Final Remedial Design Report
JCI Jones Chemicals, Inc. Superfund Site
Caledonia, New York

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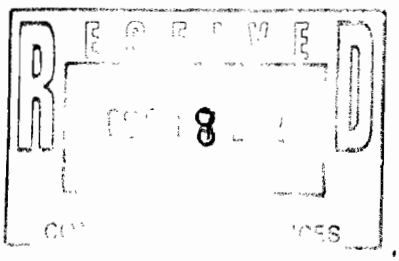
Prepared for
JCI Jones Chemicals, Inc.
100 Sunny Sol Boulevard
Caledonia, New York 14423

Prepared by
LFR Levine·Fricke Inc.
3382 Capital Circle, N.E.
Tallahassee, Florida 32308-8702



CONTENTS

TABLES

FIGURES

APPENDICES

CERTIFICATION

All engineering information, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by an LFR Levine·Fricke New York Professional Engineer.

A. Scott Starr, Senior Engineer
New York Professional Engineer (78821-1)

10-16-02
Date

1.0 INTRODUCTION

This document represents the Final Remedial Design Report for the JCI Jones Chemicals, Inc., (JCI), Caledonia, New York Superfund site ("the Site") as required by the Consent Decree ("the Decree") under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). JCI and the U.S. Environmental Protection Agency (U.S. EPA) entered into the Decree to conduct Remedial Design/Remedial Action (RD/RA) at the Site on July 11, 2001.

On behalf of JCI, LFR Levine·Fricke (LFR) prepared this Final Remedial Design Report in accordance with:

- Remedial Design Work Plan (LFR 2001). The Remedial Design Work Plan was approved by the U.S. EPA in December 2001 and included the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HSP)
- "State of Work (SOW)" included in the Decree (U.S. EPA 2001)
- "Record of Decision (ROD)" for the Site (U.S. EPA 2000)
- "Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties" (U.S. EPA 1990)
- "Remedial Design/Remedial Handbook" (U.S. EPA 1995)

1.1 Objective

The objective of this Final Remedial Design Report is to present the design approach and the results of engineering analyses to support the remediation plans and technical specifications. The Report describes site background, results of the Pre-Remedial Design field activities, design criteria, and the elements of the remedial action. The Report also includes construction quality assurance project plan (CQAPP) and the remedial action (RA) Operation and Maintenance (O&M) Plan for Element I.

1.2 Background

1.2.1 Site Description

The Site is located east of State Route 5 and on the northern side of Iroquois Road in Caledonia, northwestern Livingston County, New York (Figure 1). The Site is centered on latitude 42°58'40.9"N and longitude 77°50'49.1"W and is situated in a relatively flat, sparsely populated, lightly industrialized suburban area of the Village of Caledonia. Iroquois Road borders the Site to the south, farmlands to the north, and homes with acreage to the east and west. A construction company (formerly a lumberyard) and a printing company are located immediately northwest of the Site.

A golf course, baseball field, and tennis court are present immediately south of Iroquois Road (Figure 2). The site vicinity to the west and southwest is populated with light service industries such as hardware stores, gasoline stations, dry cleaners, restaurants, and other commercial businesses. Potable water to the Site and its vicinity is supplied through Village of Caledonia production wells located to the south.

The Site has nine buildings that comprise office space, drum storage sheds, interconnected warehouse buildings, a bleach manufacturing building, and chlorine and sulfur dioxide repackaging building (Figure 2). A railway line enters from the west, extends to within the eastern boundary, and runs to the north of the buildings.

Much of the Site is flat, and areas around the buildings are paved with asphalt. A large area south of the buildings, facing Iroquois Road, is landscaped with a maintained lawn. The area north of the buildings is also known as the "north property." The east portion of the north property is covered by gravel, the west portion by grass. In 1994 the drum storage sheds, called the "pole barns," which were originally located west of the warehouse/office complex, were moved north of the lagoon system that originally included three unlined ponds (lagoons A, B and C; Figure 2).

1.2.2 Present Operations

Commercial activities at the Site presently include:

- manufacture of sodium hypochlorite (bleach) through the reaction of chlorine and dilute sodium hydroxide
- manufacture of sodium bisulfite through the reaction of dilute sodium hydroxide and sulfur dioxide
- repackaging and distribution of chlorine, sulfur dioxide, sodium hydroxide, and various minerals acids, such as muriatic acid and hydrofluosilicic acid, from bulk to small containers
- distribution of various inorganic water treatment chemicals such as soda ash and lime

The raw materials that are used in the production and distribution processes are stored in large aboveground storage tanks (ASTs) on site. These tanks range in size from 1,000 to 16,300 gallons and have typically been constructed of stainless steel, fiberglass-reinforced plastic, cross-linked polyolefin, or other suitable synthetic material.

The non-contact cooling water for the plant is supplied through the on-site supply well, North Well. The North Well was installed in March 1985 immediately south of the lagoons (Figure 2). The North Well is 4 feet in diameter and 24 feet below ground surface (bgs), and is completed in the overburden glacial outwash soils. Groundwater from the North Well is extracted at 300 to 400 gallons per minute (gpm). Prior to 1985, non-contact cooling water was supplied through three on-site production wells,

the West Well, the Middle (South Well), and the East Well. Because of their poor yields, groundwater withdrawal from the Middle (South) and East Wells was discontinued 1995; West Well was discontinued in 1998. The North Well is reported to pump continuously with periodic shut downs for maintenance (JCI 1999).

The principal waste stream from the plant has been wastewater from tank washings, floor washings, and other waste liquids from handling and packaging. This waste stream is first treated by the on-site elementary neutralization system (ENS) through the addition of sulfur dioxide or caustic soda. Until recently, the wastewater was mixed in an approximately 1-to-99 ratio with non-contact cooling water (one part wastewater to 99 parts non-contact cooling water) prior to discharging to the lagoon system, in accordance with the New York State Pollutant Discharge Elimination System (SPDES), Permit No. NY0072079. The lagoon system has been in operation at least since 1954. Currently, the neutralized waste is no longer discharged to the lagoon system but recycled back into the facility process.

1.2.3 Historical Operations

The operational history of the Site has been summarized from information present in the remedial investigation (RI; LFR 1999). JCI purchased the property on which the Site is located in August 1939. Prior to the JCI purchase, the Site included an orchard, agricultural fields, and pasturelands. Reportedly, the property had been used as a food packaging facility prior to purchase.

