13.7659	11.4633	9.1608	6.8588	4.5615	2.3111	.4637	.0004039
6.0	32.1698	29.8672	27.5646	25.2620	22.9595	20.6569	18.3543	16.0517	13.7491	11.4465	9.1440	6.8420	4.5448	2.2953	.4544	.0003601
6.1	32.1533	29.8507	27.5481	25.2455	22.9429	20.6403	18.3378	16.0352	13.7326	11.4300	9.1275	6.8254	4.5283	2.2797	.4454	.0003211
6.2	32.1370	29.8344	27.5318	25.2293	22.9267	20.6241	18.3215	16.0189	13.7163	11.4138	9.1112	6.8092	4.5122	2.2645	.4366	.0002864
6.3	32.1210	29.8184	27.5158	25.2133	22.9107	20.6081	18.3055	16.0029	13.7003	11.3978	9.0952	6.7932	4.4963	2.2494	.4280	.0002555
6.4	32.1053	29.8027	27.5001	25.1975	22.8949	20.5923	18.2898	15.9872	13.6846	11.3820	9.0795	6.7775	4.4806	2.2346	.4197	.0002279
6.5	32.0898	29.7872	27.4846	25.1820	22.8794	20.5768	18.2742	15.9717	13.6691	11.3665	9.0640	6.7620	4.4652	2.2201	.4115	.0002034
6.6	32.0745	29.7719	27.4693	25.1667	22.8641	20.5616	18.2590	15.9564	13.6538	11.3512	9.0487	6.7467	4.4501	2.2058	.4036	.0001816
6.7	32.0595	29.7569	27.4543	25.1517	22.8491	20.5465	18.2439	15.9414	13.6388	11.3362	9.0337	6.7317	4.4351	2.1917	.3959	.0001621
6.8	32.0446	29.7421	27.4395	25.1369	22.8343	20.5317	18.2291	15.9265	13.6240	11.3214	9.0189	6.7169	4.4204	2.1779	.3883	.0001448
6.9	32.0300	29.7275	27.4249	25.1223	22.8197	20.5171	18.2145	15.9119	13.6094	11.3068	9.0043	6.7023	4.4059	2.1643	.3810	.0001293
7.0	32.0156	29.7131	27.4105	25.1079	22.8053	20.5027	18.2001	15.8976	13.5950	11.2924	8.9899	6.6879	4.3916	2.1508	.3738	.0001155
7.1	32.0015	29.6989	27.3963	25.0937	22.7911	20.4885	18.1860	15.8834	13.5808	11.2782	8.9757	6.6737	4.3775	2.1376	.3668	.0001032
7.2	31.9875	29.6849	27.3823	25.0797	22.7771	20.4746	18.1720	15.8694	13.5668	11.2642	8.9617	6.6598	4.3636	2.1246	.3599	.00009219
7.3	31.9737	29.6711	27.3685	25.0659	22.7633	20.4608	18.1582	15.8556	13.5530	11.2504	8.9479	6.6460	4.3500	2.1118	.3532	.00008239
7.4	31.9601	29.6575	27.3549	25.0523	22.7497	20.4472	18.1446	15.8420	13.5394	11.2368	8.9343	6.6324	4.3364	2.0991	.3467	.00007364
7.5	31.9467	29.6441	27.3415	25.0389	22.7363	20.4337	18.1311	15.8286	13.5260	11.2234	8.9209	6.6190	4.3231	2.0867	.3403	.00006583
7.6	31.9334	29.6308	27.3282	25.0257	22.7231	20.4205	18.1179	15.8153	13.5127	11.2102	8.9076	6.6057	4.3100	2.0744	.3341	.00005886
7.7	31.9203	29.6178	27.3152	25.0126	22.7100	20.4074	18.1048	15.8022	13.4997	11.1971	8.8946	6.5927	4.2970	2.0623	.3280	.00005263
7.8	31.9074	29.6048	27.3023	24.9997	22.6971	20.3945	18.0919	15.7893	13.4868	11.1842	8.8817	6.5798	4.2842	2.0503	.3221	.00004707
7.9	31.8947	29.5921	27.2895	24.9869	22.6844	20.3818	18.0792	15.7766	13.4740	11.1714	8.8689	6.5671	4.2716	2.0386	.3163	.00004210
8.0	31.8821	29.5795	27.2769	24.9744	22.6718	20.3692	18.0666	15.7640	13.4614	11.1589	8.8563	6.5545	4.2591	2.0269	.3106	.00003767
8.1	31.8697	29.5671	27.2645	24.9619	22.6594	20.3568	18.0542	15.7516	13.4490	11.1464	8.8439	6.5421	4.2468	2.0155	.3050	.00003370
8.2	31.8574	29.5548	27.2523	24.9497	22.6471	20.3445	18.0419	15.7393	13.4367	11.1342	8.8317	6.5298	4.2346	2.0042	.2996	.00003015
8.3	31.8453	29.5427	27.2401	24.9375	22.6350	20.3324	18.0298	15.7272	13.4246	11.1220	8.8195	6.5177	4.2226	1.9930	.2943	.00002699
8.4	31.8333	29.5307	27.2282	24.9256	22.6230	20.3204	18.0178	15.7152	13.4126	11.1101	8.8076	6.5057	4.2107	1.9820	.2891	.00002415
8.5	31.8215	29.5189	27.2163	24.9137	22.6112	20.3086	18.0060	15.7034	13.4008	11.0982	8.7957	6.4939	4.1990	1.9711	.2840	.00002162
8.6	31.8098	29.5072	27.2046	24.9020	22.5995	20.2969	17.9943	15.6917	13.3891	11.0865	8.7840	6.4822	4.1874	1.9604	.2790	.00001936
8.7	31.7982	29.4957	27.1931	24.8905	22.5879	20.2853	17.9827	15.6801	13.3776	11.0750	8.7725	6.4707	4.1759	1.9498	.2742	.00001733
8.8	31.7868	29.4842	27.1816	24.8790	22.5765	20.2739	17.9713	15.6687	13.3661	11.0635	8.7610	6.4592	4.1646	1.9393	.2694	.00001552
8.9	31.7755	29.4729	27.1703	24.8678	22.5652	20.2626	17.9600	15.6574	13.3548	11.0523	8.7497	6.4480	4.1534	1.9290	.2647	.00001390
9.0	31.7643	29.4618	27.1592	24.8566	22.5540	20.2514	17.9488	15.6462	13.3437	11.0411	8.7386	6.4368	4.1423	1.9187	.2602	.00001245
9.1	31.7533	29.4507	27.1481	24.8455	22.5429	20.2404	17.9378	15.6352	13.3326	11.0300	8.7275	6.4258	4.1313	1.9087	.2557	.00001115
9.2	31.7424	29.4398	27.1372	24.8346	22.5320	20.2294	17.9268	15.6243	13.3217	11.0191	8.7166	6.4148	4.1205	1.8987	.2513	.000009988
9.3	31.7315	29.4290	27.1264	24.8238	22.5212	20.2186	17.9160	15.6135	13.3109	11.0083	8.7058	6.4040	4.1098	1.8888	.2470	.000008948
9.4	31.7208	29.4183	27.1157	24.8131	22.5105	20.2079	17.9053	15.6028	13.3002	10.9976	8.6951	6.3934	4.0992	1.8791	.2429	.000008018
9.5	31.7103	29.4077	27.1051	24.8025	22.4999	20.1973	17.8948	15.5922	13.2896	10.9870	8.6845	6.3828	4.0887	1.8695	.2387	.000007185
9.6	31.6998	29.3972	27.0946	24.7920	22.4895	20.1869	17.8843	15.5817	13.2791	10.9765	8.6740	6.3723	4.0784	1.8599	.2347	.000006439

Appendix 9.E. Continued

N \ u	$N \times 10^{-15}$	$N \times 10^{-14}$	$N \times 10^{-13}$	$N \times 10^{-12}$	$N \times 10^{-11}$	$N \times 10^{-10}$	$N \times 10^{-9}$	$N \times 10^{-8}$	$N \times 10^{-7}$	$N \times 10^{-6}$	$N \times 10^{-5}$	$N \times 10^{-4}$	$N \times 10^{-3}$	$N \times 10^{-2}$	$N \times 10^{-1}$	N
9.7	31.6894	29.3868	27.0843	24.7817	22.4791	20.1765	17.8739	15.5713	13.2688	10.9662	8.6637	6.3620	4.0681	1.8505	.2308	.000005771

Appendix 9.E. Continued

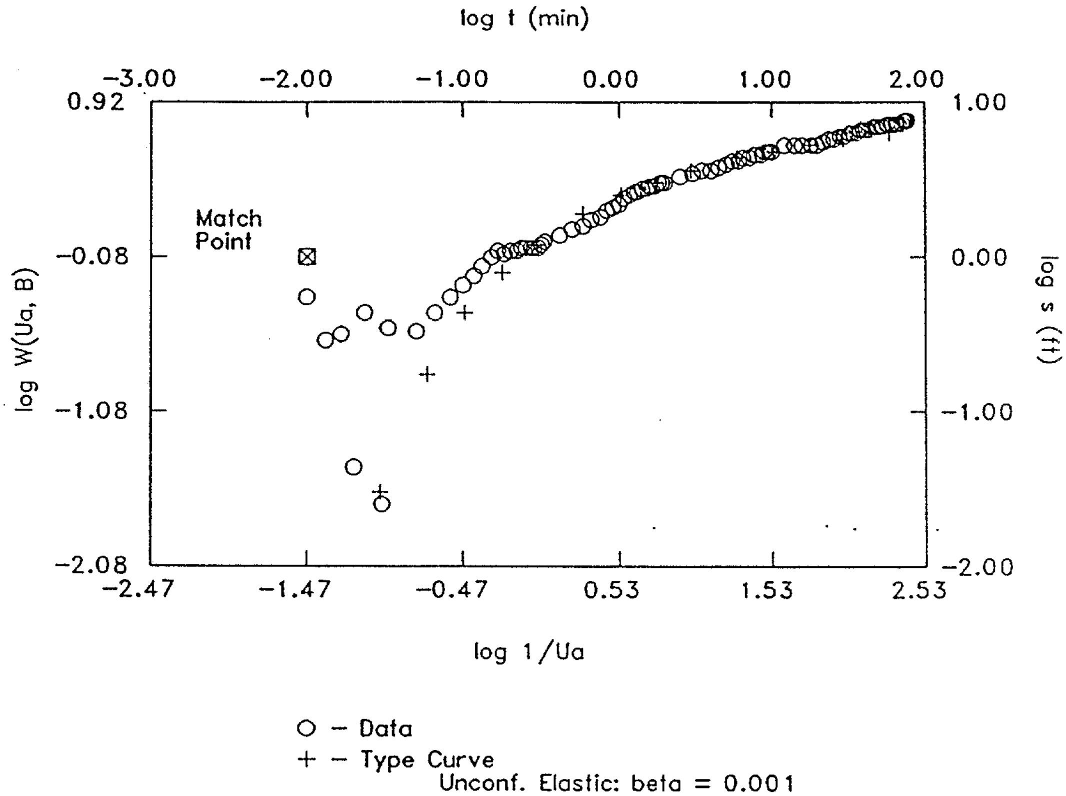
N \ u	$N \times 10^{-15}$	$N \times 10^{-14}$	$N \times 10^{-13}$	$N \times 10^{-12}$	$N \times 10^{-11}$	$N \times 10^{-10}$	$N \times 10^{-9}$	$N \times 10^{-8}$	$N \times 10^{-7}$	$N \times 10^{-6}$	$N \times 10^{-5}$	$N \times 10^{-4}$	$N \times 10^{-3}$	$N \times 10^{-2}$	$N \times 10^{-1}$	N
9.7	31.6894	29.3868	27.0843	24.7817	22.4791	20.1765	17.8739	15.5713	13.2688	10.9662	8.6637	6.3620	4.0681	1.8505	.2308	.000005771
9.8	31.6792	29.3766	27.0740	24.7714	22.4688	20.1663	17.8637	15.5611	13.2585	10.9559	8.6534	6.3517	4.0579	1.8412	.2269	.000005173
9.9	31.6690	29.3664	27.0639	24.7613	22.4587	20.1561	17.8535	15.5509	13.2483	10.9458	8.6433	6.3416	4.0479	1.8320	.2231	.000004637

NOTE: See page 218 for Theis equation and definitions of terms.

Values of *W(u)* for *u* between 1×10^{-15} and 1×10^{-3} computed by R.G. Kazmann assisted by M.M. Evans, U.S. Geological Survey; values for *u* between 1×10^{-1} and 9.9 adapted from Tables of Exponential and Trigonometric Integrals.

From Water Supply Paper 887, U.S. Geological Survey, 1942.

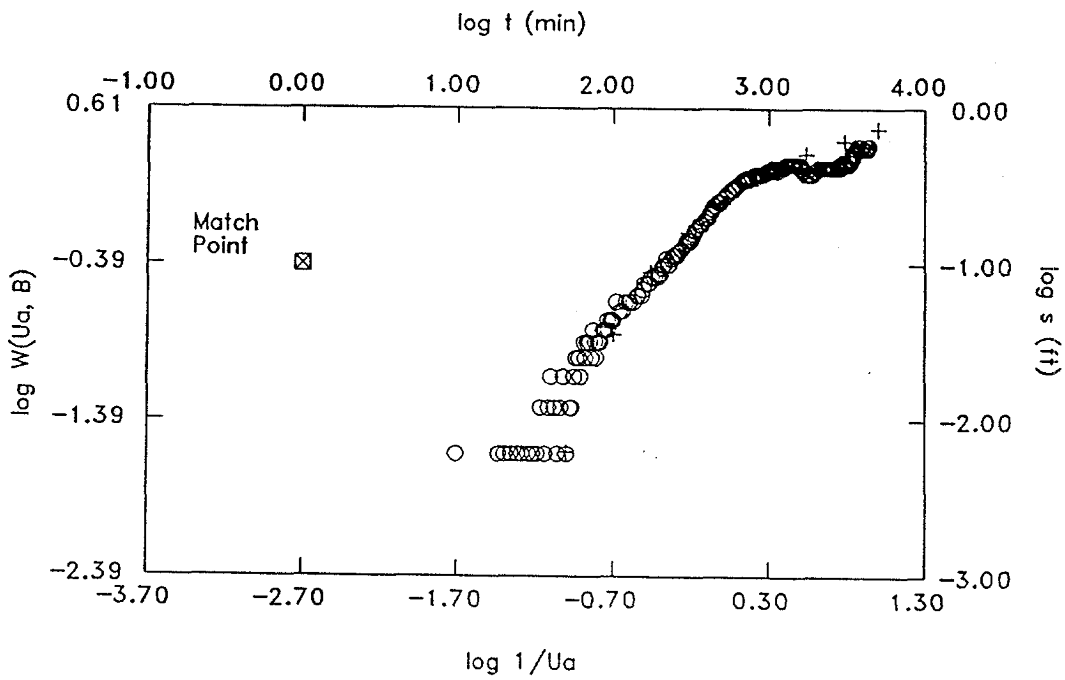
RW-1



MATCH POINT		SOLUTION	
t	= 1.000E-0002	Transmissivity (T)	= 1.429E+0002 gpd/ft
s	= 1.000E+0000	Hydraulic Conductivity (K)	= 5.718E+0000 gpd/sq ft
1/Ua	= 3.388E-0002	Storativity (S)	= 6.267E-0002
W(Ua, B)	= 8.318E-0001		

WELL INFORMATION	
WELL IDENTIFICATION	: RW-1
DATE OF AQUIFER TEST	: 1/93
AQUIFER THICKNESS (b)	: 2.500E+0001 ft
DISCHARGE RATE (Q)	: 1.500E+0000 gpm
PUMPING WELL RADIUS (r)	: 2.500E-0001 ft
DISTANCE OF OBSERVATION WELL FROM PUMPING WELL (d)	: 2.500E-0001 ft

P-1

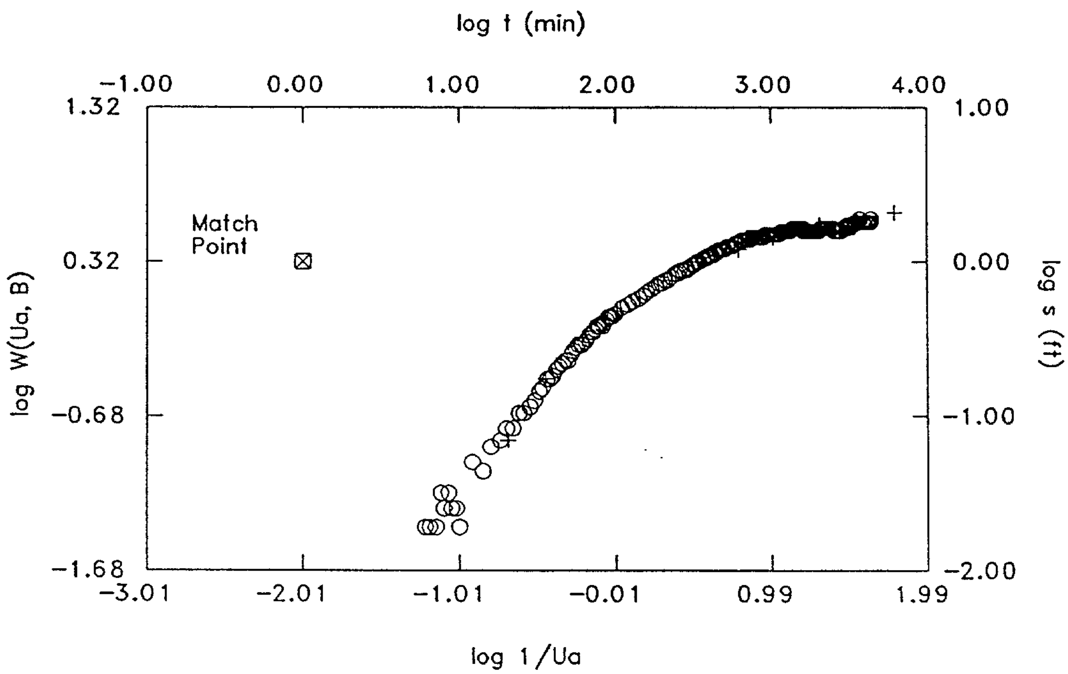


O – Data
\+ – Type Curve
Unconf. Elastic: beta = 0.001

MATCH POINT			SOLUTION		
t	=	1.000E+0000	Transmissivity (T)	=	7.001E+0002 gpd/ft
s	=	1.000E-0001	Hydraulic Conductivity (K)	=	2.800E+0001 gpd/sq ft
1/Ua	=	1.995E-0003	Storativity (S)	=	4.156E-0002
W(Ua, B)	=	4.074E-0001			

WELL INFORMATION	
WELL IDENTIFICATION	: P-1
DATE OF AQUIFER TEST	: 1/93
AQUIFER THICKNESS (b)	: 2.500E+0001 ft
DISCHARGE RATE (Q)	: 1.500E+0000 gpm
PUMPING WELL RADIUS (r)	: 8.300E-0002 ft
DISTANCE OF OBSERVATION WELL FROM PUMPING WELL (d)	: 2.800E+0001 ft

P-2



O – Data
+ – Type Curve
Unconf. Elastic: beta = 0.001

MATCH POINT		SOLUTION	
t	= 1.000E+0000	Transmissivity (T)	= 3.591E+0002 gpd/ft
s	= 1.000E+0000	Hydraulic Conductivity (K)	= 1.436E+0001 gpd/sq ft
1/Ua	= 9.772E-0003	Storativity (S)	= 9.508E-0004
W(Ua, B)	= 2.089E+0000		

WELL INFORMATION	
WELL IDENTIFICATION	: P-2
DATE OF AQUIFER TEST	: 1/93
AQUIFER THICKNESS (b)	: 2.500E+0001 ft
DISCHARGE RATE (Q)	: 1.500E+0000 gpm
PUMPING WELL RADIUS (r)	: 8.300E-0002 ft
DISTANCE OF OBSERVATION WELL FROM PUMPING WELL (d)	: 5.990E+0001 ft

Appendix B
Outline Specifications

PROJECT TABLE OF CONTENTS

-- End of Project Table of Contents --

Appendix C
Preliminary Construction Cost Estimate

APPENDIX C

Summary Report
Work Breakdown
Final

Printing Date: 06/21/93
Database Use 09/02/91

ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina
PROJECT SIZE: 1.0 LS
AUTHORIZED CONSTRUCTION FUNDS:

CAT CODE:
UIC:
DATE OF ESTIMATE:
BID DATE:

Account Number	ENVIRONMENTAL	WBS UNITS	U/M	COST/WBS UNIT ($)	TOTAL MU MATL COST ($)	TOTAL MU LABOR COST ($)	TOTAL MU EQUIP COST ($)	TOTAL CONTRACT COST ($)
33.01	Mobilization and Preparatory Work	1	LS		2,850	32,751	6,163	41,763
33.02	Monitoring, Sampling, Testing and Analysis	1	LS		0	6,230	55,250	61,480
33.03	Site Work	1	LS		67,968	22,001	62,650	152,620
33.06	Ground Water Collection and Control	1	LS		42,073	70,936	63,205	176,215
33.13	Physical Treatment	1	LS	329,173.20				329,173
33.18	Disposal (Other than Commercial)	1	LS		0	0	0	0
33.20	Site Restoration	1	LS		55	1,114	156	1,324
33.21	Demobilization	1	LS		1,000	6,314	5,411	12,725
Subtotal Environmental								775,300
Construction Contingency (20%)								155,060
Total Estimate Contract								930,359
Total Estimate Contract (Rounded)								930,000

APPENDIX C

Summary Report
Work Breakdown
Final

Printing Date: 06/21/93
Database Used: 09/02/91

ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina
PROJECT SIZE: 1.0 LS
AUTHORIZED CONSTRUCTION FUNDS:

CAT CODE:
UIC:
DATE OF ESTIMATE:
BID DATE:

Account Number	ENVIRONMENTAL	WBS UNITS	U/M	COST/WBS UNIT ($)	TOTAL MU MATL COST ($)	TOTAL MU LABOR COST ($)	TOTAL MU EQUIP COST ($)	TOTAL CONTRACT COST ($)
33.01	MOBILIZATION AND PREPARATORY WORK							
33.01.01	Mobilization of Construction Equipment and Facilities	1	LS		0	1,217	3,661	4,878
33.01.03	Preconstruction Submittals/Implementation Plan	1	LS		2,850	25,650	0	28,500
33.01.04	Setup/Construct Temporary Facilities	1	LS		0	864	2,502	3,366
33.01.05	Construct Temporary Utilities	1	LS		0	5,000	0	5,000
33.02	MONITORING, SAMPLING, TESTING AND ANALYSIS							
33.02.05	Sampling, Surface Water/Groundwater/Liquid Waste	1	LS		0	6,230	0	6,230
33.02.09	Laboratory Chemical Analysis	1	LS		0	0	55,250	55,250
33.03	SITE WORK							
33.03.02	Clearing and Grubbing	0.25	AC		0	205	213	417
33.03.03	Earthwork	1	LS		0	320	411	731
33.03.04	Roads/Parking/Curbs/Walks	1	LS		3,186	530	71	3,787
33.03.06	Electrical Distribution	1	LS		0	0	51,809	51,809
33.03.90	Metal Building (40'x65') and Concrete Foundation	5200	SF Floor		64,782	20,947	10,147	95,876
33.06	GROUND WATER COLLECTION AND CONTROL							
33.06.01	Extraction and Injection Wells	9	EA		9,000	27,000	9,000	45,000
33.06.07	Pumping/Collection	1	LS		33,073	43,936	54,205	131,215
33.13	PHYSICAL TREATMENT							
33.13.01	Filtration/Ultrafiltration	2	EA	16100.12	28,000	4,200		32,200
33.13.03	Straining	2	EA	3163.66	4,800	1,527		6,327
33.13.04	Coagulation/Flocculation/Precipitation	2	EA	22172.66	39,000	5,346		44,346
33.13.07	Air Stripping	2	EA	39562.94	71,680	7,446		79,126
33.13.12	Oil/Water Separation	2	EA	15791.04	27,000	4,582		31,582
33.13.20	Carbon Adsorption - Liquids	2	EA	17600.12	31,000	4,200		35,200
33.13.30	Filter Presses	2	EA	40036.66	69,000	11,073		80,073
33.13.90	Flow Metter/Recorder Meter	2	EA	4263.66	7,000	1,527		8,527
33.13.91	Submersible Sump Pump	2	EA	895.46	1,600	191		1,791
33.13.92	Movable Operations Platform	2	EA	5000	10,000			10,000
33.18	DISPOSAL (OTHER THAN COMMERCIAL)							
33.18.03	Transportation to Storage/Disposal Facility	1	LS		0	0	0	0
33.20	SITE RESTORATION							
33.20.01	Earthwork	1	LS		0	85	117	203
33.20.04	Revegetation and Planting	1	LS		55	97	38	190
33.20.06	Post Construction Maintenance	1	LS		0	931	0	931
33.21	DEMOBILIZATION							
33.21.01	Removal of Temporary Facilities	1	LS		0	1,397	1,050	2,447
33.21.02	Removal of Temporary Utilities	1	LS		0	800	700	1,500
33.21.04	Demobilization of Construction Equipment and Facilities	1	LS		0	1,217	3,661	4,878
33.21.06	Post-Construction Submittals	1	LS		1,000	2,900	0	3,900
Subtotal Environmental								775,300
Construction Contingency (20%)								155,060
Total Estimate Contract								930,359
Total Estimate Contract (Rounded)								930,000

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.01	MOBILIZATION AND PREPARATORY WORK										
33.01.01	Mobilization of Construction Equipment and Facilities										
33.01.01.07	EQUIPMENT										
	1 BACKHOE (80 hp)	1	DAY	310.65			310.65	310.65		1 DAY MOBILIZATION	1993 MEANS, P.454
	1 DOZER (200 hp)	1	DAY	915.20			915.20	915.20		1 DAY MOBILIZATION	1993 MEANS, P.453
	2 TRACTOR TRAILER TRUCKS	3	DAY	509.75			1,529.25	1,529.25		1.5 DAY MOBILIZATION, 2 TRUCKS	1993 MEANS, P.457
	2 LOW BED TRAILERS	3	DAY	301.85			905.55	905.55		1.5 DAY MOBILIZATION, 2 TRAILERS	1993 MEANS, P.457
33.01.01.08	OPERATORS								3,660.65		
	2 EQUIPMENT OPERATORS (MEDIUM)	2	DAY	182.28		364.56		364.56		1 DAY MOBILIZATION, 2 OPERATORS	1993 MEANS, P.457 (62% of cost)
	1 BUILDING LABORER	12	HOUR	9.61		115.32		115.32		1.5 DAY MOBILIZATION	1991 CES (UNBURDENED LABOR)
	2 TRUCK DRIVERS (HEAVY)	3	DAY	147.56		442.68		442.68		1.5 DAY MOBILIZATION, 2 DRIVERS	1993 MEANS, P.457 (62% of cost)
33.01.01.09	INITIAL ASSEMBLY AND SETUP								922.56		
	2 BUILDING LABORERS	16	HOUR	9.61		153.76		153.76		1 DAY SET UP, 2 LABORERS	1991 CES (UNBURDENED LABOR)
	1 PROJECT ENGINEER	8	HOUR	17.60		140.80		140.80		1 DAY SET UP, 1 ENGINEER	1991 CES (UNBURDENED LABOR)
									294.56		
	SUBTASK TOTAL				0.00	1,217.12	3,660.65		4,877.77		
33.01.03	Preconstruction Submittals/Implementation Plan										
33.01.03.04	ENVIRON. PRECONSTRUCTION PLAN	1	LS	3,000.00	300.00	2,700.00		3,000.00		MAT'L 10% TOTAL $; >40 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.05	SEDIMENT CONTROL PLAN	1	LS	4,000.00	400.00	3,600.00		4,000.00		MAT'L 10% TOTAL $; >60 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.08	SITE H&S PLAN	1	LS	3,000.00	300.00	2,700.00		3,000.00		MAT'L 10% TOTAL $; >40 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.13	GENERAL SITE WORK PLAN	1	LS	8,000.00	800.00	7,200.00		8,000.00		MAT'L 10% TOTAL $; >120 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.14	CONSTRUCTION QC PLAN	1	LS	3,000.00	300.00	2,700.00		3,000.00		MAT'L 10% TOTAL $; >40 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.25	CONSTRUCTION SCHEDULING	1	LS	1,500.00	150.00	1,350.00		1,500.00		MAT'L 10% TOTAL $; >20 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.26	TRAINING CERTIFICATION	1	LS	500.00	50.00	450.00		500.00		MAT'L 10% TOTAL $; ~8 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.27	MEDICAL SURVEILLANCE CERTIFICATION	1	LS	500.00	50.00	450.00		500.00		MAT'L 10% TOTAL $; ~8 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
33.01.03.28	PERMITS	1	LS	5,000.00	500.00	4,500.00		5,000.00		MAT'L 10% TOTAL $; >70 HRS TO PREPARE	ENGIN ESTIM.; BAKER P-2 RATE
	SUBTASK TOTAL				2,850.00	25,650.00	0.00		28,500.00		
33.01.04	Setup/Construct Temporary Facilities										
	INITIAL ASSEMBLY AND SETUP										
	2 BUILDING LABORERS	48	HOUR	9.61		461.28		461.28		3 DAYS FOR SET UP; 2 LABORERS	1991 CES (UNBURDENED LABOR)
	1 PROJECT ENGINEER	24	HOUR	17.60		422.40		422.40		3 DAYS FOR SET UP; 1 ENGINEER	1991 CES (UNBURDENED LABOR)
	TRAILER RENTAL										
33.01.04.01	1 OFFICE TRAILER (32'x8') - RENT	6	MO	231.00			1,386.00	1,386.00		ASSUME 6 MONTH RENTAL	1993 MEANS, P. 12
33.01.04.10	1 TOILET - TRAILER - RENT	6	MO	186.00			1,116.00	1,116.00		ASSUME 6 MONTH RENTAL	1993 MEANS, P. 18
	SUBTASK TOTAL				0.00	883.68	2,502.00		3,385.68		

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.01.05	Construct Temporary Utilities										
33.01.05.02	POWER CONNECTION	1	LS			2,500.00		2,500.00		ASSUME ALL LABOR	ENGIN ESTIMATE
33.01.05.03	TELEPHONE/COMMUN HOOKUP	1	LS			2,500.00		2,500.00		ASSUME ALL LABOR	ENGIN ESTIMATE
	SUBTASK TOTAL				0.00	5,000.00	0.00		5,000.00		
	TASK TOTAL				2,850.00	32,750.80	6,162.65		41,763.45		
33.02	MONITORING, SAMPLING, TESTING AND ANALYSIS										
33.02.05	Sampling, Surface Water/Groundwater/Liquid Waste										
	TREATMENT SYSTEM SAMPLING										
	1 ENVIRON SCIENTIST	160	HR	35.00		5,600.00		5,600.00		20 SAMPLING EVENTS, 8 HOURS EACH	ENGIN ESTIM.; BAKER P-1 RATE
	RECOVERY WELL SAMPLING - 9 WELLS										
	2 ENVIRON SCIENTISTS	18	HR	35.00		630.00		630.00		9 WELLS, 1 HR/WELL, 2 PEOPLE	ENGIN ESTIM.; BAKER P-1 RATE
	SUBTASK TOTAL				0.00	6,230.00	0.00		6,230.00		
33.02.09	Laboratory Chemical Analysis										
	TREATMENT SYSTEM START-UP									5 SAMPLES/EVENT; BIWEEKLY SAMPLING	RA WORK PLAN
	VOCs (601/602)	100	EA	180.00			18,000.00	18,000.00		FIRST MONTH; THEN MONTHLY SAMPLING	ENGIN ESTIMATE
	METALS (200 SERIES)	100	EA	225.00			22,500.00	22,500.00		FOR REMAINING 11 MONTHS - FOR A	ENGIN ESTIMATE
	OIL & GREASE	100	EA	65.00			6,500.00	6,500.00		TOTAL OF 20 SAMPLING EVENTS	ENGIN ESTIMATE
	TDS	100	EA	15.00			1,500.00	1,500.00			ENGIN ESTIMATE
	TSS	100	EA	15.00			1,500.00	1,500.00			ENGIN ESTIMATE
	RECOVERY WELL SAMPLING										
	CLP VOCs AND METALS	10	EA	525.00			5,250.00	5,250.00			
	SUBTASK TOTAL				0.00	0.00	55,250.00		55,250.00		
	TASK TOTAL				0.00	6,230.00	55,250.00		61,480.00		

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.03	SITE WORK										
33.03.02	Clearing and Grubbing										
	CLEAR AND GRUB	0.25	AC	1,669.80		204.95	212.50	417.45		TREATMENT AREAS ONLY	1991 CES, #BEBC
	SUBTASK TOTAL				0.00	204.95	212.50		417.45		
33.03.03	Earthwork										
33.03.03.02	EXCAVATION/FILL	INCLUDED IN OTHER SECTIONS WITH PIPE INSTALLATION									
33.03.03.07	GRADING	800	SY	0.76		256.00	352.00	608.00		ASSUME 1'DEEP, TWO 60'x60' AREAS	1991 CES, #BGAEA
33.03.03.08	COMPACTION	267	CY	0.46		64.00	58.67	122.67		ASSUME 1'DEEP, TWO 60'x60' AREAS	1991 CES
	SUBTASK TOTAL				0.00	320.00	410.67		730.67		
33.03.04	Roads/Parking/Curbs/Walks										
33.03.04.01	BITUMINOUS SURFACING - NORTH	133	SY	11.20	1,026.67	433.33	33.33	1,493.33		BASED ON 4' WIDE x 300 ' LONG	1991 CES
33.03.04.01	BITUMINOUS SURFACING - SOUTH	18	SY	11.20	136.89	57.78	4.44	199.11		BASED ON 4' WIDE x 40 ' LONG	1991 CES
33.03.04.03	AGGREGATE SUFACING - NORTH ONLY	76	CY	14.67	1,073.88	8.36	32.68	1,114.92		BASED ON 12' x 340' x 0.5' THICK	1991 CES; #57 GRAVEL
33.03.04.08	CURBS AND GUTTERS - SOUTH ONLY	10	LF	6.75	37.00	30.10	0.40	67.50		10' LENGTH IN SOUTHERN AREA	1991 CES
33.03.04.12	BARRELS WITH FLASHERS	20	EA	45.60	912.00			912.00		1 BARREL/10' FOR 200'; 6 MONTH RENTAL	1993 MEANS, #016-420-1620
	SUBTASK TOTAL				3,186.44	529.57	70.86		3,786.86		
33.03.06	Electrical Distribution										
	POWER DISTRIBUTION - 2 BUILDINGS/EQUIPMENT	1	LS				51,809.40			15% OF BUILDING & EQUIP COSTS	1993 MEANS
	SUBTASK TOTAL				0.00	0.00	51,809.40		0.00		
33.03.90	Metal Building (40'x65') and Concrete Foundation										
	2 BUILDINGS - STEEL/ALUM FRAME	5200	SF	16.21	58,854.00	15,908.00	9,554.00	84,316.00		EACH 2600 SF	VENDOR QUOTE
	2 CONCRETE FOUNDATIONS	5200	SF	2.22	5,928.00	5,038.80	592.80	11,559.60		SIMPLE BUILDING FOUNDATION	1993 MEANS, #131-207-0800
	SUBTASK TOTAL				64,782.00	20,946.80	10,146.80		95,875.60		
	TASK TOTAL				67,968.44	22,001.32	62,650.22		100,810.58		

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.06	GROUND WATER COLLECTION AND CONTROL										
33.06.01	Extraction and Injection Wells										
	RECOVERY WELLS - SHALLOW	9	EA	5,000.00	9,000.00	27,000.00	9,000.00	45,000.00		DIVISION OF MATL/LAB/EQUIP ESTIMATED	ENGIN ESTIMATE
	SUBTASK TOTAL				9,000.00	27,000.00	9,000.00		45,000.00		
33.06.07	Pumping/Collection										
33.06.07.01	PUMPING - WELL PUMP W/ CONTROLLER	9	EA	5,600.00		5,400.00	45,000.00	50,400.00		MAJORITY OF COST IS FOR EQUIPMENT	ENGIN ESTIMATE
33.06.07.02	MANHOLES, VALVES, BOXES	9	EA	671.73	4,276.08	919.08	850.41	6,045.57		PRECAST, 48" DIA, W/FRAME & COVER	1991 CES, #CGMV
33.06.07.03	PIPING - HPDE 2" DIA	2950	LF	3.50	6,195.00	4,130.00		10,325.00		N-1500'; S-1450'; 60/40 - MATL/LABOR	ENGIN ESTIMATE
	PIPING - PVC (SCH 80) 6" DIA	2950	LF	10.20	18,054.00	12,036.00		30,090.00		N-1500'; S-1450'; 60/40 - MATL/LABOR	ENGIN ESTIMATE
	PIPING - PVC 3" DIA (FORCE MAINS)	1200	LF	1.29	792.00	756.00		1,548.00		N-700'; S-500';	1991 CES, #QLNI
	CONNECTIONS/FITTINGS	1	LS	6,294.45	3,756.15	2,538.30		6,294.45		ASSUME 15% OF PIPING COSTS	ENGIN ESTIMATE
	PIPE TRENCH EXCAV, BACKFILL, COMPACT	922	CY	4.35		2,407.00	1,604.67	4,011.67		3' DEEP x 2' WIDE;	1991 CES, #BQFAP
	3 RAILROAD BORES - NORTH ONLY	150	LF	150.00		15,750.00	6,750.00	22,500.00		EACH 50' WIDE, 70/30 - LAB/EQUIP	ENGIN ESTIMATE
	SUBTASK TOTAL				33,073.23	43,936.38	54,205.08		131,214.69		
	TASK TOTAL				42,073.23	70,936.38	63,205.08		176,214.69		
33.13	PHYSICAL TREATMENT										
33.13.01	Filtration/Ultrafiltration										
33.13.03	Straining										
33.13.04	Coagulation/Flocculation/Precipitation										
33.13.07	Air Stripping	SEE OTHER BACKUP SHEET FOR ALL OF THESE TOTALS									
33.13.12	Oil/Water Separation										
33.13.20	Carbon Adsorption - Liquids										
33.13.30	Filter Presses										
33.13.90	Flow Metter/Recorder Meter										
33.13.91	Submersible Sump Pump										
33.13.92	Movable Operations Platform										

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.18	DISPOSAL (OTHER THAN COMMERCIAL)										
33.18.03	Transportation to Storage/Disposal Facility									NOT USED	
	PUMPING/HAULING OF LIQUIDS/SED/SLUDGE PIPING - FORCE MAIN	INCLUDED UNDER GROUNDWATER COLLECTION AND CONTROL SECTION			0.00	0.00	0.00	0.00			
	TASK TOTAL				0.00	0.00	0.00		0.00		
33.20	SITE RESTORATION										
33.20.01	Earthwork										
	GRADING	267	CY	0.76		85.33	117.33	202.67			
33.20.04	Revegetation and Planting										
	SEEDING/MULCH/FERTILIZER	6.534	MSF	29.05	54.56	97.03	38.22	189.81			1993 MEANS, #029-308-4800
33.20.06	Post Construction Maintenance										
	CLEAN-UP	1	LS			931.20		931.20		2 LABORERS FOR 2 DAYS EACH	ENGIN ESTIMATE
	TASK TOTAL				54.56	1,113.56	155.56		1,323.68		

COSTING BACKUP FOR FINAL ENGINEERING ESTIMATE

PROJECT: Hadnot Point Shallow Aquifer Remedial Design
LOCATION: MCB Camp Lejeune, North Carolina

Account Number	COST ITEM DESCRIPTION	QUANTITY	UNIT	COST PER UNIT	MATL COST	LABOR COST	EQUIP COST	TOTAL COST	SUB-TOTALS	ASSUMPTIONS	SOURCE
33.21	DEMOBILIZATION										
33.21.01	Removal of Temporary Facilities										
	OFFICE TRAILER/TOILET/BARRICADES	1	LS			1,396.80	1,050.00	2,446.80			
	SUBTASK TOTAL				0.00	1,396.80	1,050.00		2,446.80		
33.21.02	Removal of Temporary Utilities										
	SITE LIGHTING/POWER/TELEPHONE	1	LS			800.00	700.00	1,500.00			
	SUBTASK TOTAL				0.00	800.00	700.00		1,500.00		
33.21.04	Demobilization of Construction Equipment and Facilities										
	CONSTRUCTION EQUIPMENT/DISASSEMBLY				0.00	1,217.12	3,660.65	4,877.77			
	SUBTASK TOTAL				0.00	1,217.12	3,660.65		4,877.77		
33.21.06	Post-Construction Submittals										
	PUNCH LIST	1	LS		250.00	300.00		550.00			
	FINAL QA/QC REPORTS	1	LS		250.00	1,000.00		1,250.00			
	CONSTRUCTION DOCUMENTATION REPORT	1	LS		250.00	1,000.00		1,250.00			
	AS-BUILT DWGS	1	LS		250.00	600.00		850.00			
	SUBTASK TOTAL				1,000.00	2,900.00	0.00		3,900.00		
	TASK TOTAL				1,000.00	6,313.92	5,410.65		12,724.57		

HADNOT POINT INDUSTRIAL AREA

HPIA GROUNDWATER OPERABLE UNIT
LOW PROFILE AIR STRIPPING TREATMENT SYSTEM
DIRECT COST BREAKDOWN: DIVISION 11 - EQUIPMENT

X2

	COST COMPONENT	QUANTITY	UNITS	UNIT COST	TOTAL COST	REFERENCE/SOURCE
331390	11A. FLOW METER/RECORDER	1	EACH	$3,500.00	$3,500.00	VENDOR QUOTE
	METER/RECORDER INSTALLATION	16	HOURS	$47.73	$763.68	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331304	11B. POLYMER MAKE-UP/FEED SYSTEM	1	EACH	$4,000.00	$4,000.00	VENDOR QUOTE
	POLYMER SYSTEM INSTALLATION	16	HOURS	$47.73	$763.68	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
	11C. FLOCCULATION TANK W/MIXER- 1200 GAL.	1	EACH	$8,000.00	$8,000.00	VENDOR QUOTE
	TANK/MIXER INSTALLATION	16	HOURS	$47.73	$763.68	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331312	11D. OIL/WATER SEPARATOR	1	EACH	$12,000.00	$12,000.00	VENDOR QUOTE
	SEPARATOR INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
	11E. SLUDGE PUMP - AIR OPERATED	1	EACH	$2,500.00	$2,500.00	VENDOR QUOTE
	PUMP INSTALLATION	8	HOURS	$47.73	$381.84	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331330	11F. SLUDGE HOLDING TANK - 2500 GAL.	1	EACH	$7,500.00	$7,500.00	VENDOR QUOTE
	TANK INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
	11G. PRESS FEED PUMP - AIR OPERATED	1	EACH	$2,500.00	$2,500.00	VENDOR QUOTE
	PUMP INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331330	11H. DEWATERING PRESS	1	EACH	$22,000.00	$22,000.00	VENDOR QUOTE
	PRESS INSTALLATION	60	HOURS	$47.73	$2,863.80	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331312	11I. OIL STORAGE TANK - 250 GAL.	1	EACH	$1,500.00	$1,500.00	VENDOR QUOTE
	TANK INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331304	11J. SURGE/SETTLING TANK - 2500 GAL.	1	EACH	$7,500.00	$7,500.00	VENDOR QUOTE
	TANK INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331307	11K. CENTRIFUGAL PUMPS					
	1. PRIMARY FEED PUMP - 40 GPM EA.	2	EACH	—	—	INCLUDED IN COST OF LOW PROFILE
	PUMP INSTALLATION	—	—	—	—	AIR STRIPPING UNIT
331307	2. SECONDARY FEED PUMP - 40 GPM EA.	2	EACH	—	—	INCLUDED IN COST OF LOW PROFILE
	PUMP INSTALLATION	—	—	—	—	AIR STRIPPING UNIT
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331307	3. EFFLUENT PUMPS - 40 GPM EA.	2	EACH	$2,500.00	$5,000.00	VENDOR QUOTE
	PUMP INSTALLATION	48	HOURS	$47.73	$2,291.04	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331320	4. CARBON BACKWASH PUMP - 125 GPM	1	EACH	$3,500.00	$3,500.00	VENDOR QUOTE
	PUMP INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331301	5. FILTER BACKWASH PUMP - 75 GPM	1	EACH	$3,000.00	$3,000.00	VENDOR QUOTE
	PUMP INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331391	6. SUBMERSIBLE SUMP PUMP - 10 GPM	2	EACH	$400.00	$800.00	VENDOR QUOTE
	PUMP INSTALLATION	2	HOURS	$47.73	$95.46	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
330607	11L. AIR COMPRESSOR & APPURTANANCES	1	EACH	$2,500.00	$2,500.00	MCMASTER-CARR SUPPLY CO. CATALOG, 1993
	COMPRESSOR INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331301	11M. MULTI-MEDIA FILTER - DUAL UNIT	1	EACH	$7,500.00	$7,500.00	VENDOR QUOTE
	FILTER INSTALLATION	20	HOURS	$47.73	$954.60	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331307	11N. LOW PROFILE AIR STRIPPING UNITS	1	UNITS	$30,840.00	$30,840.00	VENDOR QUOTE FOR PRE-ENGINEERED AND
	INC: FEED PUMPS; BLOWER; SUMP;					PRE-FABRICATED TREATMENT PACKAGE;
	EFFLUENT PUMPS; CONTROLS;					
	START-UP; TRAINING					
	AIR STRIPPER INSTALLATION	30	HOURS	$47.73	$1,431.90	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331303	11O. CARTRIDGE FILTERS	2	UNITS	$1,200.00	$2,400.00	VENDOR QUOTE
	CARTRIDGE FILTER INSTALLATION	16	HOURS	$47.73	$763.68	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331320	11P. LIQUID PHASE CARBON UNITS	2	EACH	$6,000.00	$12,000.00	VENDOR QUOTE
	CARBON UNIT INSTALLATION	20	HOURS	$47.73	$954.60	RICHARDSONS ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331301	11Q. BACKWASH TANK - 2500 GAL.	1	EACH	$6,500.00	$6,500.00	VENDOR QUOTE
	TANK INSTALLATION	24	HOURS	$47.73	$1,145.52	RICHARDSON ENGINEERING SERVICES, 1986
						AND MEANS, 1993 PLUMBER W/ 1.15 H&S FACTOR
331392	11R. MOVABLE OPERATIONS PLATFORM	1	EACH	$5,000.00	$5,000.00	ESTIMATED
	SUBTOTAL DIVISION 11				$172,377.64	

Appendix D
Proposed Construction Schedule

APPENDIX D

PROPOSED CONSTRUCTION SCHEDULE

Phase No.	Task	Calendar Days 0–30	30–60	60–90	90–120	120–150	150–180	180–210	210–240	240–
1	Contractor Procurement	X	X	X						
2	Construction Phase									
	Mobilization and Equipment Acquisition				X					
	Site Preparation and Pad Installation					X				
	Recovery Well Installation					X				
	Groundwater Piping Installation					X	X			
	Equipment Installation						X	X		
	Electric and Control Systems Installation							X		
3	System Start-Up Phase								X	

Appendix E
Design Calculations

Process Design Calculations

S.O. No. 19134 - 51 - SRN

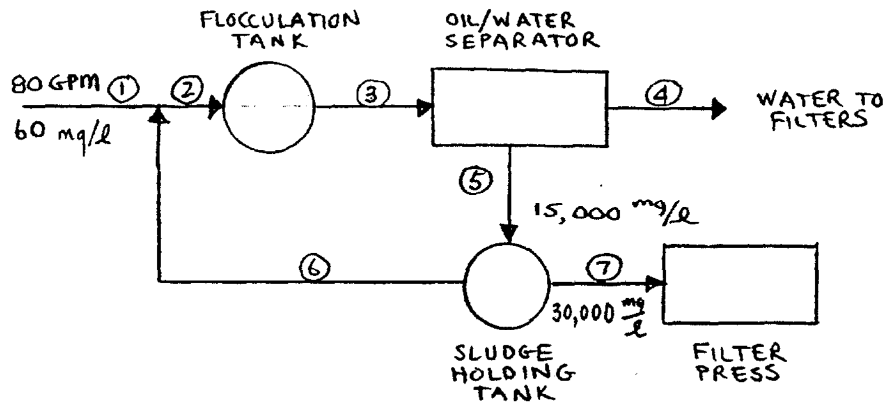
Subject: HPIA GROUNDWATER OPERABLE UNIT

SOLIDS MASS BALANCE — Sheet No. ___ of ___

90 % DESIGN — Drawing No. ___

Computed by MRW — Checked By ABG — Date 4/26/93

Baker



Assume:

a) All incoming suspended solids tranferred to SHT
b) Influent flowrate = 80 gal/min
c) Influent suspended solids = 60 mg/l
d) SOLIDS concentrated to 3 % in SHT (C_7 = 30,000 mg/l)
e) OPERATE PRESS ONE DAY PER WEEK, 2 RUNS

SYSTEM MASS BALANCE:

$$Q_1 C_1 = Q_4 C_4 + Q_7 C_7$$ {for continuous system

$$(80\ GPM)(60\ mg/l) = (Q_7)(30{,}000\ mg/l)$$

$$Q_7 = 0.16\ GPM$$

However, system does not run continuously.