Soon after the purchase of the property, JCI began production of sodium hypochlorite (bleach). In 1942, JCI purchased adjacent properties to the north and east, and JCI began repackaging chlorine from bulk sources to cylinders and 1-ton containers. Titanium tetrachloride was briefly manufactured between 1942 and 1943 for the U.S. government during World War II for use in smoke-screen operations. Repackaging of anhydrous ammonia and acids began in 1947. The production of aqua ammonia and bulk storage of hydrochloric, sulfuric, nitric, and hydrofluosilicic acids was started in 1953.

Between 1960 and approximately 1977, solvents and petroleum products, such as tetrachloroethene (PCE), trichloroethene (TCE), toluene, 1,1,1-trichloroethane (1,1,1-TCA), methylene chloride, and Stoddard solvent, were repackaged from bulk to smaller containers for distribution. Aqua ammonia was produced by combining water and ammonia until 1995.

In 1971, JCI began to transport commercial hazardous waste not generated by JCI. The hazardous waste materials were temporarily stored on site prior to transport and disposal off site. The hazardous waste materials were stored on the former Agway Property, which was located on the eastern side of the Site, and in the two pole barns, formerly located in the central portion of the Site immediately west of the warehouse/office complex. JCI discontinued the transportation and on-site storage of hazardous waste in 1980.

Repackaging of chemicals from bulk to small containers has been one of the primary activities at the plant. These repackaged chemicals not only include the chemicals manufactured at the plant, but also those that were brought in bulk loads to the Site for redistribution.

Materials brought to the Site in bulk form were generally stored in shipping containers (i.e., railroad tank cars or tanker trucks), ASTs, and underground storage tanks (USTs). The tanks were typically constructed of stainless steel, fiberglass-reinforced plastic, or other suitable synthetic material. A majority of these tanks were taken out of service and removed between 1981 and 1986. During the removal of ASTs and USTs, soil samples were collected and analyzed, as required by the New York State Department of Environmental Conservation (NYSDEC). The analytical results indicated that product releases from these storage tanks and associated effects on the subsurface have been minimal (CRA 1993).

1.2.4 Air Stripping

Analytical results of water discharged to the lagoons had indicated the presence of VOCs, which primarily included chlorinated solvents such as PCE and its degradation products TCE and 1,2-dichloroethene (1,2-DCE). Chlorinated solvents were first reported in July 1981 in all on-site production wells and in discharge water to the lagoons. To address this issue, comply with the SPDES permit, and to collect data for the treatability study related to the RI/Feasibility Study (FS), JCI installed an air stripper to treat the affected groundwater prior to discharge to the lagoon. In November 1994, LFR conducted hydraulic testing of the North and West Wells to design an air stripping tower to treat affected groundwater. An air-stripping tower, with the capacity of treating up to 500 gpm, was installed in May 1996. Since 1996, affected groundwater primarily from the North Well (300 to 400 gpm) has been treated prior to its being used as non-contact cooling water in the plant and subsequent discharged to the lagoons. Monitoring of the discharge water indicates that VOCs are below method detection limits (MDLs; JCI 2001).

The Identification of Candidate Remedial Technologies Memorandum (LFR 1996) identified air stripping as one of the remedial technologies in the potential extraction and treatment of affected groundwater at the Site. A Treatability Study Evaluation Report (TSER) for the air stripper, which was being used in the remediation of the affected groundwater from the North and West Wells, was prepared by LFR in January 1997 (LFR 1997). Results indicate that the air stripper is operating at a greater than 99.5 percent removal efficiency of chlorinated solvents (LFR 1997). The air-stripper effluent samples analyzed for VOCs continue to be below MDLs.

1.3 Regulatory Background

Two U.S. EPA Consent Decrees have been written for the Site. The first decree related to the Remedial Investigation/Feasibility Study (RI/FS) was executed on March 26, 1991. In response to this decree, the following work plans or reports were prepared and submitted for the Site.

- Work Plan, Supplemental Remedial Investigation/Feasibility Study (CRA 1993)
- Field Operations Plan, Supplemental Remedial Investigation/Feasibility Study: Volume I, Sampling and Analysis Plan (SAP; CRA 1992a)
- Field Operations Plan, Supplemental Remedial Investigation/Feasibility Study: Volume II, Quality Assurance Project Plan (QAPP; CRA 1992b)
- Field Operations Plan, Supplemental Remedial Investigation/Feasibility Study: Volume III, Health and Safety Plan (HSP; CRA 1992c)

The RI activities were initiated in 1994. The following reports were prepared and submitted in conjunction with the RI/FS.

- Site Summary Report (SSR; LFR 1996)
- Treatability Study Report (LFR 1997)
- Human Health Risk Assessment (HRA; LFR 1999a)
- Remedial Investigation Report (RI Report; LFR 1999b)
- Feasibility Study Report (FS Report; LFR 2000)

In 2000, U.S. EPA issued the Record of Decision (ROD) that identified the selected remedy to address affected soil and groundwater, which included soil-vapor extraction (SVE), source area pump-and-treat, chemical oxidation and monitored natural attenuation (MNA).

The second decree for the Site was executed by JCI on July 11, 2001. This decree provided the statement of work to conduct RD/RA activities. The RD/RA Work Plan was prepared and submitted by LFR (2001). The RD/RA Work Plan was approved in December 2001.

1.4 Pre-Remedial Design Field Activities

During January 6 through 12, 2002, LFR conducted Pre-RD field activities at the Site to obtain additional data that could be used in preparing the remedial design presented in this report. The field activities included the following:

- Source area soil sampling for VOC analyses;
- SVE pilot test
- Groundwater sampling from all on-site production and monitoring wells for VOC analyses;
- Groundwater sampling from 13 selected on-site monitoring wells for the analyses of MNA indicator parameters; and
- Water-level measurement

The above sampling was conducted in accordance with the U.S. EPA approved Remedial Design Work Plan (LFR 2001). The results of the Pre-RD fieldwork are discussed in Section 3.0 below.

2.0 REMEDIAL MEASURES REQUIREMENTS

2.1 Introduction to Remedial Measures Requirements

This section presents the regulatory requirements with which the RD/RA activities at Site must comply with to the extent practicable, the potential applicable or relevant and appropriate requirements (ARARs) identified for the Site and post-remedial construction requirements.