Therefore, V_{SHT} is actually Q_7 × 7 day sludge holding time.

$$V_{SHT} = (0.16\ GPM)(1440\ min/day)(7\ days/wk)$$

V_{SHT} = 1612 GALLONS 3% SLUDGE PRODUCED PER WEEK

USE 2500 GALLON SLUDGE HOLDING TANK

SIZE PRESS TO PROCESS 800 GALLONS OF 3 % SLURRY.

S.O. No. 19134-51-SRN

Subject: HPIA GROUNDWATER OPERABLE UNIT TREATMENT PLANT DESIGN.

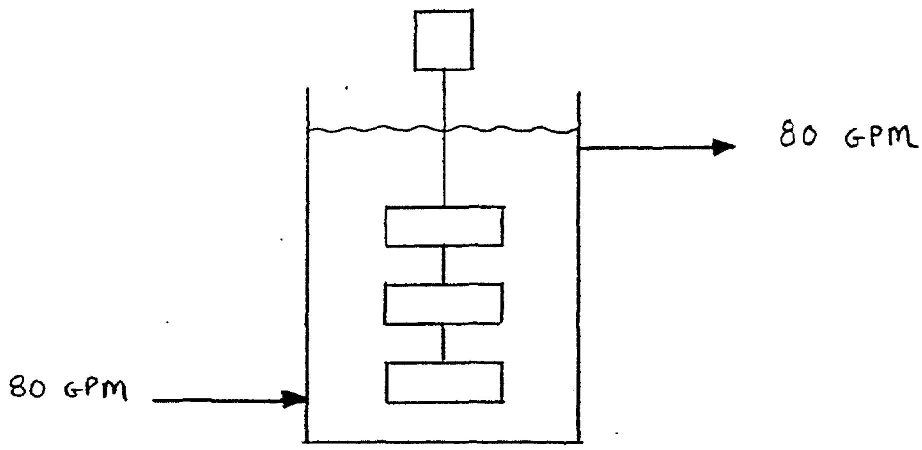
Sheet No. ___ of ___

Drawing No. ___

Computed by MRW Checked By ABG Date 4/16/93

Baker

FLOCCULATION TANK



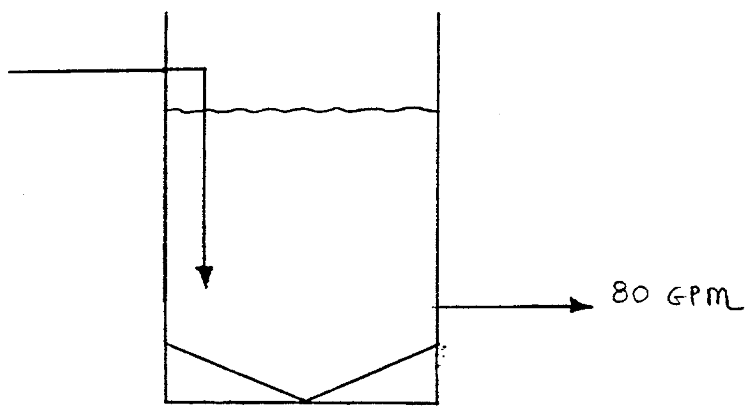
Assume: 80 GPM flowrate
15 minute holding time

TANK VOLUME = (80 gal/min)(15 min)
= 1200 gal

S.O. No. 19134 - S1 - SRN
Subject: HPIA GROUNDWATER OPERABLE UNIT
TREATMENT PLANT DESIGN
Sheet No. ___ of ___
Drawing No. ___
Computed by MRW Checked By ABG Date 4/16/93

Baker

SURGE TANK



ASSUME: 80 GPM EFFLUENT FLOWRATE
30 MINUTE HOLDING TIME

TANK VOLUME $= (80\ \text{gal/min})(30\ \text{min})$
$= 2400\ \text{gal}$

Use 2500 gallon tank.

S.O. No. 19134 - 51 - SRN

Subject: NAVY - CAMP LEJEUNE

HPIA GROUNDWATER TRTMT.

CTO - 134

Sheet No. 1 of 2

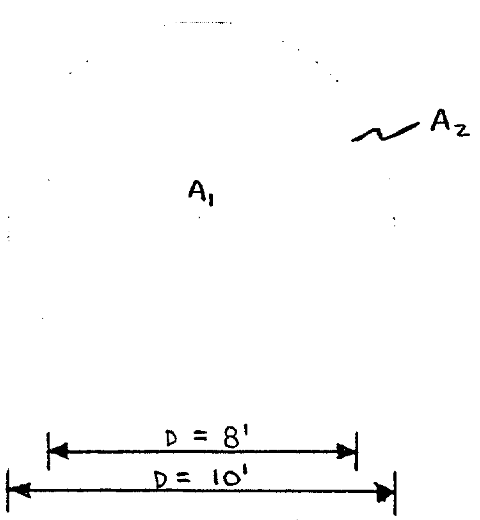
Drawing No.

Computed by MRW Checked By C??

Date 6/11/93

Baker

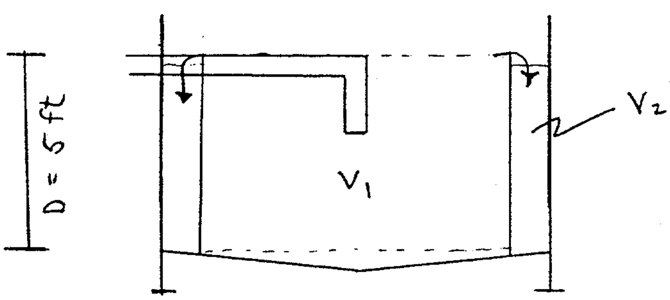
CASE 1: 10' Ø SURGE/SETTLING TK



$A_1 = \pi (8/2)^2 = 50.3\ ft^2$ ✓

$A_2 = \pi [(10/2)^2 - (8/2)^2]$

$= 28.3\ ft^2$ ✓



$V_1 = A_1 \times D$

$= (50.3\ ft^2)(5\ ft)$

$= 251.5\ ft^3$ ✓

$= 1882$ gal ✓

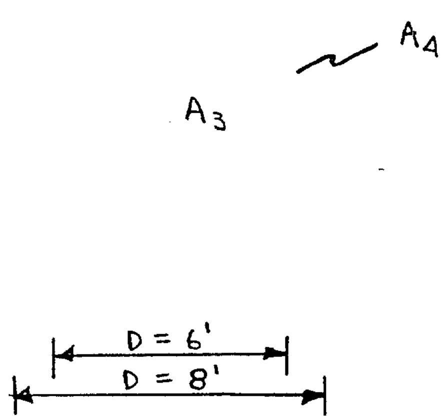
$V_2 = A_2 \times D$

$= (28.3\ ft^2)(5\ ft)$

$= 141.5\ ft^3$ ✓

$= 1059$ gal ✓

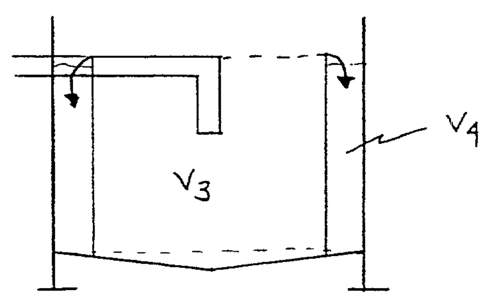
CASE 2: 8' Ø SURGE/SETTLING TK



$A_3 = \pi (6/2)^2 = 28.3\ ft^2$ ✓

$A_4 = \pi [(8/2)^2 - (6/2)^2]$

$= 21.99\ ft^2$ ✓



$V_3 = A_3 \times D$

$= (28.3\ ft^2)(5\ ft)$

$= 141.5\ ft^3$ ✓

$= 1059$ gal ✓

$V_4 = A_4 \times D$

$= (21.99\ ft^2)(5\ ft)$

$= 110.0\ ft^3$ ✓

$= 823$ gal ✓

S.O. No. 19134 - 51 - SRN

Subject: NAVY - CAMP LEJEUNE

HPIA GROUNDWATER TRTMT

CTO - 134

Sheet No. 2 of 2

Drawing No.

Computed by MRW Checked By CAH Date 6/11/93

Baker

CASE 1 (con't):

$$HRT_1 = V_1 / F = (1882\ gal)/(80\ gal/min) = 23.5\ min \checkmark$$

$$HRT_2 = V_2 / F = (1059\ gal)/(80\ gal/min) = 13.2\ min \checkmark$$

$$OF_1 = F / A_1 = (80\ gal/min)(1440\ \tfrac{min}{day})/(50.3\ ft^2) = 2290\ gpd/ft^2 \checkmark$$

CASE 2 (con't):

$$HRT_3 = V_3 / F_3 = (1059\ gal)/(80\ gal/min) = 13.2\ min \checkmark$$

$$HRT_4 = V_4 / F = (823\ gal)/(80\ gal/min) = 10.3\ min \checkmark$$

$$OF_3 = F / A_3 = (80\ gal/min)(1440\ min/day)/(28.3\ ft^2) = 4071\ gpd/ft^2 \checkmark$$

RECOMMEND CASE 1:

- OF_1 is not excessive (OF_3 is excessive)
- HRT_1 is adequate (HRT_2 is too short)
- HRT_2 is adequate (HRT_4 is ok, but shorter)

S.O. No. 19134-51-SRN

Subject: HPIA GROUNDWATER OPERABLE UNIT

Sheet No. ____ of ____

Drawing No. ____

Computed by MRW Checked By ____ Date 4/27/93

Baker

PUMP REQUIREMENTS:

X A. PRIMARY FEED PUMPS (2)

40 GPM
50' TDH

PACO MODEL 1570-1
1750 rpm
1½ HP
230 V
3 Ø

use air stripper supplied pumps

X B. SECONDARY FEED PUMPS (2)

40 GPM
50' TDH

PACO MODEL 1570-1
1750 rpm
1½ HP
230 V
3 Ø

use air stripper supplied pumps.

→ C. BACKWASH PUMP (1)

125 GPM
81' TDH

PACO MODEL 2095-1
1750 rpm
5 HP
230 V
3 Ø

→ D. EFFLUENT PUMPS (2)

80 GPM
10' TDH

PACO MODEL 1550-5
1750 rpm
1/2 HP
230 V
3 Ø

4-19-93
DPJ

CTO 0134

PROCESS CONTROL REQUIREMENTS

GROUNDWATER RECOVERY PUMPS

1. These four pumps will be pneumatic, with each pump having a low level liquid level sensor to shut of the pump in the event of low water levels.

Power (probably 110V) and control conduits will need to be provided from a control panel at the treatment system to each well to provide these controls.

GROUNDWATER TREATMENT SYSTEM

1. The primary means of control for the treatment system will be based on level controls in the surge tank. The two sand filter feed pumps (pumps no. 1 and 2) will be enabled and turned on based on liquid level in the surge tank. See the pump control diagram from the Presquile Chemical Co. job for the pump sequence.

2. The air stripper will have its own control panel (provided by the manufacturer) that will be enabled when pumps no. 1 and 2 are enabled. The air stripper control panel will provide control to the two air stripper discharge pumps (pumps 3 and 4).

3. The polymer feed system will be controlled (on or off) based on a control signal received from the flow meter.

4. A control interlock needs to be provided that would allow the operator the option of a control scheme that would turn off the treatment system and annunciate an alarm, if any one of the groundwater pumps turns off.

5. A sand filter backwash cycle will be initiated in one of two ways: via a pressure switch that is set to signal that the back-pressure has reached a predetermined value; or via an operator adjustable timer.

6. The controls for the solids handling equipment will be manually set by the operator, these include the solids withdrawal pumps from the oil water separator and surge tank, and the filter press. The filter press will have a control panel supplied by the manufacturer.

S.O. No. 19134-51-SRN

Subject: HPIA GROUNDWATER OPERABLE UNIT
AIR STRIPPER INFLUENT +
DISCHARGE CRITERIA

Sheet No. ____ of ____

Drawing No. ____

Computed by MRW Checked By DPJ Date 4/93

Baker

AIR STRIPPER DESIGN CRITERIA (rev. 4/27/93)

FLOW: 80 GPM

PARAMETER	WORST CASE CONCENTRATION (µg/l)	DISCHARGE CRITERIA (µg/l)
BENZENE	7,900	1
cis-1,2-DICHLOROETHYLENE	42,000	70
TRICHLOROETHYLENE	14,000	2.8
VINYL CHLORIDE	300	ND

ND = Not detectable

Also -

<u>if</u> Benzene is the controlling factor, evaluate as if Benzene = 7 µg/l and other parameters do not change.

S.O. No. 19134-50-SRN

Subject: RECOVERY WELL SYSTEM PUMP & SYSTEM CALCULATIONS

Sheet No. 1 of 4

Drawing No.

Computed by DPJ Checked By MRW Date 3-4-93

RECOVERY WELL PUMP & SYSTEM HEAD.

ASSUMPTIONS:

1. PUMP TEST RESULTED IN A SUSTAINABLE FLOW OF 1.5 gpm, OBRIEN & GERE PUMPTEST (DEC. 1989) DETERMINED A WELL YIELD OF 3 gpm.
2. SIZE PIPING & PUMPS ON ASSUMED MAXIMUM FLOW OF 5 gpm.
3. CHECK VELOCITIES AT 1.5 & 3 gpm

STEP 1 DETERMINE TOTAL SUCTION LIFT

* FROM PUMP TEST

A. DEPTH TO STATIC WATER LEVEL * — 7'

B DRAWDOWN * (INCREASE FOR DEEPER WELL — ~~14'~~ 24'

C FRICTION LOSSES IN WELL PIPING

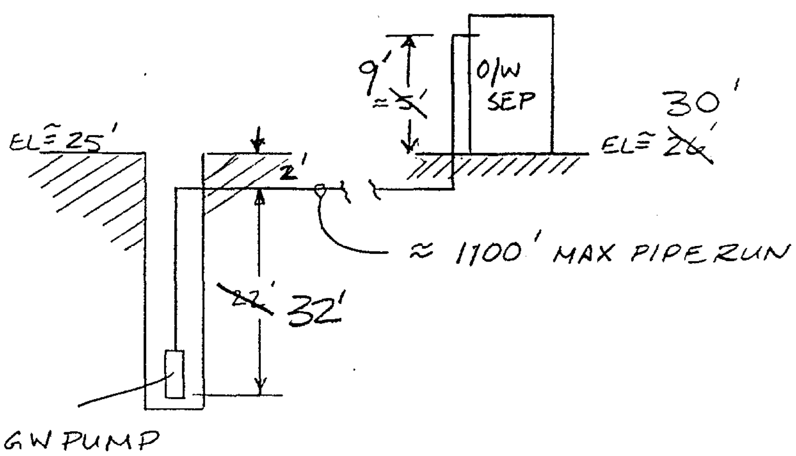
1" PVC @ 5 gpm = 1.8' PER 100'

~~22'~~ 32 ÷ 100' X 1.8 = 0.4' X 1.20 = ~~0.5'~~ 0.7

~~21.5'~~ 31.7

STEP 2 STATIC DISCHARGE HEAD = ~~2'+1'+5' = 8'~~

2'+5+9 = 16'



S.O. No. ______________________

Subject: ______________________

Sheet No. 2 of 4

Drawing No. ____________

Computed by ____________ Checked By ____________ Date 3-4-93

Baker

STEP 3 DISCHARGE SYSTEM FRICTION LOSSES

A. 1100' @ 1" PVC = 1100'/100 X 1.8 = 20' X 1.20 = 24'

B. VALVES & FITTINGS

2 - GATE VALVES @ 4'	=	8'
1 - CHECK VALVE @ 7'	=	7'
5 - 90° ELBOW @ 6'	=	30'
4 - COUPLINGS @ 3'	=	12'
		57'

57' ÷ 100 X 1.8 = 1' X 1.20 = 1'

25'

TOTAL PUMPING HEAD

1. SUCTION LIFT = ~~21.5'~~ 31.7'
2. STATIC DISCHARGE HEAD = ~~8'~~ 16
3. H_f (PIPING) = 25' 25' / 73'

~~54.5' SAY 55'~~

∴ @ 5 gpm - TDH = ~~55~~ 73'

CHECK VELOCITY 1" ϕ PVC = 1.049" ID = 0.087'

$v = \frac{Q}{A}$ AREA = 0.006 sf

Q = 5 gpm X 0.002228 = 0.0111 cfs

$V = \frac{0.0111}{0.006} = 1.86$ fps

RUN CALCULATIONS @ 3 gpm through @ 3/4" PVC PIPE $H_f = 2.2'/100'$

1. SUCTION LIFT = 7' + ~~14'~~ 24' + [~~22~~ 32'/100 X 2.2 X 1.20] = ~~21.5'~~ 32'
2. STATIC DIS. HEAD = ~~8'~~ 16'
3. H_f = 1100/100 X 2.2 X 1.20 = 29'

TOTAL = ~~60~~ 77' V = 1.8[illegible]

VALVES & FITTINGS = [illegible]

S.O. No. ______

Subject: ______

Sheet No. 3 of 4

Drawing No. ______

Computed by ______ Checked By ______ Date 3-4-93

RUN CALCS. AT:

5 gpm THROUGH 3/4" PVC H_f = 5.7'/100'
1100'

1. SUCTION LIFT = 7' + ~~14'~~ 24' + [~~22'~~ 32'/100 × 5.7 × 1.20] = ~~22.5'~~ 33

2. STATIC DIS. HEAD = ~~8'~~ 16

3. H_f(piping) = 1100/100 × 5.7 × 1.20 = 75'
H_f VALVES = (2×3)+(1×5)+(5×5)+(4×3) = 3'
=48'/100 × 5.7 × 1.20
TOTAL ~~109'~~ 127

$vel = \frac{Q}{A} = \frac{0.0111\ cfs}{0.0037\ sf} = 3\ fps$

---

3 gpm thru 3/4" PVC @ 500'

$VEL = \frac{Q}{A} = \frac{0.0067}{0.0037} = 1.8\ f$

1. SUCTION LIFT = ~~21.5'~~ 32'
2. STATIC DIS. HEAD = ~~8'~~ 16'
3. H_f piping =
500/100 × 2.2 × 1.20 = 13.2'
VALVES = 1.3'
~~44'~~ 63'

5 gpm thru 3/4" PVC @ 500'

1. SUCTION LIFT = ~~22.5'~~ 33'
2. STATIC DISCHARGE HEAD = ~~8'~~ 16'
3. H_f(piping) =
500/100 × 5.7 × 1.2 = 34'
VALVES = 1.3'
~~66'~~ 85'

S.O. No. 19134-50-SRN

Subject: Recovery Well System Pump & System Calculations

Sheet No. 4 of 4

Drawing No.

Computed by DPJ Checked By

Date 5/13/93

Baker

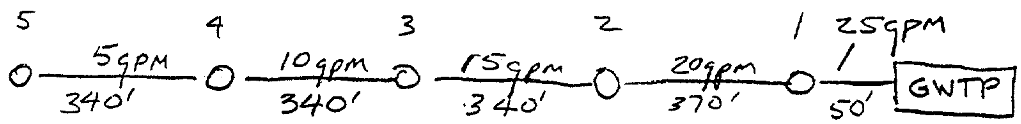
HEAD LOSS SUMMARY — 1100' OF PIPING

FLOW	PIPE SIZE 3/4"	PIPE SIZE 1"
3 gpm	77'	—
5 gpm	127'	73'

∴ USE 1" MIN DOWNWELL AND DISCHARGE PIPING @ 5 gpm

LOOK AT ADDED FLOWS

WITH 5 WELLS IN SERIES



PIPE SIZE	1"	1"	1"	1"	—
VELOCITY (fps)	1.86	3.7	5.6 fps	7.4 fps	—
			1.5"	1.5"	1.5"
			2.7 fps	3.6 fps	4.5 fps
					2.0"
					2.5 fps

1.5" φ = 0.12

= 0.0123

S.O. No. 19134

Subject: SIZE OF AIR COMPRESSOR

Sheet No. 1 of 4

Drawing No.

Computed by DPT Checked By MRW Date 5/10/93

Baker

1. LOOK AT SOUTHERN SYSTEM SINCE IT HAS LONGER PIPING RUN OF 1450'

ASSUME A 1" ϕ SCH. 40 PIPE TO CALCULATE AIR FRICTION LOSS.

FROM VENDOR INFORMATION, @ 5 gpm output from pump, AIR INPUT IS ≈ 4 scfm

TOTAL OF 5 pumps × 4 scfm = 20 scfm MIN.

ALLOW FOR SYSTEM EXPANSION TO 16 PUMPS

4 × 20 scfm = 80 scfm MIN. At 125 psig MAX.

PER VENDOR INFO, THIS WILL PROVIDE ≈ 60 gpm AT MAX HEAD OF 50' (FLUID HEAD).

∴ THIS SYSTEM WILL NOT SUPPLY ALL WELLS w/o ADDITIONAL AIR COMPRESSOR.

USE 80 scfm @ 125 psig MAX.

CHECK FRICTION LOSS IN AIR HOSE - 1" ϕ

@ 125 psig - FREE AIR OF 80 scfm - FRICTION LOSS = ≈ 1 PSI / 100'

$\Delta p_{125} = 1 \text{ psi}$

$$K = \frac{\Delta p_{125}}{100}\left(P_1 - \frac{\Delta p_{125}}{2}\right) = \frac{1}{100}\left(125 - \frac{1}{2}\right) = 1.25$$

$$\Delta p_L = P_{125} - \sqrt{P_{125}^2 - 2(K)L}$$

$$\Delta p_L = 125 - \sqrt{125^2 - 2(1.25)1500'}$$

$$= 125 - 109$$

∴ PRESSURE LOSS IS ACCEPTABL[E]

RECIPROCATING AIR COMPRESSORS

- MOST COMMONLY USED WITH ESI SYSTEMS
- PRODUCES HIGH PRESSURES(175 PSIG max), BUT LIMITED VOLUMES (100 SCFM max)
- CAN BE MADE EXPLOSION PROOF
- USUALLY OPERATED AT 50%-70% UTILIZATION
- ALWAYS USE COMPRESSORS WITH CAST IRON HEADS (NO ALUM.)
- DESIGNED FOR NON-CONTINUOUS OPERATION
- OVER SIZING THE COMPRESSOR HEADS WILL REDUCE THE RPM'S WHICH WILL DECREASE NOISE LEVEL AND INCREASE COMPRESSOR LIFE.

SCFM	* ACTUAL	PSIG(max)	H.P.	** APPROX. MAX FLOW
1-7	11	125	3.0	7 GPM
8-15	18	125	5.0	13 GPM
15-25	27	125	7.5	19 GPM
25-35	35	125	10.0	25 GPM
35-50	55	125	15.0	39 GPM
50-70	70	125	20.0	49 GPM
70-85	88	125	25.0	62 GPM
85-100	105	125	30.0	74 GPM

RECOMMENDED OPTIONS:

- AUTO START/STOP WITH OIL LEVEL SWITCH
- BELT GUARD
- MAGNETIC STARTER
- SINGLE PHASE IS ONLY AVAILABLE ON 3 AND 5 H.P.

* REFERS TO AIR VOLUME OUTPUT THAT COMPRESSOR IS CAPABLE OF PRODUCING. HOWEVER, ALWAYS SIZE COMPRESSORS WITH A 50%-70% UTILIZATION FACTOR.

** REFERS TO FLOW FOR A TOTAL FLUIDS SYSTEM WITH A MAXIMUM HEAD OF 50 FEET.

PRESSURE LOSS IN POUNDS FOR EACH 100 FEET OF STRAIGHT PIPE

Be Sure to Read Notes on Page 34-77

Nominal Pipe Size	CFM Free Air	Line Pressure — PSIG													
		10	15	20	30	40	50	75	100	125	150	200	250	300	350
½"	10		1.45	1.24	.96	.79	.67	.48	.38	.31	.26	.20	.16	.14	.12
	15			2.68	2.08	1.70	1.43	1.04	.81	.67	.57	.43	.35	.30	.25
	20				3.60	2.94	2.48	1.80	1.41	1.15	.98	.75	.61	.51	.44
	30						5.40	3.90	3.05	2.50	2.12	1.63	1.32	1.11	.96
	40							6.80	5.31	4.37	3.70	2.84	2.30	1.94	1.67
SCHEDULE 40	50								8.20	6.75	5.70	4.37	3.55	2.99	2.58
	60								11.7	9.61	8.16	6.25	5.08	4.27	3.68
	80										14.4	11.0	8.95	7.52	6.50
	100											17.1	13.9	11.7	10.1
¾"	10	.42	.35	.30	.23	.19	.16	.12							
	20	1.57	1.31	1.12	.87	.71	.60	.43	.34	.28	.24	.18	.15	.12	.11
	35			3.22	2.50	2.04	1.72	1.25	.98	.80	.68	.52	.42	.35	.31
	50				4.95	4.05	3.42	2.47	1.93	1.59	1.35	1.03	.84	.71	.61
	65						5.71	4.12	3.23	2.65	2.25	1.72	1.40	1.18	1.01
	80							6.19	4.74	3.98	3.37	2.58	2.10	1.76	1.52
SCHEDULE 40	100							9.60	7.53	6.40	5.25	4.02	3.26	2.74	2.37
	125								11.7	9.70	8.12	6.22	5.05	4.25	3.67
	150									12.6	11.5	8.85	7.16	6.03	5.20
	200											15.6	12.6	10.6	9.14
	250												19.7	16.6	14.3

PRESSURE LOSS IN POUNDS FOR EACH 100 FEET OF STRAIGHT PIPE

Be Sure to Read Notes on Page 34-77

Nominal Pipe Size	CFM Free Air	Line Pressure — PSIG													
		10	15	20	30	40	50	75	100	125	150	200	250	300	350
1″	20	.45	.38	.32	.25	.20	.17	.13	.10						
	35	1.29	1.07	.92	.71	.58	.49	.35	.28	.23	.19	.15	.12	.10	
	50			1.81	1.40	1.15	.97	.70	.55	.45	.38	.29	.24	.20	.17
	75				3.10	2.53	2.14	1.54	1.21	.99	.84	.65	.52	.44	.38
	100					4.39	3.70	2.68	2.09	1.72	1.46	1.12	.91	.76	.66
	125						5.70	4.10	3.22	2.64	2.24	1.72	1.39	1.17	1.01
SCHEDULE 40	150							5.88	4.60	3.78	3.20	2.46	1.99	1.68	1.45
	200								8.05	6.61	5.61	4.30	3.49	2.94	2.53
	250									10.3	8.87	6.72	5.45	4.59	3.96
	300										12.6	9.66	7.85	6.60	5.70
	400											17.2	14.0	11.7	10.1
	500												21.8	18.3	15.8
1 ½″	50	.31	.25	.22	.17	.14	.12								
	75	.65	.54	.46	.36	.29	.25	.18	.14	.12	.10				
	100	1.13	.94	.80	.62	.51	.43	.31	.24	.20	.17	.13	.11		
	125		1.44	1.24	.96	.78	.66	.48	.37	.31	.26	.20	.16	.14	.12
	150		2.04	1.75	1.35	1.11	.94	.68	.53	.43	.37	.28	.23	.19	.17
	200			3.04	2.36	1.93	1.63	1.18	.92	.76	.64	.49	.40	.34	.29
	250				3.68	3.01	2.54	1.83	1.44	1.18	1.00	.77	.62	.52	.45
	300					4.29	3.62	2.62	2.05	1.74	1.43	1.09	.89	.75	.64
SCHEDULE 40	400						6.35	4.58	3.59	2.94	2.50	1.92	1.55	1.31	1.13
	500							7.12	5.59	4.59	3.89	2.98	2.42	2.03	1.76
	600								8.00	6.55	5.55	4.26	3.46	2.91	2.51
	700								10.8	8.89	7.55	5.78	4.70	3.95	3.40
	800									11.6	9.80	7.50	6.10	5.12	4.42
	1000										15.2	11.7	9.45	7.95	6.86
	1200											16.4	13.3	11.2	9.61
	1400											22.9	18.6	15.6	13.5

Electrical Design Calculations

S.O. No. 19134-67-BRM

Subject: LOAD & SHORT CIRCUIT

Baker

Sheet No. 1 of

Drawing No.

Computed by DST Checked By Date 6/14/93

I TOTAL POWER REQ.

		AMPS A φ	B φ	C φ	
1. PANEL PPA	120/208	25.25	26.3	27.8	
2. PANEL PP2	277/480	21.6	21.6	21.6	
3. PANEL PP1	277/480	156.1	156.1	156.1	NOT INCLUDING SPARES
		182.2	182.2	182.2	INCLUDING SPARES

TOTAL CONNECTED PWR (WITHOUT SPARES) = $156.1 \times 480 \times \sqrt{3}$ = 129,779 WATTS OR 130 KW.

TOTAL PWR INCLUDING SPARES = $182.2 \times 480 \times \sqrt{3}$ = 151,478 OR 152 KW

ALLOWING FOR EXPANSION (ADDITIONS)

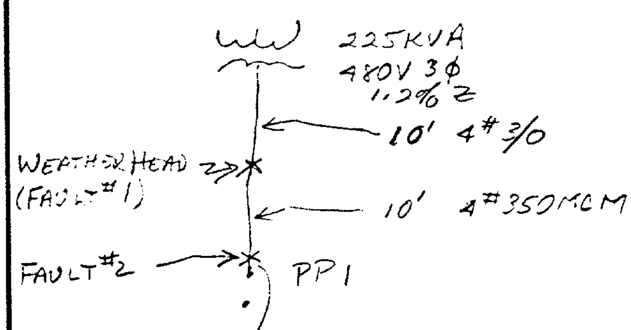
130 KW × 1.25 = 162.5 KW

OR 152 KW × 1.25 = 190. KW

∴ USE 3 75KVA 1φ TRANSF. = 225 KVA

3 50KW TRANSF CAN BE USED BUT WOULD NOT ALLOW FOR MUCH UPDATING OR EXPANSION WITH LARGER EQUIP.

II FROM COOPER/BUSSMAN ELECTRICAL PROTECTION HANDBOOK COPYRIGHTED OCT 1992 TABLE 5-7-4 SHORT-CIRCUITS CURRENTS AVAILABLE FROM VARIOUS SIZE TRANSF. 277/480 3PH KVA 225, FULL LOAD AMPS 271, 1.2% IMPEDANCE, 25,082 AIC.



FAULT#1 a) I_{FLA} = 271 A

b) $M = \frac{100}{\%Z} = \frac{100}{1.2} = 83.3$

c) I_{SCA} @TRANSF. Sec. $= 271 \times 83.3 = 22{,}574.$ A

OR USE 25,082

d) $f = \frac{\sqrt{3} \times L \times I_{SCA}}{C \times E} = \frac{\sqrt{3} \times 10 \times 25{,}082}{11900 \times 480} = 0.076$

e) $M = \frac{1}{1+f} = \frac{1}{1+.076} = 0.93$

f) I_{SCA} @ FAULT#1 $= 25{,}082 \times .93 = 23{,}327$

FAULT#2

a) $f = \frac{\sqrt{3} \times 10 \times 23{,}327}{16667 \times 480} = 0.051$

b) $M = \frac{1}{1+f} = \frac{1}{1+.051} = 0.952$

c) I_{SCA} @ FAULT#2 $= 23{,}327 \times 0.952$

$= 22{,}207$ A.

DATA TAKEN FROM COOPER/BUSSMAN ELECTRICAL PROTECTION HANDBOOK

LIGHTING CALCULATIONS
PROJ NAME: HADNOT POINT IND
DESIGNER: DST
DATE: 6/17/93
FILE NAME: LTGCALCS.WK1

Baker and Associates
Airport Office Park, Building
420 Rouser Road
Coraopolis, Pa. 15108

****

1 Room Name:	Bldg 1		2 Room Name:		
Length:	66		Length:		
Width:	39		Width:		
Area:	2574		Area:	0	
Mtg. Ht.:	12		Mtg. Ht.:		
Watts/Lamp:	40		Watts/Lamp:		
Lamps/Fixture:	2		Lamps/Fixture:		
Lumens/Lamp:	3150		Lumens/Lamp:		
Maint. Factor:	0.7		Maint. Factor:		
Footcandles:	40		Footcandles:		
Type Fixture:	NL-8		Type Fixture:		
RC:	9.5		RC:	0	
RCR:	1.9		RCR:	0.0	
Reflectances:	0.7		Reflectances:		
CU1:	0.76		CU1:		
CU2:	0.65		CU2:		
CU:	0.657		CU:	0.000	
Lamps/Fixtures	71.1	36	Lamps/Fixtures	0.0	0
Lamps used:	64		Lamps used:		
Initial FC:	51.4		Initial FC:	0.0	
Maint. FC:	36.0		Maint. FC:	0.0	

The following "design practice" shall be followed for most lighting design projects. It should be noted that there may be possible exceptions to the following and these exceptions will be resolved as they occur.

A-Method:

The Zonal Cavity Method of calculation shall be used and the following formulas shall apply:

(1) To find RCR required, use:

$$\frac{5 \times \quad (R.C.) \times (\quad L. + \quad W.)}{(A)} = \_\_\_\_\_\_ \text{ R.C.R.}$$

(2) To find lamps required:

$$\frac{(F.C.) \times \quad (A)}{(C.U.) \times \quad (M.F.) \times \quad (LPL)} = \_\_\_\_ = \text{Lamps Req'd} \_\_\_\_$$

(3) To find initial and maintained footcandles, use:

$$\frac{(Lamps) \times \quad (LPL) \times \quad (C.U.) \times \quad (M.F.)}{(A)} = \_\_\_\_ \text{ Main F. C.} \quad \_\_\_\_ \text{ Initial F. C.}$$

Formula Legend:

R.C.	=	Room Cavity
L.	=	Room Length
W.	=	Room Width
A.	=	Room Area
RCR.	=	Room Cavity Ratio
F.C.	=	Footcandles (Design Value)
C.U.	=	Coefficient of Utilization
M.F.	=	Maintenance Factor
LPL.	=	Lumens Per Lamp.

```
H7: PR [W6] "Page
A9: PR [W4] 1
B9: PR [W14] 'Room Name:
C9: U 'Bldg 1
E9: PR [W6] +A9+1
F9: PR [W14] 'Room Name:
B10: PR [W14] 'Length:
C10: U 66
F10: PR [W14] 'Length:
B11: PR [W14] 'Width:
C11: U 39
F11: PR [W14] 'Width:
B12: PR [W14] 'Area:
C12: PR +C10*C11
F12: PR [W14] 'Area:
G12: PR +G10*G11
B13: PR [W14] 'Mtg. Ht.:
C13: U 12
F13: PR [W14] 'Mtg. Ht.:
B14: PR [W14] 'Watts/Lamp:
C14: U 40
F14: PR [W14] 'Watts/Lamp:
B15: PR [W14] 'Lamps/Fixture:
C15: U 2
F15: PR [W14] 'Lamps/Fixture:
B16: PR [W14] 'Lumens/Lamp:
C16: U 3150
F16: PR [W14] 'Lumens/Lamp:
B17: PR [W14] 'Maint. Factor:
C17: U 0.7
F17: PR [W14] 'Maint. Factor:
B18: PR [W14] 'Footcandles:
C18: U 40
F18: PR [W14] 'Footcandles:
B19: PR [W14] 'Type Fixture:
C19: U "NL-8
F19: PR [W14] 'Type Fixture:
B20: PR [W14] 'RC:
C20: PR @IF(+C13-2.5<0,0,+C13-2.5)
F20: PR [W14] 'RC:
G20: PR @IF(+G13-2.5<0,0,+G13-2.5)
B21: PR [W14] 'RCR:
C21: (F1) PR @IF(@ISERR(5*C20*(+C10+C11)/+C12),0,5*C20*(+C10+C11)/+C12)
F21: PR [W14] 'RCR:
G21: (F1) PR @IF(@ISERR(5*G20*(+G10+G11)/+G12),0,5*G20*(+G10+G11)/+G12)
B22: PR [W14] 'Reflectances:
C22: U 0.7
F22: PR [W14] 'Reflectances:
B23: PR [W14] 'CU1:
C23: U 0.76
F23: PR [W14] 'CU1:
B24: PR [W14] 'CU2:
C24: U 0.65
F24: PR [W14] 'CU2:
B25: PR [W14] 'CU:
C25: (F3) PR (C23-((C21)-@INT(C21))*(C23-C24))
```

```
F25: PR [W14] 'CU:
G25: (F3) PR (G23-((G21)-@INT(G21))*(G23-G24))
B26: PR [W14] 'Lamps/Fixtures
C26: (F1) PR @IF(@ISERR(+C18*C12/(+C25*C16*C17)),0,+C18*C12/(+C25*C16*C17))
D26: (F0) PR [W6] @IF(@ISERR(+C26/C15),0,(+C26/C15))
F26: PR [W14] 'Lamps/Fixtures
G26: (F1) PR @IF(@ISERR(+G18*G12/(+G25*G16*G17)),0,+G18*G12/(+G25*G16*G17))
H26: (F0) PR [W6] @IF(@ISERR(+G26/G15),0,(+G26/G15))
B27: PR [W14] 'Lamps used:
C27: U 64
F27: PR [W14] 'Lamps used:
B28: PR [W14] 'Initial FC:
C28: (F1) PR @IF(@ISERR(+C27*C16*C25/+C12),0,+C27*C16*C25/+C12)
F28: PR [W14] 'Initial FC:
G28: (F1) PR @IF(@ISERR(+G27*G16*G25/+G12),0,+G27*G16*G25/+G12)
B29: PR [W14] 'Maint. FC:
C29: (F1) PR @IF(@ISERR(+C27*C16*C25*C17/+C12),0,+C27*C16*C25*C17/+C12)
F29: PR [W14] 'Maint. FC:
G29: (F1) PR @IF(@ISERR(+G27*G16*G25*G17/+G12),0,+G27*G16*G25*G17/+G12)
```

Structural Design Calculations

S.O. No. 19134-51-SRN

Subject: U.S. NAVY CAMP LEJEUNE N.C.
GROUNDWATER TREATMENT FACILITY — Sheet No. 1 of ___

Drawing No. ___

Computed by LEM — Checked By [signature] — Date 5/21/93

Baker

1. GENERAL DATA

BUILDING TO BE PREFAB. BUILDING –
SIZE – 65.0' x 40.0' HGT – 16.0' (EAVE)
SOLID WEB RAFTER, WITH TAPERED COLUMNS
4:12 ROOF SLOPE AND EXTERIOR GIRTS
HAS 2 - 20' BAYS AND 1 - 25' BAY (CENTER

CHECK WIND LOAD PER UBC

$P = C_e C_q q_s I = (1.39)(.9)(25.6)(1.0) = 32.0$

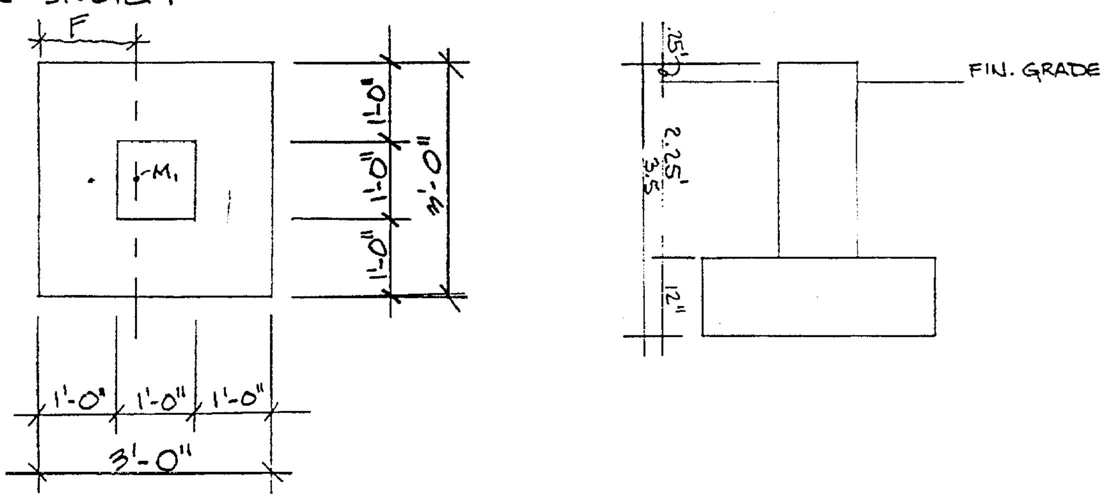
∴ FROM PRENGINEERED BLDG. CATALOG USE LOADS FROM DEAD LOAD + LIVE LOAD CHART @ 40 PSF (PG-2A-23)

D+L LOAD — $H - 7^k$ — $V - 18^k$

D+W LOAD — $H_L - 7^k$ $V_L - 11^k$ — $H_R - 3^k$ $V_R - 7^k$

USE $V - 18^k$ $H - 7$

FOOTER SKETCH



DESIGN DATA: ALLOWABLE SOIL PRESSURE 2,000 PSF
$f'_c = 3000$ PSI $f_y = 60,000$ PSI
WGHT. OF Soil PRIMARILY SAND 100 PSF (8th EDITION STL. M
ALLOW. Soil PRESSURE – 2000 psf

① ACTUAL SOIL PRESS. = $P_u = P/A = 18,000/(3' \times 3') = 2000$ PSF OK

② $d = 12 - 3" - 3/4 = 8.25"$ ASSUMES TOP & BOTTOM BARS

③ SHEAR STRENGTH OF FOOTINGS

Ⓐ 2-WAY ACTION — $B = $ Col. WIDTH $+ (d/2)2 = 12" + 8.25 = 20.25"$

$V_u = P_u (W^2 - B^2) = 2000\text{psf}((3.0')^2 - (1.6875')^2)$

$= 12,304.6$ lbs USE 12,300 lbs

$\beta_c = 1$ ∴ $V_c = 4\sqrt{f'_c}\, b_o d = 4\sqrt{3000}\,(20.25 \cdot 4)(8.25)$

$b_o = 12 + 8.25 = 20.25$ $= 146,406$ USE 146,400 lbs

S.O. No. 19134-51-SRN

Subject: U.S. NAVY Camp Lejeune N.C.

GROUNDWATER TREATMENT Facility — Sheet No. 2 of ____

Drawing No. ____

Computed by LEM — Checked By JSR — Date 5/24/93

Baker

③ SHEAR STRENGTH OF FOOTINGS (CONTINUED)

Ⓑ ONE-WAY SLAB ACTION

$G = W/2 - B_{col}/2 - D$
$= 3/2 - 1/2 - 8.25''/12''/'$

$V_u = P_u W G = 2000\ \#/SF\ (3 \cdot (18'' - 6'' - 8.25''/12))$
$= 1875\#$ — USE 1875#

$V_c = 2\sqrt{f'_c}\, b_w d = 2\sqrt{3000}\,(3 \cdot 12)(8.25)$
$= 32535\#$ — USE 32,500#

$\phi V_n = \phi V_c = .85\,(32{,}500\#) = 27{,}625\#$

$\therefore\ V_u < \phi V_n$

FOOTER SLAB - BECAUSE SHEARS ARE SO DIFFERENT THE SLAB THICKNESS COULD BE REDUCED FROM 12"

④ DESIGN FOR BENDING MOMENT

CAN TAKE MOMENT AT FACE OF COLUMN BUT TO BE CONSERVATIVE MOMENT WAS TAKEN HALF WAY BETWEEN ℄ COLUMN AND FACE OF COLUMN SEE SHEET 1 @ M_1 ON SKETCH

Ⓐ MAX. MOMENT $F = 36/2 - 3 = 15''$

$M_{max} = P(F)(F/2)(W) = (1900\#/FT^2)(1.25')(1.25'/2)(3')$
$= 4687.5\ FT\cdot\#$ USE 4700'# (56,400 IN·#)

Ⓑ STEEL DESIGN

$\bar{K} = M_{max}/\phi b d^2 = 56.4\ KSI / .9\,(12)(8.25^2)$
$\bar{K} = .0767\ KSI$

(FROM REINFORCED CONCRETE DESIGN - TABLE A8)
$\rho = .0013$

$\rho_{min} = 200/f_y = 200/60{,}000 = \rho_{min} = .00333$

SINCE $(.0013 < .00333)$ USE $\rho_{min} = .0033$

THEREFORE $A_s = \rho_{min} b d$
$= (.00333)(3 \times 12)(8.25'')$
$= .98\ in^2$

CAN USE 5 - #4 BARS $A_s = 1.0\ IN^2$
5 - #5 BARS $A_s = 1.55\ IN^2$

CHECK DEVELOPMENT LENGTH

$l_{db} = .04\, A_b\, f_y/\sqrt{f'_c}$ — $l_{db} = .0004\, d_b\, f_y$

FOR #4: $= .04\,(.20)(60{,}000/\sqrt{3000}) = .876\ IN.$ — $= .0004(60000)(.5) = 12''$

#5: $= .04\,(.31)(60000/\sqrt{3000}) = 13.58\ in$ — $= .0004\,(60000)(.625) = 15''$

ACTUAL LENGTH 36" > 15" OK

S.O. No. 19134-51-SRN

Subject: U.S. NAVY - CAMP LEJEUNE N.C.

GROUNDWATER TREATMENT FACILITY Sheet No. 3 of

Drawing No.

Computed by LEM Checked By [signature] Date 5/25/93

Baker

(5) CHECK CONCRETE COLUMN (REF. ACI 318 SECT 10.15, 15.8.2)

A: BEARING STRENGTH TOP COLUMN (WHERE STEEL COLUMN BOLTS)

$A_1 = 1' \times 1' = 1SF$ $A_2 = 3' \times 3' = 9SF$

$\text{BEAR STRENGTH} = \phi(.85 f_c' A_1)$

$= .7(.85(3000 \#/in^2)(1 \times 12)^2 = 257,040 \#$

USE 257^k

$\therefore 257^k > 18^k$ OK

B: BEARING STRENGTH AT FOOTING

$A_1 = 1SF$ $A_2 = 9SF$

$\sqrt{A_2/A_1} = \sqrt{9/1} = 3$ $3 > 2.0$ (REF 10.15)

USE

$\text{FOOTING BEARING STRENGTH} = \phi(.85 f_c' A_1)(2)$

$= .7(.85(3)(1 \cdot 12)^2(2)$

$= 514.08^k$

USE 514^k

$\therefore 514^k > 17^k$ OK

SINCE ENTIRE LOAD IS CAPABLE OF BEING TRANSFERRED BY THE CONCRETE THE COLUMN NEEDS MIN. REINFORCEMENT. (REF. 15.8.2)

$A_s = .005 A_g = .005(12'' \times 12'') = .72 in^2$ USE 4 - #5 BARS ONE EACH CORNE[R]

$.72 < A_s = 1.23$ O[K]

CHECK DEVELOPMENT LENGTH FOR COMPRESSION

$l_{db} = .02 d_b f_y / \sqrt{f_c'} = (.02)(.625)(60000/\sqrt{3000}) = 13.7 in.$

MODIFICATION FACTOR (BASED ON STEEL PROVIDED IS IN EXCESS OF STEEL REQUIR[ED])

$\text{FACTOR} = A_{s\,REQ'D} / A_{s\,PROV'D} = .72/1.23 = .59$

$\text{ACTUAL } l_{db} = (\text{FACTOR})(l_{db}) = (.59)(13.7) = 8.083 in$

USE 8.1 OK

REF. ACI 318.10.9

$A_s = .005 A_g = .72$ $A_s = 1.23$ (4 #5 BAR) $= .008$ OK

USE 6 - #5 BAR = A_s - 1.84 in²

$\text{RATIO} = A_s/A_g = 1.84/12'' \times 12'' = .013$ OK USE 6 - #5 BAR

S.O. No. 19134-51-SRN

Subject: U.S. Navy - Camp Lejeune N.C.

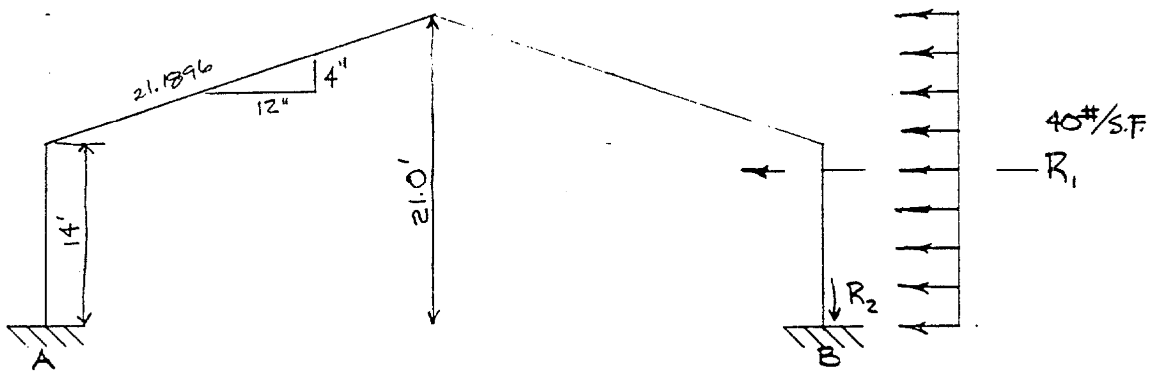
Groundwater Treatment Facility   Sheet No. 4 of ___

Drawing No. ___

Computed by LEM   Checked By [signature]   Date 5/25/93

Baker

⑥ CHECK BUILDING FOR OVERTURNING & UPLIFT



CHECK OVERTURNING

USING U.B.C. WIND LOADS CALCULATED TO BE 32 PSF BUT MANUFACTURER'S INFORMATION USED WIND INCREMENTS OF 10 PSF THEREFORE USED 40 PSF FOR DESIGN

CHECK AT A

ASSUME THE WALL IS A 90° FOR THE ENTIRE 16' HIGH (WORST CASE)

① FIND RESULTANT FORCE R_1 (FOR OVERTURING)

$$R_1 = (40\#/SF)(65')(21') = 54{,}600\#$$

② FIND OVERTURING MOMENT

$$M_o = R_1 \cdot Arm_1 = (54600\#)(11') = 600{,}600'\cdot\#$$

③ FIND RESULTANT FORCE R_2 (RESIST OVERTURN)

R_2 = Wgt. footings + WGHT WALLS (SIDEWALL ONLY)

$$R_2 = [150\#/ft^3(4(3'\times3'\times1') + 4(1'\times1'\times2.5'))] + [150\#/ft^3(2(2.5\times.5\times19) + 1(2.5\times.5\times24))]$$

$$R_2 = 6900\# + 11625\#$$

$$R_2 = 18525\#$$

④ FIND RESISTING MOMENT

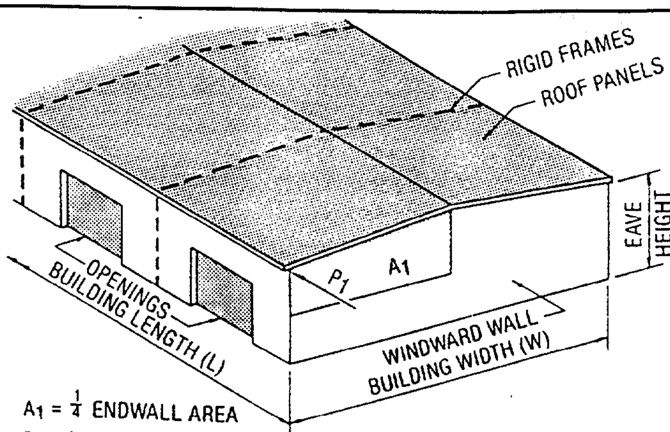
$$M_R = R_2 \cdot Arm = (18{,}525\#)(40') = 741{,}000'\cdot\#$$

NOTE: NO WGHT. OF THE BUILDING WAS CONSIDERED WHEN CALCULATED $M_R > M_o$ ∴ OK

CHECK UPLIFT - FORCE FROM MANUFACTURER LITERATURE

FROM PG-6A-30 WHEN PANELS ARE PROPERLY INSTALLED THE RESIST WIND LOADS BY DIAPHAM ACTION TRANSFERRING THE LOADS TO THE FOUNDATION. PROVIDED THE BUILDING HAS A MINIMUM EFFECTIVE LENGTH OF SOLID SHEETED WALL

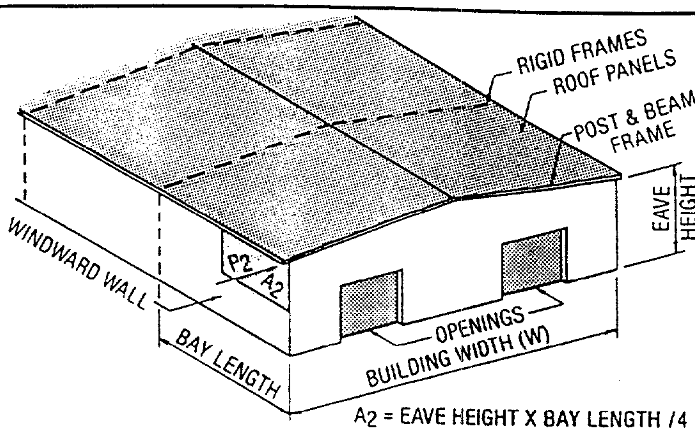
FOR 100 MPH OUR BUILDING MUST HAVE A SIDEWALL OF 33.0'
ENDWALL OF 24.0'



$A_1 = \frac{1}{4}$ ENDWALL AREA
$P_1 = A_1$ X WIND PRESSURE
L_E = L - OPENING WIDTHS

FIGURE 1

WIND ON ENDWALL



A_2 = EAVE HEIGHT X BAY LENGTH /4
$P_2 = A_2$ X WIND PRESSURE
W_E = W - OPENING WIDTHS

FIGURE 2

WIND ON PORTION OF END BAY SIDEWALL

TABLE I WIND ON ENDWALL

EAVE HEIGHT	WIND LOAD (MPH)	L_E (MINIMUM EFFECTIVE LENGTH, IN FEET) ½:12 & 1:12 BUILDINGS BUILDING WIDTH						4:12 SLOPE BLDG. BUILDING WIDTH		
		20'	30'	40'	50'	60'	70'	40'	50'	60'
10'	70	5	7	9	10	12	14	11	13	16
	80	6	9	11	13	16	18	14	17	21
	90	7	11	14	17	20	22	18	22	26
	100	9	13	18	21	24	28	21	27	32
12'	70	5	8	10	12	14	16	12	15	19
	80	7	10	13	16	18	21	16	20	24
	90	8	13	17	20	23	26	20	25	30
	100	10	15	21	24	28	32	25	31	38
14'	70	6	9	12	14	16	18	14	18	21
	80	8	12	15	18	21	24	19	23	28
	90	10	14	19	23	26	30	24	29	35
	100	12	18	24	28	33	37	29	36	43
16'	70		10	14	16	19	21	17	20	24
	80		13	18	21	24	27	21	26	32
	90		17	22	26	30	35	27	33	40
	100		21	28	32	37	43	33	41	49
20'	70			18	21	24	27	21	25	30
	80			23	27	32	36	27	33	39
	90			29	35	40	45	34	42	50
	100			36	42	49	56	42	51	61
24'	70				26	30	34	26	31	37
	80				34	39	45	33	40	48
	90				43	50	56	42	51	60
	100				53	61	69	52	62	74

TABLE II* WIND ON SIDEWALL

EAVE HEIGHT	WIND LOAD (MPH)	W_E (MINIMUM EFFECTIVE WIDTH, IN FEET) ½:12 & 1:12 SLOPE BLDGS. ALL WIDTHS	4:12 SLOPE BLDG. BUILDING WIDTH						
			40'	50'	60'	70'	80'	100'	120'
10'	70	5	7	7	7				
	80	7	9	9	9				
	90	8	11	11	11				
	100	10	14	14	14				
12'	70	6	9	9	9	9	9		
	80	8	11	11	11	11	12		
	90	10	14	14	14	14	15		
	100	12	17	17	17	18	18		
14'	70	7	10	10	10	11	11	11	11
	80	9	13	13	13	14	14	14	14
	90	12	16	17	17	17	17	18	18
	100	14	20	21	21	21	21	22	22
16'	70	8	12	12	12	12	12	13	13
	80	11	15	16	16	16	16	16	17
	90	13	19	20	20	20	20	21	21
	100	17	24	24	24	25	25	25	26
20'	70	11	16	16	16	16	16	16	17
	80	14	20	20	21	21	21	21	22
	90	18	25	26	26	26	26	27	27
	100	22	31	32	32	32	32	33	33
24'	70	14	19	20	20	20	20	20	21
	80	18	25	25	26	26	26	26	27
	90	22	32	32	32	33	33	33	34
	100	28	39	39	40	40	40	41	42

*For use with post & beam endwall.
Values shown are for 25' bays, for 20' bays multiply value by .8.

NOTES:

1. DuraRib panels, when properly fastened to supporting structural framing and using sidelap fasteners at 2'-0 on center, form structural units capable of resisting loads through in-plane shear resistance. This shear resistance affects a shear transfer of these loads to the foundation with a minimum amount of deflection. Such resistance is hereafter referred to as "Diaphragm Action".
2. The wind forces imposed on the endwall and/or portion of the sidewall can be transferred to foundation by:
   A) Diaphragm action only for buildings up to 70' wide with 1/2:12 and 1:12 roof slopes and for buildings up to 60' wide with 4:12 roof slopes.
   B) Wind bracing only for all other buildings.
3. The tabulated values indicate the minimum effective length of solid sheeted wall required to transfer a design wind load force to the foundation. Values are calculated in accordance with 1981 MBMA design practices.
   A) Table I is for wind on the endwall of a building and indicates the minimum effective length required for **each** sidewall.
   B) Table II is for wind on a portion of the sidewall end bay and indicates the minimum effective width required for **each** endwall.
4. Figures 1 and 2 are to used in conjunction with Tables I and II respectively.
5. The effective length or width **does not** include the widths of:
   A) Framed openings for overhead or sliding doors.
   B) Framed openings for glass walls.
   C) Panel runs of less than 3'-0" in width.
6. When the effective length is **less** than the tabulated value the building must be braced by means other than diaphragm action.
7. Diaphragm action is **not valid** for buildings utilizing rigid board insulation.
8. When endwalls and/or sidewalls are constructed entirely or partially of materials other than DuraRib panel, they must be properly engineered to sustain the design wind load.
9. All standard interior bents are designed to sustain a specific transverse wind load as outlined in Star building specifications.
10. A design load value of 160#/L.F. of wall as determined by structural testing, was used in generating Tables I and II. The design load value includes a 33 1/3% increase for wind load.

REGISTERED PROFESSIONAL ENGINEER
JACK RAE TAYLOR
7105
OKLAHOMA

S.O. No. 19134-51-SRN

Subject: U.S. NAVY CAMP LEJEUNE N.C.

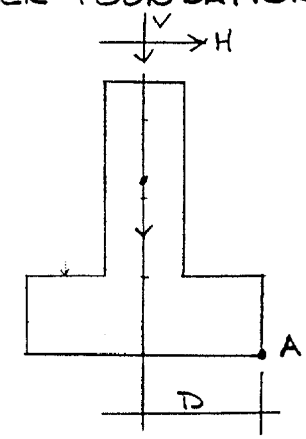
GROUNDWATER TREATMENT FACILITY — Sheet No. 5 of

Drawing No.

Computed by LEM — Checked By JSP — Date 5/27/93

Baker

CHECK FOUNDATION FOR OVERTURNING



ASSUME LARGEST HORIZONTAL FORCE AND VERTICAL FORCE COMBINATION FROM PG ①

$H_L = 7^k \quad V_L = 11^k$

OVERTURNING MOMENT

$\Sigma M_A = (7)(3.5') = 24.5^{'\cdot k}$

EQUATE MOMENTS

$24.5^{'\cdot k} = (11^k \cdot D) + [(1\times1\times2.5\times150\#/cf) + (3\times3\times1)(150)]D$

$24.5^{'\cdot k} = 12.725D \Rightarrow D\ 1.93' \qquad \text{ACT. } D = 1.5'$

∴ WIDTH TO NARROW

TRY 2×2 FOUNDATION

$24.5^{'\cdot k} = (11\cdot D) + [(.375 + 2.4)D] \Rightarrow 24.5 = 13.775D$

$D = 1.77 < 2.0$ THERE FORE USE 4'×4'×1' FOOTING

CHECK FACTORY OF SAFETY

$F.S. = \dfrac{\text{STABILIZING MOMENT}}{\text{OVERTURNING MOMENT}} = \dfrac{27.55^{'\cdot k}}{24.5^{'\cdot k}} = \underline{1.12}$

CHECK FOUNDATION FOR SLIDING

COEFFICIENT OF FRICTION - $f = .55$

RESISTANT FORCE $\quad F = .55(\Sigma W) = .55(11^k + (4\times4\times1 + 1\times1\times2.5)150)) = 7.576$

ACTUAL HORIZONTAL FORCE $\quad H = 7^k$

$F.S. = \text{RESISTANT FORCE}/\text{ACTUAL HORIZONTAL FORCE} = 7.576/7 = \underline{1.08}$

USE 4'×4'×1' FOOTING
1'×1'×2.5' COLUMN

Mechanical Design Calculations

S.O. No. ______

Subject: MLB CAMP LEJEUNE CALCULATIONS

Sheet No. 1 of 1

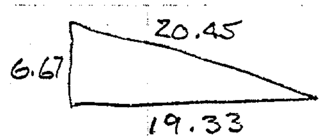
Drawing No. ______

Computed by BRG   Checked By ______   Date 6-4-93

Baker

			WALL
NORTH WALL	1072 ☐	GROSS WALL	1
	120 ☐	GARAGE DOOR	2
	17 ☐	WINDOW	
EAST WALL	760 ☐	GROSS WALL	3
	21 ☐	DOOR	4
SOUTH WALL	1072 ☐	GROSS WALL	5
	120 ☐	GARAGE DOOR	6
	21 ☐	DOOR	7
	17 ☐	WINDOW	
WEST WALL	760 ☐	GROSS WALL	8
	21 ☐	DOOR	9

ROOF AREA



2 SIDES = 40.90 FT

40.9 × 65.67 L = 2686 ☐ ROOF

U-VALUES

WALLS & ROOF 0.065

WINDOWS

DOUBLE PANE CLEAR 1/8" GLASS U = 0.70

DOOR

1 3/4" U = 0.45

FLOOR SLAB ON GRADE 6" U = 26 BTU/H °F/FT

GARAGE DOOR U = 0.45

S.O. No. ____

Subject: ____

Sheet No. 2 of 2

Drawing No. ____

Computed by ____ Checked By ____ Date ____

Baker

BUILDING VOLUME

BASE = 65.67 x 38.67 x 16.33 = 41469.36 FT^3
ROOF = 1/2 x 6.67 x 38.67 x 65.67 = 8469 FT^3

TOTAL VOLUME = 49938 ⇒ SAY 50,000 FT^3

MAINTAIN 4 AC/HR IN WINTER
10 AC/HR IN SUMMER

4 AC/HR x 50,000 FT^3 x 1HR/60MIN = 3333 ⇒ 3350 CFM WINTER VENT.

ADDITIONAL 6AC FOR SUMMER

6 AC/HR x 50,000 FT^3 x HR/60MIN = 5000 CFM ADDITIONAL SUMMER VENT.

WINTER EXHAUST FAN EF-2

3350 CFM AT 0.125" SP

SELECT COOK MODEL ACRU-B CATALOG #195R4B
1/3 HP 740 RPM 3811 MAX. TIP SPEED
10.4 SONES 119 LBS
120V-1-60

SUMMER EXHAUST FAN EF-3

5000 CFM AT 0.125" SP

SELECT COOK MODEL ACRU-B CAT. # 195R7B
1 HP 1070 RPM 5511 MAX. TIP SPEED
21.5 SONES 136 LBS.

WINTER AIR BALANCE

EXHAUST :	WINTER EXH. FAN EF-2	3350
	EF-1	720
	AIR STRIPPER	900
		4970 CFM REQ'D

MAKEUP AIR UNIT REQ'D FOR 4970 CFM

S.O. No.

Subject:

Sheet No. 3 of 3

Drawing No.

Computed by BRG Checked By Date

Baker

MAKE-UP AIR UNIT SELECTION

4970 CFM REQUIRED

SELECT MCQUAY H&V UNIT

BASE HEATER SELECTION ON HEATING AIR FROM 23° (WINTER DESIGN) TO 73

$\Delta T = 73 - 23 = 53\,°F$

$1.085 \times 4970 \times 53 = 285{,}800$ BTUH

$\frac{285{,}800 \text{ BTUH}}{3413 \text{ BTUH/KW}} = 83.7 \text{ KW} \Rightarrow 84 \text{ KW}$

SPACE HEATING LOAD IS 65,849 BTUH

OUTDOOR AIR LOAD IS $1.085 \times (65-23) \times 4970 = 226483$ BTUH

TOTAL LOAD = 65,849 + 226,483 = 292,332 BTUH

USING A 1.2 SAFETY FACTOR DUE TO LARGE OA LOAD

$292{,}332 \times 1.2 = 350798 \Rightarrow 350800$ BTUH

H&V UNIT PROVIDES 285,800 BTUH

350,800 - 285,800 = 65,000 BTUH ADDITIONAL HEAT REQUIRED

$\frac{65{,}000 \text{ BTUH}}{3 \text{ UNIT HTRS}} = 21667$ BTUH EA $\Rightarrow$ 22000 BTUH EA.

$\frac{22000}{3413} = 6.4 \text{ KW} \Rightarrow 7.5 \text{ KW}$

SELECT MARKEL ELEC. UNIT HEATER CAT. # FZF5107CAIL
208-3-60 20.8 AMP 1/50 HP FAN 1500 RPM
700 CFM 34° RISE

S.O. No. ______

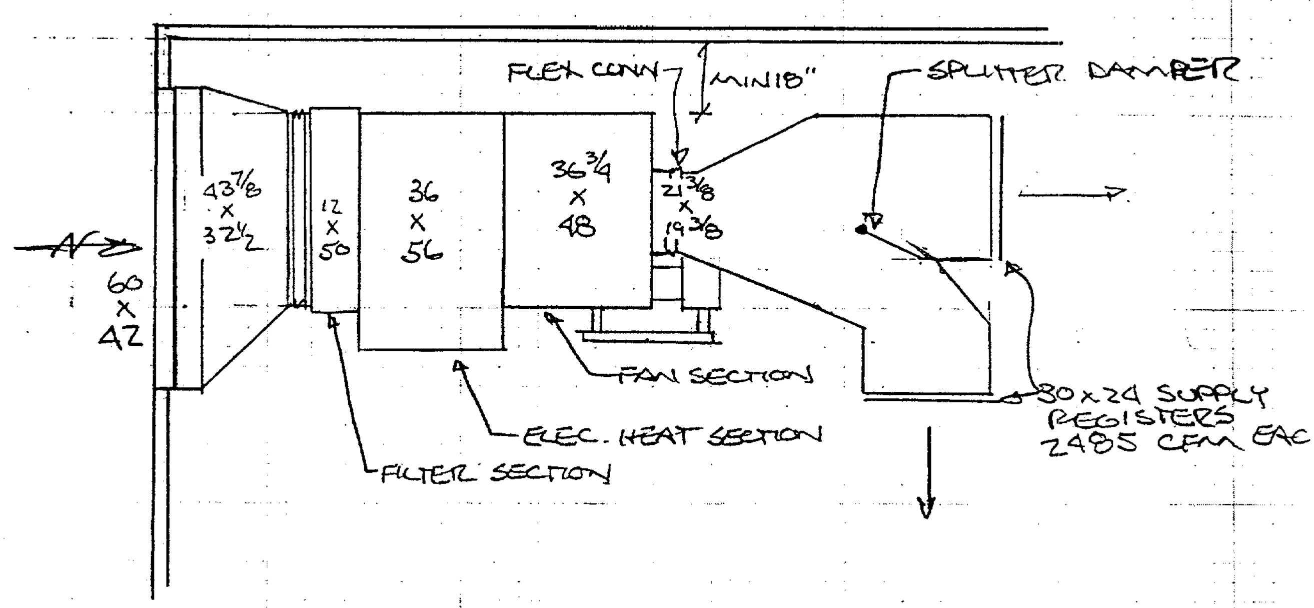
Subject: ______

Sheet No. 4 of 4

Drawing No. ______

Computed by ______ Checked By ______ Date ______

Baker



LOUVER SELECTION
WINTER VENTILATION

$\frac{4970\text{ CFM}}{600\text{ FPM MAX}} = 8.28\text{ FT}^2\text{ MIN.}$

SELECT 60X42 LOUVER 8.70 FT² FREE AREA
.065 IN. PRESS. DROP

SUMMER VENTILATION

5000 CFM ⇒ PROVIDE SAME SIZE LOUVER

HV-1 STATIC PRESS

OA LOUVER	.1"
FILTER (DIRTY)	1.0"
DUCTWORK	.2
ELEC. COIL	.2
	1.5"

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**************************************************************************
**************************************************************************
**                                                                      **
**              T R A C E   6 0 0   A N A L Y S I S                     **
**                                                                      **
**              by  Trane Customer Direct Service Network               **
**                                                                      **
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MLB CAMP LEJEUNE GROUNDWATER TREATMENT
CAMP LEJEUNE, NORTH CAROLINA
NAVY CLEAN
BEINZER

Weather File Code:	GREENSBO	
Location:		
Latitude:	36.0	(deg)
Longitude:	80.0	(deg)
Time Zone:	5	
Elevation:	887	(ft)
Barometric Pressure:	28.9	(in. Hg)
Summer Clearness Number:	0.95	
Winter Clearness Number:	0.95	
Summer Design Dry Bulb:	90	(F)
Summer Design Wet Bulb:	79	(F)
Winter Design Dry Bulb:	23	(F)
Summer Ground Relectance:	0.20	
Winter Ground Relectance:	0.20	
Air Density:	0.0735	(Lbm/cuft)
Air Specific Heat:	0.2444	(Btu/lbm/F)
Density-Specific Heat Prod:	1.0776	(Btu-min./hr/cuft/F)
Latent Heat Factor:	4,743.5	(Btu-min./hr/cuft)
Enthalpy Factor:	4.4085	(Lb-min./hr/cuft)

Design Simulation Period: June To November
System Simulation Period: January To December
Cooling Load Methodology: TETD/Time Averaging

Time/Date Program was Run: 11:48:40 6/11/93
Dataset Name: LEJEUNE .TM

AIRFLOW - ALTERNATIVE 1

SYSTEM SUMMARY
(Design Airflow Quantities)

		Main					Auxil.	Room
System Number	System Type	Outside Airflow (Cfm)	Cooling Airflow (Cfm)	Heating Airflow (Cfm)	Return Airflow (Cfm)	Exhaust Airflow (Cfm)	Supply Airflow (Cfm)	Exhaust Airflow (Cfm)
1	UH	0	0	443	0	0	0	0
Totals		0	0	443	0	0	0	0

CAPACITY - ALTERNATIVE 1

SYSTEM SUMMARY
(Design Capacity Quantities)

		Cooling				Heating						
System Number	System Type	Main Sys. Capacity (Tons)	Aux. Sys. Capacity (Tons)	Opt. Vent Capacity (Tons)	Cooling Totals (Tons)	Main Sys. Capacity (Btuh)	Aux. Sys. Capacity (Btuh)	Preheat Capacity (Btuh)	Reheat Capacity (Btuh)	Humidif. Capacity (Btuh)	Opt. Vent Capacity (Btuh)	Heating Totals (Btuh)
1	UH	0.0	0.0	0.0	0.0	-28,637	0	0	0	0	0	-28,637
Totals		0.0	0.0	0.0	0.0	-28,637	0	0	0	0	0	-28,637

ENGINEERING CHECKS - ALTERNATIVE 1

ENGINEERING CHECKS

				Cooling				Heating		
System Number	Main/ Auxiliary	System Type	Percent Outside Air	Cfm/ Sq Ft	Cfm/ Ton	Sq Ft /Ton	Btuh/ Sq Ft	Cfm/ Sq Ft	Btuh/ Sq Ft	Floor Area Sq Ft
1	Main	UH	0.00	0.00	0.0	0.0	0.00	0.18	-11.4-	2,504

System 1 Block UH - UNIT HEATERS

******** COOLING COIL PEAK ********						*	CLG SPACE PEAK		*	HEATING COIL PEAK		
Peaked at Time ==>		Mo/Hr: 0/ 0				*	Mo/Hr: 0/ 0		*		Mo/Hr: 13/ 1	
Outside Air ==>		OADB/WB/HR: 0/ 0/ 0.0				*	OADB: 0		*		OADB: 23	
						*			*			
	Space	Ret. Air	Ret. Air	Net	Percnt	*	Space	Percnt	*	Space Peak	Coil Peak	Percnt
	Sens.+Lat.	Sensible	Latent	Total	Of Tot	*	Sensible	Of Tot	*	Space Sens	Tot Sens	Of Tot
Envelope Loads	(Btuh)	(Btuh)	(Btuh)	(Btuh)	(%)	*	(Btuh)	(%)	*	(Btuh)	(Btuh)	(%)
Skylite Solr	0	0		0	0.00	*	0	0.00	*	0	0	0.00
Skylite Cond	0	0		0	0.00	*	0	0.00	*	0	0	0.00
Roof Cond	0	0		0	0.00	*	0	0.00	*	-7,333	-7,333	25.60
Glass Solar	0	0		0	0.00	*	0	0.00	*	0	0	0.00
Glass Cond	0	0		0	0.00	*	0	0.00	*	-1,061	-1,061	3.71
Wall Cond	0	0		0	0.00	*	0	0.00	*	-14,809	-14,809	51.71
Partition	0			0	0.00	*	0	0.00	*	0	0	0.00
Exposed Floor	0			0	0.00	*	0	0.00	*	-5,434	-5,434	18.98
Infiltration	0			0	0.00	*	0	0.00	*	0	0	0.00
Sub Total==>	0	0		0	0.00	*	0	0.00	*	-28,637	-28,637	100.00
Internal Loads						*			*			
Lights	0	0		0	0.00	*	0	0.00	*	0	0	0.00
People	0			0	0.00	*	0	0.00	*	0	0	0.00
Misc	0	0	0	0	0.00	*	0	0.00	*	0	0	0.00
Sub Total==>	0	0	0	0	0.00	*	0	0.00	*	0	0	0.00
Ceiling Load	0	0		0	0.00	*	0	0.00	*	0	0	0.00
Outside Air	0	0	0	0	0.00	*	0	0.00	*	0	0	0.00
Sup. Fan Heat				0	0.00	*		0.00	*		0	0.00
Ret. Fan Heat		0		0	0.00	*		0.00	*		0	0.00
Duct Heat Pkup		0		0	0.00	*		0.00	*		0	0.00
OV/UNDR Sizing	0			0	0.00	*	0	0.00	*	0	0	0.00
Exhaust Heat		0	0	0	0.00	*		0.00	*		0	0.00
Terminal Bypass		0	0	0	0.00	*		0.00	*		0	0.00
						*			*			
Grand Total==>	0	0	0	0	0.00	*	0	0.00	*	-28,637	-28,637	100.00

-----COOLING COIL SELECTION-----

	Total Capacity		Sens Cap.	Coil Airfl	Entering DB/WB/HR			Leaving DB/WB/HR		
	(Tons)	(Mbh)	(Mbh)	(cfm)	Deg F	Deg F	Grains	Deg F	Deg F	Grains
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Totals	0.0	0.0								

-----AREAS-----

	Gross Total	Glass (sf)	(%)
Floor	2,584		
Part	0		
ExFlr	289		
Roof	2,[illegible]	0	0
Wall	3,[illegible]	34	1

-----HEATING COIL SELECTION-----

	Capacity	Coil Airfl	Ent	Lvg
	(Mbh)	(cfm)	Deg F	Deg F
Main Htg	-28.6	443	65.0	125.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Reheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-28.6			

-----AIRFLOWS (cfm)-----

Type	Cooling	Heating
Vent	0	0
Infil	0	0
Supply	0	443
Mincfm	0	0
Return	0	443
Exhaust	0	0
Rm Exh	0	0
Auxil	0	0

--ENGINEERING CHECKS--

Clg % OA	0.0
Clg Cfm/SqFt	0.00
Clg Cfm/Ton	0.00
Clg SqFt/Ton	0.00
Clg Btuh/SqFt	0.00
No. People	0
Htg % OA	0.0
Htg Cfm/SqFt	0.17
Htg Btuh/SqFt	-11.44

--TEMPERATURES (F)--

Type	Clg	Htg
SADB	0.0	125.0
Plenum	0.0	65.0
Return	0.0	65.0
Ret/OA	0.0	65.0
Runarnd	0.0	65.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

MAIN SYSTEM HEATING - ALTERNATIVE 1

PEAK HEATING LOADS
(Main System)

Room Number	Description	Floor Area (Sq Ft)	Space: Peak Time Mo/Hr	Space: OA Cond. DB/WB (F)	Space: Rm Dry Blb (F)	Space: Supp. Dry Bulb (F)	Space Air Flow (Cfm)	Space Sens. Load (Btuh)	Coil: Peak Time Mo/Hr	Coil: OA Cond. DB/WB (F)	Coil: Rm Dry Blb (F)	Coil: Supp. Dry Bulb (F)	Coil Air Flow (Cfm)	Coil Sens. Load (Btuh)
1	BUILDING	2,584	13/ 1	23 28	65	125.8	443	-28,637	13/ 1	23 28	65	125.8	443	-28,637
Zone 1	Total/Ave.	2,584		23 28	65	125.8	443	-28,637		23 28	65	125.8	443	-28,637
Zone 1	Block	2,584	13/ 1	23 28	65	125.8	443	-28,637	13/ 1	23 28	65	125.8	443	-28,637
System 1	Total/Ave.	2,584		23 28	65	125.8	443	-28,637		23 28	65	125.8	443	-28,637
System 1	Block	2,584	13/ 1	23 28	65	125.8	443	-28,637	13/ 1	23 28	65	125.8	443	-28,637

BUILDING ENVELOPE HEATING LOADS
(Roof - Skylight)
(At time of Coil Peak)

Room Number	Description	Roof Return Air Sensible Load (Btuh)	Roof R.A. CLTD (F)	Roof Space Sensible Load (Btuh)	Roof Space CLTD (F)	Skylight Return Air Solar (Btuh)	Skylight Space Solar (Btuh)	Skylt Solar CLF	Skylight Return Air Conduction Load (Btuh)	Skylt R.A. CLTD (F)	Skylight Space Conduction Load (Btuh)	Skylt Space CLTD (F)
1	BUILDING	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
Zone 1	Total/Ave.	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
Zone 1	Block	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
System 1	Total/Ave.	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
System 1	Block	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0

BUILDING ENVELOPE HEATING LOADS
(Wall - Window)
(At time of Coil Peak)

Room Number	Description	Wall Plenum Load (Btuh)	Wall Plenm CLTD (F)	Wall Space Load (Btuh)	Wall Space CLTD (F)	Glass Space Solar (Btuh)	Glass Return Air Solar (Btuh)	Glass Solar CLF	Glass Space Conduction (Btuh)	Glass Space CLTD (F)	Glass Return Air Conduction (Btuh)	Glass R.A. CLTD (F)
1	BUILDING	0	0.0	-14,809	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
Zone 1	Total/Ave.	0	0.0	-14,809	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
Zone 1	Block	0	0.0	-14,809	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
System 1	Total/Ave.	0	0.0	-14,809	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
System 1	Block	0	0.0	-14,809	-42.0	0	0	0.000	-1,861	-42.0	0	0.0

BUILDING ENVELOPE HEATING LOADS
(Exposed Floor - Partitions - Infiltration)
(At time of Coil Peak)

Room Number	Description	Exposed Floor Sensible (Btuh)	Expsd Floor CLTD (F)	Partition Sensible (Btuh)	Part. CLTD (F)	Infilt. Airflow (Cfm)	Infilt. Sensible (Btuh)	Infilt. Latent (Btuh)	Plenm Dry B Temp. (F)	Ceiling Sensible Load (Btuh)	Envelope Total (Btuh)
1	BUILDING	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
Zone 1	Total/Ave.	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
Zone 1	Block	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
System 1	Total/Ave.	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
System 1	Block	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637

HEATING LOADS AT SPACE PEAK - ALTERNATIVE 1

BUILDING ENVELOPE HEATING LOADS
(Roof - Skylight)
(At time of Space Peak)

Room Number	Description	Roof Return Air Sensible Load (Btuh)	Roof R.A. CLTD (F)	Roof Space Sensible Load (Btuh)	Roof Space CLTD (F)	Skylight Return Air Solar (Btuh)	Skylight Space Solar (Btuh)	Skylt Solar CLF	Skylight Return Air Conduction Load (Btuh)	Skylt R.A. CLTD (F)	Skylight Space Conduction Load (Btuh)	Skylt Space CLTD (F)
1	BUILDING	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
Zone	1 Total/Ave.	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
Zone	1 Block	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
System	1 Total/Ave.	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0
System	1 Block	0	0.0	-7,333	-42.0	0	0	0.000	0	0.0	0	0.0

BUILDING ENVELOPE HEATING LOADS
(Wall - Window)
(At time of Space Peak)

Room Number	Description	Wall Plenum Load (Btuh)	Wall Plenm CLTD (F)	Wall Space Load (Btuh)	Wall Space CLTD (F)	Glass Space Solar (Btuh)	Glass Return Air Solar (Btuh)	Glass Solar CLF	Glass Space Conduction (Btuh)	Glass Space CLTD (F)	Glass Return Air Conduction (Btuh)	Glass R.A. CLTD (F)
1	BUILDING	0	0.0	-14,009	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
Zone	1 Total/Ave.	0	0.0	-14,009	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
Zone	1 Block	0	0.0	-14,009	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
System	1 Total/Ave.	0	0.0	-14,009	-42.0	0	0	0.000	-1,861	-42.0	0	0.0
System	1 Block	0	0.0	-14,009	-42.0	0	0	0.000	-1,861	-42.0	0	0.0

BUILDING ENVELOPE HEATING LOADS
(Exposed Floor - Partitions - Infiltration)
(At time of Space Peak)

Room Number	Description	Exposed Floor Sensible (Btuh)	Expsd Floor CLTD (F)	Partition Sensible (Btuh)	Part. CLTD (F)	Infilt. Airflow (Cfm)	Infilt. Sensible (Btuh)	Infilt. Latent (Btuh)	Plenm Dry B Temp. (F)	Ceiling Sensible Load (Btuh)	Envelope Total (Btuh)
1	BUILDING	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
Zone	1 Total/Ave.	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
Zone	1 Block	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
System	1 Total/Ave.	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637
System	1 Block	-5,434	-42.0	0	0.0	0	0	0	65.0	0	-28,637

01 Card - Job Information

Project: MLB CAMP LEJEUNE GROUNDWATER TREATMENT
Location: CAMP LEJEUNE, NORTH CAROLINA
Client: NAVY CLEAN
Program User: GEINZER

----- Climatic Information -----

Weather Code	Summer Clearness Number	Winter Clearness Number	Summer Design Dry Bulb	Summer Design Wet Bulb	Winter Design Dry Bulb	Building Orientation	Summer Ground Reflect	Winter Ground Reflect
GREENSBO			98	79	23			

----- Load Section Alternative #1 -----

----- General Room Parameters -----

Room Number	Zone Reference Number	Room Descrip	Floor Length	Floor Width	Const Type	Plenum Height	Acoustic Ceiling Resistance	Floor to Floor Height	Duplicate Floors Multiplier	Duplicate Rooms per Zone	Perimeter Depth
1	1	BUILDING	38.33	65.33	3	8		19.7			

----- Thermostat Parameters -----

Room Number	Cooling Room Design DB	Room Design RH	Cooling T'stat Driftpoint	Cooling T'stat Schedule	Heating Room Design DB	Heating T'stat Driftpoint	Heating T'stat Schedule	T'stat Location Flag	Mass / No. hrs Average	Carpet On Floor
1					65					NO

----- Roof Parameters -----

Room Number	Roof Number	Roof Equal to Floor?	Roof Length	Roof Width	Roof U-Value	Const Type	Roof Direction	Roof Tilt	Roof Alpha
1	1		40.9	65.67	.065	71			

----- Wall Parameters -----

Room Number	Wall Number	Wall Length	Wall Height	Wall U-Value	Wall Constuc Type	Wall Direction	Wall Tilt	Wall Alpha	Ground Reflectance Multiplier
*	1		1	.065	71	8			

---------------------------------- Wall Parameters ---------------------------------

Room Number	Wall Number	Wall Length	Wall Height	Wall U-Value	Wall Constuc Type	Wall Direction	Wall Tilt	Wall Alpha	Ground Reflectance Multiplier
1	1	952				0			
1	2	120		.45		0			
1	3	739				90			
1	4	21		0.45		90			
1	5	931				180			
1	6	120		0.45		180			
1	7	21		0.45		180			
1	8	739				270			
1	9	21		0.45		270			

-- Wall/Glass Parameters --

Room Number	Wall Number	Glass Length	Glass Width	Pct Glass or No. of Windows	Glass U-Value	Shading Coefficient	External Shading Type	Internal Shading Type	Percent Solar to Ret. Air	Visible Transmittance	Inside Visible Reflectance
M	1		1	1	0.7	.58					
1	1	17									
1	5	17									

-------------------------------------- Exposed Floor Parameters--------------------------------------

Room Number	Exposed Floor Number	-----Slab------ Perimeter Length	Loss Coefficient	---Exposed Floor--- Floor Area	Floor U-Value	Const Type	Temp Flag	Cooling Temp	Heating Temp	Adjacent Room No
1	1	280.68	.62							

-------------------- System Section Alternative #1 --------------------

----------------------------- System Type ------------------------------

System Set Number	System Type	---OPTIONAL VENTILATION SYSTEM--- Ventil Deck Location	Cooling SADBVh	Heating SADBVh	Cooling Schedule	Heating Schedule	Fan Static Pressure
1	UH						

-- Zone Assignment --

System Set Number	Ref #1 Begin	Ref #1 End	Ref #2 Begin	Ref #2 End	Ref #3 Begin	Ref #3 End	Ref #4 Begin	Ref #4 End	Ref #5 Begin	Ref #5 End	Ref #6 Begin	Ref #6 End
1	1	1										

Utility Description Reference Table

System:
UH UNIT HEATERS

Appendix F
Manufacturer's Catalog Data

Section 11300
Polymer Feed System

PolyMax

Liquid Polymer Blending System

PolyMax is a compact liquid polymer blending unit that mixes, blends and ages polymeric flocculating agents, all in one unit. The use of thin-film technology to introduce the polymer with water followed by several in-line mixing devices, provides the ideal environment for the polymer molecules to disperse into water. The integral aging chamber provides aging time from 1.5 to over 30 minutes (depending on throughput) for the polymer molecules to uncoil and activate.

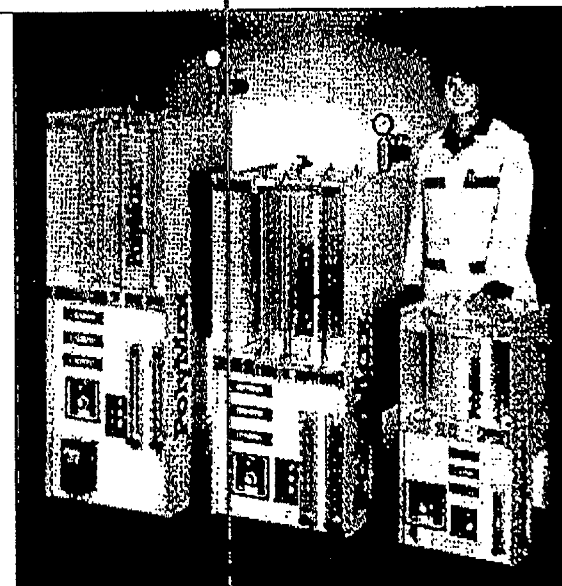
No other compact blending unit maximizes polymer activation like PolyMax. This results in **significantly** lower polymer usage and savings in operating costs.

Why does PolyMax work so well? Because, high-energy, high-shear devices such as mechanical mixers and centrifugal pumping action are avoided. These devices contribute to fracturing and break-up of the long-chain polymer molecules rendering them less effective, which results in much higher polymer usage. Rather, mixing in PolyMax is accomplished by several in-line elements combining to effect gentle, yet unusually effective and homogeneous blending of polymer and water.

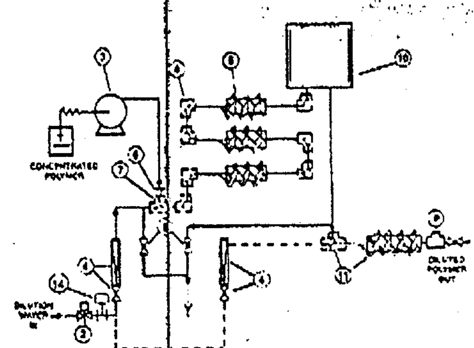
PolyMax mixing elements include an inlet mixing block that spreads the polymer into a thin film for initial combining with dilution water. Multiple 90 degree, specially baffled elements follow the inlet mixing block. Finally, three conventional in-line mixers complete the mixing/blending process. The blended polymer then passes into a detention/aging chamber containing an internal labyrinth where detention time and further gentle mixing allows the individual polymer molecules to uncoil and activate, maximizing their effectiveness. PolyMax is available in a wide range of sizes with numerous options to enhance its use. Write, fax, or telephone for Technical Bulletin 700. (See reverse side.)

PolyMax Model #	Stock Solution GPH	Dilute Solution Flow GPH
4001-40/1.0	0.01-1.0	4-40
4002-100/1.0	0.01-1.0	10-100
4003-100/2.5	0.02-2.5	10-100
4004-200/1.0	0.01-1.0	10-200
4005-200/2.5	0.02-2.5	10-200
4006-600/1.0	0.01-1.0	72-600
4007-600/2.5	0.02-2.5	72-600
4008-600/4.5	0.02-4.5	72-600
4009G-600/7	1-7	72-600
4010G-600/20	2-20	72-600
4011G-600/40	4-40	72-600
4012-1200/4.5	0.02-4.5	72-1200
4013-1200/8.0	0.04-8.0	72-1200
4014G-1200/7	1-7	72-1200
4015G-1200/20	2-20	72-1200
4016G-1200/40	4-40	72-1200
4017G-1200/100	10-100	72-1200
4018G-1200/200	20-200	72-1200
4019DF-8/7	0.04-8/1-7	72-1200
4020DF-8/20	0.04-8/2-20	72-1200
4021DF-8/40	0.04-8/4-40	72-1200
4022DF-8/100	0.04-8/10-100	72-1200
4023DF-8/200	0.04-8/20-200	72-1200

Special Low Flow Options Are Available



PolyMax is available in three different case sizes
(1) 4001-4005, 17 × 17 × 33 in.
(2) 4006-4013, 20 × 20 × 47 in.
(3) Dual feed units and gear pump units, 20 × 20 × 56 in.



Major Components

1. Control Panel
2. Inlet Water Solenoid Valve
3. Polymer Pump
4. Water Valve/Flowmeter
5. Backwash/Drain Valves
6. Polymer Check Valve
7. Inlet Mixing Block
8. Baffled 90 Degree Ells
9. In-Line Mixers
10. Detention Chamber/Labyrinth
11. Downstream Dilution
12. PolyMax Housing
13. Internal Light
14. Low Flow Switch

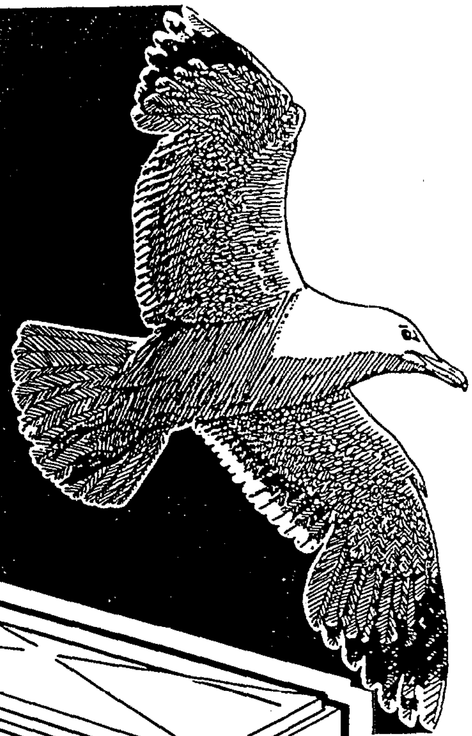
Recommended Accessories

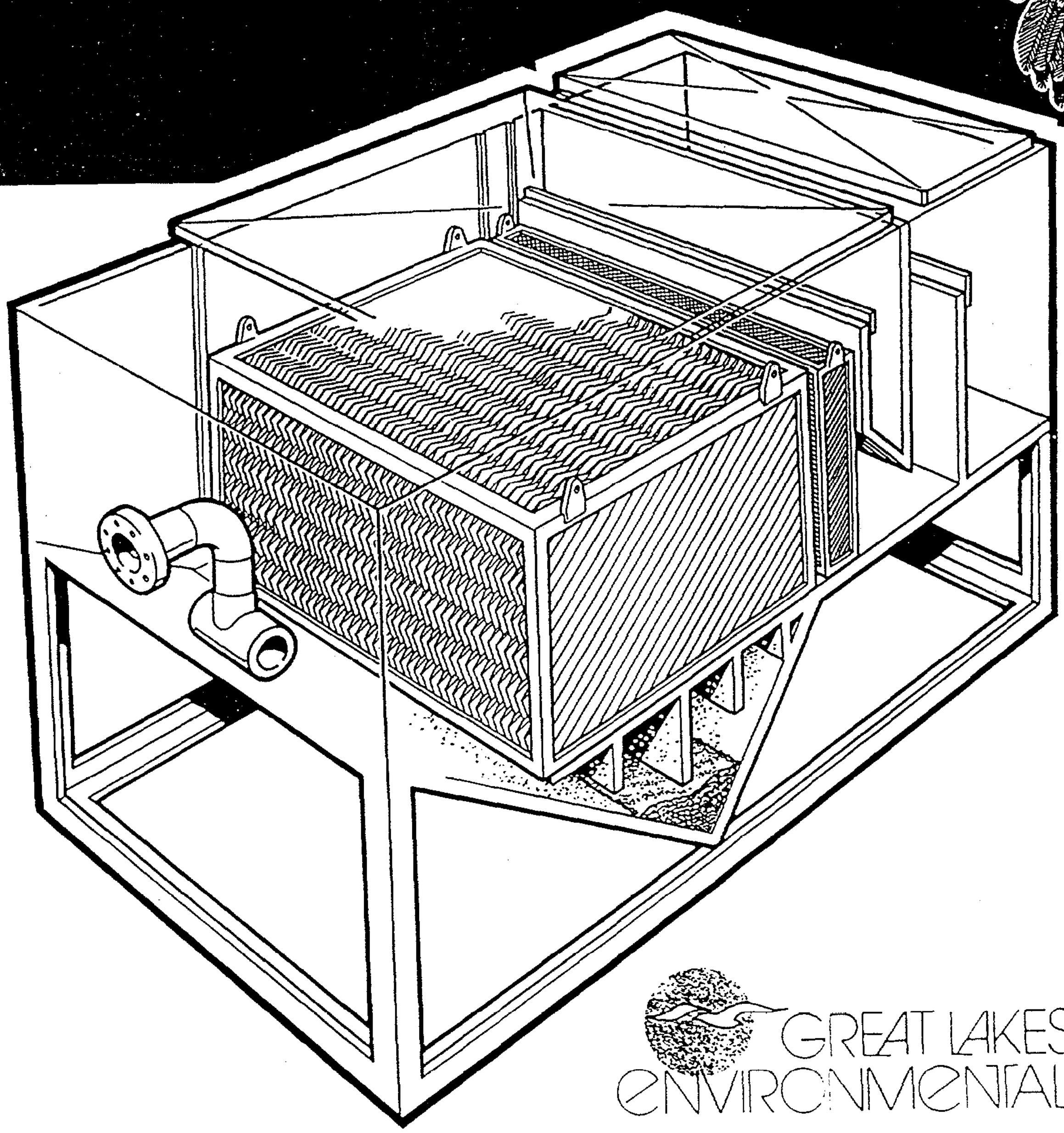
- ★ Inlet Water Pressure Regulator
- ★ Inlet Polymer Flexible Tubing, 4 ft.
- ★ Diaphragm Pump Priming Kit
- ★ Outlet Pressure Relief Valve
- ★ Outlet Shutoff Valve
- † Spare Parts Kit
- † Floor Stand
- † Pump Calibration Kit
- † Drum Cart
- † Horizontal Drum Adaptor Kit

★ Supplied standard with PolyMax
† Recommended optional accessories
Many other options available

Section 11302
Packed Gravity Oil/Water Separator

SLANT RIB COALESCING OIL/WATER SEPARATOR

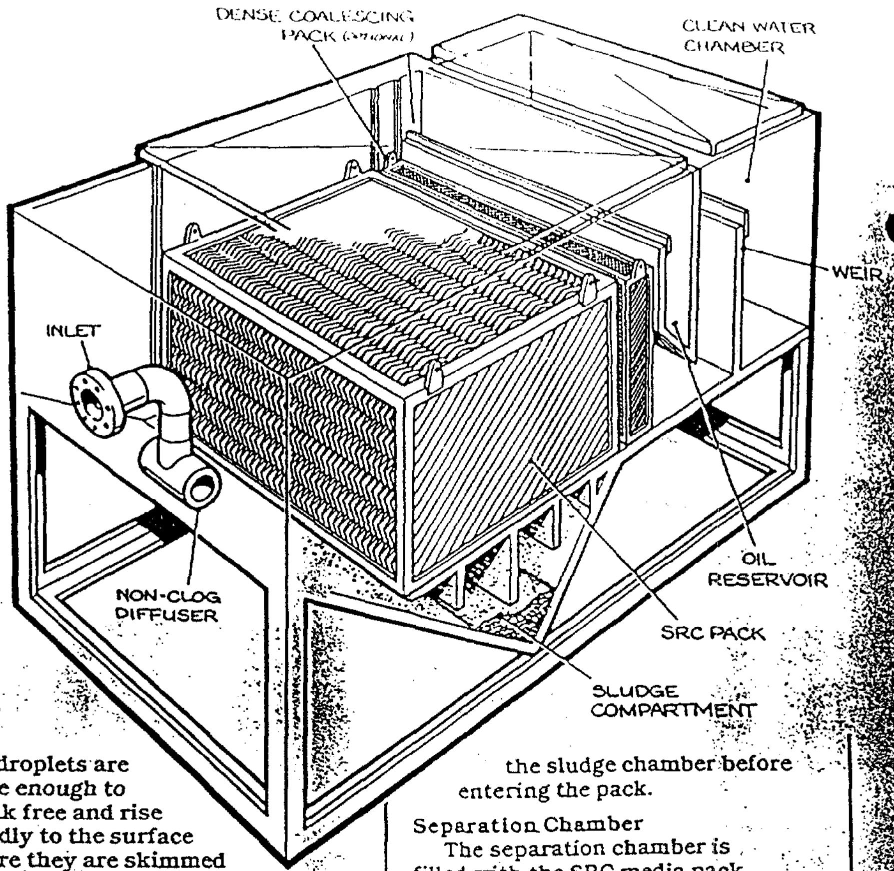




GREAT LAKES ENVIRONMENTAL

1/4

The Slant Rib Coalescing Separator is a highly effective gravity separator for the removal of dispersed oil and solids from water.