2.2 Remedial Design

2.2.1 Conceptual Remedial Design

The JCI RD/RA includes the following major design components:

- SVE System to address chlorinated solvent in source soils beneath the former above ground solvent tank area. The 'foot print' of the source area is approximately 100 feet long by 40 feet wide . Vertically, the area of treatment extends from near land surface to the top of the saturated zone.
- Source area pump-and-treat system to hydraulically contain and treat affected groundwater in the saturated zone
- Chemical oxidation to treat any potential DNAPL that may be present in the source area

The relatively low groundwater concentrations outside the source area would be addressed by MNA. Institutional controls such as deed restrictions would be established to restrict the groundwater usage to non-potable purposes until remedial goals have been achieved.

2.2.2 Remedial Design Objective

The Remedial Design objectives for the Site are proposed as follows:

- Treat source area soils beneath the former above-ground storage tank area affected with chlorinated solvents including tetrachloroethene (PCE) via SVE
- Hydraulically contain and treat affected groundwater through a network of groundwater extraction wells installed in the source area
- Treat potential DNAPL that may be present through chemical oxidation
- Conduct MNA sampling of the affected groundwater downgradient from the source area

2.3 Applicable or Relevant and Appropriate Requirements (ARARs)

Applicable or Relevant and Appropriate Requirements (ARARs) or TBCs with which the selected remedy must comply include the following:

2.3.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

- 6 NYCRR Parts 700 – 705 Groundwater and Surface Water Quality Regulations
- Safe Drinking Water Act (SDWA) MCLs and non-zero MCLGs (40 CFR Part 141)
- 10 NYCRR Part 5 State Sanitary Code

2.3.2 Action-Specific Applicable or Relevant and Appropriate Requirements

- National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61)
- 6 NYCRR Part 257, Air Quality Standards
- 6 NYCRR Part 200, New York State Regulations for Prevention and Control of Air Contamination and Air Pollution
- 6 NYCRR Part 376, Land Disposal Restrictions
- 40 CFR 50, Air Quality Standards
- New York State Pollutants Discharge Elimination System (6 NYCRR Parts 750 – 758)
- Resource Conservation and Recovery Act (42 U.S.C. & 6901 et seq.)

2.3.3 Location-Specific Applicable or Relevant and Appropriate Requirements

Fish and Wildlife Coordination Act, 16 U.S.C. 661

2.3.4 Advisories, "To Be Considered," or Other Criteria

- New York State Air Guide - 1 for the Control of Toxic Ambient Air Emissions
- New York Guidelines for Soil Erosion and Sediment Control
- New York State Air Cleanup Criteria, January 1990
- NYSDEC Technical and Operational Guidance Series 1.1.1 November 1991
- NYSDEC Technical and Administrative Guidance Memorandum No. 94-HWR-4046

A summary of soil and groundwater remediation goals is presented below. The soil remediation goals are the NYSDEC TAGM #HWR-94-4046: Soil Cleanup Objectives. The groundwater remediation goals are based on the New York State Groundwater Quality Standards 6 NYCRR Part 703.5.

Chemical of Concern	Soil Medium (milligrams per kilogram or mg/kg)	Groundwater Medium (micrograms per liter or µg/l)
Tetrachloroethene (PCE)	1.4	5
Trichloroethene (TCE)	0.7	5
Cis-1,2-Dichloroethene (cis-1,2-DCE)	0.3	5
Trans-1,2-Dichloroethene (trans-1,2-DCE)	0.3	5
1,1-Dichloroethene (1,1-DCE)	0.4	5
Vinyl chloride	0.2	2

2.4 Description of the Remedial Measures

Based on the analysis presented in the FS (LFR 2000), U.S. EPA (2000) issued the ROD that listed the selected following remedial alternatives:

- Soil Alternative #2: SVE of PCE-Affected Soil; and
- Groundwater Alternative #4: Source Area Pump-and-Treat/Monitored Natural Attenuation/Institutional Controls/ Chemical Oxidation

The above remedies are grouped into Remedial Work Elements I and II for the soil and groundwater medium, respectively:

2.4.1 Remedial Work Element I

Remedial Work Element I involves the treatment of soils affected with chlorinated solvents exceeding the soil cleanup objectives in the former solvent tank area at the Site by in situ Soil Vapor Extraction (SVE).

2.4.2 Remedial Work Element II

Remedial Work Element II for the groundwater medium involves the following components:

- Extracting affected groundwater in the former solvent tank source area using a network of recovery wells in the overburden and bedrock aquifers.
- Treatment of extracted groundwater with the existing air stripper, which allows for the utilization of the treated water as non-contact cooling water within the plant, and discharge of the non-contact cooling water to the on-site lagoons until groundwater remediation goals in the former solvent tank area have been achieved.
- In situ treatment of the DNAPL beneath former solvent tank source using an oxidizing agent, such as potassium permanganate (KMnO4), sodium permanganate (NaMnO4), or hydrogen peroxide (H2O2).
- Continued extraction and treatment of affected groundwater from the North Well
- Discontinued pumping from the West Well to eliminate the potential to draw contaminants to deeper water-bearing zones.
- Monitored natural attenuation (MNA) of the slightly affected groundwater located outside the former solvent tank source area and beyond the influence of existing and proposed extraction wells.
- Implementation of institutional controls (i.e., deed restrictions) to limit future on-site groundwater use to non-potable purposes until groundwater remediation goals are achieved.

2.5 Post-Remedial Construction Requirements

As per the consent decree, periodic operation, maintenance and monitoring (OM&M) are required for each remedial work element following completion of construction activities. The OM&M Plan provided in Section 7.0 details the post-remedial construction requirements for remedial work element I (SVE system). As required by the consent decree, the OM&M plan for remedial work element II (groundwater pump-and-treat and chemical oxidation) will be submitted within 30 days prior to remedial construction completion of element II.

3.0 SITE CONDITIONS

3.1 Introduction to Site Conditions

This section summarizes the site condition from data gathered during the RI/FS and the recent Pre-RD field activities conducted at the Site. A brief discussion on subsurface soil conditions, groundwater flow and distribution of chlorinated solvent contamination is included.

3.2 Physical Setting

The topography of the Village of Caledonia is rolling to flat, with elevations ranging from about 710 feet above mean sea level (amsl) at the highest point to about to 640 feet amsl along Spring Creek to the west (Figure 1). Although the surrounding area has considerable relief, the Site itself is relatively flat, with surface elevations ranging between 640 and 660 feet amsl. The two swales along Sunny Sol Boulevard and the lagoon system on the north property are some of the prominent surface features on the Site.

The vegetated areas to the north are covered with pasture grass and to the south are landscaped with turf grass and ornamental evergreen trees. The adjacent properties are mostly residential and municipal recreational areas vegetated in turf grass, ornamental shrubs and some hardwoods along property lines. Agricultural lands and wooded areas surround much of the developed area within the Village of Caledonia.

The Site lies entirely within Zone C, an area of minimal flooding outside both the 100- and 500-year flood zones. The isolation of the Site from the flood-prone zones documents that floodplain management concerns are not applicable to the Site. No wetlands were identified on the Site or adjacent properties. The nearest wetland area, CA-1, is approximately 0.5 mile west of the Site, and is associated with Spring Creek, also located to the west of the Site. There are no records of significant wildlife species or cultural resources present at or in the vicinity of the Site.

The Site has been used for industrial purposes since August 1939. The conceptual future land use for the property is anticipated to be industrial. Groundwater from on Site is presently treated through an air stripper and used only as non-contact cooling water, with minimum exposure to on site workers. Potable water is obtained from the Village of Caledonia. There are no future plans to install drinking water supply wells on site. A deed restriction will be implemented to restrict groundwater usage.

The future land use for the property located immediately north of the former solvent AST source area is anticipated to be industrial. The future land use for the properties located to the northeast and east is reported to be agricultural. Future land use to the west and southwest of the Site is reported to be light service industries such as hardware stores, gasoline stations, dry cleaners, restaurants, and other commercial businesses.

The climate of the Village of Caledonia is characteristic of western New York State, with warm summers and cold winters with moderate to heavy snowfall. Average daily temperatures range from 24 degrees Fahrenheit (°F) in January to 71°F in July. The average annual precipitation is 30 inches. Drainage is through the highly permeable silty and sandy gravel type soil that underlies the Site.

3.3 Hydrogeology

The hydrogeology and groundwater quality was evaluated through a network of monitoring wells presented on Figure 3; the monitoring well construction details are provided in Table 1.

The Site is underlain by two distinct stratigraphic zones, an upper overburden zone, and an underlying bedrock zone (Figure 4). The overburden zone can be grouped into two separate lithologic units consisting of an upper gravel-sand-silt mixture and lower gravelly silt. The gravel-sand-silt mixture unit includes varying amounts of gravel, sand, and silt, and was encountered from 25 to 40 feet bgs. The gravel-sand-silt mixture unit grades below into the gravelly silt unit, which is characterized by sediments with decreasing amounts of gravel and increased silt content. The gravelly silt unit directly overlies the bedrock between the depths of 40 to 70 feet bgs.

A carbonate bedrock (dolomite) was encountered at depths ranging between 30 and 80 feet bgs. The surface of the bedrock was found to slope steeply to the east. The upper portions of the bedrock are highly weathered and fractured. The thickness of the weathered zone varies, but was found to be less than 10 feet thick. The dolomitic bedrock at the Site appears to be equivalent to the Onondaga Formation of Upper Devonian age.

The overburden zone was found to be highly transmissive, yielding significant quantities of water. Many of the production wells in the region are completed in the overburden zone. Hydraulic testing conducted at the Site indicates the transmissivity of the overburden zone to range between 25 and 41 square feet per minute (ft^2/min). Groundwater yield in the underlying bedrock, however, was found to be significantly lower.

At the present time, North well is the only on-site production well reportedly pumping at between 300 to 400 gpm for 24 hours a day, 7 days a week with periodic shutdowns for maintenance. Water level measurements taken in January 2002, indicate the groundwater flow in the overburden zone is to the east- northeast (Figures 5). Hydraulic gradient for overburden zone was calculated to be 1.3×10^{-3} feet/foot (ft/ft). In the vicinity of the pumping North Well, the hydraulic gradient was calculated to be 6.9×10^{-3} ft/ft.

Groundwater flow in the bedrock zone during non-pumping conditions is both to the west and northeast (Figures 6). A groundwater "mound," or divide, appears to occur at monitoring well BP-1, located in the central portion of the Site. East of BP-1, the groundwater flow is toward the northeast. The average hydraulic gradient is 5.3×10^{-3} ft/ft.

During the RI phase, numerous rounds of water-level measurements were collected during both non-pumping and pumping conditions during the RI phase LFR (1999). During non-pumping conditions, the principal groundwater flow direction of the overburden zone is toward the northeast. The average hydraulic gradient across the Site was estimated 2×10^{-3} ft/ft. The hydraulic gradient in the bedrock zone was estimated to range between be 5×10^{-3} ft/ft and 8×10^{-3} ft/ft.

In January 2002, the depths to groundwater measured during groundwater sampling were found to be generally lower by one to two feet than those measured in 1998 (Table 2); OP-10 and L-3 were completely dry. The deeper water levels are reflective of the drier-than-normal conditions that have reportedly existed here for the past two years.

3.4 Summary of Contamination

This section presents a summary of soil and groundwater contamination present at the Site. Summary results of the January 2002 soil and groundwater sampling are presented in Tables 3 and 4, respectively. The soil and groundwater samples were collected in accordance with U.S. EPA approved Remedial Design Work Plan (LFR 2001). All soil and groundwater samples were analyzed for VOCs by Method OLM 4.2 and OLC 2.1, respectively using the Contract Laboratory Procedures (CLP) as per the U.S. EPA approved Work Plan and QAPP (LFR 2001). All wells were sampled in accordance with U.S. EPA Region 2 SOP "low flow sampling techniques," except well BP-3 and BP-4. Due to an obstruction in the casings, BP-3 and BP-4 could not be sampled with the 2-inch Grundfos submersible pump, which can purge at a low flow rate of 200 ml per minute or less. Instead, wells BP-3 and BP-4 were purged with a submersible at higher rate of 0.5 to 1 gpm and subsequently sampled with a Teflon disposable bailer. Analytical results for BP-3 and BP-4 were found to be consistent with the historical sampling results and with other Site data.