GENERAL INFORMATION

The Great Lakes Slant Rib Coalescing (SRC) Separators are capable of effectively separating oils and solids from water where the oil and solids have a specific gravity different than that of water. The SRC performance is superior to other gravity coalescing units for the separation of dispersed oil and settleable solids. Effluent concentrations of dispersed oil are less than 10 mg/L. The SRC Separators are 1/2 the volume and as little as 1/3 the length of straight gravity separators.

The Slant Rib Coalescers are installed in rectangular tanks containing special baffles and weirs designed to direct flow, skim oil and control the liquid levels in the separator. Pitched sludge compartments are provided below the separation chamber for easy sludge removal.

The separators are available in standard models with capacities from 5 GPM to 2000 GPM. They can be installed above grade, flush with grade, or below grade as required. The separators can operate entirely by gravity or pumps can be supplied for product or effluent transfer when required.

DESIGN

When certain materials are placed in the waste water flow, removal efficiencies of oil increase due to impingement on their surfaces. Plastic media is particularly effective because of its oleophilic (oil attracting) characteristics. As fine oil droplets impinge upon or pass close to the plastic surface, they are attracted to it and adhere. Additional droplets continue to be attracted and coalesce or merge with previous droplets to produce much larger droplets. At a point, the droplets are large enough to break free and rise rapidly to the surface where they are skimmed or decanted. This coalescing action allows removal of smaller droplets than is possible with a straight gravity separator.

The effectiveness of any particular coalescing media is governed by several variables; density, available surface area, velocity and direction of flow and shape of the media. All of these variables influence the potential contact area, so it becomes of particular importance to form the media properly to maximize contact while minimizing blinding. The Slant Rib Coalescing (SRC) media pack was designed with consideration of all these factors. The SRC media provides greater coalescing and solids separation area than any other media currently available. The patented shape and specific spacing of the plates provides maximum protection from blinding, while providing a series of inclines that enhance solids separation and a tortuous path through which the water must pass. This continuous change of direction insures a high degree of oil droplet contact on the plate surface with resultant coalescence and oil removal. The ribs are slanted toward the surface in the direction of flow, encouraging separated oil to float to the surface along the plates before breaking free.

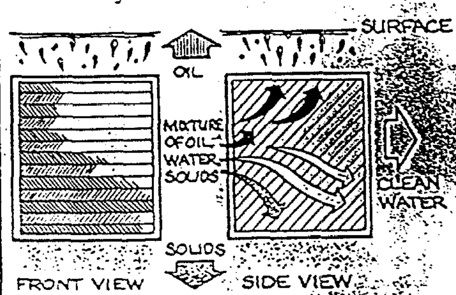
OPERATION

Inlet and Diffusion Chamber

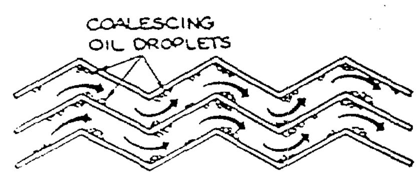
Flow enters the inlet chamber where it is dispersed through a non-clog diffuser across the width and depth of the media pack. Larger solids drop out here into the sludge chamber before entering the pack.

Separation Chamber

The separation chamber is filled with the SRC media pack. The ribbed plates are arranged vertically in the direction of flow,



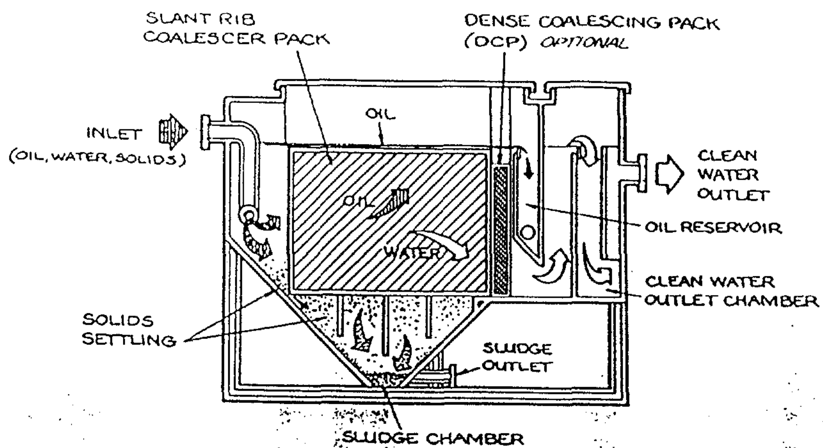
spaced ¾" apart. When looking at the side of the media pack the ribs run from the bottom of the inlet side to the top of the outlet side on a 45° angle. The depth of the ribs is more than twice the distance of the spacing creating an overlap condition. This causes the flow to zig-zag around 90° corners throughout the pack, causing resistance to flow, collisions of the droplets 20 microns and larger with the plates and coalescence. The coalesced oil has the least restricted path to exit the waste stream, and slides to the surface on the underside of the rib.



PATH OF WATER
TOP VIEW

An optional Dense Coalescer Pack (DCP) is available when additional polishing is desired.

2/4



SLANT RIB COALESCING SEPARATOR

Solids entering the pack encounter a 55° angle of inclination created by the ribs which is optimum for solids settling. The solids slide down the top of the rib and fall to the next rib gathering mass and velocity as they near the bottom of the pack and drop into the sludge chamber. The horizontal projected area of the top side of the ribs provides a conservative 0.20 GPM per square foot separation rate at design loadings.

SOLIDS SETTLING
FRONT VIEW

Sludge Chamber

The sludge chamber is located directly beneath the separation chamber and provides adequate volume for the settled sludge. The sides of the sludge chamber are sloped 45° to insure easy and complete removal of the sludge.

Oil Removal

The separated oil accumulates at the surface of the separation chamber where it displaces the water. As the oil layer increases, oil spills over a weir into an oil reservoir where it can flow by gravity or be pumped automatically to remote storage tanks.

Clean Water Chamber

The clean water leaving the SRC media pack passes under an oil retention baffle and into the effluent or clean water chamber. From there, the clean water passes over a weir which maintains the liquid level in the separator. The clean water flows by gravity through a "T" pipe outlet or effluent pumps can be provided. The "T" pipe provides an excellent spot for sampling.

Covers

Hatches are provided for easy access into the separator. Sealed vapor tight hatches are available. Lifting lugs are provided on the media packs and on the separator.

MATERIALS OF CONSTRUCTION

Materials of construction include ¼" thick Class A carbon steel, stainless steel and fiberglass. The standard Slant Rib Coalescing media is fiberglass reinforced plastic (FRP) with special additives to make the plates highly oleophilic. The plates can also be supplied in stainless steel. Fiberglass separators are constructed with an exterior welded steel frame encased in fiberglass for corrosion protection. All steel tank welds are Magnaflux tested in accordance with military specifications.

COATINGS

Above grade carbon steel tanks are coated on the exterior with coal tar epoxy. Flush with grade and below grade carbon steel tanks have asphaltum exterior coatings. Steel separators are supplied with a standard interior coating of zinc primer. Special interior and exterior coatings are available.

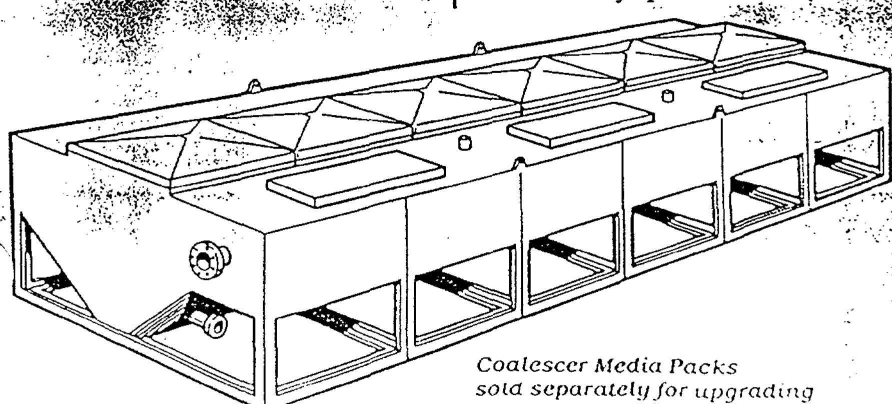
AVAILABLE OPTIONS

- Flow control package
- Water Pump out system
- Recovered Oil Pump Out System
- Effluent Oil Monitor
- Heaters for freeze protection
- Dense Coalescing Pack
- Sludge Pump Out System
- Design Flexibility to Satisfy Your Application

APPLICATIONS

- Automotive
- Airports
- Bus Terminals
- Bulk Plants
- Chemical Plants
- Fabricated Metal Plants
- Glass Factories
- Military Bases
- Oil Fields
- Petroleum Plants
- Pulp and Paper Mills
- Parking Lots
- Railroad Yards
- Textile Mills
- Tramp Oil
- Truck Terminals
- Utility Companies
- Wash Racks

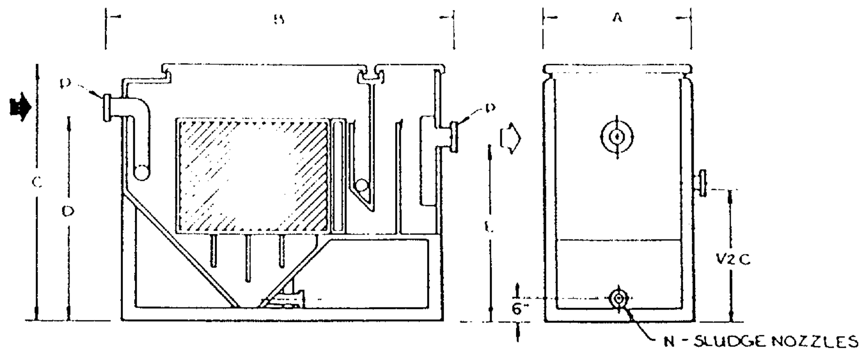
For further information contact Great Lakes Environmental, Inc., or our local representative. We will be glad to assist you in selecting a properly sized unit for your application.



Coalescer Media Packs sold separately for upgrading existing gravity separators.

GREAT LAKES ENVIRONMENTAL

Slant Rib Coalescing Oil/Water Separator



DIMENSIONS, WEIGHTS & CAPACITIES

MODEL	A	B	C	D	E	P	N	No. Packs	Coalescing Area Sq. Ft.	Settling Area Sq. Ft.	Empty Weight	Operating Weight
SRC-15	2.4′	7.3′	4.0′	3.3′	2.7′	3″	2	1	330	82	1260	2700
SRC-30	2.4′	7.3′	5.0′	4.4′	3.8′	3″	2	1	670	167	1720	4120
SRC-50	2.4′	8.3′	6.0′	5.4′	4.7′	4″	2	1	1000	250	1840	5190
SRC-75	3.4′	8.3′	6.0′	5.4′	4.7′	4″	2	1	1510	377	2130	7160
SRC-100	3.4′	8.3′	7.1′	6.5′	5.4′	6″	2	1	2010	502	3380	10650
SRC-150	5.4′	8.3′	7.1′	6.5′	5.4′	6″	2	1	3360	840	4800	16920
SRC-200	6.5′	8.3′	7.3′	6.5′	5.4′	6″	2	2	4030	1007	5380	19920
SRC-250	8.5′	8.3′	7.3′	6.5′	5.1′	8″	2	2	5370	1342	6540	25930
SRC-300	9.5′	8.3′	7.3′	6.5′	5.1′	8″	2	3	6040	1518	7251	29060
SRC-400	6.9′	14.0′	7.3′	5.7′	4.6′	10″	4	4	8060	2014	7700	30500
SRC-500	8.9′	14.0′	7.3′	5.7′	4.6′	10″	4	4	10740	2684	9200	39500
SRC-600	9.9′	14.0′	7.3′	5.7′	4.6′	10″	4	6	12080	3020	10000	44000
SRC-800	6.9′	16.7′	11.3′	9.5′	8.2′	14″	6	8	16120	4028	12100	66000
SRC-1000	8.9′	16.7′	11.3′	9.5′	8.2′	14″	6	8	21480	5368	14600	86000
SRC-1200	9.9′	16.7′	11.3′	9.5′	8.2′	14″	6	12	24160	6040	15900	96000

Dimensions and capacities are for reference only and are not to be used for construction.
Model No. represents nominal flow rates in GPM.

SRC Separators up to 4000 gpm influent flow are available

GREAT LAKES ENVIRONMENTAL
463 Vista · Addison, IL 60101 · 708-543-9444
FAX 708-543-1169

F. H. TIMBLIN CO
P. O. Box 254
Industry, PA 15052
412-643-1755

Section 11303
Centrifugal Pumps

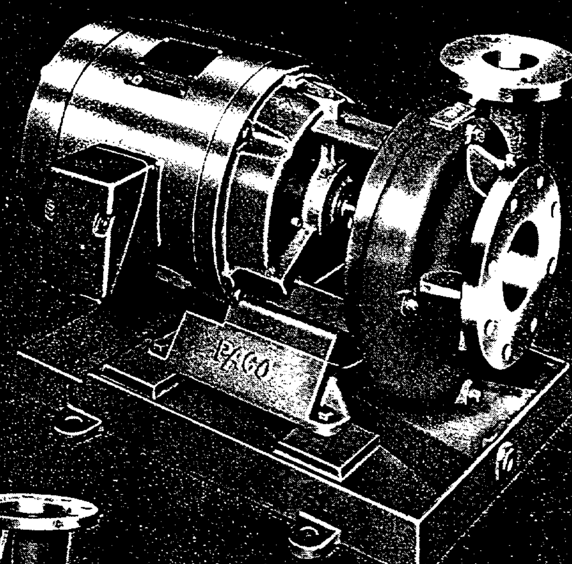
A1a

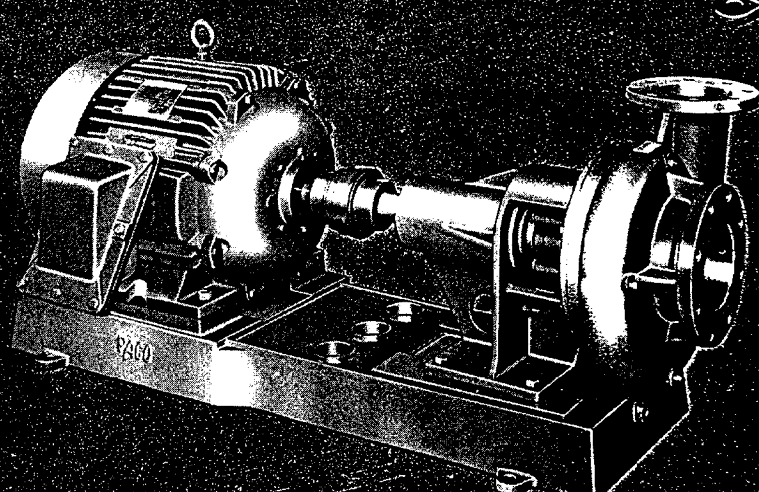
PACO®

END SUCTION CENTRIFUGAL PUMPS

TYPE L AND TYPE OL

Compact
High Performance
Versatile
Parts Interchangeability
Close Coupled Construction
Flexible Coupled Construction





Capacities to 4100 GPM
Heads to 790 Feet
Horsepowers — ⅓ to 125
Sizes — 1 to 10-inch Discharge

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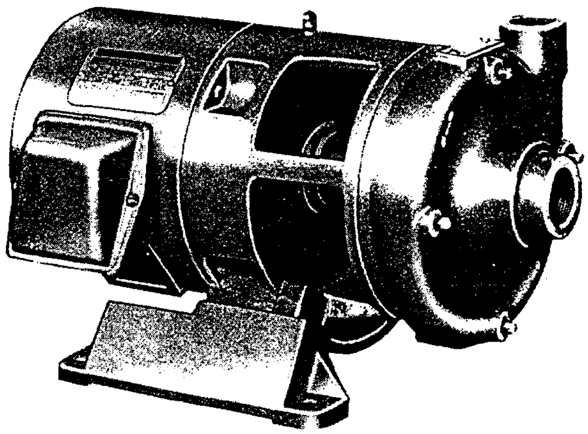
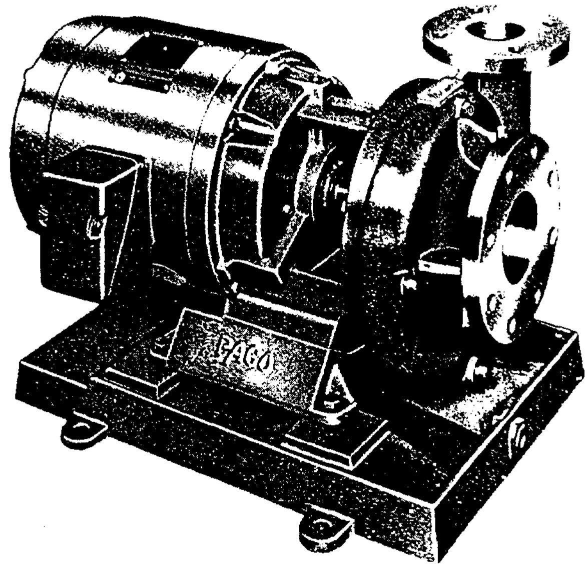
PACO®

TYPE L UNITYPE SINGLE STAGE

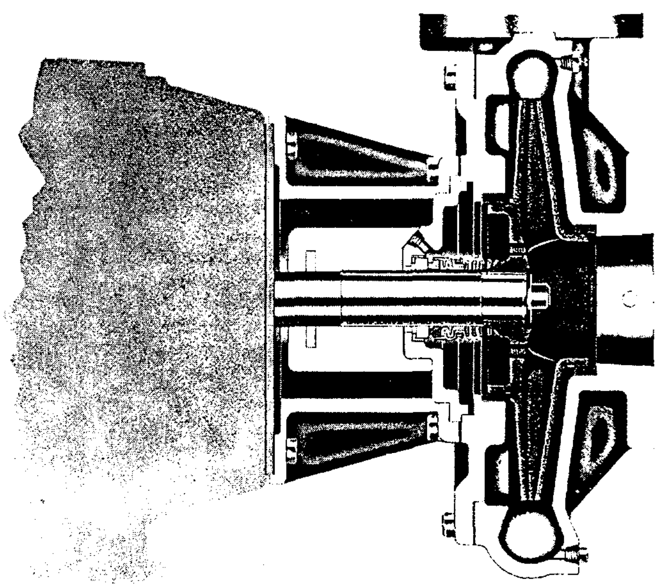
END SUCTION
CENTRIFUGAL PUMPS



Type L Unitype with threaded connections.



Type L. Unitype with flanged connections. Cast iron base optional extra.



Cut-away shows bracket and backplate detail.

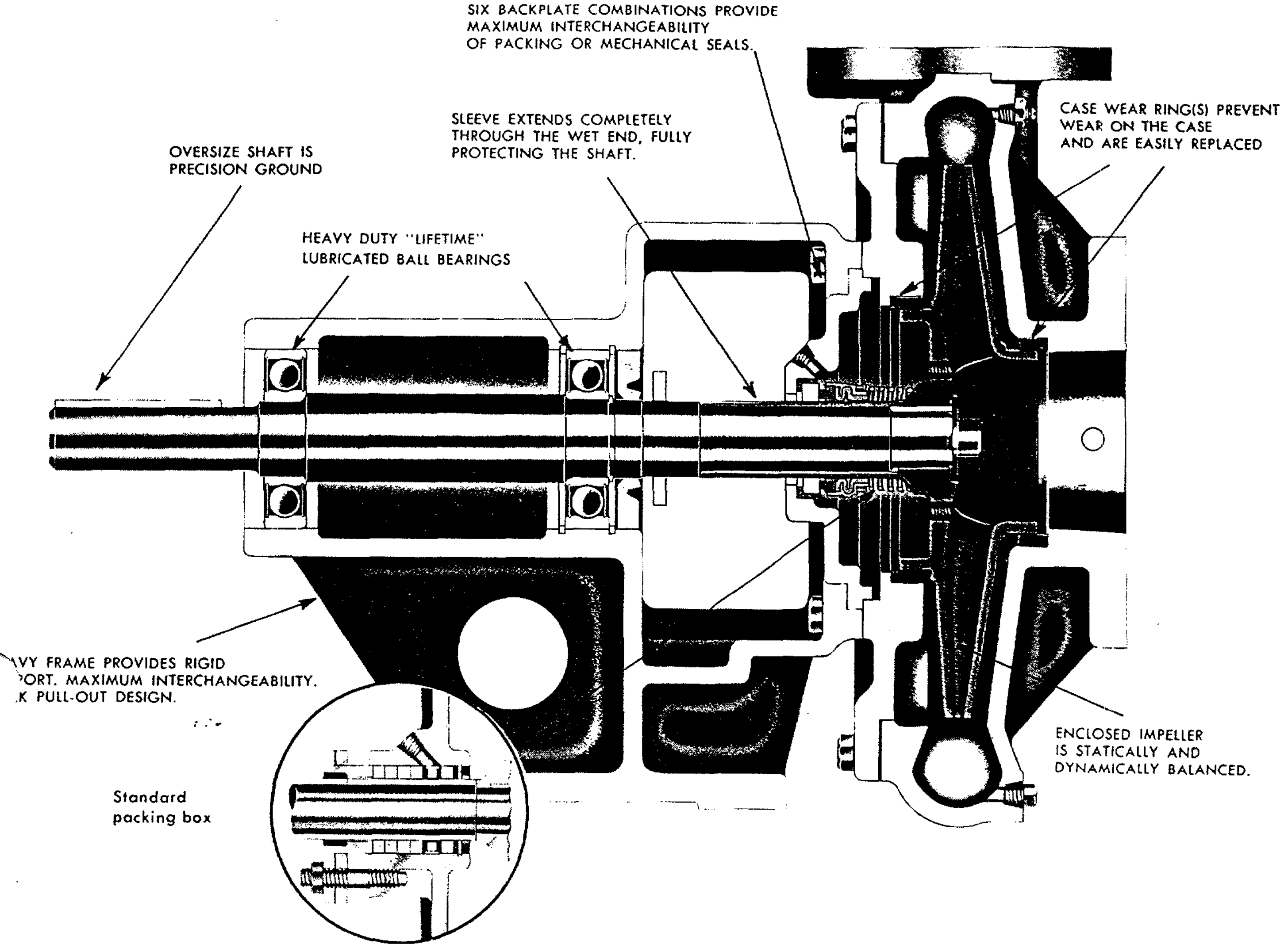
PACO type L, single stage, centrifugal pumps are available in both UNITYPE and frame mounted designs. They are designed and built for ideal compactness, high performance, durability, and versatility of application. They range in size from 1″ to 10″ with capacities as high as 4100 GPM. PACO type L pumps emphasize standardization of parts and maximum interchangeability permitting the customer a minimum of stock parts and flexibility for future modifications.

The PACO UNITYPE features a short shaft design for minimum overhang and minimum shaft deflection. UNITYPE and frame mounted mod-

2/7

TYPE L FRAME MOUNTED SINGLE STAGE

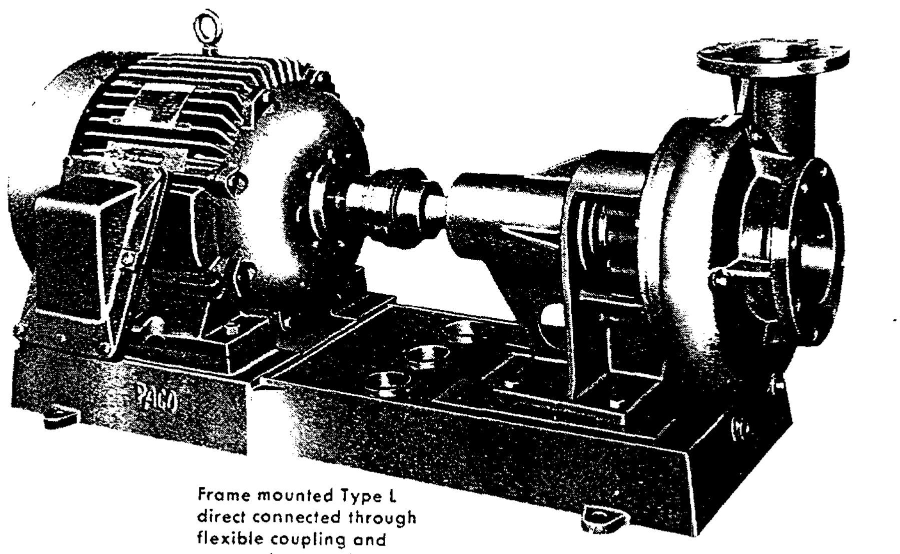
END SUCTION CENTRIFUGAL PUMPS



els may be mounted vertically or horizontally, with discharge connections available in several positions.

With their heavy frames, shafts and ball bearings, PACO frame mounted pumps are the ideal for reliable heavy duty service. They are available in 6 different frame sizes to match all HP requirements up to 180 HP.

Frame mounted models are available with cast iron bases with drip-lip and drain tapping or fabricated steel bases.



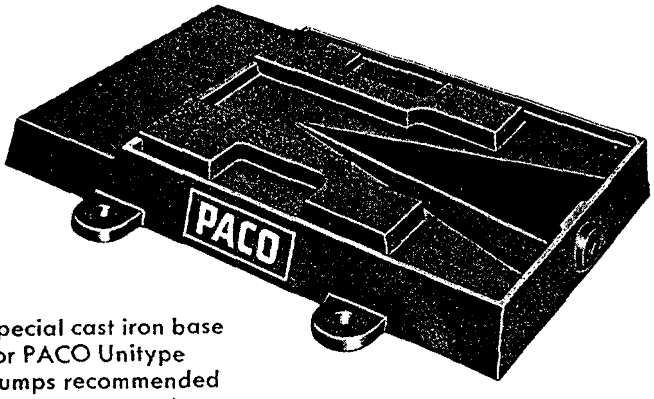
Frame mounted Type L direct connected through flexible coupling and mounted on cast iron base.

PACO®

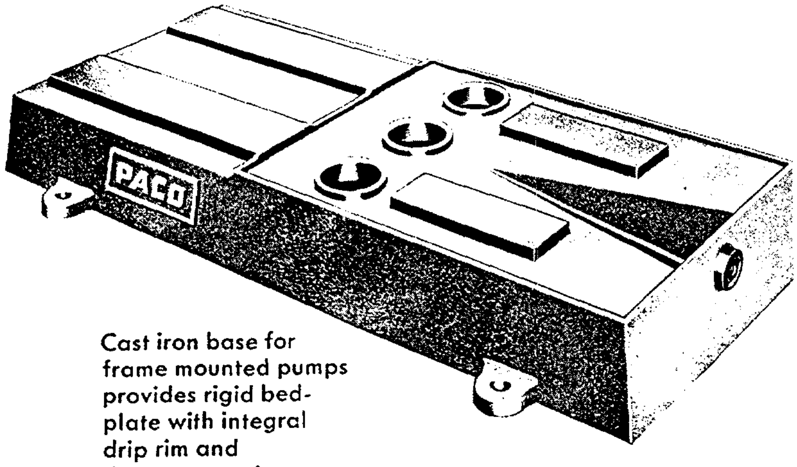
CONSTRUCTION FEATURES

END SUCTION CENTRIFUGAL PUMPS

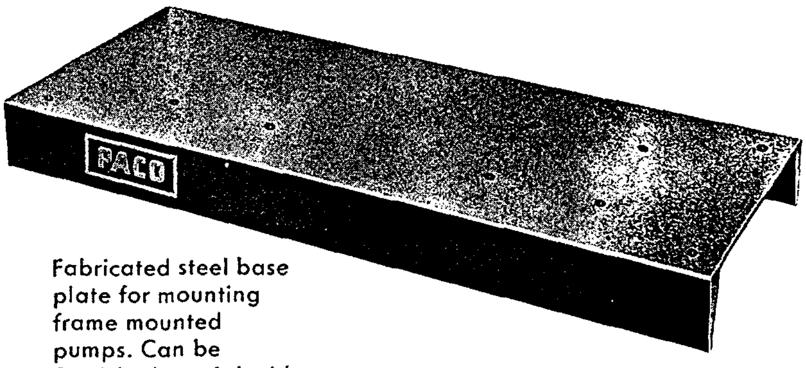
BASES



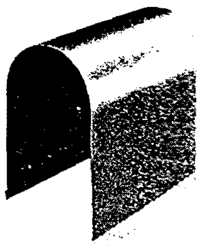
Special cast iron base for PACO Unitype pumps recommended for quietness and ease of servicing.



Cast iron base for frame mounted pumps provides rigid bed-plate with integral drip rim and drain connection.

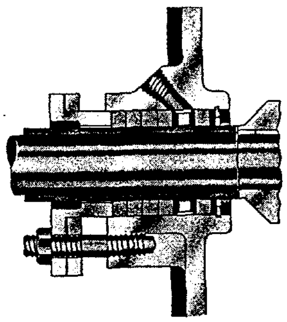


Fabricated steel base plate for mounting frame mounted pumps. Can be furnished special with fabricated drip rim and drain connection.

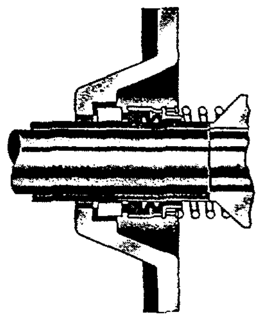


Heavy gauge coupling guards of rolled steel are available.

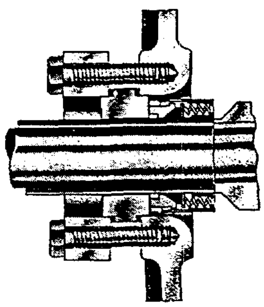
BACKPLATE CONSTRUCTIONS - TYPE L



1. STANDARD PACKING BOX



2. STANDARD MECHANICAL SEAL



3. SPECIAL MECHANICAL SEAL

The wide selection of mechanical shaft seals and packed boxes made possible by the backplate interchangeability (as shown above and on page 9), provides PACO Type L pumps with wide versatility. The PACO "quick-apart" 2-piece bronze gland packing box enables pump to be quickly and easily repacked. (see #1 above)

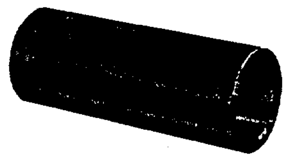
Mechanical shaft seals can be furnished for almost any liquid. Special, balanced, double and liquid cooled seals (#2 thru 6) each have special application according to liquid being pumped, temperature, pressure, presence of abrasives or other character-

4/7

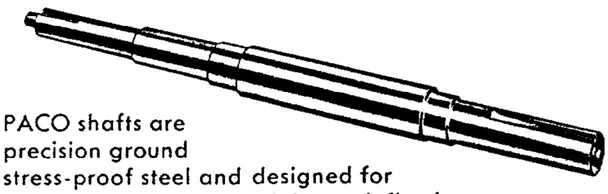
TYPES L & OL

END SUCTION CENTRIFUGAL PUMPS

Replaceable bronze shaft sleeve protects shaft from wear or corrosion. Stainless steel, monel, other metals and coatings available.

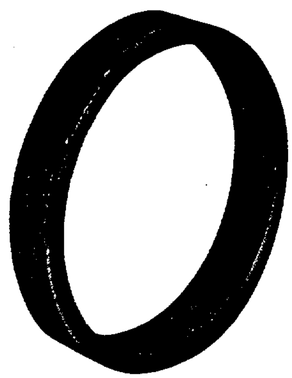


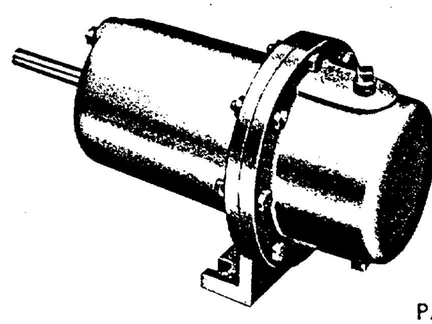
All PACO impellers are dynamically balanced. (Larger sizes are hydraulically balanced.) Iron and bronze are standard, other alloys available.



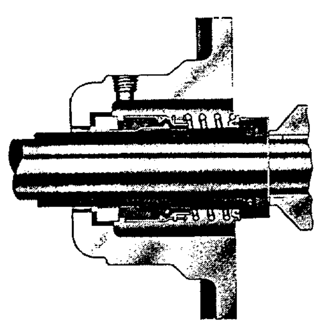
PACO shafts are precision ground stress-proof steel and designed for minimum deflection. Special alloy options available.

Bronze case wear rings prevent case wear, insure close 'earances and maximum .fficiencies. Other metals available to suit application.

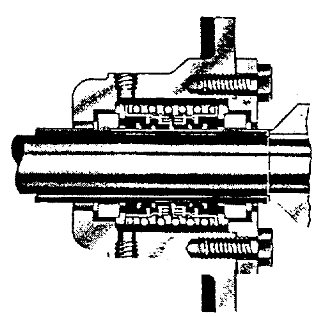




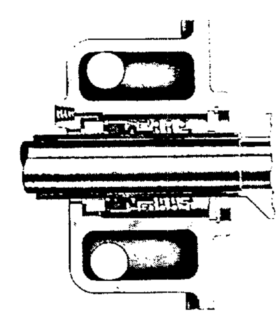
PACO pressurizer for use with double mechanical shaft seal.



4. BALANCED MECHANICAL SEAL



5. DOUBLE MECHANICAL SEAL



6. LIQUID COOLED MECHANICAL SEAL

istics of the liquid. Double shaft seals has provision 'or protection against abrasive materials by main- aining seal chamber at a higher pressure than pump pressure. (Construction features of shaft seals shown with table on page 8.)

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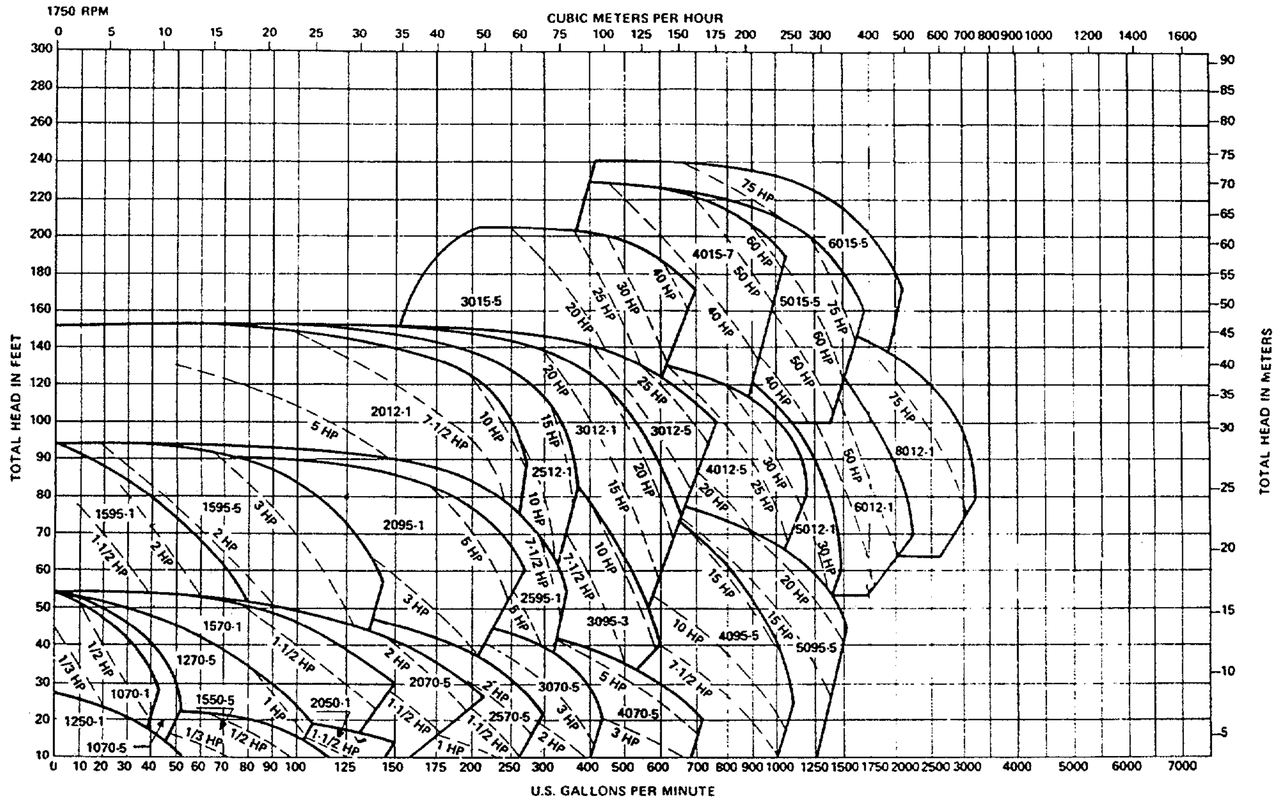
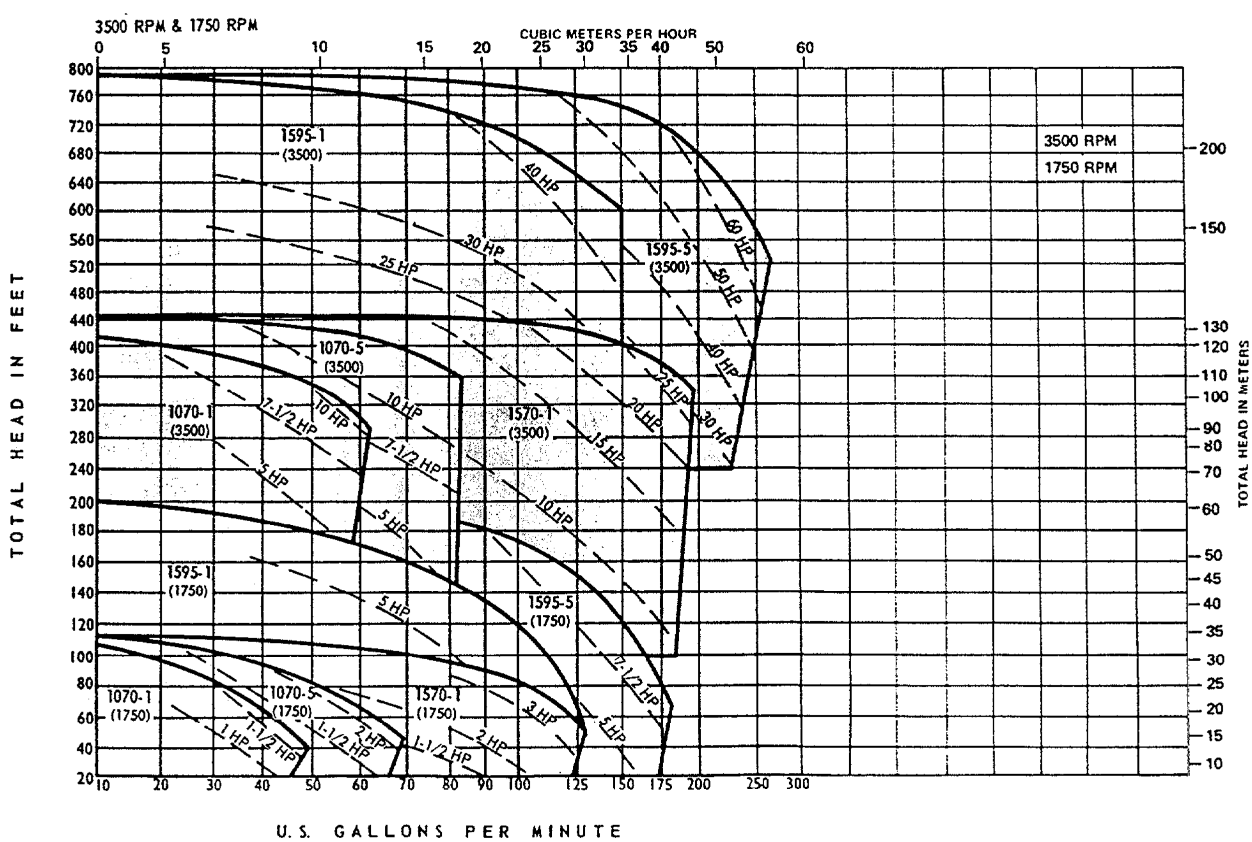
1750 RPM PUMP SELECTION CHART

END SUCTION
CENTRIFUGAL PUMPS

INDIVIDUAL PERFORMANCE CURVES MUST BE USED FOR FINAL SELECTION



TWO STAGE TYPE OL SELECTION CHART



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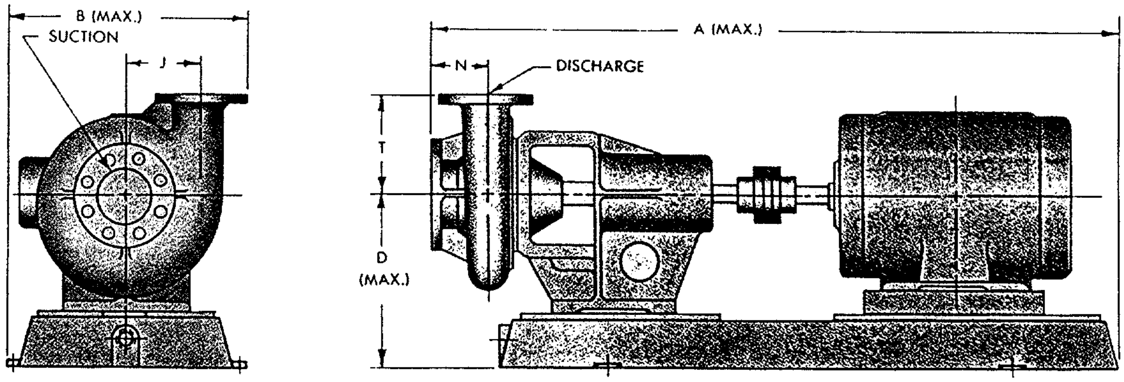
DIMENSIONS — TYPE L FRAME MOUNTED

END SUCTION CENTRIFUGAL PUMPS

1" THRU 2" HAVE THREADED CONNECTIONS

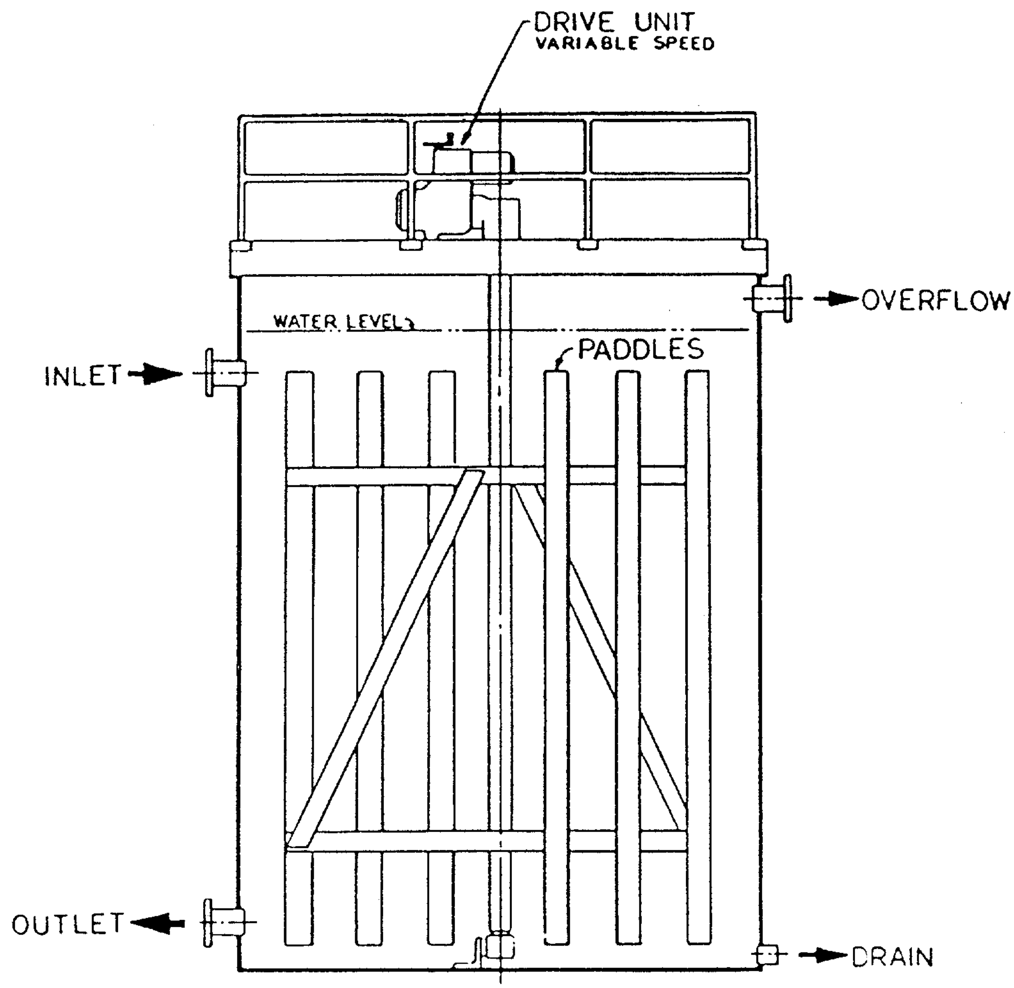
2 1/2" AND UP HAVE FLANGED CONNECTIONS



PUMP MODEL	DISCH. AND SUCT. SIZE	DIMENSIONS IN INCHES					
		A	B	D	J	N	T
1050	1" x 1 1/4"						
1070	1" x 1 1/4"	36 5/8	17 1/2	8 3/4	4	3 1/4	4 1/2
1250	1 1/4" x 1 1/4"	26 1/8	13 3/8	7	3 1/16	2 5/8	3 3/4
1270	1 1/4" x 1 1/2"	36 5/16	17 1/8	8 3/4	4 1/4	3 1/4	4 1/2
1550	1 1/2" x 2"	27 11/16	13 3/8	7	3 1/4	3 1/4	4
1570	1 1/2" x 2"	41 1/2	21 1/4	9 1/4	4 1/2	3 1/4	5 1/8
1595	1 1/2" x 2"	42 3/4	21 1/4	9 1/4	5 3/8	3 5/8	6
2050	2" x 2 1/2"	27 7/16	13 3/8	7	3 1/2	3	4 1/4
2070	2" x 2 1/2"	42 5/8	21 1/4	9 1/4	4 1/2	3 5/8	5 3/8
2095	2" x 2 1/2"	53 1/4	23 7/16	13	5 3/4	3 3/4	6
2012	2" x 2 1/2"	42 7/8	21 1/4	10	6 3/4	3 7/8	7 3/4
2570	2 1/2" x 3"	43 1/8	21 7/16	9 1/4	4 1/4	3 1/2	5 3/4
2595	2 1/2" x 3"	56	28	13	6	4	6 3/4
2512	2 1/2" x 3"	49 1/2	21 1/4	13	7	3 1/2	8 1/4
3070	3" x 4"	49 5/8	21 7/16	13	4 7/8	4	6
3095	3" x 4"	56	28	13	6 1/4	4	7
3012	3" x 4"	52 1/8	22 1/2	13	7 1/4	3 7/8	8 5/8
3015	3" x 4"	54 3/4	23 7/16	14	9	4 1/4	9 3/4
4070	4" x 5"	53 1/4	23 7/16	13	5 3/4	4 3/8	7 1/4
4095	4" x 5"	60 1/8	28 3/8	15	6 7/8	4 3/8	7 1/2
4012	4" x 5"	53 13/16	23 7/16	13	7 1/2	5 1/8	11 1/4
4015	4" x 5"	63 5/16	28	15	9 1/2	4 1/2	11
5095	5" x 6"	51 1/2	21 7/16	14	7 1/2	5 1/8	8
5012	5" x 6"	54 5/8	23 7/16	14	8 1/4	5 1/2	10 1/2
5015	5" x 6"	69 11/16	30 1/8	17	9 1/2	6	11 1/8
6012	6" x 8"	65 3/8	28	15	7 3/4	6 1/4	12 1/4
6015	6" x 8"	70 1/4	30 1/8	17	10	6 1/4	12 1/2
8012	8" x 10"	70 1/2	30 1/8	16	8	6	13
10015	10" x 12"	81 1/8	82 1/8	20	11 1/4	7 1/2	14

Section 11304
Flocculation Tank and Appurtenances

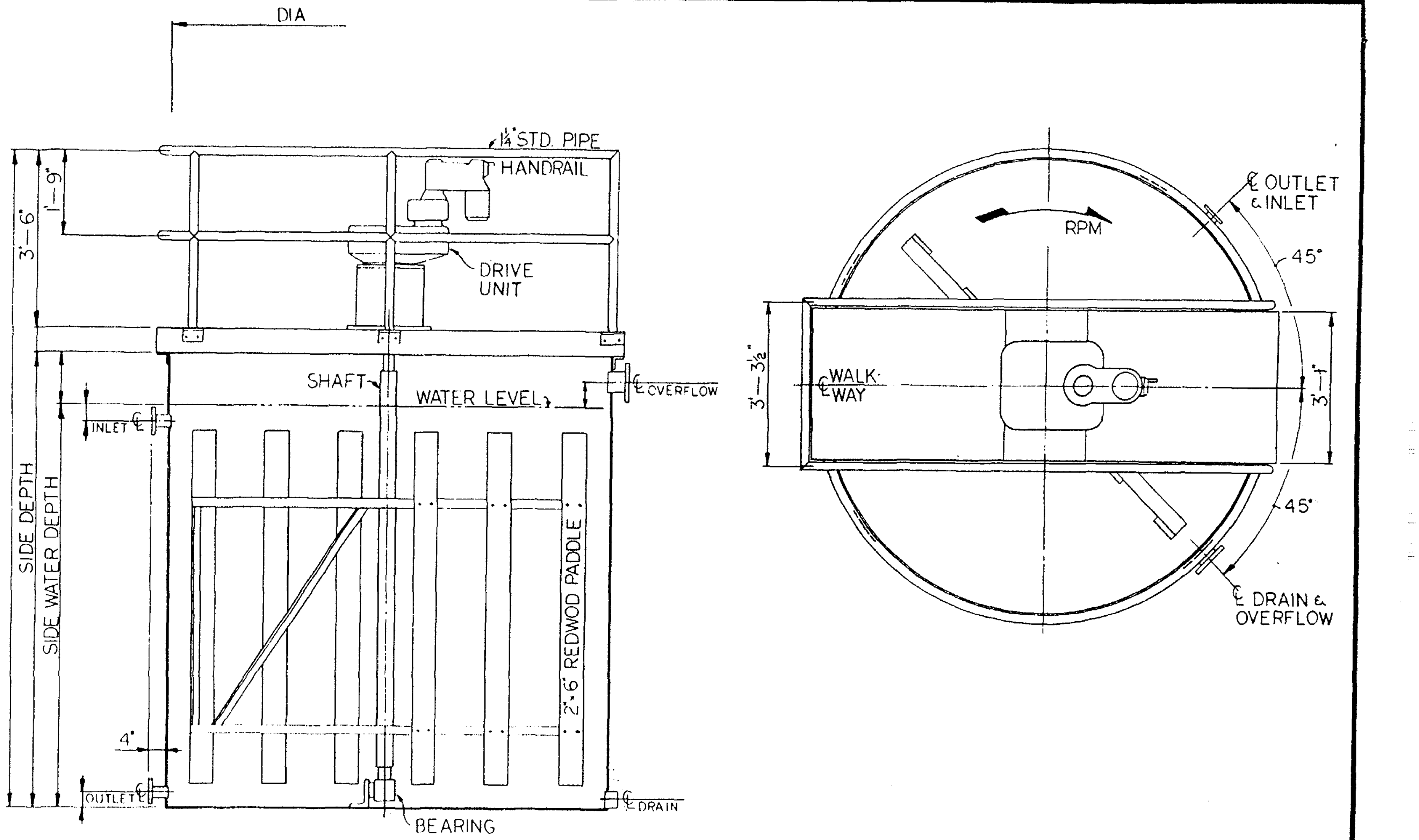
VERTICAL FLOCCULATOR
GENERAL DESCRIPTION



The WesTech Vertical Flocculator is a highly efficient mechanism that gently, but thoroughly, mixes chemically treated water by means of paddles mounted on a structural frame attached to a rotating shaft.

The action of the paddles brings solids in the water passing through the flocculation basin into contact with chemical additives, so that floc particles are formed that can be readily settled in a sedimentation basin.

The tip speed of the paddles is variable, so that an optimum speed for floc formation can be selected to suit requirements, and varied to allow for changes in the influent.



SIZE	FLOW GPM	APPROXIMATE WEIGHT LBS SHIPPING	FLOODED	CUSTOMER	PROJECT NAME

2/2

FLOCCULATOR GENERAL ARRANGEMENT
DESCRIPTION

3312
TYPE | SIZE

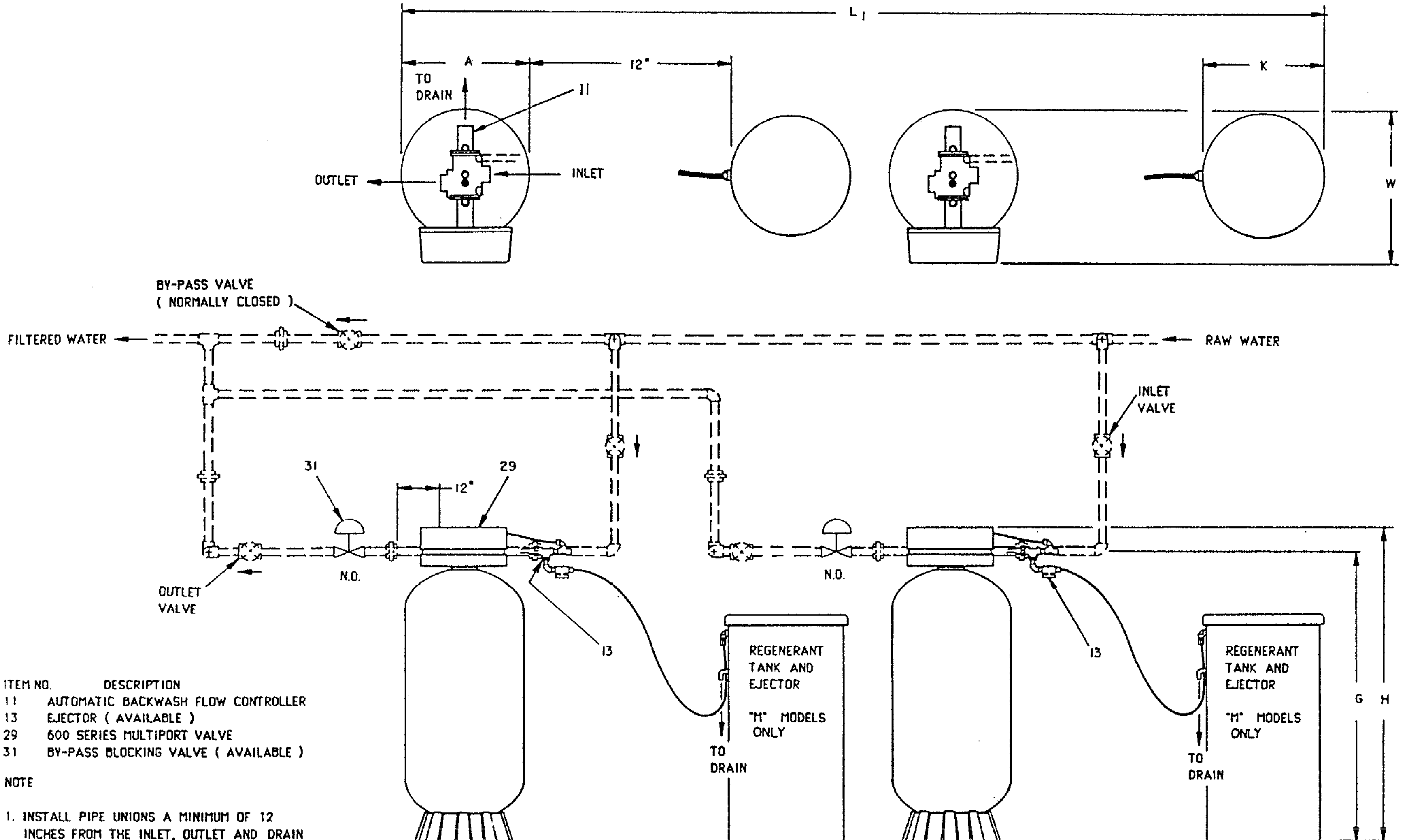
DATE	STD BY	STD CHKD	STD APPVD	SCALE	DATE	PROJ BY	PROJ CHKD	PROJ APPVD
2-16-73	chos	AG	cks	NONE				

REVISION | BY | CHKD | DATE | LTR

WesTech ENGINEERING INC

DRAWING NUMBER	PROJECT NUMBER	REV
7-3301 C 3		

Section 11306
Multi-Layer Sand Filters



ITEM NO.	DESCRIPTION
11	AUTOMATIC BACKWASH FLOW CONTROLLER
13	EJECTOR (AVAILABLE)
29	600 SERIES MULTIPORT VALVE
31	BY-PASS BLOCKING VALVE (AVAILABLE)

NOTE

1. INSTALL PIPE UNIONS A MINIMUM OF 12 INCHES FROM THE INLET, OUTLET AND DRAIN LINE ADAPTORS OF THE CONTROL VALVE.
2. ALL PIPE AND PIPE FITTINGS, ETC. SHOWN IN DASHED LINES TO BE FURNISHED BY OTHERS.

N.O. = NORMALLY OPEN

TOLERANCES (EXCEPT AS NOTED) FRACTION ± DECIMAL ± ANGLE ±

REVISIONS: NO. | DATE | REMARKS | NO. | DATE | REMARKS

DATE 9-22-86

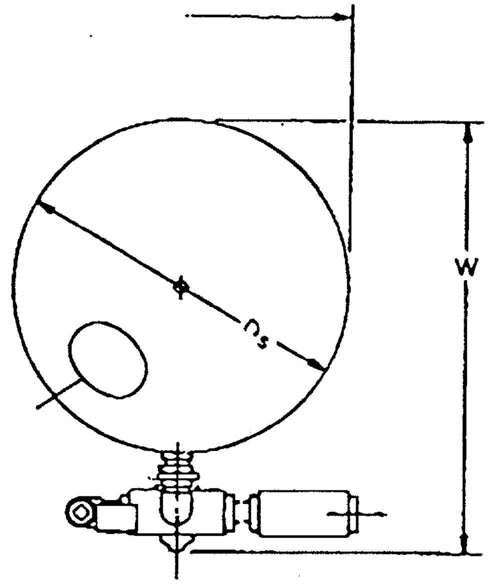
TITLE: TWIN UNIT 600 VALVE WATER FILTER (FIBERGLASS TYPE)

CUSTOMER

DWG. NO. D - 262 - 37 | REV. 0

SHEET 1 OF 1

bruner.



✱ MANHOLE

ITEM NO.	DESCRIPTION
11	AUTOMATIC BACKWASH FLOW CONTROLLER
12	WATER METER (AVAILABLE)
15	CYCLE CONTROLLER

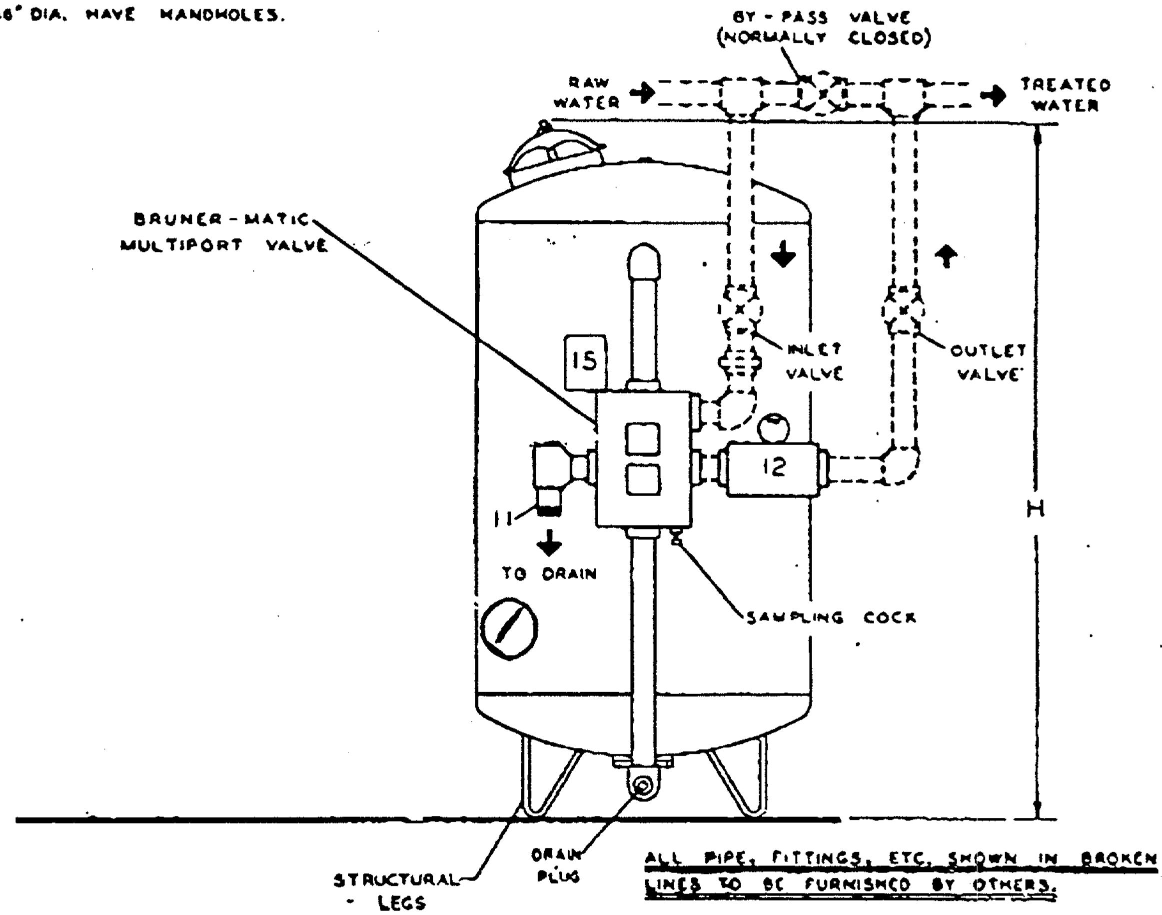
✱ CONDITIONER TANKS SMALLER THAN 36" DIA. HAVE HANDHOLES.

APPROX. DIMENSIONS

H ______ Ds ______

W ______

L ______



ALL PIPE, FITTINGS, ETC. SHOWN IN BROKEN LINES TO BE FURNISHED BY OTHERS.

BRUNER-MATIC MULTIPORT VALVE	SINGLE UNIT HEAVY DUTY	bruner CORPORATION
	BRUNER CORPORATION MILWAUKEE, WISCONSIN • CITY OF INDUSTRY, CALIFORNIA	DWG. NO. A-260-117

2/4

101

Bruner Corporation
500 West Oklahoma Avenue
Milwaukee, Wisconsin 53207
U.S.A.

414-747-3700
Telex: 6878041 Raytec
FAX: 414-747-3812

Supplementary Data Sheet

SPECIFICATIONS MULTI-LAYERED ML†

MODEL NUMBER			WATER QUALITY[2]											
			SUPERIOR		HIGH		UTILITY			TANK				
AUTO-MATIC	MANUAL GATE VALVE	PIPE SIZE[1]	FLOW RATE	PRES-SURE LOSS[3]	FLOW RATE	PRES-SURE LOSS[3]	FLOW RATE	PRES-SURE LOSS[3]	BACK-WASH RATE[5]	SIZE DIA. x SIDE SHELL	FILTER MEDIA LOAD-ING	FLOOR SPACE REQ'D. L x W	HT.[4]	OPER-ATING WEIGHT
		IN.	GPM	PSI	GPM	PSI	GPM	PSI	GPM	IN.	CU. FT.	IN.	IN.	LBS.
ML-12HF	ML-12G	1	8	5	12	8	16	12	11.5	12 x 54	2	13 x 21	60	500
ML-14HF	ML-14G	1	11	6	16	11	21	17	15	14 x 60	2.5	15 x 23	66	690
ML-16HF	ML-16G	1¼	14	7	21	12	28	18	20	16 x 60	4	17 x 25	66	850
ML-20HF	ML-20G	1¼	22	6	33	12	44	19	30	20 x 54	5	21 x 29	72	1,800
ML-20HF	ML-20G	1½	22	3	33	6	44	10	30	20 x 54	5	21 x 30	72	1,850
ML-24HF	ML-24G	1¼	31	9	47	18	63	29	45	24 x 54	7	25 x 33	74	2,350
ML-24HF	ML-24G	1½	31	5	47	9	63	16	45	24 x 54	7	25 x 34	74	2,400
ML-30HF	ML-30G	1½	49	10	74	19	98	26	75	30 x 54	10	31 x 40	79	3,675
ML-30HF	ML-30G	2	49	6	74	13	98	20	75	30 x 54	10	31 x 41	79	3,700
ML-36HF	ML-36G	2	71	9	106	17	141	27	105	36 x 60	15	37 x 46	90	5,550
ML-36HF	ML-36G	2½	71	5	106	10	141	15	105	36 x 60	15	37 x 48	90	5,650
ML-42HF	ML-42G	2½	96	7	144	13	192	20	150	42 x 60	21	43 x 53	92	8,295
ML-42HF	ML-42G	3	96	6	144	11	192	16	150	42 x 60	21	43 x 54	92	8,350
ML-48HF	ML-48G	3	126	6	188	11	251	17	180	48 x 60	27	49 x 64	86	10,400
ML-48HF	ML-48G	4	126	3	188	5	251	8	180	48 x 60	27	49 x 66	86	10,500
ML-54HF	ML-54G	3	159	8	239	15	318	22	240	54 x 60	34	55 x 70	87	12,800
ML-54HF	ML-54G	4	159	4	239	6	318	10	240	54 x 60	34	55 x 72	87	12,900
ML-60HF	ML-60G	3	197	10	295	20	393	31	300	60 x 60	43	61 x 76	89	15,800
ML-60HF	ML-60G	4	197	5	295	9	393	13	300	60 x 60	43	61 x 78	89	15,900
ML-72HF	ML-72G	4*	283	5	424	8	565	11	420	72 x 60	61	73 x 90	93	22,750
ML-72HF	ML-72G	6*	283	3	424	6	565	8	420	72 x 60	61	73 x 94	93	25,000
ML-84HF	ML-84G	4*	385	6	578	10	770	16	570	84 x 60	84	85 x 102	97	33,000
ML-84HF	ML-84G	6*	385	3	578	5	770	7	570	84 x 60	84	85 x 106	97	36,500
ML-96HF	ML-96G	6*	503	4	754	8	1005	12	750	96 x 60	109	97 x 118	101	45,000
ML-96HF	ML-96G	8*	503	2	754	4	1005	6	750	96 x 60	109	97 x 121	101	49,000

† Filter Media Consists of Various Sized, Distinctly Layered Sand.

1,2,3,4,5 Refer to back page for notes.

SPECIFICATIONS ACID NEUTRALIZER AN††

MODEL NUMBER			WATER QUALITY[2]											
			SUPERIOR		HIGH		UTILITY			TANK				
AUTO-MATIC	MANUAL GATE VALVE	PIPE SIZE[1]	FLOW RATE	PRES-SURE LOSS[3]	FLOW RATE	PRES-SURE LOSS[3]	FLOW RATE	PRES-SURE LOSS[3]	BACK-WASH RATE[5]	SIZE DIA. x SIDE SHELL	FILTER MEDIA LOAD-ING	FLOOR SPACE REQ'D. L x W	HT.[4]	OPER-ATING WEIGHT
		IN.	GPM	PSI	GPM	PSI	GPM	PSI	GPM	IN.	CU. FT.	IN.	IN.	LBS.
AN-12HF	AN-12G	1	3	1	4	1	5	3	10	12 x 54	2	13 x 21	60	425
AN-14HF	AN-14G	1	3	1	5	2	6	3	13.5	14 x 60	3	15 x 23	66	625
AN-16HF	AN-16G	1	4	1	6	2	8	4	15	16 x 60	4	17 x 25	66	850
AN-20HF	AN-20G	1	7	1	10	1	13	3	25	20 x 54	6	21 x 29	72	1,700
AN-24HF	AN-24G	1¼	9	1	14	2	19	4	35	24 x 54	9	25 x 33	74	2,250
AN-30HF	AN-30G	1½	15	2	22	4	29	6	60	30 x 54	14	31 x 40	79	3,500
AN-36HF	AN-36G	2	21	1	32	3	42	5	85	36 x 60	20	37 x 46	90	5,300
AN-42HF	AN-42G	2	29	2	43	4	58	7	115	42 x 60	28	43 x 53	92	7,900
AN-42HF	AN-42G	2½	29	1	43	2	58	4	115	42 x 60	28	43 x 54	92	8,000
AN-48HF	AN-48G	3	38	1	57	2	75	3	150	48 x 60	34	49 x 64	86	9,900
AN-54HF	AN-54G	3	48	1	72	2	95	4	190	54 x 60	44	55 x 70	87	12,200
AN-60HF	AN-60G	3	59	1	88	3	118	5	230	60 x 60	54	61 x 76	89	15,100
AN-72HF	AN-72G*	4 BWA	85	2	127	4	170	7	330	72 x 60	78	73 x 88	93	21,700
AN-84HF	AN-84G*	4 BWA	116	3	173	7	231	11	450	84 x 60	106	85 x 100	97	31,500
AN-96HF	—	6 BWA	151	5	226	9	302	15	600	96 x 60	138	97 x 112	101	41,300
AN-96HF	AN-96G	6*	151	2	226	3	302	4	600	96 x 60	138	97 x 114	101	41,200

†† Filter Media Consists of Crushed and Graded Calcium Carbonate.

1,2,3,4,5 Refer to back page for notes.

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Bruner Corporation
500 West Oklahoma Avenue
Milwaukee, Wisconsin 53207
U.S.A.

414-747-3700
Telex: 6878041 Raytec
FAX: 414-747-3812

Supplementary Data Sheet

**NOTES:
HF SERIES
FILTERS
ML & AN**

1. 4BWA-Minimum 4" water supply required. Filter manifold connections 3" inlet and outlet and 3" backwash assist.
   Reference: Drawing series D-262-16 (automatic units only).

   6BWA-Minimum 6" water supply required. Filter manifold connections 3" inlet and outlet and 4" backwash assist.
   Reference: Drawing D-262-16.

   4",6",8" - Filter manifold is a manual or automatic butterfly valve nest
   Reference: Drawing series D-262-17.

   All other models feature the BRUNERMATIC multiport valve.
   Reference: Drawing series D-262-13, 14, 15.

2. As a general rule - Lower flows produce higher quality water and larger volume of treated water between backwashing.

   SUPERIOR
   - Recommended for most filtering applications under all operating conditions.
   - Best quality water
   - Maximum time on line between backwashing
   - Lowest pressure loss
   - Recommended for influent suspended solids loads up to and greater than 300 ppm.

   HIGH
   - Well suited for many filtering applications
   - Very good quality water
   - Moderate time on line between backwashing
   - Increased pressure loss
   - Recommended for influent suspended solids loads less than 300 ppm.

   UTILITY
   - Flow rates listed are at peak design - operation at higher flow rates not recommended
   - Satisfactory water quality
   - Shorter on line time
   - Higher pressure loss
   - Recommended for influent suspended solids loads less than 150 ppm.

   Multi layered filters are capable of 10 micron effluent water quality or better.
   All other filter types are capable of 40 micron effluent water quality or better.

3. All pressure drop figures are based on new filter media and a water temperature of 60 °F.
   N.R. - not recommended.

4. Allow a minimum of 24" above filter for access into top of tank.

5. It is recommended that filters be backwashed before the pressure drop increases by 12 p.s.i. over the pressure drop of a clean filter.

   a. Other special filter media and tank sizes are available through our engineering department.
   b. Consult factory for applications on water temperatures above 120 °F.
   c. Refer to HF sales bulletin 2-2200 for further sales information.

4/4

Section 11307
Low Profile Air Stripper Package

ShallowTray
low profile air strippers

April 19, 1993

Alan Larson
Baker Environmental, Inc.
Airport Office Park,Bldg. 3
420 Rouser Rd.
Coraopolis, PA 15108

RE: Proposal #393515-1
SITE ID: Hadnot Point
Jacksonville, NC

Dear Alan,

I have revised proposal #393515-1 for our **four-tray Model 3641** ShallowTray low profile air stripper for your remediation application.

I understand that the treatment flow rate is **80 gpm** and the water temperature is 50°F. ShallowTray systems are more tolerant of inorganics than other types of aeration equipment, however, high concentrations can cause operational difficulties if proper precautions are not taken.

Expected performance for the **Model 3641** ShallowTray air stripper operating at **80 gpm** (normal operation range is 1-90 gpm) and 50°F is as follows:

Contaminant	Untreated ppb	After 1st Tray ppb	After 2nd Tray ppb	After 3rd Tray ppb	After 4th Tray ppb
Vinyl Chloride	300	3	<1	<1	<1
Trichloroethylene	180	9	1	<1	<1
c-1,2-Dichloroethylene	42,000	2,381	135	8	1
Benzene	7,900	1,344	229	39	7

The price for one ShallowTray Model 3641, with optional components, is listed below:

Basic System Model 3641	
Sump tank & 1 tray, 304L stainless steel	
3 Additional tray(s), 304L stainless steel	
Blower, 4 tray, 7.5 hp, 900 cfm @ 18wc, 3 phase, 230V, EXP	
Inlet screen and damper, 304L stainless steel demister, air pressure gauge, spray nozzle, sight tube, gaskets, stainless steel latches, Schedule 80 PVC piping, tray cleanout ports, steel frame.	
Basic System Price	$22,929

Options		
Oil / Water separator	0	$0
Oil / Water separator options (alarm & hi-level switches, frame)	0	$0
Feed pump, 90 gpm, 50 tdh, 3 hp, 3 phase, 230V, EXP	1	$1,111
Discharge pump, 90 gpm, 50 tdh, 3 hp, 3 phase, 230V, EXP	1	$1,111
Additional blower	0	$0
Blower start/stop panel	0	$0
NEMA 3R main disconnect switch	1	$98
Standard NEMA 3R control panel with alarm interlocks, motor starter, panel light, UL Listed (for remote mount)	0	$0
Standard NEMA 3R control panel with pump level controls, alarm interlocks, motor starter, panel light, UL Listed (for remote mount)	1	$2,660
Control panel IS components	2	$644
Intermittent operation	1	$728
Strobe alarm light	0	$0
Alarm horn	0	$0
Low air pressure alarm switch	1	$171
High water level alarm switch	1	$70
Discharge pump level switch	1	$70
Water pressure gauges	1	$47
Digital water flow indicator & totalizer	1	$963
Air flow meter	1	$144
Temperature gauges	1	$39
Line sampling ports	2	$53
Air blower silencer	0	$0
Washer wand	1	No Charge
Auto dialer	0	$0
Other	0	$0
Options Cost		$7,908
Price With Options		$30,836

The system is 7'3" high, 6'2" long and 5' wide and weighs approximately 1,840 lbs. Customer to supply feed pump Hi/Lo probes and Hi/Hi tank alarm probes.

All systems are shipped pre-assembled and factory tested. Normal shipment is approximately 4 weeks from receipt of order. Purchase terms are 30% with the order, 70% net 30 days from delivery. Prices are valid for 90 days only. I look forward to working with you on this project. Once again, thank you for your interest in our products.

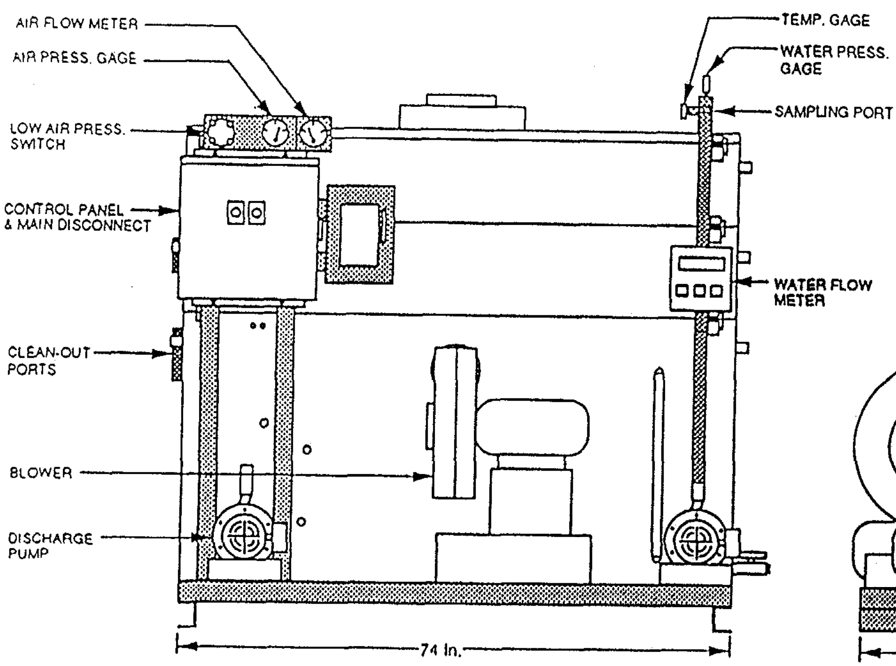
Sincerely,

David Steele

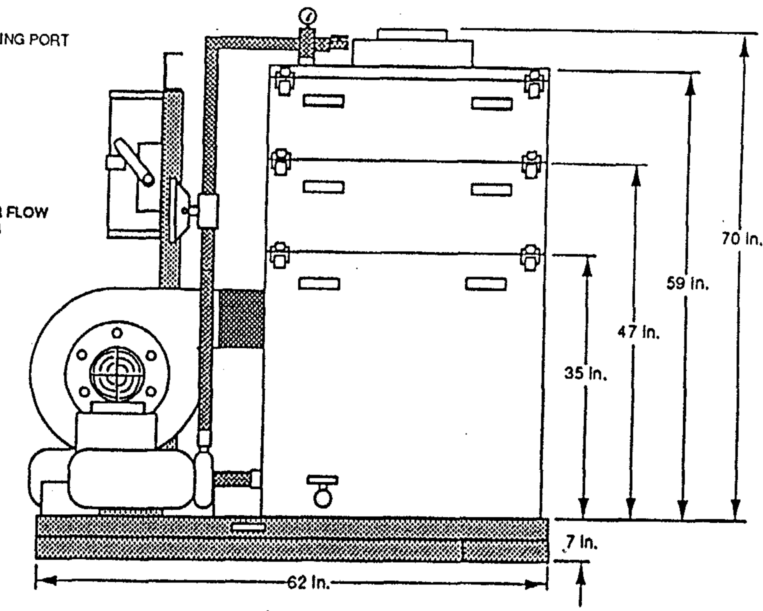
David Steele
Customer Service

File: Baker Env., Inc.

FRONT



RIGHT SIDE



MINIMUM CLEARANCE

FRONT	1.5 ft.
TOP	34 in.
REAR	N/A
LEFT	3.5 ft.
RIGHT	1 ft.

BASIC SYSTEM

- ✓ SUMP TANK
- ✓ AERATION TRAYS
- ✓ BLOWER
- ✓ AIR PRESSURE GAGE
- ✓ DEMISTER PAD
- ✓ PIPING
- ✓ SPRAY NOZZLE
- ✓ WATER LEVEL SIGHT TUBE
- ✓ GASKETS
- ✓ LATCHES
- ✓ FRAME

OPTIONAL ITEMS

- ✓ DISCHARGE PUMP
- ✓ FEED PUMP
- ADDITIONAL BLOWER
- ✓ EXP MOTORS
- BLOWER START/STOP PANEL
- ✓ CONTROL PANEL
- ✓ MAIN DISCONNECT SWITCH
- ✓ IS COMPONENTS/REMOTE MOUNT
- ✓ INTERMITTENT OPERATION
- __ STROBE LIGHT
- __ ALARM HORN
- __ POWER LOSS INDICATOR
- ✓ LOW AIR PRESSURE ALARM SWITCH
- ✓ HIGH WATER LEVEL ALARM SWITCH
- ✓ DISCHARGE PUMP LEVEL SWITCH
- ✓ WATER PRESSURE GAGES
- ✓ DIGITAL WATER FLOW INDICATOR
- ✓ AIR FLOW METER
- ✓ TEMPERATURE GAGES
- ✓ LINE SAMPLING PORTS
- AIR BLOWER SILENCER
- ✓ WASHER WAND
- __ AUTO DIALER

NOTE:

1. DRAWING REPRESENTS A UNIT TYPICAL TO THE SPECIFICATION YOU REQUESTED. MINOR CHANGES MAY RESULT IN THE MANUFACTURING PROCESS

POWER: 3Ø, 230volt, 4 WIRE and GROUND

*CONSULT N.E.E.P. FOR AMPACITIES AND OTHER VOLTAGE OPTIONS

CONNECTION INFORMATION

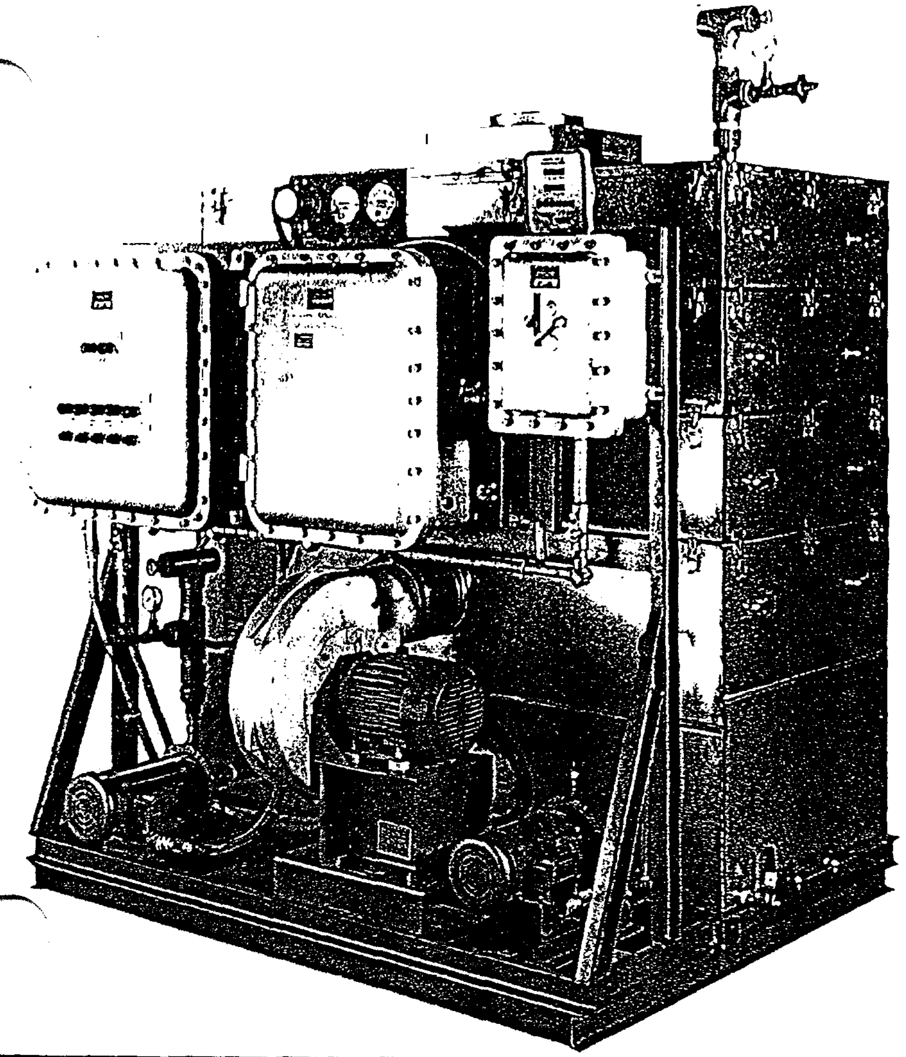
ITEM	SIZE
GRAVITY DISCHARGE	3 in. Ø FEMALE SLIP JOINT, PVC80
DISCHARGE PUMP	2 in. Ø FEMALE SLIP JOINT, PVC80
WATER INLET	2 in. Ø FEMALE SLIP JOINT, PVC80
AIR EXHAUST NOZZLE	8 in. Ø FLANGE

NORTH EAST ENVIRONMENTAL PRODUCTS, INC.
17 TECHNOLOGY DRIVE
WEST LEBANON, NH 03784
(603) 298-7061

TOLERANCES UNLESS OTHERWISE SPECIFIED ± 1 in.	DRAWING NAME: 3621		
	DRAWING #: PROPOSAL #393515		
DRAWN: DS	CUSTOMER: Baker Env.		
DATE: 3/5/93	SCALE:	SIZE: A	SHEET: OF:

3/18

3600 Series

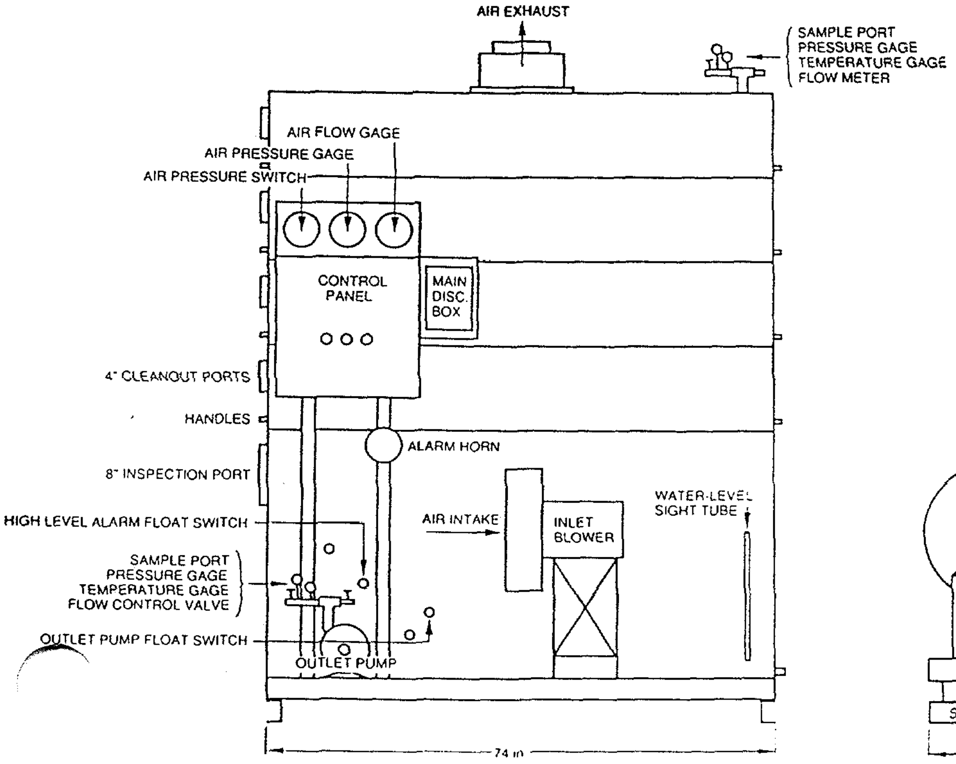


Model Pictured: 3631

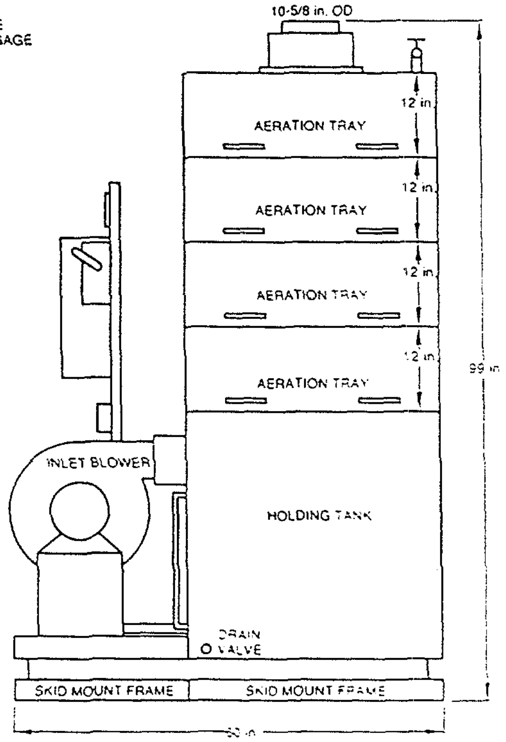
Options chosen for system pictured:

- ☑ EXP Feed and Discharge pumps
- ☑ Two NEMA 7 control panels with alarm interlocks, motor starters and intrinsically safe relays for the ShallowTray system, as well as EXP controls for two well pumps, an oil water separator and surge tank
- ☑ NEMA 7 main disconnect switch
- ☑ Low air pressure alarm switch
- ☑ High water level alarm switch
- ☑ Discharge pump level switch
- ☑ Water pressure gauges
- ☑ Digital water flow indicator and totalizer
- ☑ Air flow meter
- ☑ Temperature gauges
- ☑ Line sampling ports

Typical 3641 Configuration*



FRONT VIEW



RIGHT SIDE VIEW

*Use these drawings as a guideline only. Systems are built to your project's specifications.

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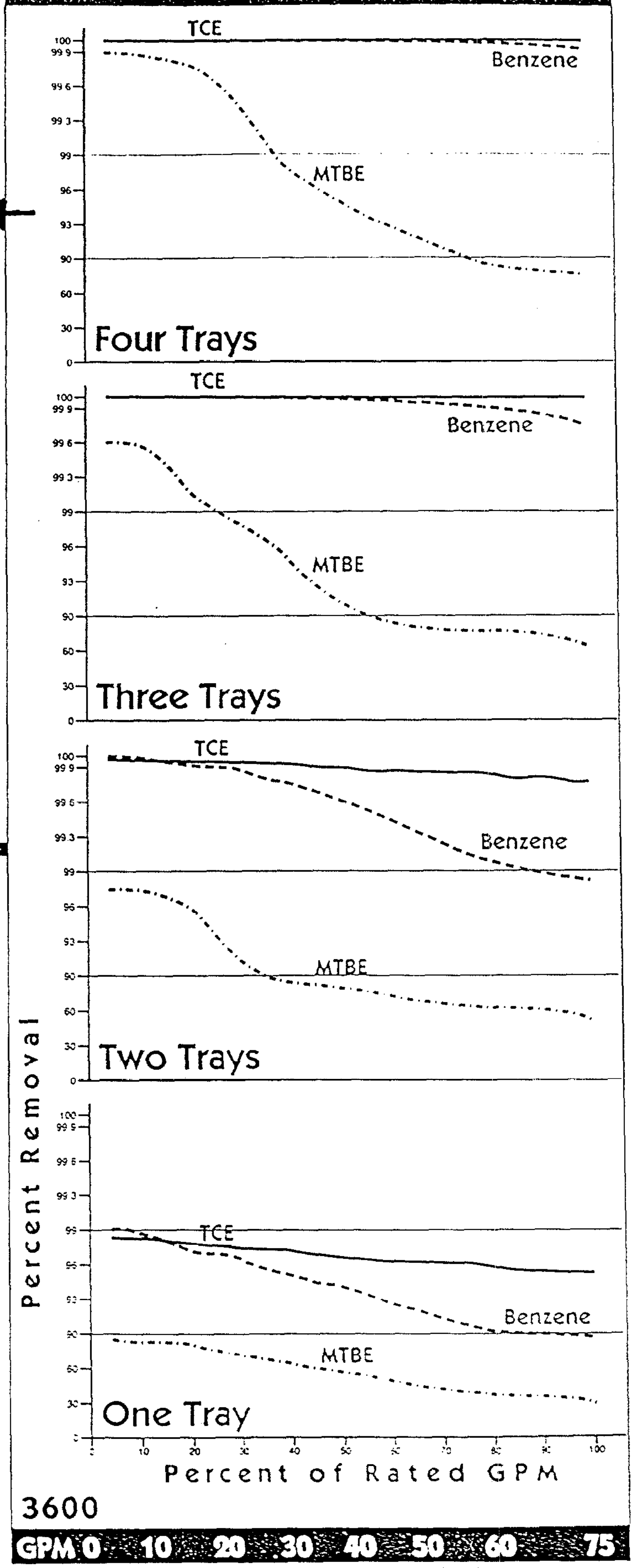
Models	flow rate	# trays	width	length	height	min. cfm	approx. lbs.
3611	1-75gpm	1	5'	6'2"	5'3"	900	1240
3621	1-75gpm	2	5'	6'2"	6'3"	900	1440
3631	1-75gpm	3	5'	6'2"	7'3"	900	1640
3641	1-75gpm	4	5'	6'2"	8'3"	900	1840

ShallowTray

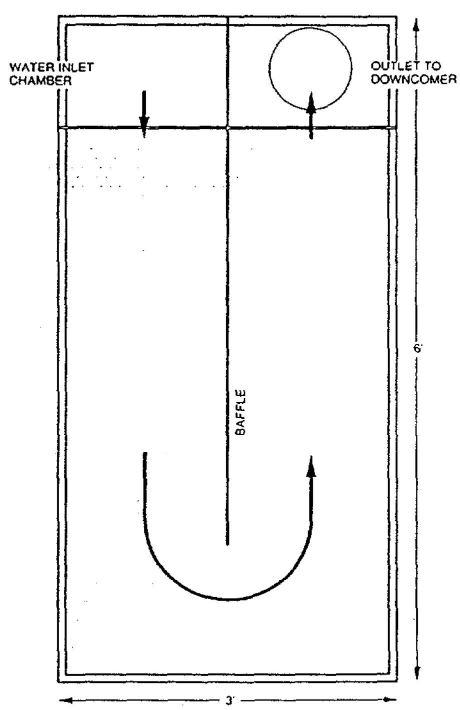
o profile air strippers

Percent Removal vs. Flow Rate



The graphs represent approximate removal efficiencies. Use the ShallowTray™ modeling program to calculate expected performance.

3600 AERATION TRAY



TOP VIEW

ShallowTray™

low profile air strippers

System Performance Estimate

Client & Proposal Information:

Baker Env.
393515-2
Option 1,Avg.

Model chosen:	3600
Water Flow Rate:	80.0 gpm
Air Flow Rate:	900 cfm
Water Temp:	63.0 F
Air temp:	40.0 F
A/W Ratio:	84.1 cu. ft/ cu. ft
Safety Factor	None

Contaminant	Untreated Influent	Model 3611 Effluent Water Air(lbs/hr) % removal	Model 3621 Effluent Water Air(lbs/hr) % removal	Model 3631 Effluent Water Air(lbs/hr) % removal	Model 3641 Effluent Water Air(lbs/hr) % removal
Benzene	290 ppb	35 ppb 0.010204 88.1978%	5 ppb 0.011405 98.6071%	1 ppb 0.011565 99.8356%	<1 ppb 0.011603 99.9806%
c-1,2-Dichloroethylene	1870 ppb	62 ppb 0.072352 96.6985%	3 ppb 0.074713 99.8910%	<1 ppb 0.074830 99.9964%	<1 ppb 0.074833 99.9999%
Trichloroethylene	650 ppb	19 ppb 0.025251 97.0993%	1 ppb 0.025971 99.9159%	<1 ppb 0.026011 99.9976%	<1 ppb 0.026011 99.9999%
Vinyl Chloride	325 ppb	2 ppb 0.012926 99.4372%	<1 ppb 0.013005 99.9968%	<1 ppb 0.013006 100.0000%	<1 ppb 0.013006 100.0000%

This report has been generated by ShallowTray Modeler software version 1.3.0. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. The software will accurately predict the system performance when both the equipment and the software are operated according to the written documentation and standard operation. North East Environmental Products, Inc. cannot be responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment. Report generated: 4/28/93

ShallowTray™
low profile air strippers

System Performance Estimate

Client & Proposal Information:

Baker Env.
393515-2
Option 1
95%

Model chosen: 3600
Water Flow Rate: 80.0 gpm
Air Flow Rate: 900 cfm
Water Temp: 63.0 F
Air temp: 40.0 F
A/W Ratio: 84.1 cu. ft/ cu. ft
Safety Factor None

Contaminant	Untreated Influent	Model 3611 Effluent Water Air(lbs/hr) % removal	Model 3621 Effluent Water Air(lbs/hr) % removal	Model 3631 Effluent Water Air(lbs/hr) % removal	Model 3641 Effluent Water Air(lbs/hr) % removal
Benzene	**770 ppb**	**91 ppb** 0.027172 88.1978%	**11 ppb** 0.030373 98.6071%	**2 ppb** 0.030734 99.8356%	**<1 ppb** 0.030808 99.9806%
c-1,2-Dichloroethylene	**4460 ppb**	**148 ppb** 0.172556 96.6985%	**5 ppb** 0.178279 99.8910%	**<1 ppb** 0.178472 99.9964%	**<1 ppb** 0.178478 99.9999%
Trichloroethylene	**1520 ppb**	**45 ppb** 0.059026 97.0993%	**2 ppb** 0.060747 99.9159%	**<1 ppb** 0.060825 99.9976%	**<1 ppb** 0.060827 99.9999%
Vinyl Chloride	**325 ppb**	**2 ppb** 0.012926 99.4372%	**<1 ppb** 0.013005 99.9968%	**<1 ppb** 0.013006 100.0000%	**<1 ppb** 0.013006 100.0000%

This report has been generated by ShallowTray Modeler software version 1.3.0. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. The software will accurately predict the system performance when both the equipment and the software are operated according to the written documentation and standard operation. North East Environmental Products, Inc. cannot be responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment. Report generated: 4/28/93

ShallowTray™

low profile air strippers

System Performance Estimate

Client & Proposal Information:

Baker Env.
393515-2
Option 1

Max.