3.4.1 Quality Assurance and Quality Control Review

This section presents a summary of quality assurance/quality control (QA/QC) review of the soil and groundwater samples analyzed by CAS laboratories in January 2002.

3.4.1.1 Soil Samples

Ten soil samples were analyzed for VOCs by method OLM 4.2 using CLP protocols. Samples were identified as B-1 to B-10, the sampling depths were included in parenthesis as suffix. The soil samples were collected in Encore samplers for VOC

analyses and 4-oz jars for percent moisture analysis. All samples were analyzed within the required holding times. The initial and continuing calibration criteria were met for all analytes. Surrogate and internal standards were within limits. Site specific quality control (QC) was performed on sample B-5. Matrix spike/matrix spike duplicate (MS/MSD) and Blank Spike recoveries were within limits. The relative percent differences (RPDs) were within limits.

Various compounds for samples B-3, B-4, B-5, B-6, B-7 and B-8 have been flagged with an "E" as being outside the calibration range of the instrument. The samples were repeated at dilutions and both sets of data have been reported. However, the diluted sample data (which is the higher concentration) is presented in Table 3.

The equipment, trip and laboratory blanks associated with these soil samples were free of contamination. No other analytical or QA/QC were encountered.

3.4.1.2 Groundwater Samples

Twenty-three water samples from monitoring wells and production wells were analyzed for VOCs by method OLC 2.1 using CLP protocols; 13 samples were analyzed for methane by method RSK-175. The monitoring well samples were identified as OP-1 through OP-3; OP-4 through 16, BP-1 through BP-6, L-2, L-3 and PZ-1. The production wells are identified as North, West and East Wells. Eleven QA/QC check samples were submitted with these monitoring and productions well samples. The QA/QC samples included one MS/MSD, five trip blanks, and duplicates of OP-8 and OP-16. The samples were collected and analyzed in January 2002.

OP-10 and L-3 were dry and therefore could not be sampled. If these wells continue to be dry during future monitoring events, need for replacement monitoring wells will be discussed with U.S. EPA. Previous rounds of groundwater sampling between 1996 and 1998 indicate relatively low concentrations of chlorinated solvents in L-3 (less than 1 μg/l) and OP-10 (less than 25 μg/l).All samples were analyzed within the required holding times. The initial and continuing calibration criteria were met for all analytes. Surrogate and internal standards were within limits. Site specific QA was performed on North Well, OP-3, OP-15, OP-1 and L-2. All MS/MSD and Blank Spike recoveries were within limits. All RPDs were within limits.

Various compounds for samples OP-11, OP-16, OP-9, West Well, and North Well have been flagged with an "E" as being outside the calibration range of the instrument. The samples were repeated at dilutions and both sets of data have been reported out. However, the diluted sample data (which is the higher concentration) is presented in Table 4.

The trip and laboratory blanks associated with these groundwater samples were free of contamination. No other analytical or QA/QC were encountered.

3.4.2 Source Area Soil Contamination

As part of the SVE pilot test, LFR collected ten (10) additional soil borings in the former AST area; the soil boring locations and soil isoconcentrations are shown on Figure 7. The results were used to compliment earlier soil sampling conducted for the RI phase (LFR 1999 Continuos two-foot split spoon soil samples were collected from land surface to the top of the saturated zone. Each split spoon sample was screened with an OVA-PID. From within each split-spoon, a discrete Encore grab soil sample was taken from the area where the highest OVA reading was recorded. One soil sample from each location (the sample exhibiting the highest OVA reading) was submitted to Columbia Analytical Services, Inc., Rochester, NY ("CAS").

During the RI phase (LFR 1999), soil samples were collected and analyzed from seven soil borings (SB-1 through SB-4 and DP-1 through DP-3) in the former AST area to delineate the extent of affected soil. The results were presented in the RI report, which was approved by the U.S. EPA. The RI formed the basis for FS Report and ROD.

As previously observed during the RI phase, PCE and its breakdown products are the chemicals of concern present in the soils; the results of soil sampling conducted in January 2002 are summarized in Table 3. Results indicate higher chlorinated solvent concentrations at about 13 to 15 feet bgs just above the water table or in the "smear zone". PCE concentrations range from 510 to 90,000 μg/kg (Figure 7). TCE concentrations range from 9 to 2,700 μg/kg. The highest PCE and TCE concentrations were detected in sample B-2 at 15 feet bgs. cis-1,2-DCE was detected in one soil sample, B-2, at 2,900 μg/kg. PCE concentrations ranging up to 330,000 μg/kg were detected in the AST source area during the RI phase (LFR 1999).

The former solvent AST area appears to be the primary source of chlorinated solvents detected at the Site. Outside the former solvent tank source area, PCE and TCE levels in soil were detected (during the RI phase; LFR 1999) in relatively low concentrations ranging between 2 and 310 μg/kg. The chlorinated solvent concentrations in soils outside the source area at the Site are below the NYSDEC Recommended Soil Cleanup Objectives (RSCOs; NYSDEC 1994) and the soil remediation goals.

The results of additional soil sampling were used in the design of the SVE system, which is described in Section 5.

3.5 Groundwater Sampling

A summary of monitoring and production wells sample results from January 2002 is presented in Table 4. The table also includes a summary of the historical sampling results. The extent of the groundwater plume has been defined in the RI phase; PCE isoconcentration maps, from August 1998 sampling data, for 17 – 22 bgs; 27 – 30 feet bgs; and 35 – 48 feet bgs are depicted on Figure 8, 9 and 10, respectively. PCE concentrations from January 2002 sampling for the overburden and bedrock zones are

shown on Figures 11 and 12, respectively. The 1998 and 2000 PCE concentrations are also depicted on geologic cross-section shown on Figure 4.

Since direct-push groundwater sampling methods were used to define the extent of affected groundwater in the lower portions of the overburden zone (between 27 and 48 feet bgs), additional permanent monitoring wells will be necessary to monitor the lower portions of the overburden zone for effectiveness of the groundwater cleanup. JCI proposes to install two to three monitoring wells in the lower overburden zone during the remedial construction phase. The locations including well construction details will be provided in the Remedial Action Work Plan (RAWP), which is required prior to initiating remedial construction.

Four rounds of well sampling conducted at the Site between 1996 and 2002 indicate that PCE and its breakdown products represent the chemicals of concern at the Site. Sampling data between 1996 and 2002 indicate that chlorinated solvent concentrations have decreased significantly at the Site. The decrease in chemical concentration may be attributed to source depletion, volatilization, dispersion, dilution and other abiotic processes discussed below. There does not appear to be a significant accumulation of PCE breakdown products such as cis-1,2-DCE or vinyl chloride suggesting absence of biologically mediated natural attenuation processes. The length and width of the PCE-affected groundwater plume is slightly over 1,700 feet (along the northeast–southwest axis) and 500 feet (along the north–south axis). Vertically, PCE in the source area extends to at least 48 feet bgs in the source area. Groundwater concentrations decline significantly at increasing distances from the source beneath the former AST area (Figure 11).

Recent analytical results from January 2002 sampling at the Site indicate PCE concentrations ranging from below MDL of 1 micrograms per liter (μg/l) to 2,080 μg/l, and TCE concentrations from below MDL to 46 μg/l. The highest PCE and TCE concentrations were detected in OP-16, located in the former solvent AST source area. OP-16 is 44 feet below ground surface and its screen interval straddles the overburden and upper portion of the weathered bedrock zones as shown on Figure 4. PCE concentrations in OP-16 have declined from 62,000 μg/l in 1998 to 2,080 μg/l in 2002. In North Well, PCE concentrations decreased from 570 μg/l in1996 to 140 μg/l in 1998 to 35.6 μg/l in2002. Between 1996 and 2002, PCE levels in West Well decreased from 300 to 207 μg/l.

Monitoring well OP-6 was re-sampled on April 5, 2002 to address an anomalous PCE concentration that was detected during January 2002 sampling event. The January 2002 sampling results indicated a PCE concentration of 359 μg/l. Historic PCE concentrations for OP-6 were 29 μg/l (1996), 48 μg/l (1997) and 22 μg/l (1998). The results of the April 5, 2002 re-sampling indicated a PCE concentration of 67.6 μg/l. Monitoring well OP-6 is located about 700 feet hydraulically downgradient of the source area. The cause of the elevated PCE concentration during the January 2002 sampling event is undetermined. The April 2002 sampling that detected PCE at 67.6 μg/l appears to be consistent with the historic sampling results. OP-6 will be included in monitoring program subsequent to remedial construction to evaluate PCE

concentrations. Extensive soil sampling during the RI phase did not indicate the presence of a source in this area. If future monitoring events show an increasing PCE-concentration trend in OP-6, JCI will consult with U.S. EPA to determine if groundwater treatment is necessary in this area.

Relatively low concentrations of chlorinated solvents were detected in the bedrock monitoring wells, BP-1 through BP-6 and L-2, (Table 4). PCE or TCE were below the remediation goal of 5 μg/l PCE and TCE.

The elevated PCE concentration of 2,080 μg/l in the monitoring well OP-16, located in the former solvent tank area, may indicate the potential presence of DNAPL in this area. PCE concentrations of this magnitude were found to be limited primarily to the former solvent tank area. Relatively lower levels of dissolved PCE (ranging from 3 to 270 μg/l; Figures 8 through 11) were detected in the groundwater samples taken outside the former solvent tank area, indicating that the potential DNAPL may be limited to this small area at the source.

3.6 Evaluation of Monitoring with Natural Attenuation Indicator Parameters

Protocols for evaluating monitored natural attenuation were described in the RD Work Plan (LFR 2001); the U.S. EPA subsequently approved the RD Work Plan. Samples from the13 selected overburden monitoring wells along the groundwater flow path (OP-3, OP-5 through OP-9, OP-11 through OP-15, and PZ-1) were collected and analyzed at CAS laboratories for natural attenuation indicator parameter listed below. Dissolved ferrous iron and sulfide were measured in the field using HACH kits. The analytical results are presented in Table 5.

The following natural attenuation indicator parameters were analyzed at CAS laboratory by U.S. EPA methods:

- Total Alkalinity (Method 310.1)
- Nitrate Nitrogen (Method 353.2)
- Nitrate Nitrite Nitrogen (Method 353+35)
- Total Organic Carbon (Method 9060)
- Sulfate (Method 300)
- Chloride (Method 300)
- Methane/ethene/ethane (RSK-175)

Physical parameters such as temperature, pH, specific conductance, dissolved oxygen, turbidity and oxidation-reduction potential (Eh) measured during sampling are presented in Table 6.

Natural attenuation is defined as the biodegradation, dispersion, advection, dilution, sorption, volatilization, and/or chemical and biochemical stabilization of contaminants to effectively reduce contaminant toxicity, mobility, or volume to levels that are protective of human health and the ecosystem. Biodegradation is generally considered to be the primary mechanism for attenuating biodegradable contaminants.

Chlorinated solvents may undergo biodegradation through three different pathways: (1) through use as an electron acceptor (reductive dechlorination); (2) through use as an electron donor; or (3) through cometabolism. Although all pathways may be present in the subsurface, reductive dechlorination is the most important process for the natural biodegradation of the highly chlorinated solvents. During reductive dechlorination, the chlorinated hydrocarbon is used as an electron acceptor (not as a source of carbon) and replaced with a hydrogen atom. Reductive dechlorination generally occurs by sequential dechlorination from PCE to TCE to DCE to vinyl chloride (Nyer and Duffin 1997).

Biodegradation is generally evaluated by collecting and analyzing site-specific natural attenuation indicator parameters to document contaminant loss and geochemical trends favoring natural attenuation. Typically natural attenuation indicator parameters are measured along axis of the plume, as well as transverse to it, and compared to the established background levels. For example, if DO levels within the plume are below background levels, it is generally an indication of aerobic biodegradation. Nitrate and sulfate concentrations below background levels in the plume indicate anaerobic biodegradation through dentrification and sulfate reduction. Higher than background concentrations of ferrous iron and methane in the plume indicate ferric iron reduction and methanogenesis. Reportedly, methanogenesis under reductive and anaerobic conditions is most effective for reductive dechlorination of chlorinated solvents. Values of Eh are used to evaluate oxidative and reductive conditions in the subsurface.