Model chosen: 3600
Water Flow Rate: 80.0 gpm
Air Flow Rate: 900 cfm
Water Temp: 63.0 F
Air temp: 40.0 F
A/W Ratio: 84.1 cu. ft/ cu. ft
Safety Factor None

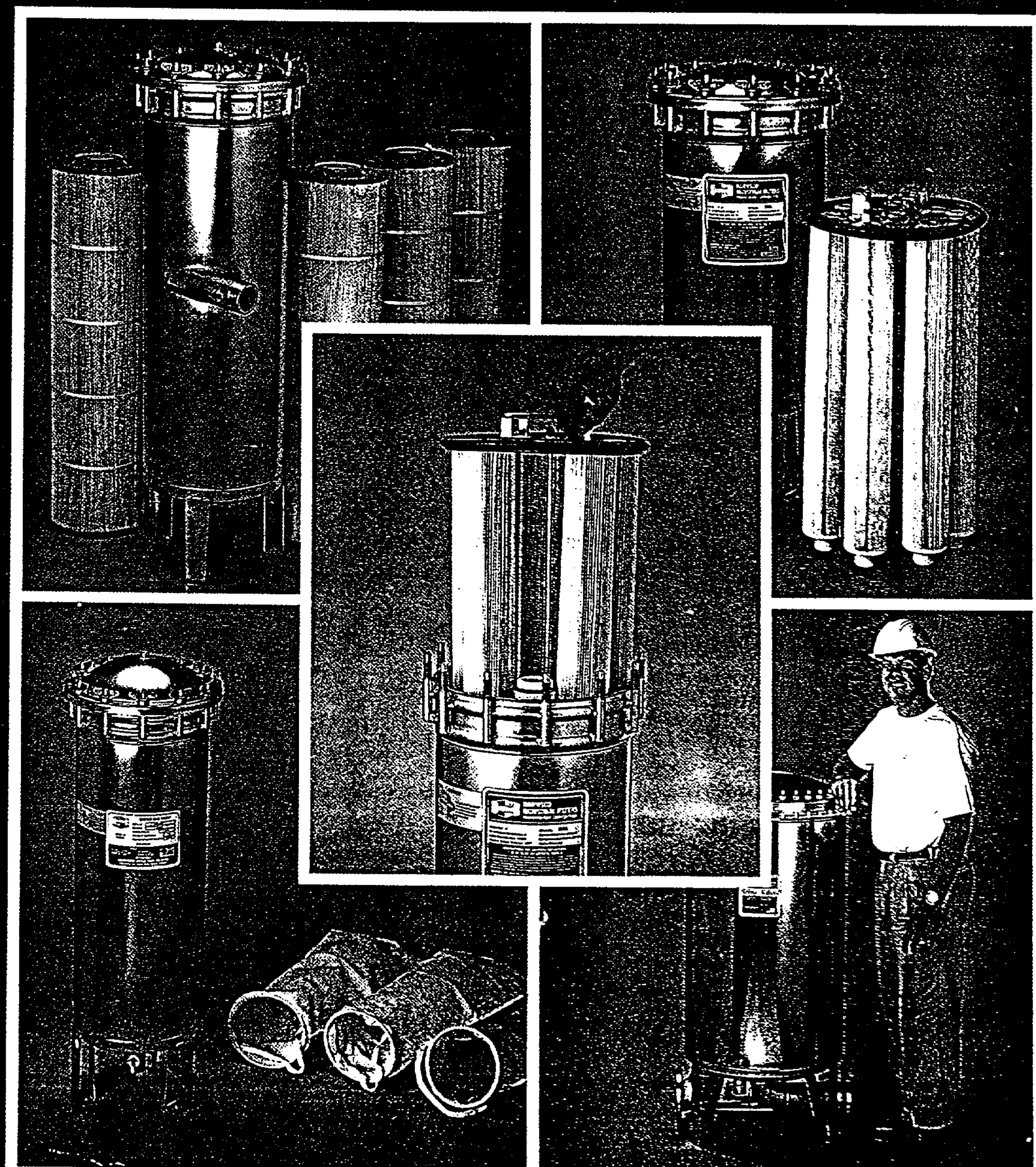
Contaminant	Untreated Influent	Model 3611 Effluent Water Air(lbs/hr) % removal	Model 3621 Effluent Water Air(lbs/hr) % removal	Model 3631 Effluent Water Air(lbs/hr) % removal	Model 3641 Effluent Water Air(lbs/hr) % removal
Benzene	7900 ppb	933 ppb 0.278803 88.1978%	111 ppb 0.311697 98.6071%	13 ppb 0.315619 99.8356%	2 ppb 0.316059 99.9806%
c-1,2-Dichloroethylene	42000 ppb	1387 ppb 1.625236 96.6985%	46 ppb 1.678899 99.8910%	2 ppb 1.680660 99.9964%	<1 ppb 1.680738 99.9999%
Trichloroethylene	14000 ppb	407 ppb 0.543959 97.0993%	12 ppb 0.559766 99.9159%	1 ppb 0.560207 99.9976%	<1 ppb 0.560246 99.9999%
Vinyl Chloride	360 ppb	3 ppb 0.014286 99.4372%	<1 ppb 0.014406 99.9968%	<1 ppb 0.014406 100.0000%	<1 ppb 0.014406 100.0000%

This report has been generated by ShallowTray Modeler software version 1.3.0. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. The software will accurately predict the system performance when both the equipment and the software are operated according to the written documentation and standard operation. North East Environmental Products, Inc. cannot be responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment. Report generated: 4/28/93

Section 11308
Cartridge Filter Units

Harmsco® Industrial Filters

Stainless steel filters for water treatment, waste water compliance, parts washing, chemicals, photographic, plating, tool & die, inks, oils, beverages, liquid foods, pharmaceuticals, electronics, waste treatment, ground water remediation, hospitals, HVAC, petro-chemicals & more!



1/4

Harmsco® Up-flow Cartridge Filtration...

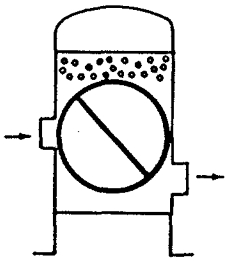
A Design so Superior it's Patented!

Harmsco's **up-flow** design out performs conventional filters! To understand how up-flow filters work, follow the diagram shown below.

Fluid enters the filter under pressure and flows through the filter media, holes in the center tubes and perforations in the rods that hold the cartridges in place. As the fluid continues its path through the filter, it flows ***upward*** past the top seal where it spills over into the standpipe as it hits the filter's domed lid. Notice the top of the standpipe is at the high point of the filter. Also, note the filter cartridges are sealed at the bottom and held in place with threaded pipe caps on the Harmsco model shown in this diagram. This unique design offers the following significant advantages:

No Air Entrapment During Operation

Air entrapment during operation is eliminated because the outlet (top of the standpipe) is located at the ***high point*** of the filter.



Conventional Filters

Air accumulation is a common problem with conventional filter designs because their outlets are located below the inlets. Reduced efficiency results since the filter media cannot be utilized where air has accumulated.

Because air travels upward with the fluid and exits the filter through the standpipe, vents to discharge accumulated air are not required. (If vents are required, lids with vent fittings are available.)

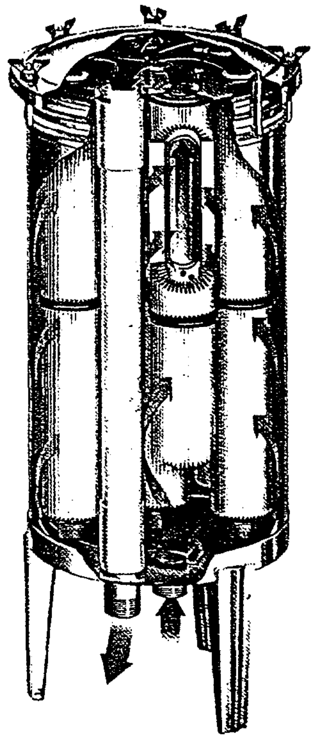
Superior Filtration

Since 100% of the media is used 100% of the time, superior filtration is assured!

Two Filter Types Available:

***"Cartridge Cluster"* filters**

Cartridge replacement is made easy with ***cartridge cluster*** filters since the entire set of cartridges are removed at one time for quick cartridge change-out or cleaning.

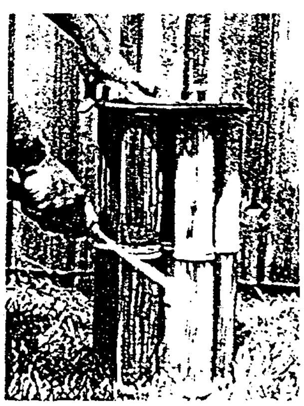


Twelve Models Available

Harmsco Industrial Filters are available in twelve models for flow rates up to 800 GPM.

Harmsco Reusable Filter Cartridges

Harmsco filter cartridges may be cleaned and reused in most applications. Entire cluster can be cleaned without disassembly, as shown below.



No Fluid By-pass During Servicing

Fluids cannot by-pass Harmsco filters during servicing because the filter's outlet (top of standpipe) is located ***above*** the filter's inlet. A significant advantage in critical filtration applications!

Electro-Polished

All Harmsco Industrial Filters are electro-polished for increased resistance to corrosion.

Fail-Safe Lids

Lids come standard with wing nuts so they may be easily opened without tools. Multiple studs provide fail-safe closure. No single-bolt clamp closure used! (HIF-150-FL and HIF-200-FL filters come standard with hex nuts).

Pressure Rated to 150 psi

Filters may be safely used in pressures up to 150 psi.

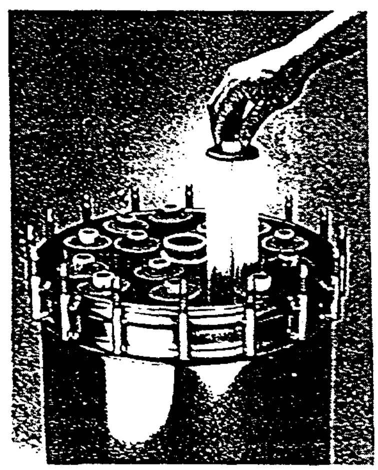
Compact Design

Our compact, space saving design requires less floor space than other filters. We have more cartridges with more filter media than anyone!

Large Capacity Filters Feature

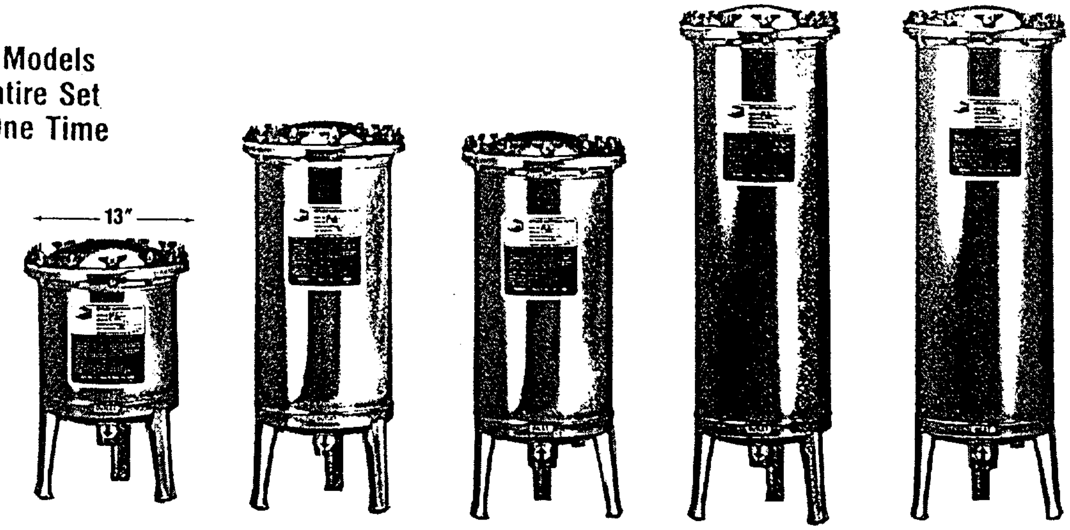
***"Cartridge Lifters"* for Easy Cartridge Removal**

Large capacity Harmsco filters use ***cartridge lifters*** to remove a stack of cartridges at one time for added convenience. Cartridge lifters can accommodate up to four cartridges, depending on the filter being used.



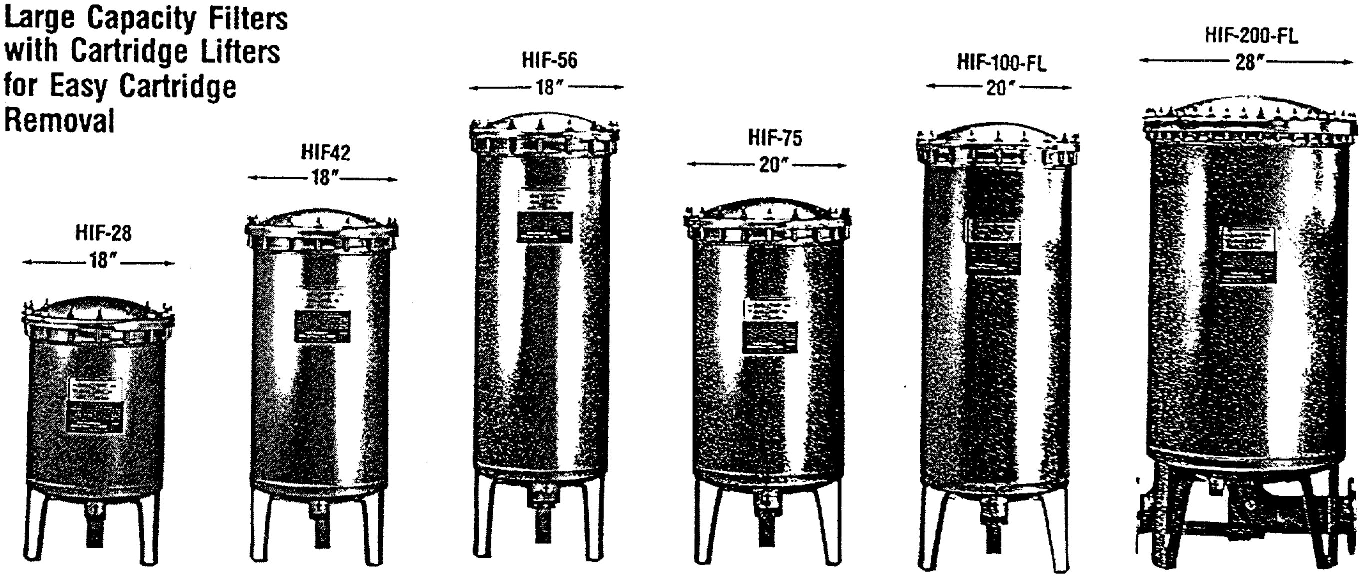
Cartridge Cluster Models to Remove the Entire Set of Cartridges at One Time

NOTE: In high flow applications, two or more cartridge cluster models may be installed in parallel to take advantage of Harmsco's unique cartridge cluster design.



	HIF-7	HIF-14	HIF-16	HIF-21	HIF-24
Flow rate (range in GPM)	up to 30	30-60	60-75	75-90	90-105
No. of std. size cartridges	7	14	16	21	24
Alternative length cartridge	single only	7 doubles	8 doubles	7 triples	8 triples
Pipe size (NPT)	1½"	1½"	2"	1½"	2"
Filter height	19.5" (49.5 cm)	28" (71 cm)	28" (71 cm)	37" (94 cm)	37" (94 cm)
Floor space required	13x13" (33x33 cm)	13x13" (33x33 cm)	13x13" (33x33 cm)	13x13" (33x33 cm)	13x13" (33x33 cm)
Service height clearance	35" (89 cm)	48" (122 cm)	48" (122 cm)	68" (173 cm)	68" (173 cm)
Shipping weight (approx.)	29 lbs. (13 kilos)	39 lbs. (17.6 kilos)	39 lbs. (17.6 kilos)	50 lbs. (22.6 kilos)	50 lbs. (22.6 kilos)

Large Capacity Filters with Cartridge Lifters for Easy Cartridge Removal



	HIF-28	HIF-42	HIF-56	HIF-75	HIF-100	HIF-150-FL	HIF-200-FL
Flow rate (range in GPM)	105-125	125-175	175-225	225-300	300-400	400-600	600-800
No. of std. size cartridges	28	42	56	75	100	150	200
Alt. length cartridge	14 doubles	14 triples	28 doubles	25 triples	50 doubles	50 triples	100 doubles
Pipe size (NPT)	2"	2"	3"	3"	3"	4" flanged	4" flanged
Filter height	30" 76 cm	40" 107 cm	50" 127 cm	42" 107 cm	52" 132 cm	48" 122 cm	58" 147 cm
Floor space required	18 x 18" 46 x 46 cm	18 x 18" 46 x 46 cm	18 x 18" 46 x 46 cm	20 x 20" 51 x 51 cm	20 x 20" 51 x 51 cm	28 x 28" 71 x 71 cm	28 x 28" 71 x 71 cm
Service height clearance	48" (122 cm)	68" (173 cm)	87" (221 cm)	70" (178 cm)	87" (221 cm)	76" (193 cm)	93" (236 cm)
Shipping weight (approx.)	79 lbs. 36 kilos	100 lbs. 45.3 kilos	129 lbs. 58.5 kilos	167 lbs. 75.7 kilos	188 lbs. 86 kilos	274 lbs. 124 kilos	321 lbs. 155.6 kilos

Standard Filters: Standard filters are 304 stainless steel. Rim gaskets and top seals are EPDM. Bottom seals for large capacity filters are natural gum rubber. O-rings for cluster filters are Buna-N. Other options available.

NOTE: Flow rates are guidelines only. Filter selection is influenced by the cartridge to be used, viscosity, suspended solids and length of filter run desired. Rates shown are for clean water at ambient temperature. Flow rates vary and typically range between three to six gallons per sediment cartridge.

Patents: Harmsco Industrial Filters are manufactured under one or more of the following patents: U.S. Patents #3720322 and #4187175 Canada: #977693 Great Britain: #1372014. West Germany: #22618707. France: #7246864. Hurricane #5174896. Other patents pending.

Options

Metal

304 Stainless Steel

316-L Stainless Steel

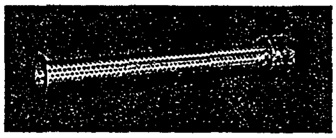
Coatings Available:

Xylan: Single coat process for excellent resistance to corrosion.

Dykor: Triple coat process for excellent resistance to corrosion.

Cartridge Holders & Caps

CPVC (Standard)



Stainless (Optional)

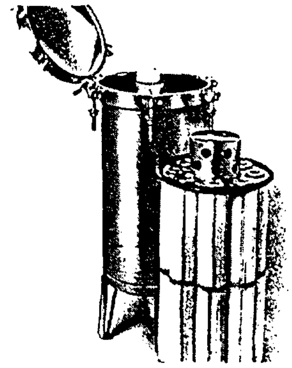
Standpipes

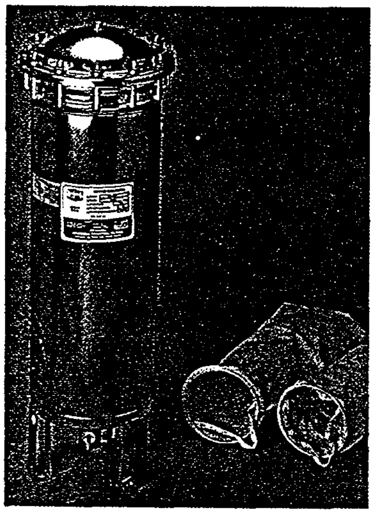
PVC (Standard)
For temperatures to 160°F.

CPVC (Optional)
For temperatures to 200°F.

Stainless (Optional)
For temperatures to 350°F.

Swing-Bolt Models Available:
- **SB-8** (8 cartridges)
- **SB-16** (16 cartridges)
- **SB-24** (24 cartridges)





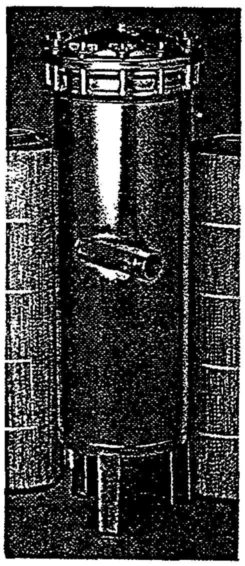
BetterBag™ Filters

Select Harmsco's high capacity BetterBag filters when more precise cartridge filtration is not required. Special features include electro-polished stainless steel, 18-gauge stainless steel basket to accommodate large #2 filter bag, easy wing nut lid closure and compact design. Models include:

Product Code	Description	Pipe Size	Max. Flow Rate	Shipping Wt.
BBHP	Stainless with PVC standpipe	1½"	100 GPM	50 lbs.
BBHP-SS	All stainless steel	1½"	100 GPM	52 lbs.
BBHP-2	All stainless steel	2"	150 GPM	54 lbs.

Filter Bags Available:

Product Code	Material	Nominal Micron	Product Code	Material	Nominal Micron
HIF-PF-5	Polyester felt	5	HIF-PP-50	Polypropylene	50
HIF-PF-25	Polyester felt	25	HIF-PP-100	Polypropylene	100
HIF-PF-50	Polyester felt	50	NMO-100	Nylon mesh	100
HIF-PF-100	Polyester felt	100	NMO-200	Nylon mesh	100



Shown above: Hurricane filter, Model HUR-170 HP for flow rates to 200 GPM. Ht. 48", Dia. 13", Shiping Wt. 54 lbs.

Introducing the Harmsco HURRICANE™

(Patented Dec. 29, 1992 #5,174,896)

A revolutionary concept in industrial filtration! For heavy solids and when exceptionally long filter runs are desired.

The **Harmsco Hurricane** utilizes patented features to provide dramatically improved filter efficiencies to optimize solids removal and provide exceptionally long filter runs.

Here's how it works: Fluid enters the filter *tangentially.* A *rotational flow* is created within the filter to separate heavy solids using *centrifugal force.* Much like a particle separator, heavy solids contained in the fluid stream drop to the bottom of the filter's *outer* chamber so they may be drained off manually or automatically. The lighter solids rise upward into the filter's *inner* chamber where they are removed by the filter's cartridge, made with *angled* pleats which are directed *toward* the rotational flow to entrap more solids.

The following filter cartridges are available for Hurricane HUR-170-HP filters:

Product Code	Nominal Micron	Filter Area	Shipping Wt.
HC/170-0.35	0.35	170 sq. ft.	10 lbs.
HC/170-1	1	170 sq. ft.	10 lbs.
HC/170-5	5	170 sq. ft.	10 lbs.
HC/170-20	20	170 sq. ft.	10 lbs.
HC/170-50	50	170 sq. ft.	10 lbs.

Notice: More Hurricane filters are forecasted. Stay tuned for further reports!

MADE IN U.S.A.

Toll Free: **(800)-327-3248** • Fax: **(407) 845-2474**

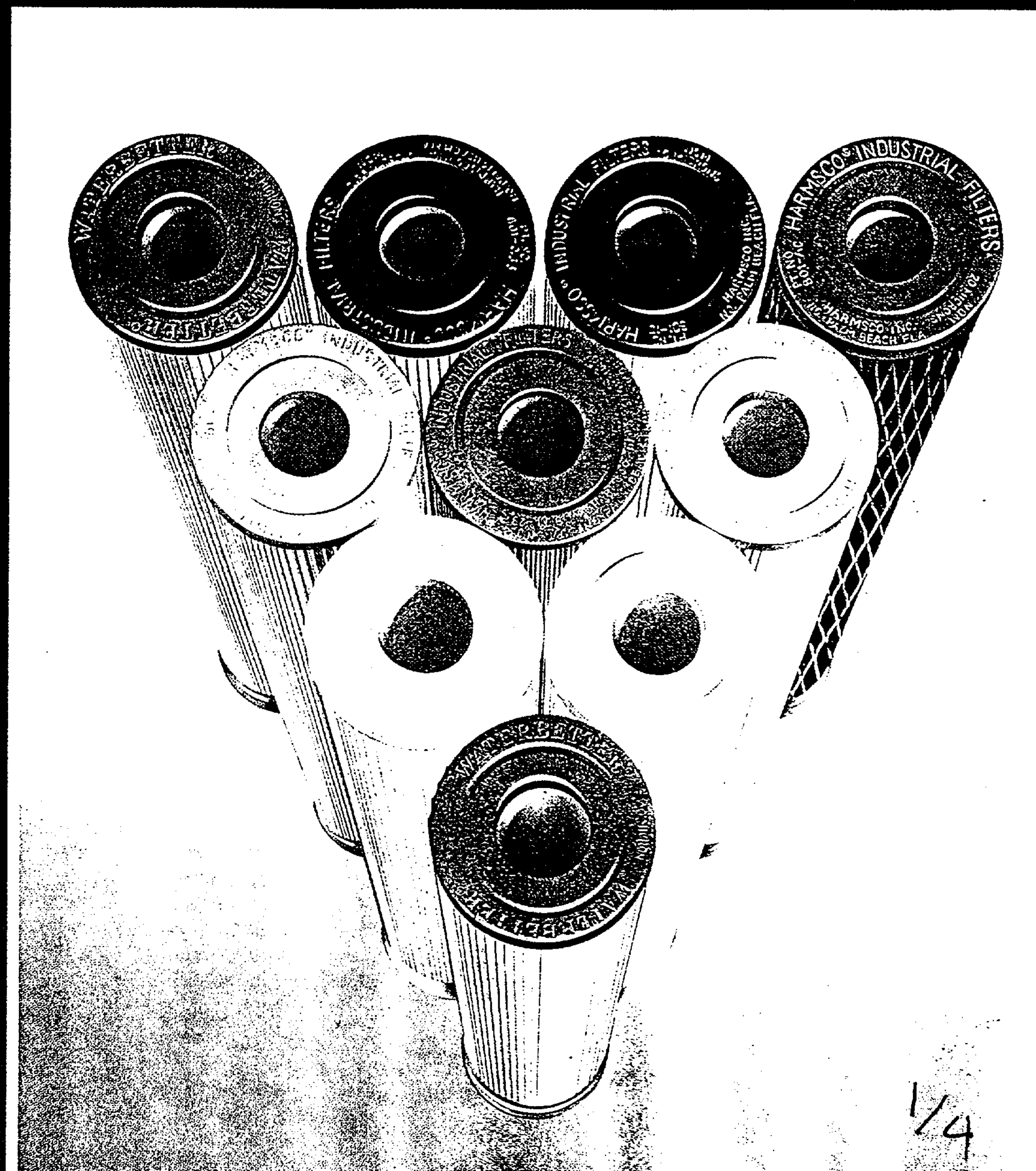
Harmsco® Industrial Filters
P.O. Box 14066 / North Palm Beach, FL 33408

Available from:

Lit. No. 93-H

Harmsco® Filter Cartridges

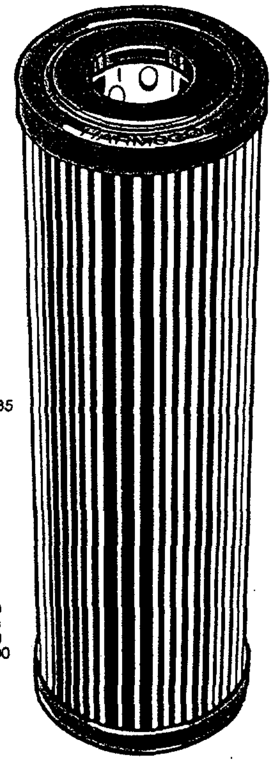
Pleated polyester filter cartridges for high flow,
low pressure drop, increased contaminant removal, long filter runs,
reusability and the lowest cost per gallon filtered.



Harmsco® Filter Cartridges... *Compare Our Many Advantages!*

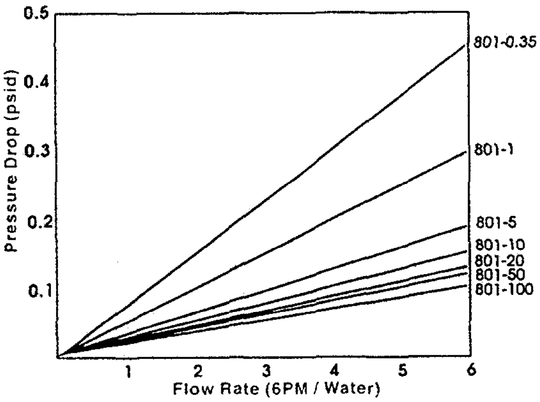
More Filter Area and Pleated Design for Increased Contaminant Removal

Harmsco filter cartridges provide superior filtration because our additional media and pleated design provide more filter area for increased contaminant removal.



Low Pressure Drop

High flow and low pressure drop are typical with Harmsco cartridges due to the increased filter area they provide. See chart below:



Long Filter Runs and Reduced Labor Costs

Long filter runs and reduced labor costs associated with cartridge replacement are common with Harmsco cartridges, which have more square footage of media than any other brand.

Thermally Bonded for Structural Integrity

Harmsco cartridges are thermally bonded to provide an integral union between the PVC end caps, PVC center tubes and filter media for added strength. Due to this unique design, Harmsco cartridges can withstand pressure differentials to 80 psid, providing extended life.

Wide Range of Removal Ratings and Color Coding for Easy Identification

Harmsco cartridges are available in the following nominal micron ratings for a wide range of filtration applications.

Micron*	End Cap	Description
0.35	Brown	Ultra fine porosity.
1	Tan	Fine porosity for final filtration.
5	White	Our most popular final filter.
10	Red	Medium porosity filter cartridge.
20	Blue	Our most popular pre-filter.
50	Yellow	Medium-coarse filter cartridge.
100	Green	Coarse filter cartridge.

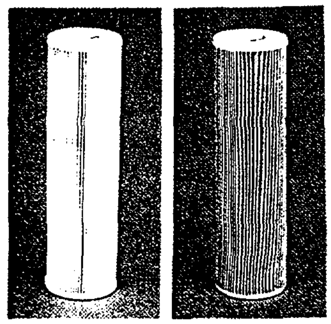
Highly Efficient

Removal efficiencies are shown below based on tests conducted by the Microtrac Division of Leeds & Northrup Co.

Filter Cartridge	Percent Removal
801-0.35	100%
801-1	99.9%
801-5	100%
801-10	99.5%
801-20	98.5%

Reusable

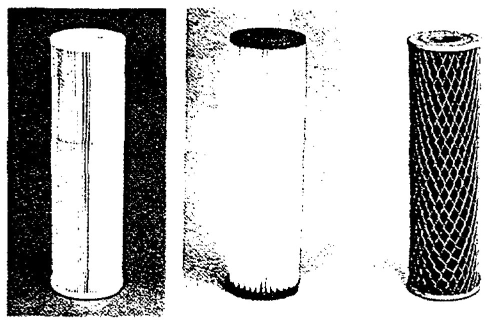
Our proprietary blend of Polyester-Plus™ filter media is cleanable in most filtration applications. Therefore Harmsco *cartridges reduce* costs because they are reusable!



New Harmsco filter cartridge — Harmsco cartridge cleaned & used four times

Three Types

Three cartridge types are available for a wide range of applications, including Harmsco **"801-Series", Water-Better™** and **Activated Carbon** filter cartridges.



801-Series — WaterBetter — Activated Carbon

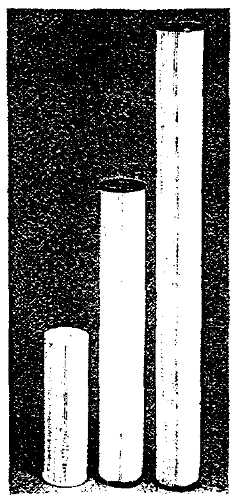
Three Lengths

Standard size cartridges are available in three lengths to fit Harmsco Industrial Filters and housings made by other manufacturers. Standard lengths include:

Single length
9¾"

Double length
19½"

Triple length
29¼"



FDA Approved Materials

Harmsco cartridges may be used for potable water and liquid foods because all materials are FDA approved.

2/4

Specifications

Filter media:	Polyester	**Surface area:**	
End caps:	Plastisol (pliable PVC)	**801-Series:**	6 sq. ft. per 9¾" length
Center tubes:	Rigid PVC, perforated	**WaterBetter:**	4 sq. ft. per 9¾" length
Temperature:	160°F (standard cartridges) 200°F (high temp. cartridges)	**Dimensions:**	2¾" O.D.; 1 1/16" I.D.
		Lengths:	9¾", 19½", 29¼"
pH:	3 to 11	**Shrink wrap:**	Single length 801-Series cartridges are available shrink wrapped.
Packaging:	Cartridges packed 24 per carton.		

Tests Prove Harmsco Cartridges Outperform Depth Type Filter Elements and Reduce Filtration Costs

A test facility was set up to evaluate the performance of various filter cartridges. The objective was to establish which cartridge removes more solids, filters longer and filters more gallons before it reached capacity. Cartridges tested were nominal five microns, and types included string wound, spun polypropylene, rigid resin bonded cellulose, Harmsco "801-Series" and WaterBetter™ cartridges.

Test equipment included a test tank, circulating pump, filter housing, mixer and pressure gauges installed prior and after the filter housing. A mixture of water and AC Coarse Test Duct (3% by weight) was used as the test particulate.

To start the test, each cartridge was weighed (dry) and installed in the filter housing. A flow rate of three gallons per minute was maintained. A mixer was operated to keep the test dust in suspension and a stop watch was used to note start-up and termination times.

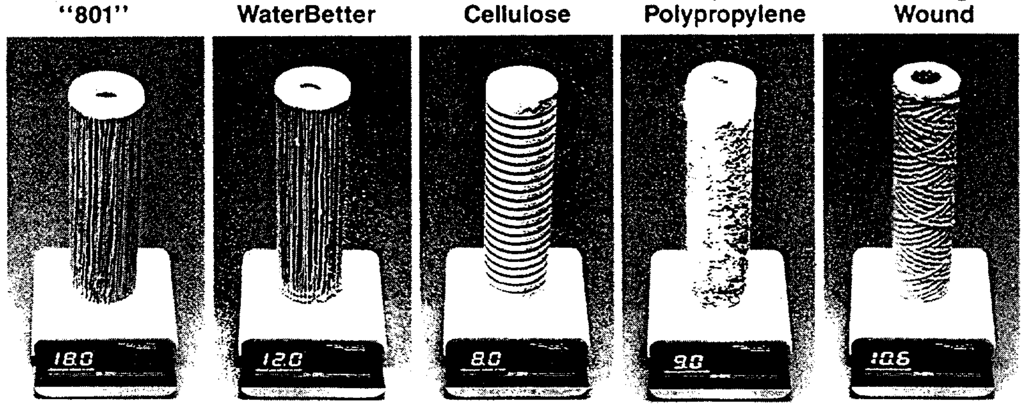
Filtration commenced until a thirty psi pressure differential was achieved. The elapsed time was recorded. After each cartridge was allowed to dry, it was again weighed to establish the amount of solids it had removed from the test stream. In all tests the filtered product was equivalent. The test results are shown below:

Test Results:

Solids Removal

Harmsco pleated cartridges removed more solids than all other cartridges tested. The solids removal weights for the cartridges tested are shown at right.

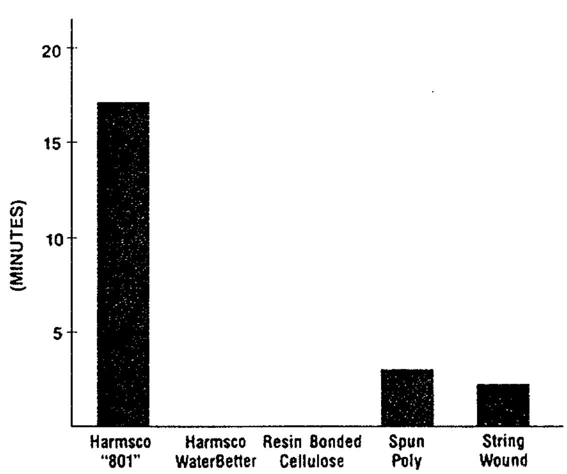
	Harmsco "801"	Harmsco WaterBetter	Resin Bonded Cellulose	Spun Polypropylene	String Wound



Solids Removed:	12.0 oz.	7.0 oz.	3.3 oz.	2.5 oz.	2.1 oz.

Elapsed Time

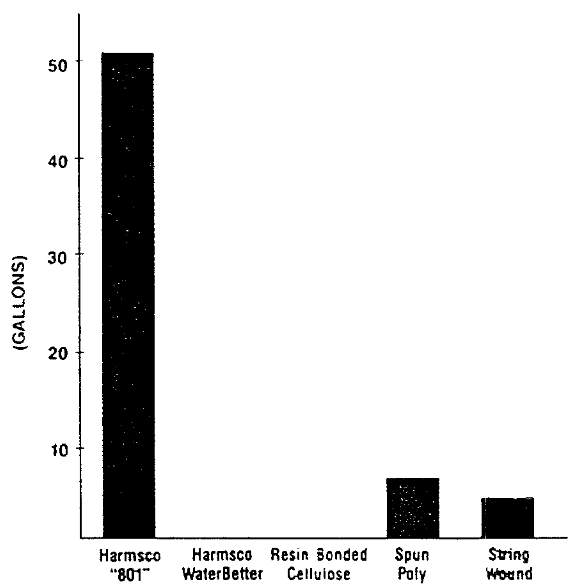
Harmsco cartridges provide longer filtration before they reach 30△p. The chart below shows the lapsed time each cartridge filtered before a 30 psi pressure differential was achieved.



Elapsed Time Until Filter Reached 30△p.

Gallons Filtered

Harmsco cartridges filter more gallons because they filter longer before they reach 30△p as shown below.

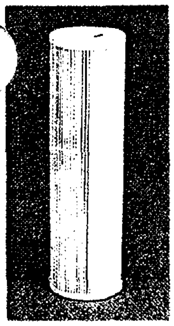


Gallons Filtered Before Filter Reached 30△p.

With Harmsco cartridges the more you filter the more you save. With others, the more you filter the more you pay!

Product Codes and Cartridge Selection

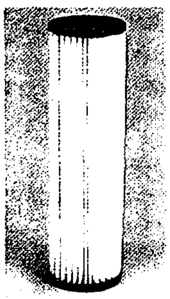
Top-of-the-Line Harmsco "801-Series" cartridges with six sq. ft. of media per 9¾" length



Nominal Micron	Product Code: Single/Regular	Product Code: Single/High Temp.	Product Code: Double	Product Code: Triple	End Cap	No. per Case
0.35	801-0.35	———	———	———	Brown	24
1	801-1	801-1-HT	921-1	931-1	Tan	24
5	801-5	801-5-HT	921-5	931-5	White	24
10	801-10	———	921-10	931-10	Red	24
20	801-20	801-20-HT	921-20	931-20	Blue	24
50	801-50	801-50-HT	921-50	931-50	Yellow	24
100	801-100	———	———	———	Green	24

NOTE: Standard single length 801-Series cartridges available shrink wrapped (designated by "W" following product code.)

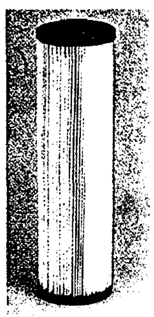
WaterBetter™ Filter Cartridges with four sq. ft. of media per 9¾" length



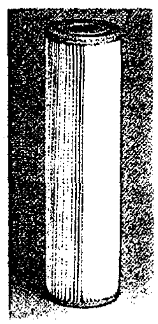
Nominal Micron	Product Code: Single Length	Product Code: Double Length	Product Code: Triple Length	End Cap	No. per Case
1	WB-1	WB-921-1	WB-931-1	Tan	24
5	WB-5	WB-921-5	WB-931-5	White	24
20	WB-20	WB-921-20	WB-931-20	Blue	24
50	WB-50	WB-921-50	WB-931-50	Yellow	24

Taste, Odor, Chlorine, Cyst Removal

801-AC-W



801-0.35



801-1

801-AC-W cartridges for taste, odor, chlorine removal

Polyester felt, impregnated with high quality, coconut shell activated carbon. 50% activated carbon; 50% polyester felt. Grey Plastisol end caps; candle netting for added strength. Recommended flow rate: 0.5 to 1.0 GPM/cartridge. Replaceable after six months or when carbon has expired. Ideal for taste, odor and chlorine removal.

801-0.35 and 801-1 cartridges for Giardia Cysts removal

Harmsco 801-0.35 and 801-1 filter cartridges are Independent Lab Certified for Giardia Cysts removal, up to 99.9%.

Note: Above cartridges are packaged 24 per carton. 801-AC-W cartridges are individually shrink wrapped as standard.

Specialty Products

Harmsco "Big Blue"

Nominal Micron	Width	Length	Code
5	4½"	9¾"	HB-10-5-W
20	4½"	9¾"	HB-10-20-W
50	4½"	9¾"	HB-10-50-W
5	4½"	20"	HB-20-5-W
20	4½"	20"	HB-20-20-W
50	4½"	20"	HB-20-50-W

Note: Above cartridges individually shrink wrapped.

6" x 18" x 2 5/8"

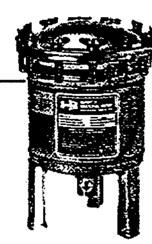
Nominal Micron	Code
5	8618-5
10	8618-10
20	8618-20

Hurricane

Nominal Micron	Area (sq. ft.)	Code
0.35	170	HC/170-0.35
1	170	HC/170-1
5	170	HC/170-5
20	170	HC/170-20
50	170	HC/170-50

Harmsco Industrial Filter Housings

Harmsco, Inc. manufacturers a complete line of heavy-duty, non-code, economical stainless steel filters to accomodate up to 200 filter cartridges and flow rates to 800 GPM per single filter. For a copy of our product brochure, please contact our distributor or call the toll-free number listed below.



Stainless steel Harmsco Filters available for 7 to 200 cartridges.

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Harmsco® Industrial Filters

P.O. Box 14066 / North Palm Beach, FL 33408

Available from:

Lit. No. 93-C

Section 11309
Carbon Adsorbers

MODEL 4
Granular Activated Carbon Adsorption System

The Calgon Carbon Model 4 is an adsorption system designed specifically for the removal of dissolved organic contaminants from liquids using granular activated carbon. The Model 4 reflects Calgon Carbon's extensive experience in adsorption system design and operation.

The Model 4 system is delivered completely assembled on a steel skid, requiring only site process and utility hookups to be ready for operation. The pre-engineered Model 4 design is available with three piping materials of construction options to satisfy most requirements.

The process piping network for the Model 4 accommodates operation of the adsorbers in parallel or series. In series operation, the first stage can be isolated from the flow, have the granular carbon exchanged, and returned to operation as the second stage without interrupting treatment.

The Model 4 system allows for ease of granular activated carbon exchange. The system is suited for use with Calgon Carbon's Bulk-Back Service in which the granular activated carbon is supplied in containers for convenient transfer to the adsorbers. Bulk-Back units also receive the spent carbon from the adsorbers for return to Calgon Carbon for reactivation services.

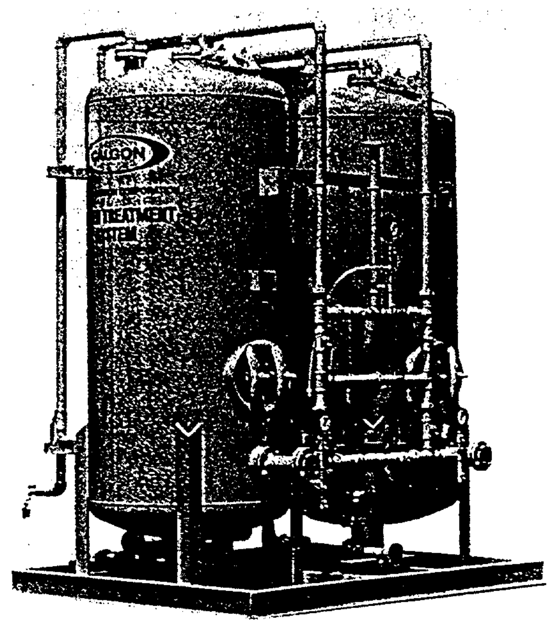
MATERIALS OF CONSTRUCTION

Adsorbers: Carbon steel ASME code pressure vessels
Adsorber internal lining: Vinyl ester lining (nominal 40 mil) for potable water and most liquid applications
System external coating: Epoxy mastic paint system
Standard adsorption system piping options:

Solid PVC Piping System
- Schedule 80 PVC pipe and PVC ball valves
- Schedule 80 PVC underdrain and PPL screened nozzles

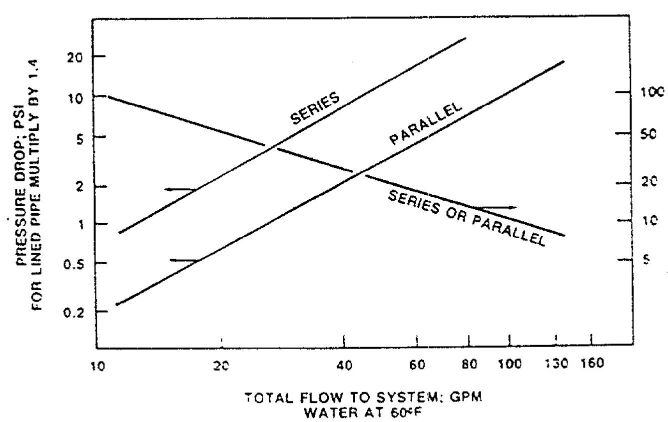
Carbon Steel Piping System
- Schedule 80 steel pipe and ductile iron ball valves
- PPL lined carbon discharge with TFE lined plug valve
- Schedule 80 PVC underdrain and PPL screened nozzles

Polypropylene Lined Piping System
- PPL lined steel pipe and diaphragm valves
- TFE lined plug valves on carbon fill and discharge
- Solid PPL underdrain and screened nozzles



OPERATING CONDITIONS

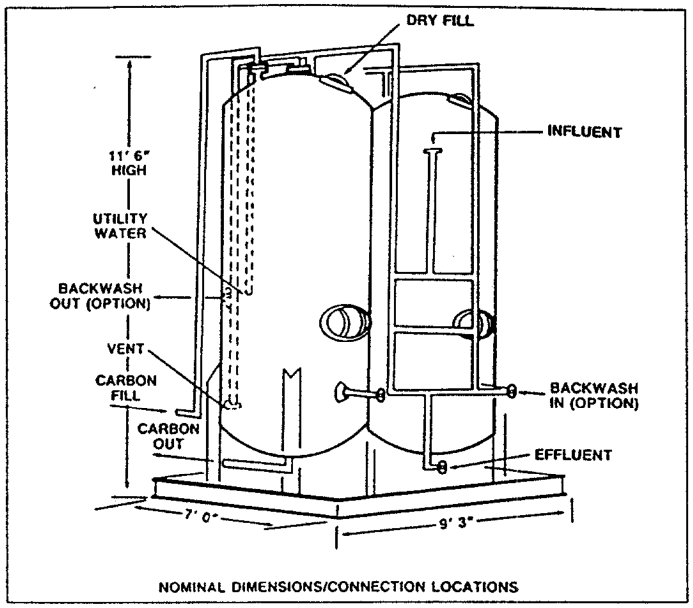
Carbon per adsorber:	72 cubic feet (2,000 lbs)
Pressure rating:	75 psig
Pressure relief:	Rupture disk - 72 psig setting
Vacuum rating:	14 psig
Temperature rating:	150°F maximum
Backwash rate:	125 gpm (40% expansion)
Carbon transfer mode:	Pressure slurry transfer
Utility air:	30 scfm at 30 psig (not recommended for PVC pipe)
Utility water:	100 gpm at 30 psig
Freeze protection:	None provided; enclosure or protection recommended



ELF

DIMENSIONS AND FIELD CONNECTIONS

Adsorber vessel diameter:	4 ft
Process pipe:	2 in
Process pipe connection:	2 in flange
Utility water connection:	1 1/2 in flange
Utility air connection:	3/4 in hose connection
Carbon hose connection:	2 in Kamlok type
Carbon dry fill opening:	top 11 in x 15 in handhole
Backwash connections:	3 in flange
Drain/vent connection:	2 in flange; unrestricted
Adsorber maintenance access:	14 in x 18 in manway
System shipping weight:	9,000 lb with carbon
System operating weight:	26,000 lb



NOMINAL DIMENSIONS/CONNECTION LOCATIONS

CAUTION

Wet activated carbon preferentailly removes oxygen from air, In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low-oxygen spaces should be followed, including all applicable federal and state requirements.

For more information on the product described in this bulletin, or information on other adsorption equipment, please contact one of our Regional Sales Offices located nearest to you:

SALES OFFICES

Region I
P.O. Box 6768
Bridgewater NJ 08807
Tel (908) 526-4646
Fax (908) 526-2467

Region IA
5600 77 Center Drive
Suite 200
Charlotte NC 28217
Tel (704) 527-7580
Fax (704) 523-3550

Region II
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Tel (412) 787-6700
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Fax (412) 787-6676

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Lisle IL 60532
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Fax (708) 505-1936

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San Mateo CA 94403
Tel (415) 572-9111
Fax (415) 574-4466

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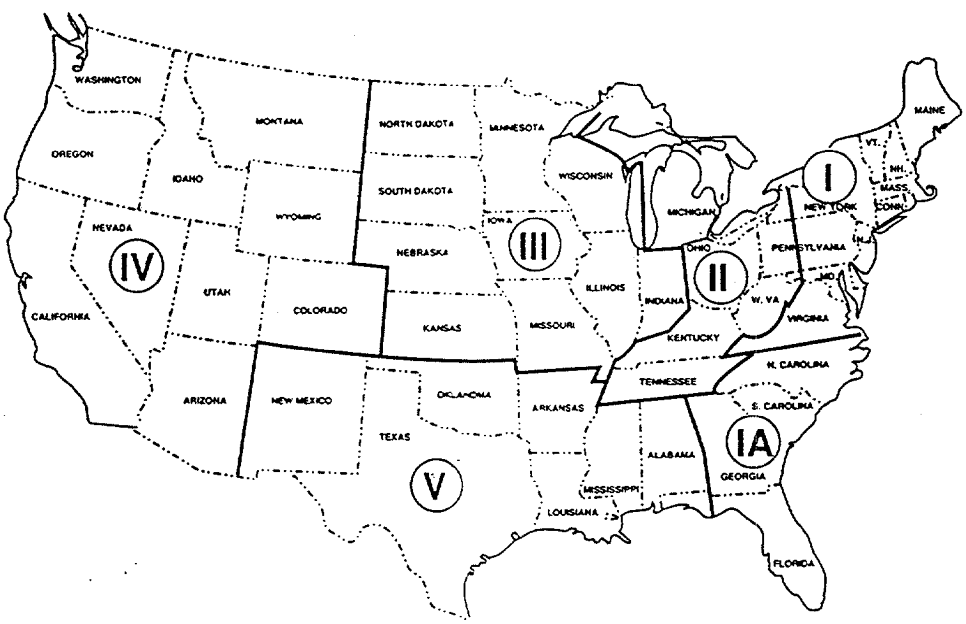
Tel (713) 690-2000
Fax (713) 690-7909



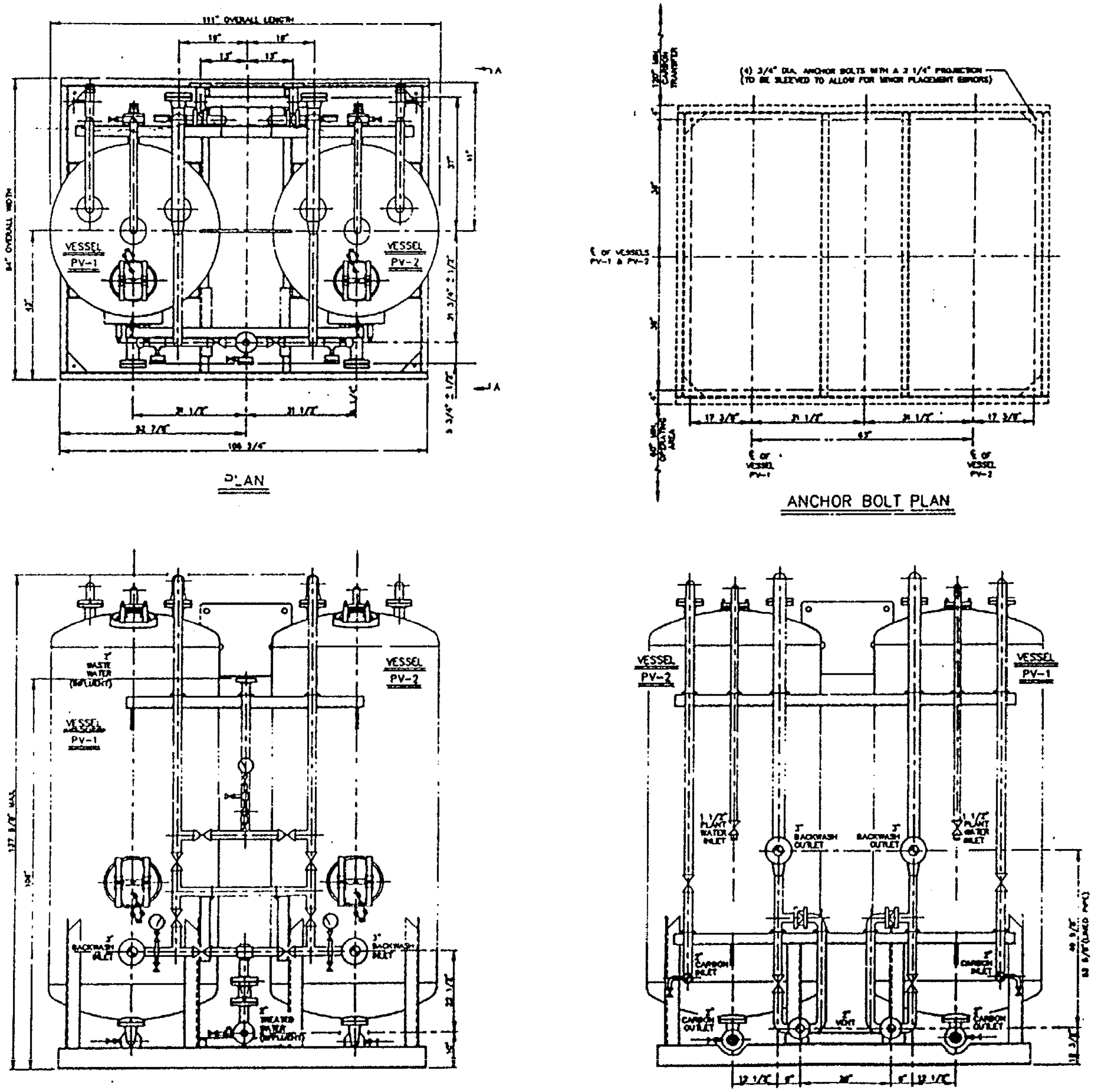
International
P.O. Box 717
Pittsburgh PA 15230
Tel (412) 787-4519
Fax (412) 787-4523

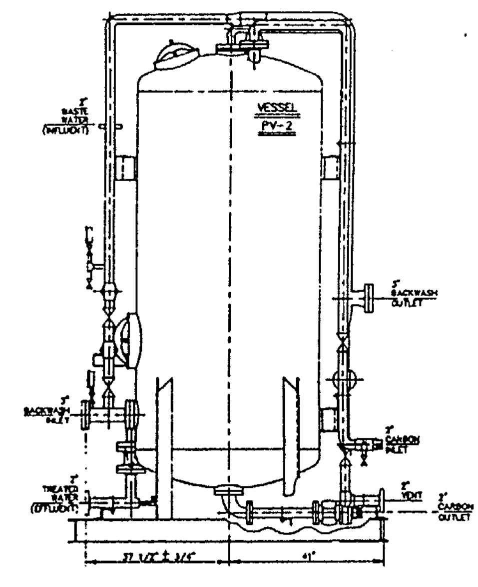
Canada
Calgon Carbon Canada, Inc.
Suite 304
6303 Airport Road
Mississauga, Ontario
Canada L4V 1R8
Tel (416) 673-7137
Fax (416) 673-8883

Belgium
Chemviron Carbon
Boulevard de la Woluwe 60
Boite 7
B-1200 Brussels, Belgium
Tel 32 2 773 02 11
Fax 32 2 770 93 94

CALGON
CALGON CARBON CORPORATION

2/4





NOTE: REFER TO SPECIFICATION FOR DESCRIPTION OF PIPE SYSTEM, VALVES AND ACCESSORIES, INCLUDING ALL MATERIALS OF CONSTRUCTION.

WEIGHTS

EMPTY	9,000 LBS.
W/DRY CARBON	13,000 LBS.
W/WET CARBON	16,000 LBS.
OPERATING	26,000 LBS.

PLOTTED: 6-17-91

CALGON

CALGON CARBON CORPORATION
P. O. BOX 717 PITTSBURGH, PA 15230-0717

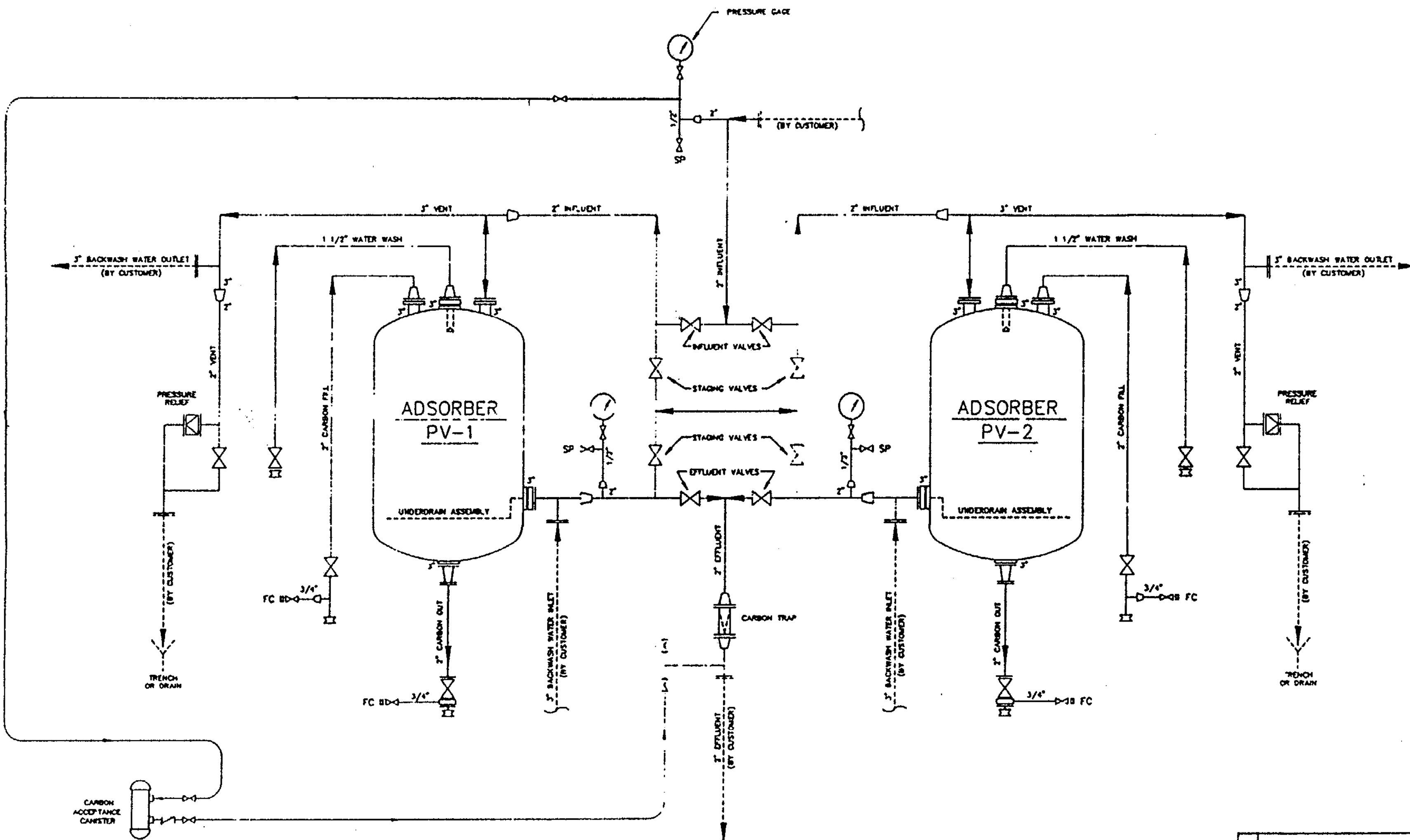
PLANT: STANDARD MODEL 4

TITLE: MODEL 4 ADSORPTION SYSTEM
BACKWASHABLE – 2" PIPE
DUAL VESSEL GENERAL ARRANGEMENT AND ANCHOR BOLT LOCATIONS

DRAWN	CHECKED	APPROVED	SCALE
JFS	JVS		3/4" = 1'2"

PROJECT	DRAWING NO.	REV.
	90-91-1419	0

3/4



PLOTTED: 9/26/91

NOTES:
1. SEE SPECIFICATION FOR MATERIAL AND ITEM DESCRIPTIONS.
2. SEE ARRANGEMENT DRAWING FOR LAYOUT AND CONNECTION LOCATIONS.

NO.	REVISION	BY	DATE	FILM

CALGON

CALGON CARBON CORPORATION

P. O. BOX 717 PITTSBURGH, PA. 15230-0717

PLANT: MODEL 4

TITLE: MODEL 4 ADSORPTION SYSTEM
DUAL VESSEL FLOW DIAGRAM
BACKWASHABLE – 2" PIPE

DRAWN	CHECKED	APPROVED	SCALE
JFS	JVS		NONE

PROJECT	DRAWING NO.	REV.
	90-91-1418	0

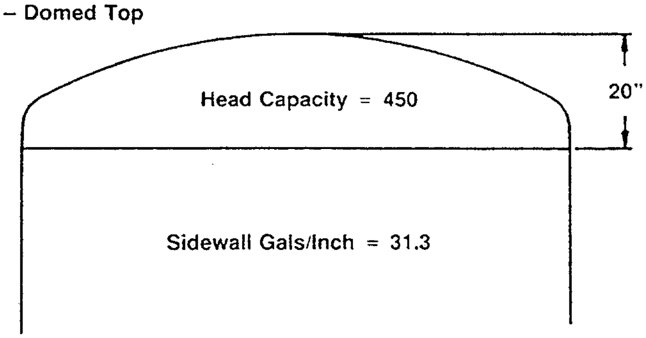
4/4

Section 11311
Sludge Holding Tank and Appurtenances

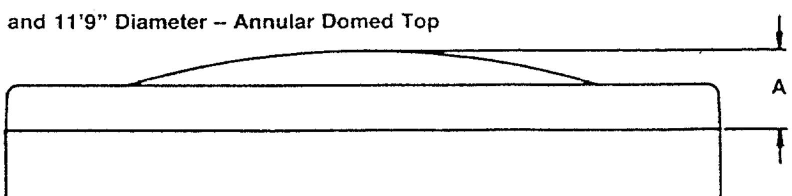
Closed Top Part No.	Nominal Capacity (gal.)	Diameter x Height (in.)	Approx. Wall* Thickness (in.)	Approx. Weight (lbs.)
F082DT	2000	8'x6'4"	1/4	840
F083DT	3000	8'x9'	1/4	980
F084DT	4000	8'x11'8"	1/4	1140
F104DT	4000	10'4'x7'1"	1/4-9/32	1075
F085DT	5000	8'x14'3"	1/4-9/32	1280
F105DT	5000	10'4"x8'8"	1/4-9/32	1206
F086DT	6000	8'x16'11"	1/4-9/32	1520
F106DT	6000	10'4"x10'3"	1/4-11/32	1336
F126DT	6000	11'9"x8'1"	1/4-5/16	1375
F087DT	7000	8'x19'7"	1/4-9/32	1710
F107DT	7000	10'4"x11'10"	1/4-11/32	1480
F127DT	7000	11'9"x9'4"	1/4-5/16	1500
F088DT	8000	8'x22'3"	1/4-11/32	1900
F108DT	8000	10'4"x13'5"	1/4-11/32	1647
F128DT	8000	11'9"x10'7"	1/4-5/16	1625
F109DT	9000	10'4"x15'	1/4-11/32	1813
F129DT	9000	11'9"x11'10"	1/4-5/16	1768
F1010DT	10000	10'4"x16'7"	1/4-7/16	1988
F1210DT	10000	11'9"x13'1"	1/4-5/16	1910
F1012DT	12000	10'4"x19'10"	1/4-7/16	2390
F1212DT	12000	11'9"x15'6"	1/4-3/8	2215
F1014DT	14000	10'4"x23'	1/4-1/2	2820
F1214DT	14000	11'9"x18'	1/4-7/16	2565
F1015DT	15000	10'4"x24'7"	1/4-1/2	3100
F1215DT	15000	11'9"x19'2"	1/4-7/16	2750
F1216DT	16000	11'9"x20'5"	1/4-7/16	2935
F1218DT	18000	11'9"x22'11"	1/4-1/2	3350
F1220DT	20000	11'9"x25'5"	1/4-1/2	3580
F1221DT	21000	11'9"x26'8"	1/4-1/2	3800
F1222DT	22000	11'9"x27'11"	1/4-19/32	4410
F1225DT	25000	11'9"x31'7"	1/4-5/8	5550
F1230DT	30000	11'9"x37'9"	1/4-23/32	6950

*Walls are tapered

8' Diameter – Domed Top

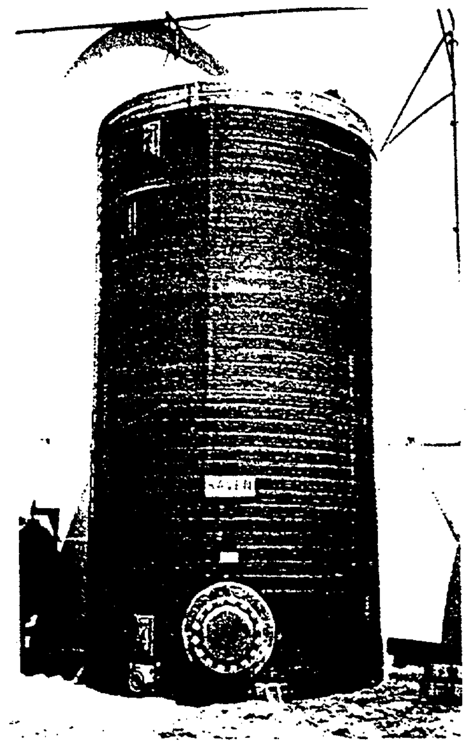


10'4" and 11'9" Diameter – Annular Domed Top



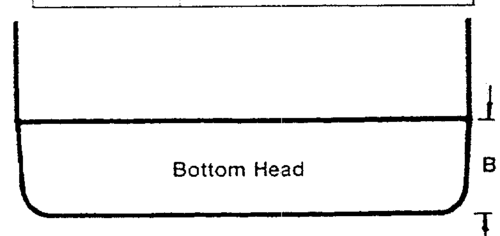
Dia.	Top Head Capacity (gal.)	A Dim. (in.)	Sidewall Gals/Inch
10'4"	366	13	52.3
11'9"	607	17	67.5

Chop-hoop Filament Wound Flat Bottom Domed Top Fiberglass Tanks



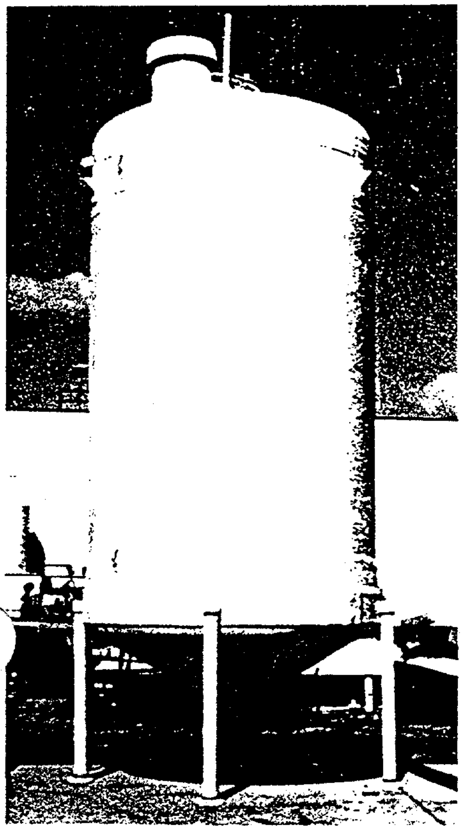
- Domed top tanks are designed for atmospheric pressure only and must be vented. Refer to venting specifications on page D5.
- Standard tank is designed for 1.3 specific gravity material. 1.8 and 2.1 versions are available upon request.
- All filament wound tanks include three lift lugs.
- For accessories refer to pages D1-14.
- For resin selection see pages E1-E4.
- For warranty information see page E5.

Dia.	Bottom Head Capacity (gal.)	B Dim. (in.)
8'	240	8
10'4"	366	7
11'9"	607	9



NOTE: Tank bottom must be fully supported and pad must remain level within 1/8" over a ten foot span. Consult a local engineer for specific site requirements.

Chop-hoop Filament Wound 30° Cone Bottom Fiberglass Tanks

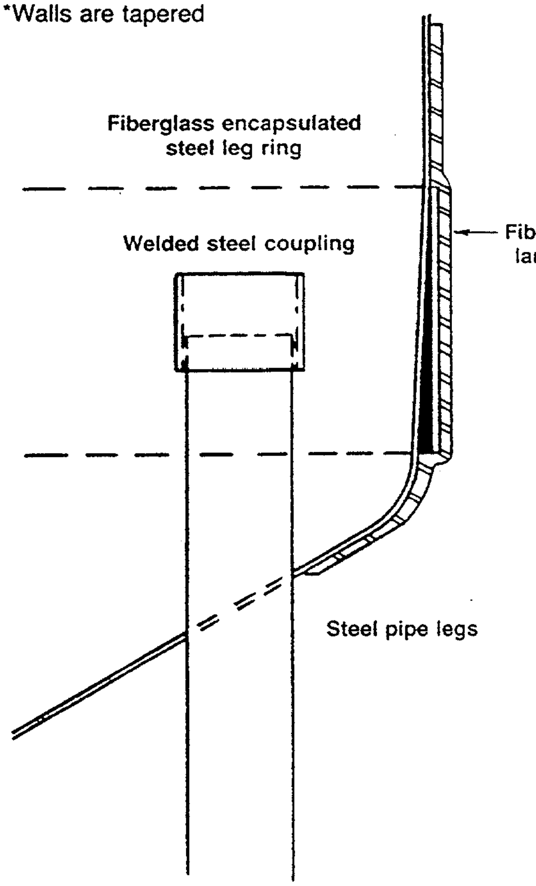


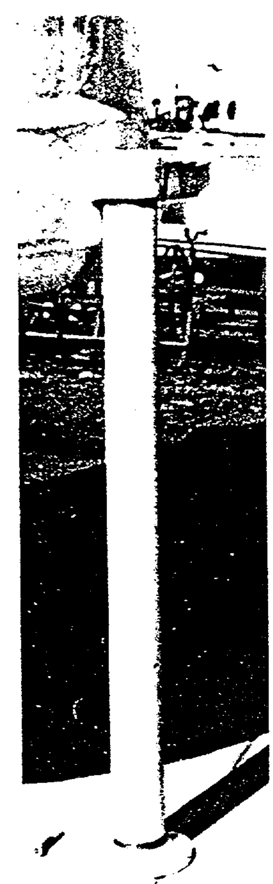
Open Top Part No.	Nominal Capacity (gal.)	Dia. x Height (in.)	Wall* Thick. (in.)	Approx. Weight (lbs.)	No. of Legs
C38-2MO	2000	8'x7'1"	1/4	1280	4
C38-3MO	3000	8'x9'9"	1/4	1430	4
C38-4MO	4000	8'x12'5"	1/4	1570	4
C310-4MO	4000	10'4"x8'6"	1/4	2230	6
C38-5MO	5000	8'x15'1"	1/4-5/16	1710	4
C310-5MO	5000	10'4"x10'1"	1/4	2340	6
C38-6MO	6000	8'x17'9"	1/4-5/16	1950	4
C310-6MO	6000	10'4"x11'8"	1/4-5/16	2450	6
C310-7MO	7000	10'4"x13'3"	1/4-5/16	2560	6
C310-8MO	8000	10'4"x14'10"	1/4-5/16	2720	8
C310-9MO	9000	10'4"x16'5"	1/4-5/16	2860	8
C310-10MO	10000	10'4"x18'0"	1/4-5/16	3010	8

Closed Top Part No.	Nominal Capacity (gal.)	Dia. x Height (in.)	Wall* Thick. (in.)	Approx. Weight (lbs.)	No. of Legs
C38-2MC	2000	8'x7'8"	1/4	1340	4
C38-3MC	3000	8'x10'4"	1/4	1480	4
C38-4MC	4000	8'x13'0"	1/4	1620	4
C310-4MC	4000	10'4"x9'0"	1/4	2350	6
C38-5MC	5000	8'x15'8"	1/4-5/16	1760	4
C310-5MC	5000	10'4"x10'7"	1/4	2460	6
C38-6MC	6000	8'x18'4"	1/4-5/16	1980	4
C310-6MC	6000	10'4"x12'2"	1/4	2570	6
C310-7MC	7000	10'4"x13'9"	1/4	2680	6
C310-8MC	8000	10'4"x15'4"	1/4-5/16	2830	8
C310-9MC	9000	10'4"x16'11"	1/4-5/16	2970	8
C310-10MC	10000	10'4"x18'6"	1/4-5/16	3120	8

*Walls are tapered

- 30° cone bottom tanks are supported by steel pipe legs threaded into a fiberglass encapsulated steel leg ring. Legs must be ordered separately. (See page B6 for detail.)
- 8' diameter open top tanks include an external flanged lip. 10'4" diameter tanks include an internal flange lip. (See page B6 for detail.).
- Closed top tanks are designed for atmospheric pressure only and must be vented. (Refer to venting specifications on D5.)
- Standard tank is designed for 1.3 specific gravity material. 1.8 and 2.1 versions are available upon request.
- For accessories refer to pages D1-14.
- For resin selection see pages E1-E4.
- For warranty information see page E5.
- **Seismic Zone design requires special consideration. Contact Plastics Engineering for full assistance.**

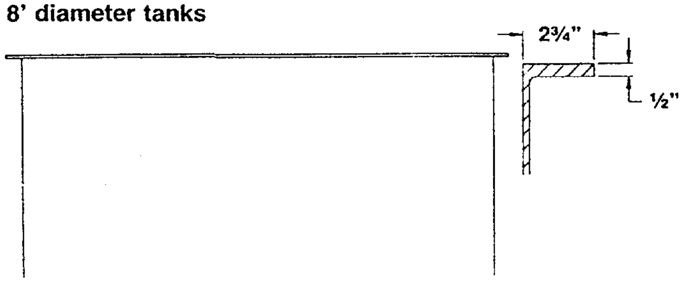




2/7

Open Top – External Flanged Lip

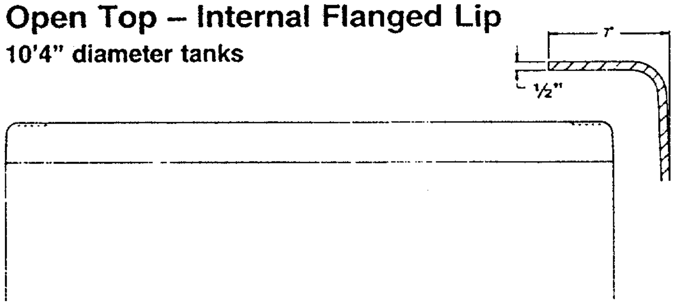
8' diameter tanks



Tank Diameter	Sidewall Gal./inch	30° Cone Cap. (gals.)	Top Head Cap. (gals.)	"0" clearance Leg Length (in.)
8'0"	31.3	470	450	34
10'4"	52.3	920	366	41½

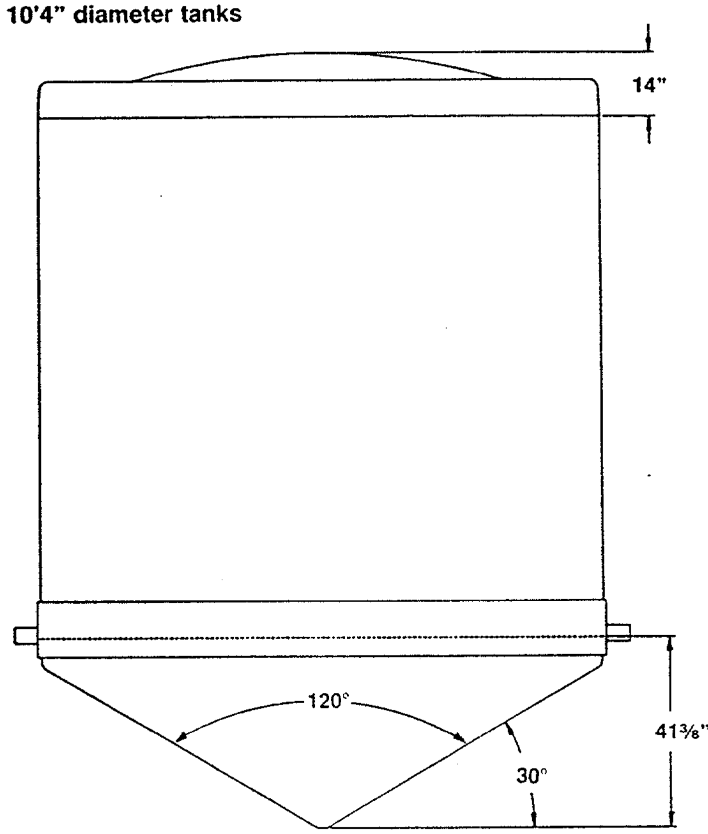
Open Top – Internal Flanged Lip

10'4" diameter tanks



Closed Top – Annular Dome

10'4" diameter tanks

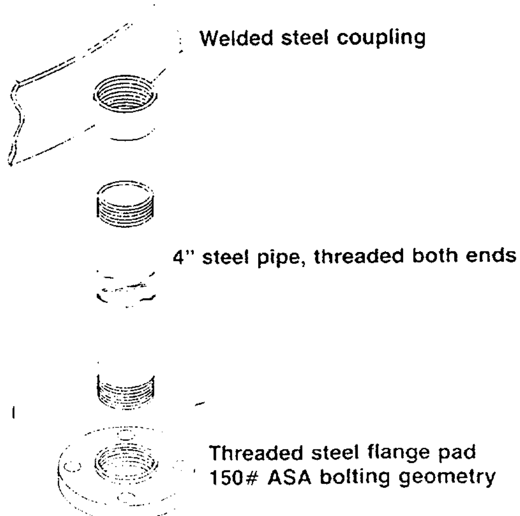


Note: 8' cone height = 34"

Closed Top – Domed Head

8' diameter tanks

Steel Pipe Legs



LEG ORDERING INFORMATION

To order legs, specify number required (found in table on B5) and overall length. Overall leg length is determined by adding amount of leg for "0" clearance (shown above) to desired clearance between the bottom of the cone and the floor. (**NOTE:** Raven recommends that clearance not exceed 24" unless specific application has been reviewed by the factory.)

EXAMPLE: Legs for an 8' diameter 6000 gallon tank (part #C38-6MC) with a 24" clearance from bottom of cone to the floor would be ordered as follows:

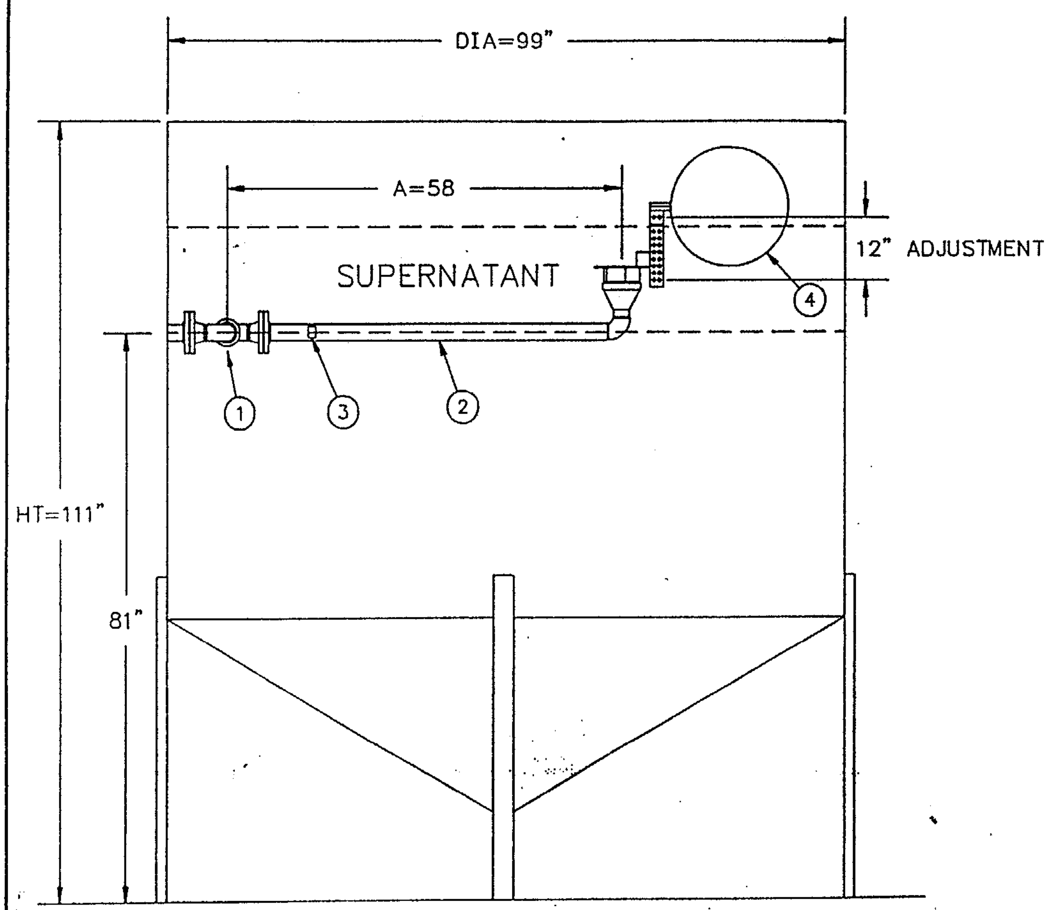
Number of legs required = 4 (page B5)

Leg length = "0" clearance + required clearance.

34" + 24"

Correct order would be (4) 58" tall legs.

3/7



ITEM	PART No.	PART NAME	MAT'L	QTY	COMMENTS
1	D139-900	2" STYLE 40 SWING JT	316SST	1	
2	99999A	2" PRIMARY ARM	316SST	1	SCH 10
3	446798	I.D. TAG	ASSY	1	
4	99999B	15 GAL FLOAT ASSY	SST	1	
		DRAWING		1	
	453416	ASSY MANUAL		1	
		PAINT			
	TP-041	TEST PROC.			

DESCRIPTION

2" SST/TEFLON FLOATING SKIMMER FOR CONE TANK

SHIP TO:
BAKER ENVIRONMENTAL, INC
AIRPORT OFFICE PARK
BUILDING 3
CORAOPOLIS, PA 15108

CUTTING LENGTHS				STD. DIMS		
ITEM	MAT'L	FORMULA	CUT	ITEM	STD	MAX

SYM	REVISION	DATE	BY
A	ISSUED	10/06/92	DSS

EMCO WHEATON
CARY, N.C.
U.S.A.

RELIABLE PRODUCTS FOR THE PROTECTION OF THE ENVIRONMENT

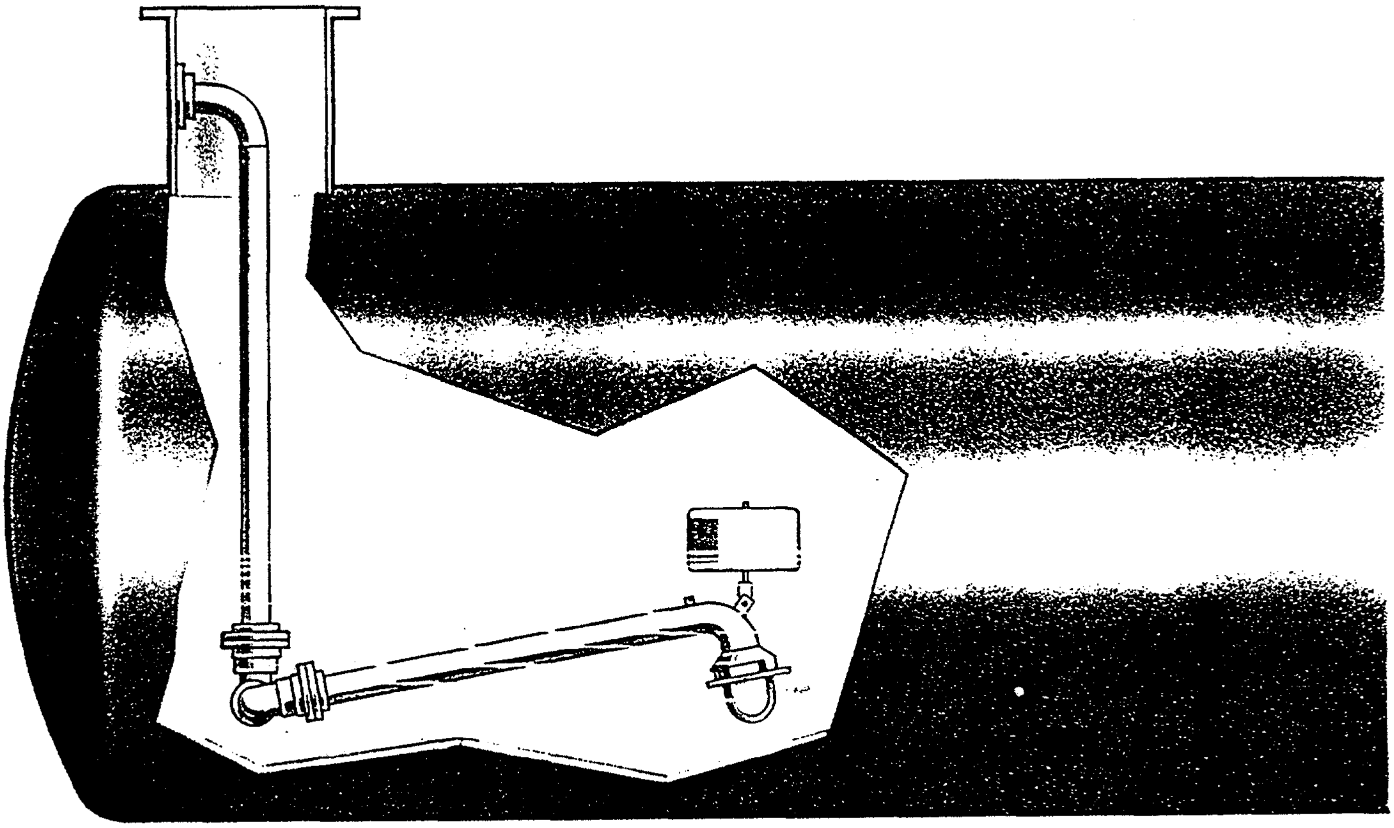
DO NOT SCALE DRAWING

DRAWN	DATE	QTY	E.W.O/N
DSS	10/06/92	1	
CHECKED	DATE	SIZE 2"	CUST. No
APPROVED	DATE	SEAL TEFLON	SIZE B / DRAWING No. C9-900 / REV. A
ΣM=	QUOTE	SPRING ----	

4/7

FLOATING SUCTIONS

Wheaton



Typical C-21 installaton

Emco Wheaton Floating Suctions are designed to draw off clean fuel from near the surface of storage tanks. With Emco Wheaton floating suctions, contamination of fuel by water, foreign matter or sediment is reduced. Every part of the floating suction is engineered for long, trouble-free life. Outstanding engineering features include an unsinkable float and a permanently lubricated ball bearing swing joint. Units are available in 10 basic types, in 7 different sizes and 3 metals . . . aluminum, steel or (special) stainless steel.

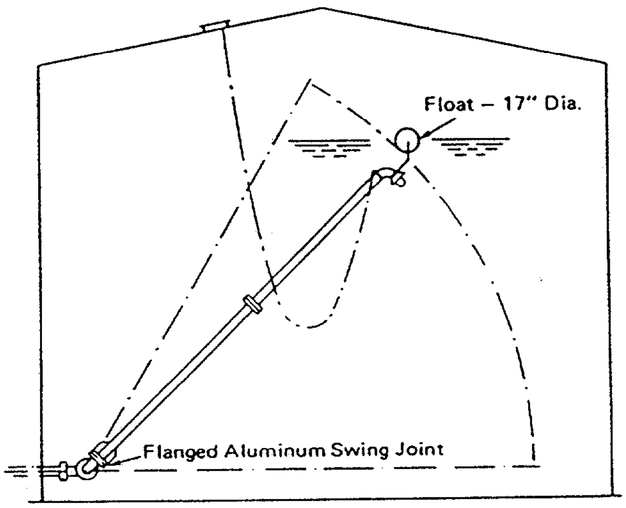
Swing joints on floating suctions are free-rotating with dual rows of ball bearing raceways for minimum torque. Raceways are double sealed by "O" rings. Each floating suction bellmouth has an oversized inlet with a baffle plate to minimize "Vortexing" at high pumping rates. A pipe foot, welded to the baffle plate maintains an intake level of nine inches minimum (except 2" size). Minimum level for 2" size is 1.75".

The unsinkable floats are aluminum cased and foam filled. The standard float is 17" in diameter to fit an 18" manhole, but buoyant enough to power even a six inch floating suction. Provisions can be made for the use of more than one float.

Emco Wheaton floating suctions are made with all aluminum pipe welded to an inlet elbow, with a standard A.S.A. 125 lb. flat-faced flange, with flanged aluminum swing joints in 3", 4", 6", 8", 10" and 12" sizes, with welded aluminum bellmouth. In the 2" size, the swing joint is threaded, unless a flange is specified. Swing joints are also available in steel or stainless steel. Emco Wheaton floating suctions provide the cleanest fuel possible in buried or above-ground horizontal and vertical tanks. When ordering, please specify: type number; size; style of tank (horizontal or vertical); diameter and height or length of tank.

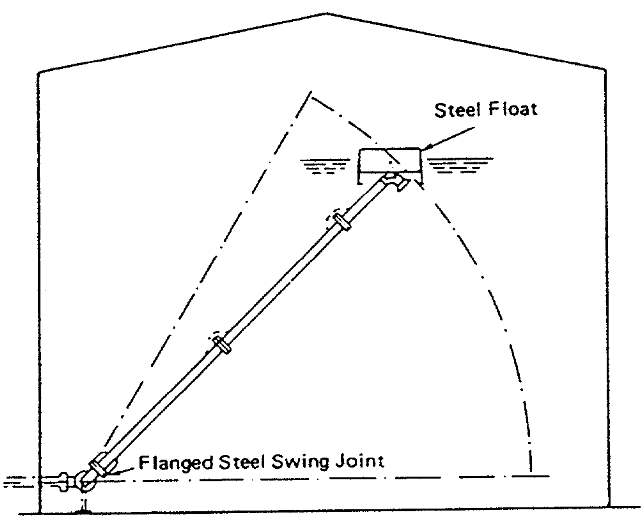
Wheaton

FLOATING SUCTIONS



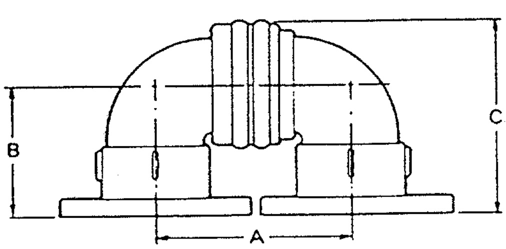
C-0024

Aluminum Single Pipe Design for Cone Roof Tank

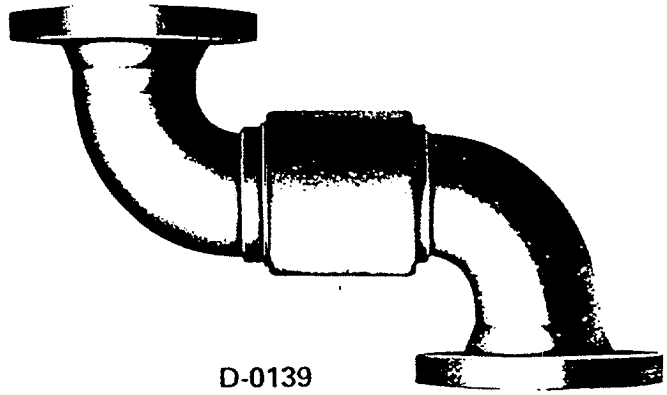


C-0025

Steel Single Pipe Design for Cone Roof Tank



D-0150



D-0139

Type **C-0024** and **C-0025** Floating Suctions are designed for cone roof tanks of all sizes. Although available in aluminum as well as steel, steel swing joints are recommended in larger sizes if compatible with product in tank. Type **D-0139** Flanged Steel Swing Joint has dual ball bearing raceways, induction hardened. Twenty foot lengths of pipe are flanged together on the larger diameter tanks for correct extension into the vertical tank. Type C-0025 Floating Suction can be supplied in larger sizes with steel float. Available in steel, aluminum, or stainless steel. The recommended alloy will be based on specification depending upon size, diameter, height of tank, and product stored in tank. Be sure to send with order or inquiry, all information for prompt handling.

Type C-0024 and C-0025 Units can be used for swing lines in cone roof tanks, as well as a floating suction.

BASIC DIMENSIONS (For further information, see Catalog D) *

Aluminum (D-0150)

Size	A	B	C
2"	5-3/4"	4-1/8"	6"
3"	8-1/8"	5-1/8"	7-7/16"
4"	9-1/4"	6-1/4"	10-7/8"
6"	20-1/8"	8"	12-5/8"
8"	23-3/4"	10"	15-15/16"

Steel (D-0139)

Size	A	B	C
6"	20-3/8"	9-1/2"	14-1/8"
8"	24-5/8"	12"	17-15/16"
10"	29-3/4"	14"	21"
12"	37-1/2"	16-1/2"	24-1/2"

* Larger sizes available upon request.

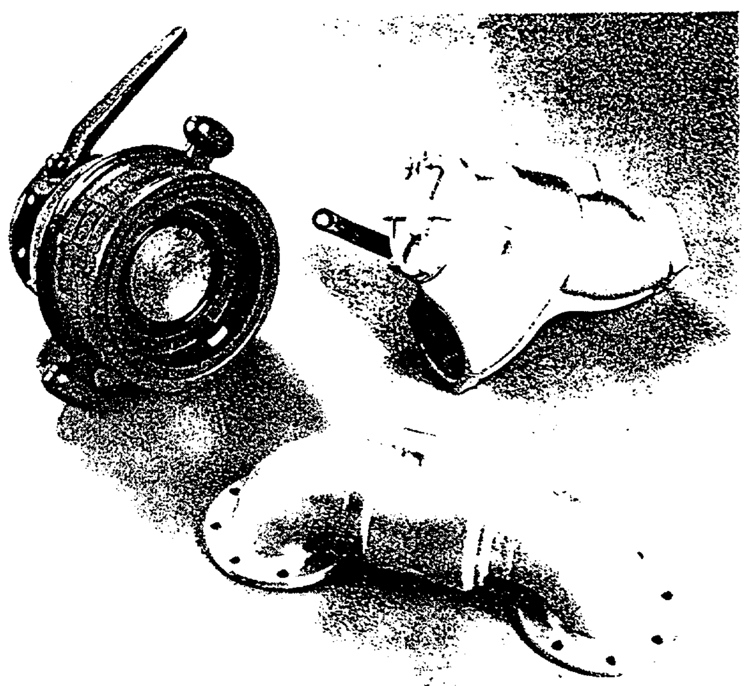
6/7

EMCO WHEATON LOADING ARM ASSEMBLIES.

Emco Wheaton is recognized as a world leader in loading system design. Our loading valves, swing joints, couplings and arms are the toughest, most precisely engineered components you can buy.

Emco Wheaton offers a wide range of available designs. Our Engineers have first-hand experience in loading requirements and offer the design assistance you need.

For more information about out Loading Arm Assemblies, send for our free catalog.



Distributed by:

Wheaton

Emco Wheaton, Inc.
Chamberlain Blvd.
Conneaut, Ohio 44030
Phone 216/599-8151
Cable "EMCOWHEAT"
Telex: 980436 Buckeye Cout

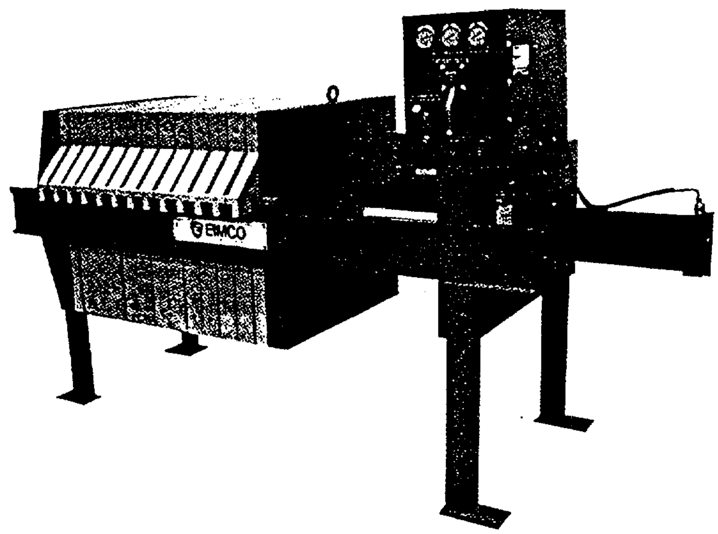
REV. 6-84

7/7

Section 11312
Dewatering Press

FILTER PRESSES

Model 630 FB
24" x 24"



Applications
• Hazardous and metallic wastes • Pharmaceuticals and chemical products • Pigments and dyes • Precious Metals • Ore processing • Coal dewatering • Water treatment • Biological sludges • Clarification of liquid • Food products and juices

Shriver "FB" Design Filter Presses

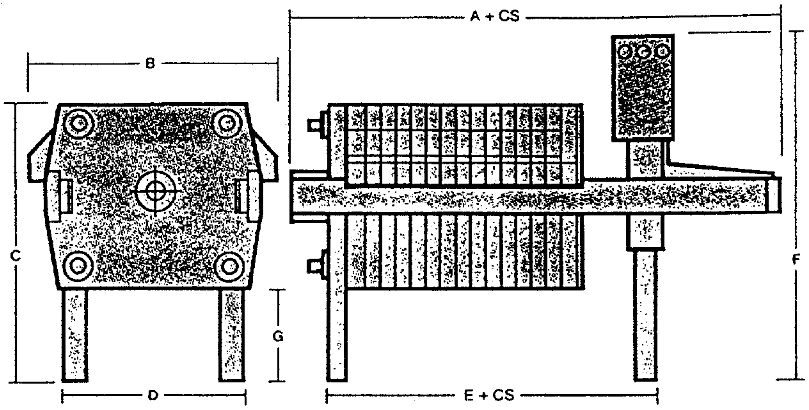
- Most cost effective sidebar Filter Presses
- Easy operation and Maintenance
  - Safe pneumatically operated hydraulic controls
  - Complete corrosion resistance
- Minimal weight and space requirements
- Maximal area and volume
- U.S. made and engineered including molded polypropylene plates
  - Factory Service
  - Parts availability
- 80 years experience in process and design
  - 30,000 installed units
  - Qualified experienced technical staff
  - Flexibility in design options (See below)
- Food grade construction
- Efficient cake washing
- Driest cakes with membranes and/or air blow

Optional Additions

- Recessed, CGR, Plate and frame, and membrane plates
- Widest media selection
- Drip trays
- Cake dumpsters or drum discharge
- Filtrate blowdown system
- Core blowback system
- Alternative plate materials
- 100 psi and 225 psi designs
- Plate shifters
- Temperatures to 200°F in polypropylene construction
- Air powered
- Cake washing or airblow
- Feed pump combinations
- Eimco Delta-stak inclined plate clarifier combinations
- Precoating and conditioning systems

Eimco Shriver Model 630 FB

Filter Press Specifications



Approximate Dimensions (inches)
Do not use for construction

Design Pressure (PSIG)	100	225
A	65½	72
B	34⅛	34⅛
C	51	51
D	22	22
E	29½	31
F	66¾	69½
G	26	26

CGR and Recessed Plates Only

Cake Thickness (inches)	CS-Chamber Space (inches)		Cake Volume Per Chamber (Ft^3)	Filter Area Per Chamber (Ft^2)
	1st Chamber	Each Additional Chamber		
1	4¾	2¹⁄₁₆	0.22	6.09
1¼	5	2⁵⁄₁₆	0.29	6.40
1½	5¼	2⁹⁄₁₆	0.37	6.81

Press Weights Pounds Empty (Approximate)

Design Pressure	Frame and 1st Chamber	Each Additional Chamber	Max. # of Chambers, Standard Design (Approximate)*
100 PSIG	1900	40	40
225 PSIG	2600	45	45

*Basis 80 lbs./ft^3 cakes   Note: Cake weight = Wet bulk density times volume

Example Calculation

Find length and weight of Model 630 with 25 chambers having 1¼" cakes of 80 lbs/ft^3 bulk density, 100 psig.