The DO values at the Site are elevated (Table 5), in excess of 2 milligrams per liter (mg/l), indicating aerobic conditions within the plume. Nitrate and sulfate concentrations within the groundwater plume are relatively high, indicating absence of nitrate or sulfate reduction processes. The relatively low ferrous iron and methane levels do not indicate iron reduction or methanogenesis. The elevated Eh values suggest oxidative conditions. Chlorinated solvents are effectively biodegraded under anaerobic and reducing conditions. Weighting of natural attenuation indicator parameters was conducted using site specific data. The scoring sheets are presented in Appendix A. The scores indicate that there is inadequate to limited evidence for biodegradation at the Site.

However, as described above, historic groundwater sampling since 1996 (Table 4) show that there is a significant decline in chlorinated solvent concentrations at the Site. It appears that chlorinated solvents are attenuating via abiotic processes such as dilution, dispersion, volatilization, and/or advection. With the exception of anomalous PCE detection in OP-6, groundwater concentrations in most wells have declined significantly and the groundwater plume appears to be reaching steady-state, as there is no evidence of plume expansion over time. Since 1997, groundwater concentrations

at the hydraulically downgradient end of the plume have been less than 6 μg/l (in OP-14) and non-detect (in OP-13) since 1997. The results of recent sampling (January 2002) indicate PCE groundwater concentrations in OP-14 and OP-13 to be 3.4 μg/l and non-detect, respectively. With active source treatment through SVE, pump-and-treat and chemical oxidation, MNA of low level chlorinated solvents downgradient of the source area appears to be a an appropriate solution for remediating the low level concentrations.

The proposed remedy is designed to capture and treat groundwater contamination in the former AST area and in the vicinity of wells OP-16, OP-9, North, West and East Wells. Contamination outside this area will be addressed through MNA. As stated earlier, with exception of OP-6, groundwater concentrations in most wells are at or slightly above the MCL and can be addressed through MNA especially with active source treatment. Groundwater concentrations in OP-6 have ranged between 22 and 48 μg/l. The January 2002 sampling event indicated a slight increase to 67.6 μg/l. The increase appears anomalous as extensive soil sampling in this area conducted during the RI phase did not indicate the presence of a source area. Groundwater concentrations in OP-6 will continue to be monitored ; if concentrations continue to increase and begin to migrate toward the eastern property line at levels above the groundwater quality standard under MNA, then JCI will consult with U.S. EPA to determine if groundwater treatment is necessary for this area.

A Risk evaluation study undertaken during the RI (LFR 1999) did not indicate the presence of any sensitive habitats, endangered species or potential receptors in the site vicinity that could be potentially impacted by the groundwater plume.

First order rate constants were calculated and provided in the FS Report (LFR 2000). The retardation factor (R) was calculated to be 11.5. Estimated time for the low levels of chlorinated solvents downgradient of the source to achieve remediation goals was calculated to range between 142 days (R = 1) and 1,632 days (for R = 11.5).

4.0 SITE PREPARATION

Site preparation activities will be implemented prior to construction of the remedial systems. The site preparation activities will consist generally of initial tasks that must be completed by the remedial action contractor and owner's engineer before on-site construction can begin.

4.1 Regulations and Permits

The selected remedial action contractor will be required to pull all building and electrical permits prior to construction. In addition, the remedial action contractor will be required to coordinate all building and electrical inspections and provide the inspectors access to the project as necessary.

LFR will be required to obtain the required environmental permits that may be required. These permits may include a modification of the SPDES permit and acquisition of an Underground Injection Control permit.

4.2 Environmental Controls

The remedial action contractor will be required to provide barricades and fencing to prevent unauthorized personnel from entering the construction areas to prevent potential exposure pathways. Minimal inhalation and direct contact exposure to volatile organic compounds is expected by the construction workers during trenching in the source area. This exposure will be monitored using an organic vapor analyzer (OVA) and regulated in accordance with the Site Health and Safety Plan. Exposure by on-site JCI Jones Chemical employees is not expected since construction activities will not be performed in work areas and there will be minimal disturbance of affected media.

4.3 Traffic Controls

Since the locations of all proposed construction activities are located on JCI Jones Chemical property, only limited on-site traffic control will be required. The proposed construction areas are outside of traffic areas; however, barricades and temporary fencing will be used to control access to the construction areas.

4.4 Site Access

Access to the construction areas will be limited during construction activities to authorized personnel. The source area and proposed extraction well locations are remote to JCI Jones Chemical process operations; therefore, Jones personnel are expected to need access to the construction areas.

4.5 Staging Areas and Decontamination Areas

The remedial action contractor will establish material and equipment staging areas and decontamination areas. These areas will be used to prevent the spread of affected media.

4.6 Conversion of West Well to a Monitoring Well

The submersible pump and electrical conduit will be removed from the West Well and this well will be converted into a monitoring well. The pump effluent piping to the air stripper will be properly abandoned and the control panel will be modified to remove the West Well pump controls. The below grade piping will be abandoned in-place by draining the line and capping each end of the piping. The above grade piping will be removed and properly disposed.

5.0 FINAL DESIGN OF REMEDIAL COMPONENTS

5.1 Introduction to Final Design of Remedial Components

Based upon the conclusion of the Feasibility Report (LFR, 2000), JCI Jones Chemical is required to implement the following Remedial Work Elements:

- Element I: treatment of PCE and its by products-affected soil in the former solvent tank source area by soil-vapor extraction (SVE). Affected soils will be treated until PCE and its by products levels in the vadose zone are below the New York State soil cleanup objectives.
- Element II: hydraulic containment and treatment of PCE and its by products-affected groundwater in the source area through a groundwater pump-and-treat system. Extracted water will be treated by the existing air stripper, routed to the plant for use as non-contact cooling water and discharged to on-site lagoons. After achieving hydraulic containment, PCE-DNAPLs in the source area will be treated by an oxidizing agent such as potassium permanganate. Monitored natural attenuation will be used to address the PCE-affected groundwater outside the source area. Treatment of PCE and its by products -affected groundwater will continue until groundwater levels are below the U.S. EPA MCLs and NYSDEC's groundwater standards.

The following sections describe the proposed design of the Remedial Work Elements to remediate the PCE and its by products -affected soil and groundwater. Construction drawings for the proposed remedial systems are included as Appendix C and written specifications are included as Appendix D.