Chamber space = 5 + (24 X 2⁵⁄₁₆) = 60½"
Length = A + chamber space
65½ + 60½ = 126"

Empty weight = 1900 + (24 X 40) = 2,860 lbs.
Cake weight = 80 X 0.29 X 25 = 580 lbs.
TOTAL WEIGHT 3,440 lbs

Weight distribution: 55:45% Head: Tail Stand
Weight may be greater with added options

Special designs available for presses with different conditions or longer than shown.

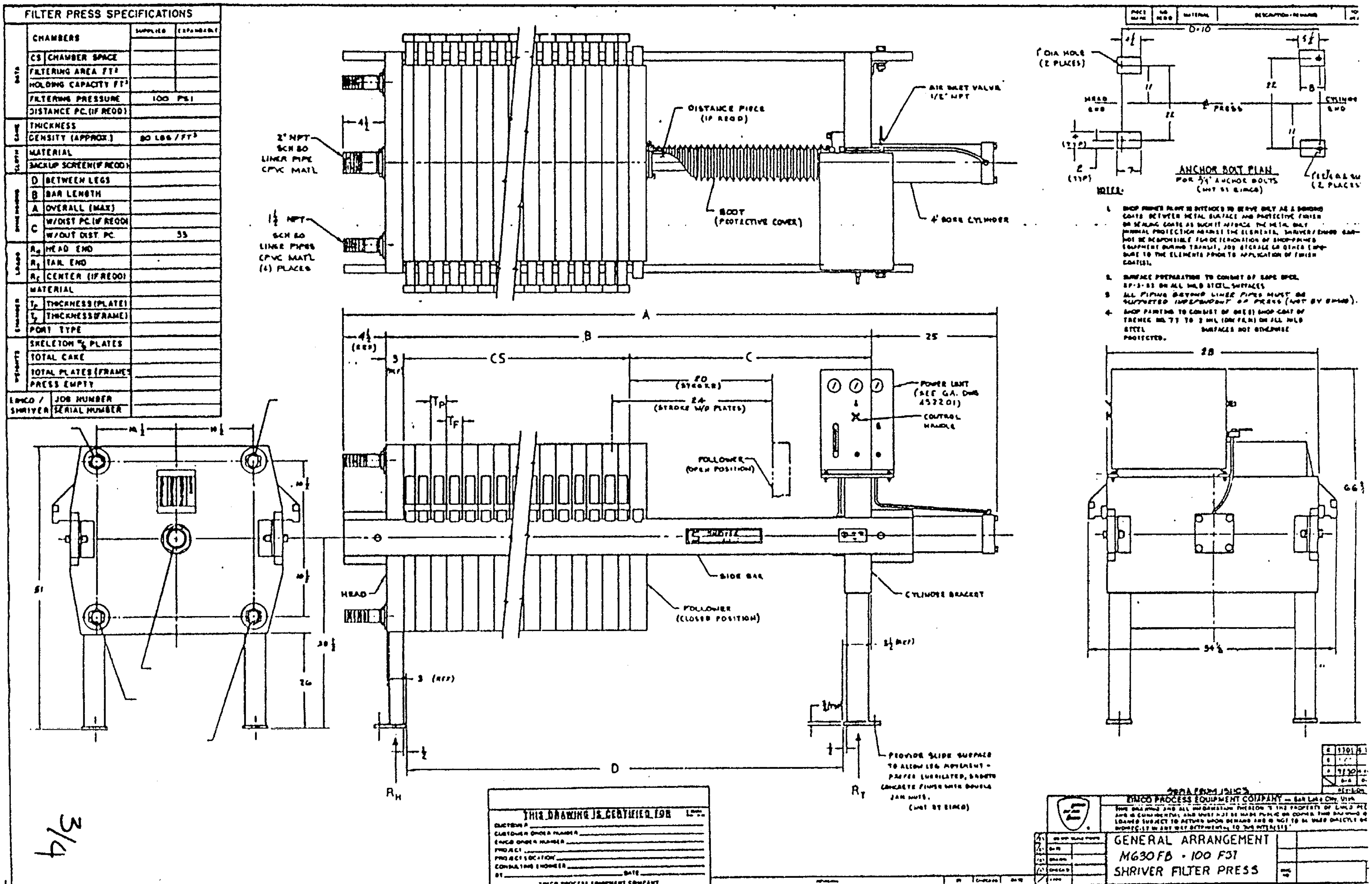
Eimco Process Equipment Co.
P.O. Box 300
Salt Lake City, Utah 84110
(801) 526-2000 Telex: 388-320

In Canada Contact:
Eimco Process Equipment Co., Ltd.
5155 Creekbank Rd.
Mississauga, Ontario L4W1X2
(416) 625-6070 Telex: 06-961455

For pricing and information contact:

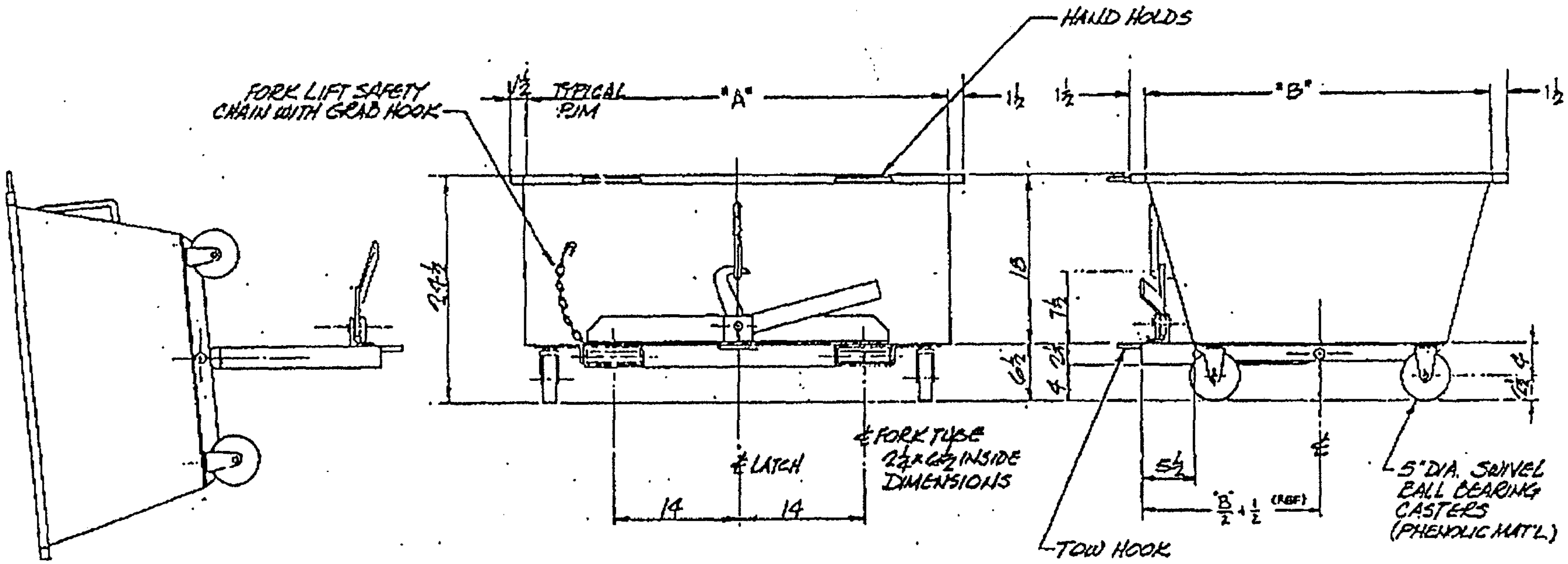
Form #2215-630-R.1

FILTER PRESS SPECIFICATIONS			
CHAMBERS		SUPPLIED	EXPANDABLE
CS	CHAMBER SPACE		
FILTERING AREA FT²			
HOLDING CAPACITY FT³			
FILTERING PRESSURE		100 PSI	
DISTANCE PC. (IF REQD)			
THICKNESS			
DENSITY (APPROX.)		80 LBS / FT³	
MATERIAL			
BACKUP SCREEN (IF REQD)			
D	BETWEEN LEGS		
B	BAR LENGTH		
A	OVERALL (MAX)		
C	W/DIST PC. (IF REQD)		
C	W/OUT DIST. PC.	53	
R_H	HEAD END		
R_T	TAIL END		
R_C	CENTER (IF REQD)		
MATERIAL			
T_P	THICKNESS (PLATE)		
T_F	THICKNESS (FRAME)		
PORT TYPE			
SKELETON & PLATES			
TOTAL CAKE			
TOTAL PLATES (FRAMES)			
PRESS EMPTY			
EIMCO / SHRIVER	JOB NUMBER		
EIMCO / SHRIVER	SERIAL NUMBER		



M630FB-100PSI

3/4



EIMCO PART Nº. (SEE TABLE)

MAT'L. STEEL

TOTAL NET WT. LBS.

PART Nº.	"A" x "B"	FT³ PRESS SIZE (REF)
41536C31P	92 x 60	25 & 30
41536C31N	66 x 60	40 & 50
41536C31M	90 x 42	25 & 30
41536C31K	60 x 42	20
41536C31X	48 x 42	15
41536C31J	72 x 42	10
41536C31H	82 x 56	8
41536C31F	72 x 56	6
41536C31D	60 x 56	4 & 5
41536C31C	52 x 56	3
41536C31A	44 x 56	2

REVISION	BY	CHECKED	DATE
ADDED '41536C31P' OPTION	SAB	KC	11-24-97

EIMCO PROCESS EQUIPMENT COMPANY — Salt Lake City, Utah

HOLD FRACTIONAL MACHINED DIMENSIONS TO ± 1/32"

DATE: 5 OCT 83
DRAWN: SC
CHECKED: HOTT
APPR: RHE

CAKE DUMPSTER

DWG. NO. 41536C31 REV. A

Section 11313
Positive Displacement Pumps

OPERATOR'S MANUAL 66615X-XXX-C

INCLUDING: OPERATION, INSTALLATION & MAINTENANCE

RELEASED: 5-31-88
REVISED 1-18-89
(REV.C) IPP/PSE

1-1/2" DIAPHRAGM PUMP

1:1 RATIO

IMPORTANT: READ THIS MANUAL CAREFULLY BEFORE INSTALLING, OPERATING OR SERVICING THIS EQUIPMENT.

MODELS	INLET OUTLET TH'D	BODY MAT'L	AIR SECTION SERVICE KIT (PAGE 6)	FLUID SECTION SERVICE KITS (PAGE 4)
66615X-XXX-C	1-1/2 NPT	ALUMINUM	637118-C	637124-X
66616X-XXX-C	1-1/2 NPT	CAST IRON	637118-C	637124-X
66617X-XXX-C	1-1/2 BSP	ALUMINUM	637118-C	637124-X
66618X-XXX-C	1-1/2 BSP	CAST IRON	637118-C	637124-X

See Model Description Chart page 3 for -XXX

637155 Abrasion Resistant Conversion Kit is available for use in heavy and abrasive material applications (see page 5).

PUMP DATA

MODEL — See Chart on page 3
TYPE — Air-Operated Double Diaphragm
MAT'L — See Option Chart on page 3
WEIGHT-ALUM. (CTR. BODY) 44 lbs. to 76 lbs.
CAST IRON (CTR. BODY) 82 lbs.
MAXIMUM AIR INLET PRESSURE - 120 psi max. (8 bar)
MAXIMUM FLOW (with Flooded Inlet) — 90 gpm
MAXIMUM PARTICLE SIZE - 1/4" dia.

See page 3 for dimensional data

GENERAL DESCRIPTION

The ARO® diaphragm pump offers high-volume delivery even at low air pressures, easy self-priming, the ability to pump high-viscosity materials and ability to easily pass solids to 1/4 in. diameter. This pump is highly versatile and is designed to correspond to the needs of the customer. Several "wetted parts" options are available to handle almost any application. See option chart on page 3 for model description.

MODEL 66615X-XXX-C

 THE ARO CORPORATION

OPERATING AND SAFETY PRECAUTIONS FOR DIAPHRAGM PUMPS

- HEED ALL WARNINGS AND CAUTIONS.
- Use ARO replacement parts to assure compatible pressure rating.
- WARNING: DO NOT EXCEED MAXIMUM INLET AIR PRESSURE OF 120 PSI (8 BAR). OPERATING PUMP AT HIGHER PRESSURE MAY CAUSE PUMP DAMAGE AND/OR PERSONAL INJURY AND/OR PROPERTY DAMAGE.
- WARNING: THE MODELS LISTED BELOW CONTAIN ALUMINUM WETTED PARTS AND ARE SUBJECT TO THE FOLLOWING WARNING.
  MODELS: 66615X-XXX-C, 66617X-XXX-C
  DO NOT USE III.-TRICHLOROETHANE, METHYLENE CHLORIDE OR OTHER HALOGENATED HYDROCARBON SOLVENTS IN THIS PUMP. THE PUMP CONTAINS ALUMINUM WHICH MAY REACT WITH THE SOLVENT AND EXPLODE.
  MATERIALS CONTAINING HALOGENATED HYDROCARBON SOLVENTS SHOULD NOT BE USED WITH THIS EQUIPMENT.
  CONSULT YOUR MATERIAL SUPPLIER FOR COMPATIBILITY WITH ALUMINUM.
- WARNING: WHEN USING PUMP IN A LOCATION WHERE SURROUNDING ATMOSPHERE IS CONDUCIVE TO SPONTANEOUS COMBUSTION OR WHEN PUMPING, FLUSHING OR RECIRCULATING INFLAMMABLE SUBSTANCES (E.G., PAINTS, SOLVENTS, LACQUERS, ETC.), FAILURE TO SAFEGUARD AGAINST STATIC SPARK, OPEN FLAME, HEAT AND IMPROPER VENTILATION COULD RESULT IN EXPLOSION AND/OR FIRE CAUSING SEVERE PERSONAL INJURY OR DEATH AND/OR PROPERTY DAMAGE.

  Safety precautions should include:
  - Use of static wire hoses.
  - Proper grounding of pump (at clamps), dispensing valve or device, hoses, any object to which material is being transferred, and containers. After grounding, periodically check to verify continuity of electrical path to ground. Test with ohmmeter from each components (i.e., hoses, pump, clamp, container, spray gun, etc.) to ground to insure continuity. Ohmmeter reading shown should be 10 ohms or less. Consult local electric codes for specific grounding requirements.
  - Submersion of outlet hose end, dispensing valve or device within material being dispensed whenever possible. (Avoid free streaming of material being dispensed.)
  - Piping exhaust to a safe remote location when pumping hazardous or inflammable substances since the material being pumped is exhausted with the air if the diaphragm ruptures. Use a grounded 3/4" min. I.D. hose between pump and muffler.
  - Proper ventilation of area where pump and containers are located.
  - Keeping inflammables away from heat, open flames and sparks.
  - Keeping containers closed when not in use.
  - Secure pump, connections and all contact points to avoid vibration and generation of contact or static spark.
  - Be sure material hoses and other components are able to withstand fluid pressures developed by this pump.
  - Disconnect air line from pump when system sits idle for long periods of time.
  - Suction and discharge connections should be flexible connections (such as hose), not rigid piped, and should be compatible with the substance being pumped.
- WARNING: DO NOT SERVICE OR CLEAN PUMP, HOSES OR DISPENSING VALVE WHILE THE SYSTEM IS PRESSURIZED AS SERIOUS PERSONAL INJURY COULD RESULT. First disconnect air line, then relieve pressure from system by opening dispensing valve or device and/or carefully and slowly loosening and removing outlet hose or piping from pump.

(continued on Page 8)

AIR AND LUBE REQUIREMENTS

- WARNING: DO NOT EXCEED MAXIMUM INLET AIR PRESSURE OF 120 PSI (8 BAR). OPERATING PUMP AT HIGHER PRESSURE MAY CAUSE PUMP DAMAGE AND/OR PERSONAL INJURY AND/OR PROPERTY DAMAGE.
- A filter capable of filtering out particles larger than 50 microns should be used on the air supply. In most applications there is no lubrication required other than the "O" ring lubricant which is applied during assembly or repair. When lubricated air is necessary, supply air lubricator with a good grade of SAE 90 wt. non-detergent oil and set lubricator to a rate not to exceed one drop per minute.

INSTALLATION

Always flush the pump with a solvent compatible with material being pumped if the material being pumped is subject to "setting up" when not in use for a period of time. Disconnect air supply from pump if it is to be inactive for a few hours.

The outlet material volume is governed not only by the air supply but also by the material supply available at the inlet. The material supply tubing should not be too small or restrictive.

When the diaphragm pump is used in a force-feed (flooded inlet) situation it is recommended that an ARO 104104-C04 "Check Valve" be installed at the air inlet. Secure diaphragm legs to a suitable surface to insure against damage by vibration.

MAINTENANCE

Part views and descriptions are provided on page 4 through 7 for part identification.

This pump is relatively easy to service and maintain. A clean work surface should be provided to protect sensitive internal moving parts from dirt and foreign matter during service. The service kits are available for the two, separate diaphragm pump functions: 1. FLUID SECTION 2. AIR SECTION. The FLUID SECTION is divided further to match typical active WETTED PARTS OPTIONS, SEE "PARTS LIST/FLUID SECTION" (Page 4).

Before disassembling, turn the pump upside down to drain material from pump. This will empty captured material in outlet manifold

DIMENSIONAL DATA

ALL DIMENSIONS GIVEN IN INCHES AND MILIMETERS (MM)

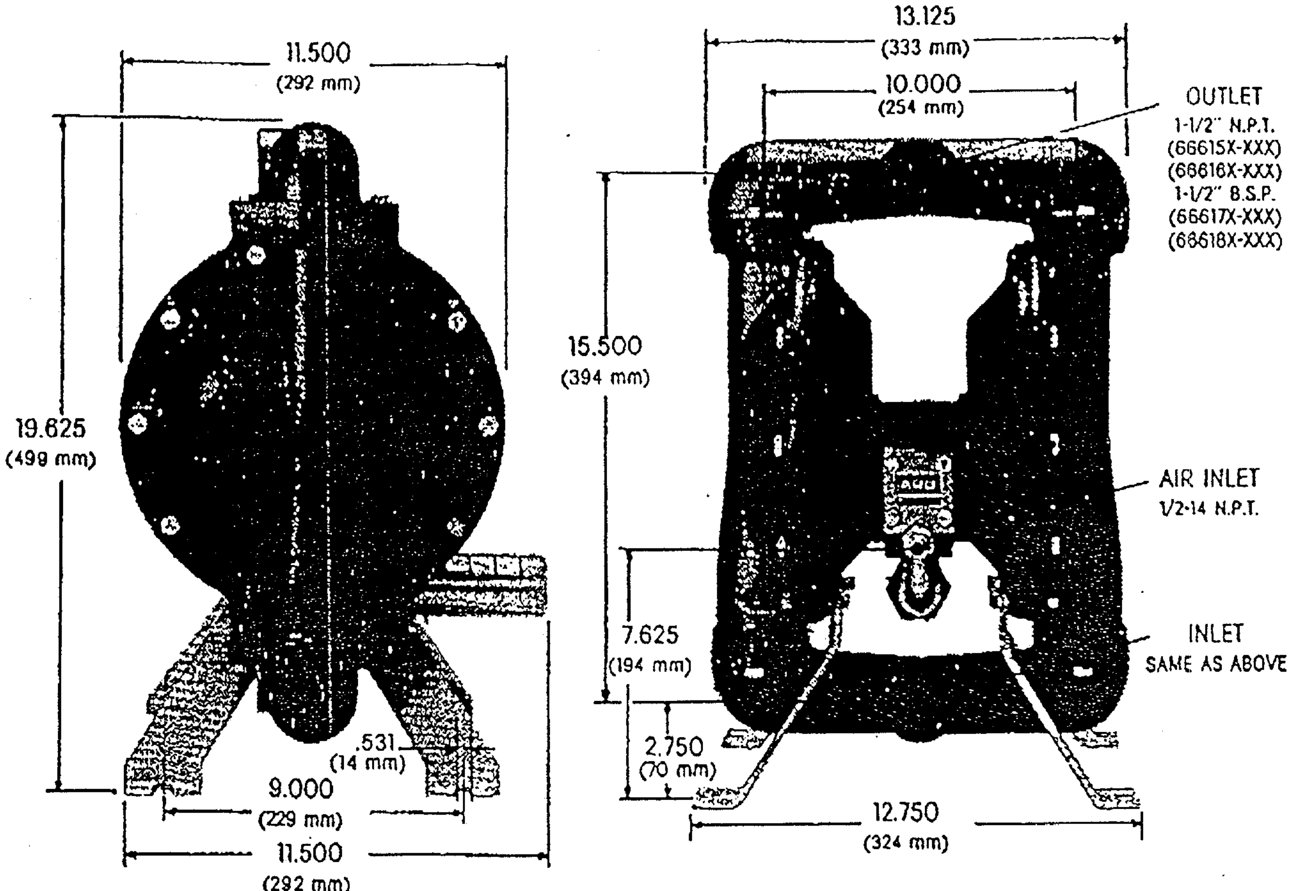


FIGURE 1

MODEL DESCRIPTION CHART

PART NAME	(CODE) MATERIAL OPTIONS
PUMP SIZE, TYPE, & CENTER BODY MATERIAL	15 1-1/2 INCH NPT, ALUMINUM CENTER BODY 16 1-1/2 INCH NPT, CAST IRON CENTER BODY 17 1-1/2 INCH BSP, ALUMINUM CENTER BODY 18 1-1/2 INCH BSP, CAST IRON CENTER BODY
CAPS, MANIFOLD	0 ALUMINUM 1 STAINLESS STEEL 2 CAST IRON
SEAT MAT'L	2 STAINLESS STEEL 3 POLYPROPYLENE 4 PVDF (KYNAR®)
BALL	4 T.F.E. (TEFLON®) 6 ACETAL
DIAPHRAGM	1 NEOPRENE 2 BUNA "N" 3 VITON 4 T.F.E. (TEFLON®) 5 E.P.R. 9 HYTREL

6661XX-XXX

Section 11315
Pneumatic Pumping System

EJECTOR SYSTEMS, INC.

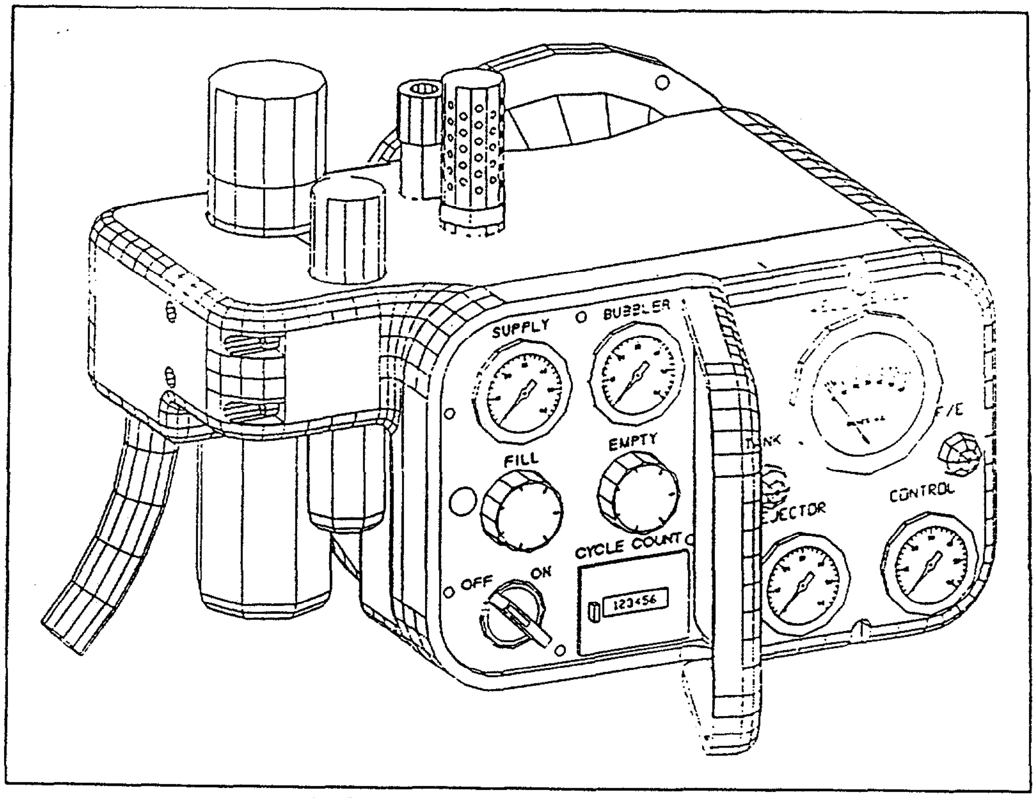
S2 SINGLE-WELL PUMPING SYSTEM

EJECTOR SYSTEMS, INC.
910 NATIONAL AVENUE
ADDISON, IL
60101
(708) 543-2214
1-800-OIL-LEAK

1/92

1/7

Ejector Systems, Inc. presents the most advanced solution yet for groundwater remediation and leachate pumping. The same ingenuity that made ESI the first to use pneumatics for groundwater pumping is now combined with the new S2 single well controller to offer a vast number of options, yet remain amazingly economical.



S2 SINGLE WELL CONTROLLER

Product Only and Total Fluids pumps are both compatible with the new S2 controller. Ejector Systems, Inc.'s pumps are entirely pneumatic and have only two moving parts thereby reducing maintenance. In addition to leachate pumping, they can be used to pump lighter-than-water, phase-separated hydrocarbons, such as gasoline and fuel oils; heavier-than-water hydrocarbons, such as creosote or chlorinated solvents; or dissolved hydrocarbons only. Refer to the chart on page four for flow rate and air consumption.

2/7

Some standard features on the new S2 single-well controller are:

- The S2 system is totally submersible.
- An extremely rugged **11" high x 14.5" wide x 10" deep** casing encloses the S2 so it fits easily into a below grade box.
- Water problems are virtually eliminated with the S2's **Pulsed Auto-Drain** which eliminates condensate in the compressed air system.
- The **Manual Discharge** feature allows the pump to fire with the simple push of a button.

Dependent upon the specific site requirements, optional features are available:

- To ensure accurate level control in sealed well applications with a vacuum, the **Differential Pressure** option is available.
- The **High Tank Shut-Off** option will shut down the pumping system in the event of a high level condition.
- A **Vacuum Fill** Unit which will apply a vacuum to the vent line during the fill cycle is available.
- Product recovery is maximized with the **Level Tracking** option which ensures that the inlet of the Product Only pump is always at the liquid surface of the well.

3/7

MAXIMUM FLOW RATE AND APPROXIMATE AIR CONSUMPTION VS. EJECTOR DIAMETER AND LENGTH

Diameter of Ejector

	1.5 inches	3 inches	4 inches	5 inches	6 inches	8 inches
1.5 feet	0.5 1.0	2.0 1.8	3.8 6.5	6.5 4.2	9.3 5.7	17.3 10.9
3 feet	1.0 1.2	4.1 2.9	7.5 4.8	12.9 8.6	18.6 11.7	34.5 21.5
4 feet	1.3 1.4	5.4 3.6	10.0 7.0	17.2 10.5	24.8 13.0	46.0 27.7
5 feet	** Special	6.8 4.4	12.5 8.3	21.5 13.2	31.0 19.6	57.5 34.0
6 feet	** Special	8.1 5.1	15.0 9.7	25.8 15.6	** Special	** Special

Length of Ejector

- Top number in each cell represents maximum flow rate at 5 cpm.
- Bottom number represents approximate air consumption assuming 25 feet of 1/2 inch ID air line and 1 inch diameter discharge line.

**Special - These pumps must be special ordered.

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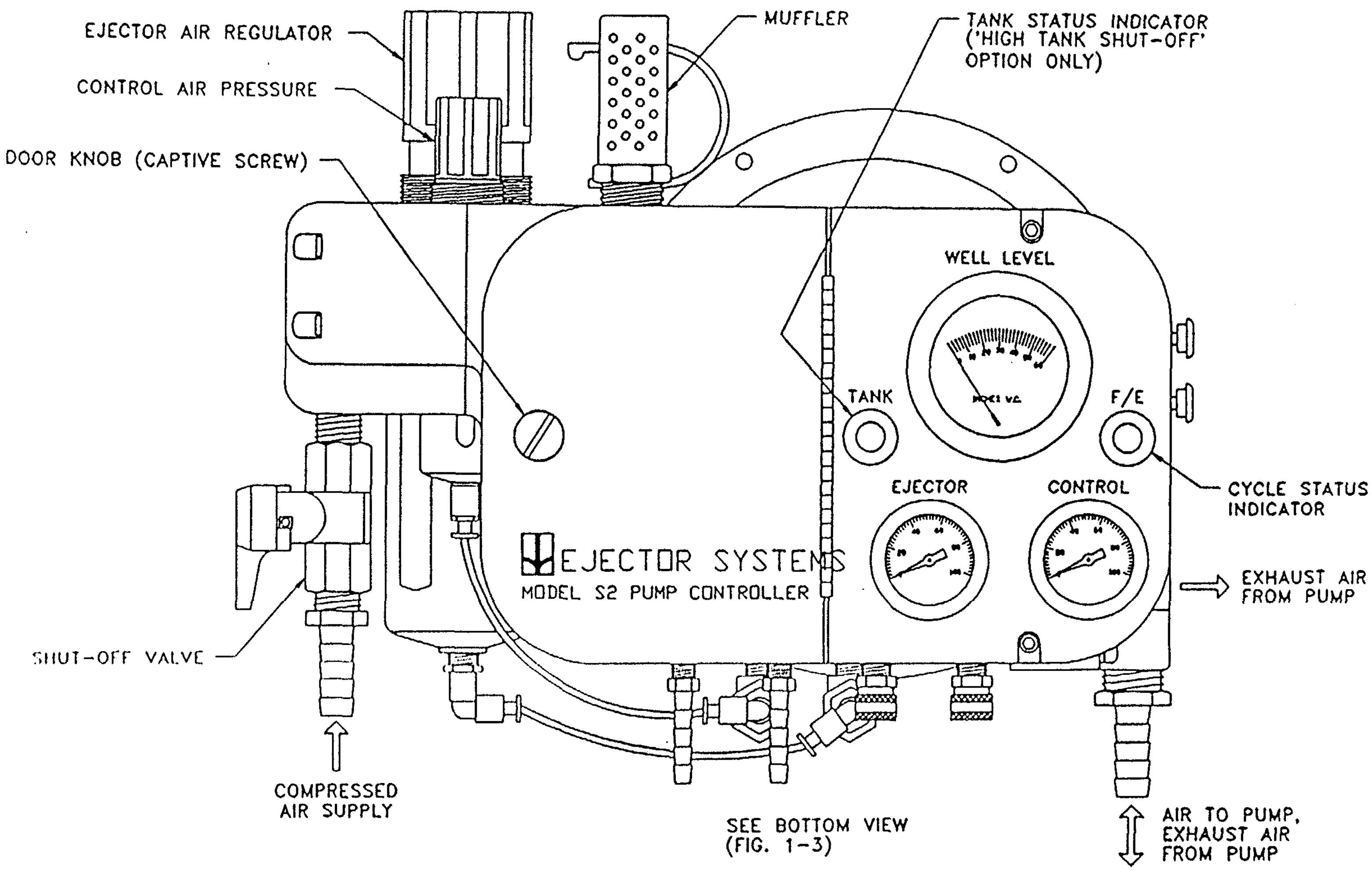

FRONT VIEW

EJECTOR SYSTEMS, INC.

5

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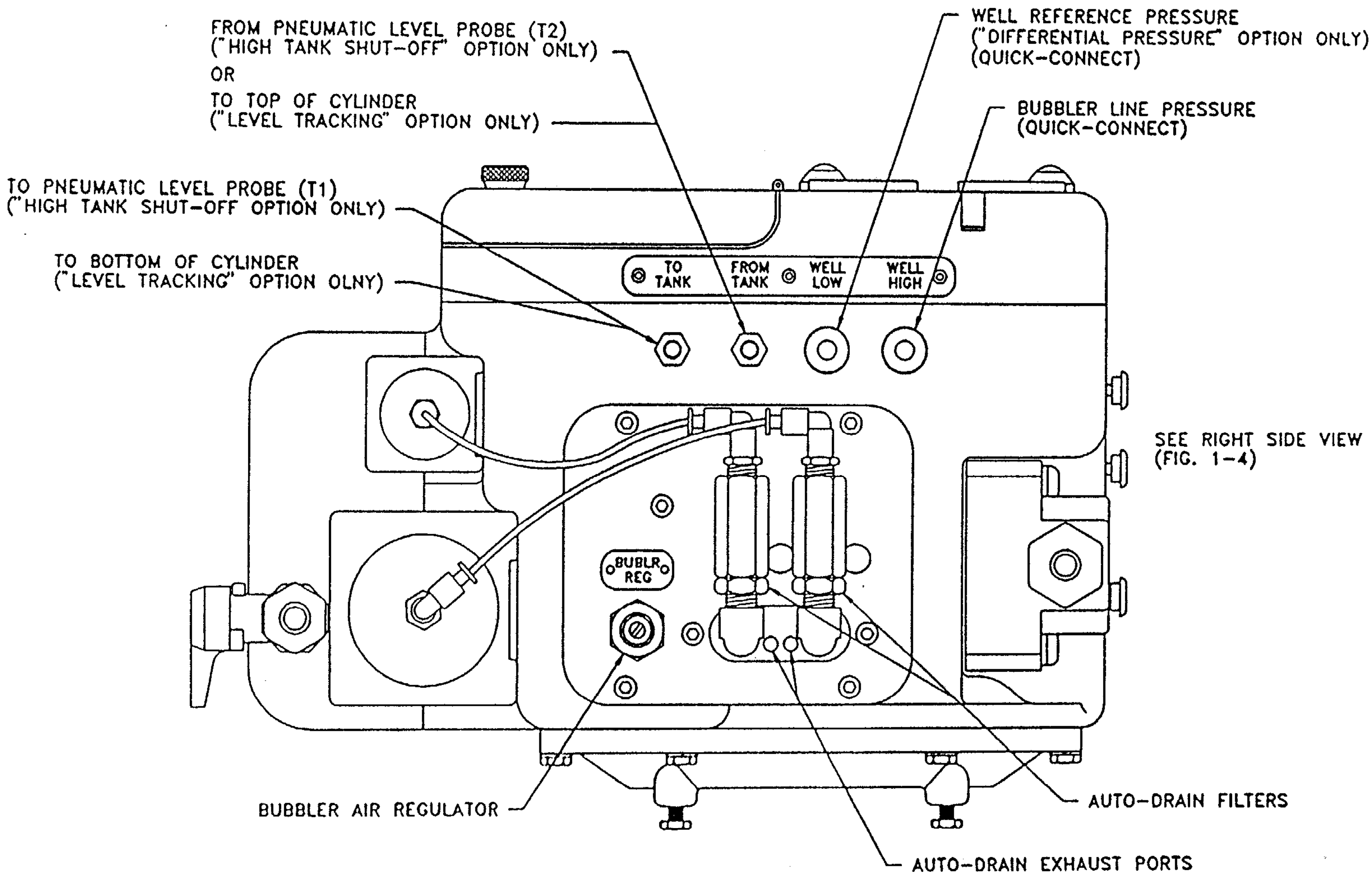
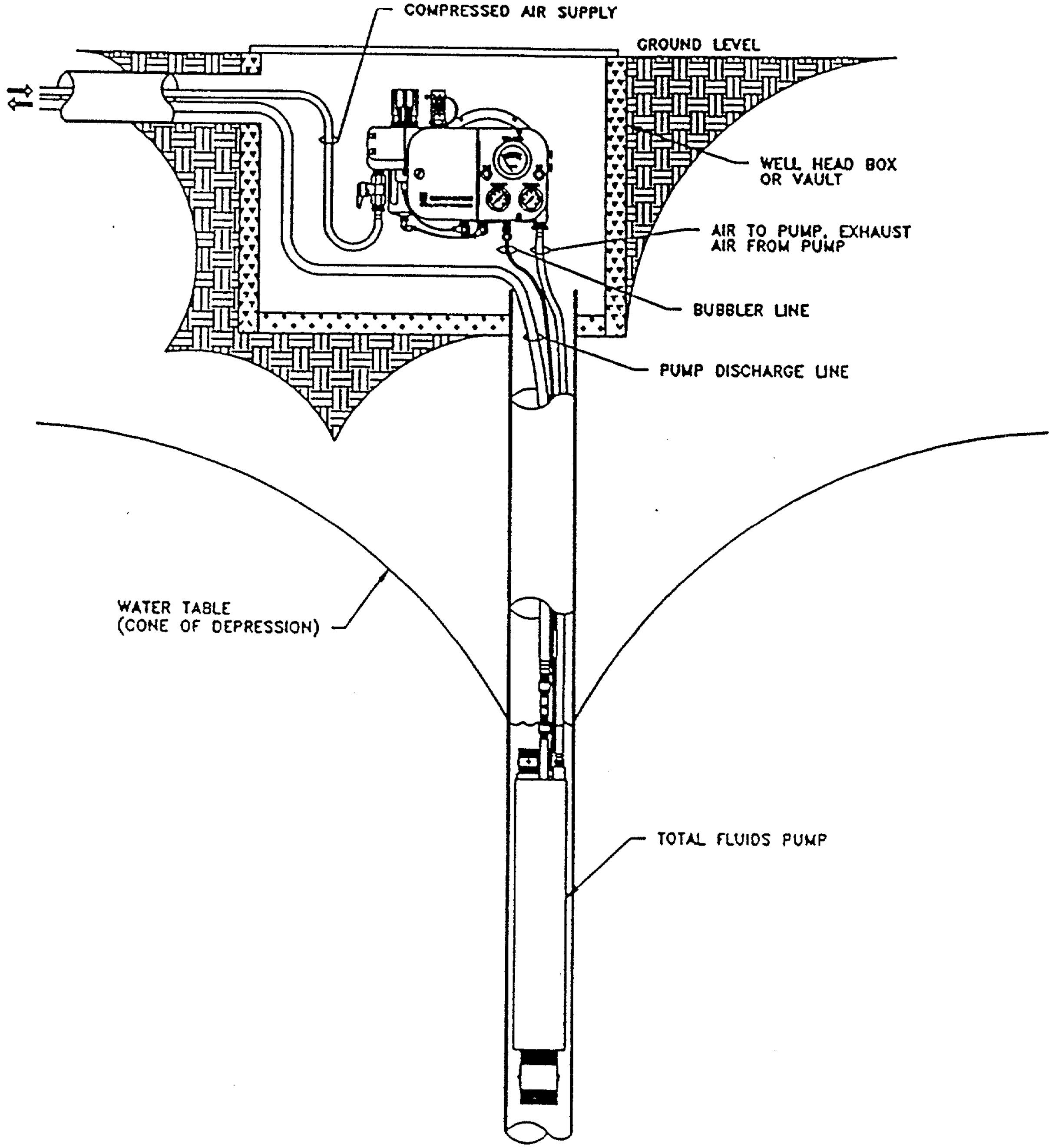

FROM PNEUMATIC LEVEL PROBE (T2) ("HIGH TANK SHUT-OFF" OPTION ONLY)
OR
TO TOP OF CYLINDER ("LEVEL TRACKING" OPTION ONLY)
WELL REFERENCE PRESSURE ("DIFFERENTIAL PRESSURE" OPTION ONLY) (QUICK-CONNECT)
BUBBLER LINE PRESSURE (QUICK-CONNECT)
TO PNEUMATIC LEVEL PROBE (T1) ("HIGH TANK SHUT-OFF OPTION ONLY)
TO BOTTOM OF CYLINDER ("LEVEL TRACKING" OPTION OLNY)
TO TANK
FROM TANK
WELL LOW
WELL HIGH
SEE RIGHT SIDE VIEW (FIG. 1-4)
BUBLR REG
BUBBLER AIR REGULATOR
AUTO-DRAIN FILTERS
AUTO-DRAIN EXHAUST PORTS

BOTTOM VIEW



BELOW GRADE WELL HEAD ELEVATION

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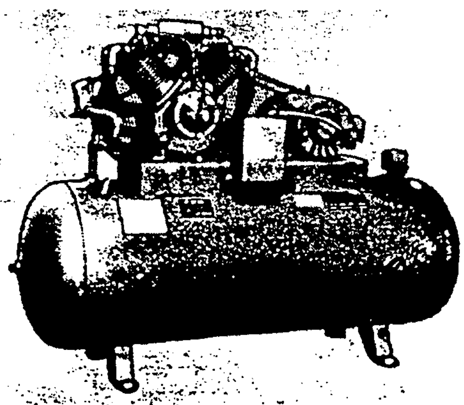
COMPRESSORS



Two Stage Tank Mount Compressors

Powerful industrial compressors build air pressure in two steps—they draw air into a large cylinder where it is compressed to medium pressure, then discharge it into a smaller cylinder for further compression. Maximum operating pressure is 200 psi. Compressors feature an automatic pressure switch for loadless starting. They stop and start automatically to keep pre-determined pressure in tanks. Switch cuts in at 140 psi and cuts off at 175 psi.

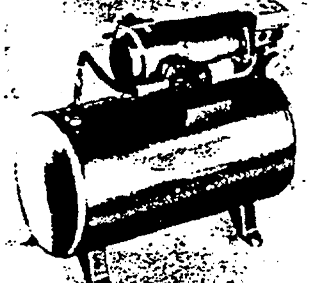
The National Electrical Manufacturers' Association standard 1800 rpm motor is V-belt driven and operates on 230/460-volts, 3-phase, 60 Hz. Mounted on an American Society of Mechanical Engineers' (ASME) National Board code air tank.

Complete with a totally enclosed belt guard, air gauge, ASME approved safety valve, and an intake filter silencer. On models 3 hp and **over a 230-volt magnetic starter is included. Magnetic starter is optional on 1½ and 2 hp models. On units with magnetic starter specify 230 or 460-volt. Units with 460-volt magnetic starter or 50 Hz are available. Specify No. 4364K999 and hp. Prices on request.**

Disp. cfm	Approx. Free Air cfm	hp	Comp. Speed rpm	Tank Cap. Gals.	Bore, Inches Low Press.	Bore, Inches High Press.	Stroke Inches	Overall Inches Lg.	Overall Inches Wd.	Overall Inches Ht.	No.	NET EACH
10.5	5.3	1½	542	80	4⅝	2½	2	66	20	44	4364K32 ♦	$1691.11
14.1	7.5	2	725	80	4⅝	2½	2	66	20	44	4364K43 ♦	1828.36
12.8	9.7	3	440	80	4⅝	2½	3	66	20	44	4364K44	2077.26
20.7	16.5	5	710	80	4⅝	2½	3	66	20	44	4364K35	2039.04
36.1	26.2	7½	620	80	4⅝	2½	3	66	20	46	4364K36	3065.76
44.6	34.4	10	765	80	4⅝	2½	3	66	23	46	4364K37	3538.08
61.5	53.7	15	770	120	6¼	3¼	4½	72	29	61	4364K38	4777.20
93.0	77.6	20	655	120	6¼	3¼	4	72	29	58	4364K39	5948.64
109.4	91.1	25	770	120	6¼	3¼	4	72	29	58	4364K41	6339.60

♦ Magnetic starters for these compressors.

1½ hp (specify 230-volt or 460-volt) .... No. 4364K55 ..... NET EACH $221.67
2 hp (230-volt) .... No. 4364K53 ..... NET EACH 259.00
2 hp (460-volt) .... No. 4364K57 ..... NET EACH 221.67

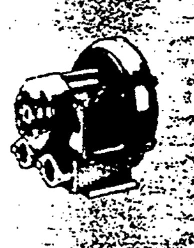


Single Stage Tank Mount Air Compressors—1/4 HP

Built tough for industrial plants and laboratories where compressed air up to 100 psig is required. Mounted on a 12-gallon American Society of Mechanical Engineers' tank. Oil-less, twin-cylindered, piston-design, air-cooled units are driven by a thermally protected, 1725 rpm, ¼ hp motor that operates on 115-volts, 1-phase, 60 Hz. Equipped with a filter, safety valve, pressure gauge, pre-set adjustable pressure switch, and shut-off and check valves.

Max. Working psig	Free Air cfm	Pressure Switch Cuts In	Overall Size, In. Lg.	Wd.	Ht.	No.	NET EACH
50	2.4	30 psig	26¼"	13"	20⅞"	9900K12	$647.71
100	2.0	70 psig	26¼"	13"	20⅞"	9900K14	646.13

Single-Stage Blower/Compressors

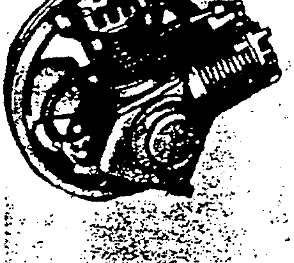


Centrifugal units deliver substantial air flows at moderate pressures. Ideal for pneumatic conveying aeration, film dryers, and agitation of fluids and semi-solids. Oil-free air.

Easily changed from pressure to suction use, and may be mounted in a variety of positions. Direct connect motor shaft impeller provides reliable performance. No gears, belts, motor brushes, and sliding vanes that require maintenance. The impeller, mounting base, and housing are aluminum alloy for strength and corrosion resistance. Motors are totally enclosed and fan cooled.

Voltage	Phase	Max. Static Water Pressure	Connections	Flow scfm	No.	NET EACH
200-230	3	26.5"	1"	27	9960K11	$363.79
200-230/460	3	50"	1¼"	55	9960K13	446.55
200-230/460	3	54.5"	1½"	98	9960K14	477.59
200-230/460	3	118"	2"	206	9960K16	900.00
115	1	27.5"	1"	27	9960K17	418.97
115	1	34"	1"	42	9960K18	429.31
115/230	1	53"	1½"	94	9960K21	543.10

Compressor Heads



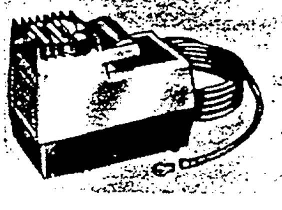
Single and two-stage compressor heads are for replacement and for assembly of complete compressors (motor is not included).

Positive splash lubrication system controls lubrication to all moving parts. Heads have a counter-balanced precision crankshaft, tapered bearings, balanced flywheel, a large oil reservoir, and a dustproof crankcase.

No. of Cylinders	Free Air cfm ♦	rpm ♦	Suggested Motor hp	Bore Size, Inches	Stroke Inches	Overall, Inches Lg.	Wd.	Ht.	No.	NET EACH
SINGLE STAGE—100 PSI MAXIMUM WORKING PRESSURE										
1	1.80	890	⅓ to ½	2	1¾	5¾	6 15/16	10¼	4366K11	$232.11
2	5.37	810	1 to 1½	2⅜	2	6	10⅝	10⅞	4366K17	428.17
TWO STAGE—175 PSI MAXIMUM WORKING PRESSURE•										
2	3.80	780	¾ to 1	2⅝ × 1¾	2	8 9/16	15	10½	6777K11	$433.40
3	6.75	720	1½ to 2	2⅝ × 1¾	2	8¾	17¼	12 9/16	6777K12	578.82
2	16.5	710	3 to 5	4⅝ × 2½	3	20	18	19	6777K13	916.58
4	34.4	765	7½ to 10	4⅝ × 2½	3	21⅛	24	20½	6777K14	1803.85

♦ With largest motor for this unit in the "Suggested Motor hp" column. •Have finned intercooler.

Multi-Set Oil-less Piston Air Compressor



Plenty of air pressure for air tools—excellent for spraying paint and insecticides, sandblasting, inflating, cleaning, and stapling.

Has five adjustable pressure settings: 10, 30, 50, 70, and 100 psi. UL listed unit has an air delivery of 2.2 cfm at 50 psi, and 1.3 cfm at 100 psi. Maximum operating pressure is 100 psi.

This high-powered compressor is powered by a direct-drive, ½ hp, split-phase, thermal overload protected motor that operates on 115-volts, AC, 60 Hz. Furnished with a 15-foot air hose, bleeder air chuck, safety valve, rubber feet, 6-foot cord with a 3-prong plug, and an on/off switch.

No. 9991K17 .... NET EACH $160.00

1/1

McMASTER-CARR