5.2 Soil-Vapor Extraction

Collection of soil samples by macro core samplers using direct push technology during the RI phase (LFR 1999) and hollow stem auger split spoon sampling in January 2002 indicated that sorbed PCE is present in the vadose zone in the area of the former storage tank. It appears that the most affected soil is present at shallow depth in the area of DP-1, which suggests that this is the location of the release. In addition, there appears to be a smear zone located at approximately 14 to 16 feet bgs as a result of the

fluctuation in the groundwater table. As required by Remedial Work Element I, a SVE system is proposed to treat the affected soil that is above the PCE and its byproducts remediation standards in the vadose zone. SVE is a proven technology for vadose zone remediation, and has proven to be reliable in numerous applications throughout the United States. Favorable conditions for efficient remediation with SVE are present at this site and include a sufficiently deep groundwater table and porous vadose zone.

5.2.1 Mass Estimate

Based on the data presented in the Feasibility Study Report (LFR, 2000), an estimate of the mass of PCE sorbed to soil in the vadose zone was made. These calculations are at least an order-of-magnitude approximation and do not take into account the possible presence of free liquid-phase PCE, and PCE in the vapor and soil moisture phases in the void space. To estimate the mass of PCE in the vadose zone, the following assumptions were made.

- The density of the soil is 110 pounds per cubic foot.
- The affected volume of soil was separated into four zones based upon PCE concentrations: 1 to 5 mg/kg; 5 to 10 mg/kg; 10 to 100 mg/kg; and greater than 100 mg/kg.
- The vadose zone thickness is 17 feet.
- The area of affected soil is approximately 120 feet long by 30 feet wide (see Figure 3).

Using these estimates, the mass of PCE-affected soil in the vadose zone is approximately 80.35 kilograms. The mass estimation calculations are shown in Appendix E.

5.2.2 Soil-Vapor Extraction Well Construction and Layout

An SVE pilot study was performed in January 2002 to determine the radius of influence of the proposed SVE wells and vapor extraction rates at various applied vacuums. An analysis of this data indicated that an appropriate design radius of influence for the SVE wells would be 40 feet. However, the actual radius of influence of each well is likely to be over 60 feet. The pilot test data and SVE and vapor observation well construction logs are included as Appendix E.

Assuming a radius of influence of 40 feet, three, 4-inch diameter SVE wells, designated SVEW-1 through SVEW-3 are proposed for this SVE system. Two new SVE wells will be installed to a depth of approximately 17 feet bgs, with 15 feet of 0.01-inch PVC slotted screen. The existing vapor extraction well, SVE-1, installed for the pilot test will be re-used. This vapor extraction well is constructed to a depth of approximately 15 feet bgs, with 10 feet of 0.01-inch PVC slotted screen. The locations of the existing and proposed SVE wells are shown on Figure 13. In addition, this figure shows the projected limits of influence of the SVE wells based on the 40-foot

radius of influence. A detail of a typical SVE well is illustrated in the construction drawings included in Appendix C.

Since the vadose zone lithology is uniformly porous due to sandy-gravel composition, LFR does not foresee problems with preferential pathways developing. Therefore, it is not necessary to limit the screened interval and is sufficient to have the extraction wells screened across the entire vadose zone.

5.2.3 Soil-Vapor Extraction System Design

Soil vapors will be extracted through the SVE wells and routed through conveyance piping to a 16- by 20-foot treatment equipment building. The vapors will then pass through a 117-gallon insulated moisture separator tank to remove excess moisture prior to the SVE blower. Soil vapors will be routed from the SVE blower into two parallel granular activated carbon (GAC) canisters that are in series with an additional two GAC canisters for removal of VOCs. Treated soil vapors will be discharged to the atmosphere from a vent six feet above the roofline of the structure.

The design flow rate and operating vacuum were determined by an evaluation of the pilot test data. A flow rate of 250 cubic feet per minute (cfm) from each well at an operating pressure at the wellheads of 41 inches of water column vacuum will produce the desired radius of influence of 40 feet. The total system flow rate for the three well extraction system will be 750 cfm. It is estimated that there will be a head loss of 24 inches of water column across the fittings and treatment system equipment. Therefore, a vacuum pump capable of delivering 750 cfm at 65 inches of water column is required.

Based on these requirements, the recommended vacuum pump for the system wells is a Rotron™ model DR/P-13BM72D or equivalent blower. This blower is equipped with a 20-horsepower motor and operates on 460-VAC, three-phase, electrical power. Manufacturer cut-sheets for the blower are included as Appendix -F. The blower will be skid-mounted and equipped with a particulate filter, a timer, pressure and vacuum gages, an adjustable vacuum relief valve, a 117-gallon moisture separator tank, a flow meter, and a thermometer. The blower will be equipped with sound suppression equipment on both the suction and discharge piping. A liquid level sensor will be installed in the moisture separator tank. The blower will contain internal controls to shut down if the motor's temperature reaches a factory-set high temperature limit. After the motor cools, the blower will restart automatically. The adjustable vacuum relief valve, mounted on the skid, will allow fresh air to enter the suction line if the vacuum reaches a preset point. This feature should minimize the likelihood of shutdown caused by high motor temperature. A visible flashing alarm mounted on the outside of the treatment building will be tripped if the system is automatically shut down due to a high level water or high temperature condition.

A 120-foot by 30-foot 40-millimeter high density polyethylene liner will placed over the affected soil in the source area to prevent short circuiting of the vapor extraction system.

The existing monitoring and vapor observation wells in the area of the SVE system will be used to monitor subsurface vacuum and to confirm the effectiveness of the treatment system. 5.2.4 Soil-Vapor Extraction Emission Control

Although no air permit is required since remediation is being required under CERCLA, JCI is required to comply with the requirements of 6NYCRR Part 212 for General Process Emission Sources and the New York State Division of Air Resources (DAR) Guidelines for the Control of Toxic Ambient Air Contaminants (Guidelines; November 12, 1997). Based upon this requirement, an analysis was performed in accordance with Appendix B of the Guidelines to determine the allowable emission rate. This analysis is included as Appendix G.

The allowable emission rate was determined for the three compounds expected to be present in the vapor stream. These compounds are PCE, TCE, and cis-1,2-DCE. Since PCE is the most sensitive compound of the three based upon its much higher detected concentration in the vapor-phase as demonstrated by the pilot test sampling and lower Annual Guideline Concentration (AGC; 1.0 $\mu g/m^3$), it was selected for the emission rate analysis.

Using the Standard Point Source Method (Guidelines, Appendix B), the maximum allowable annual emission rate for PCE is 257 pounds per year or 0.029 pound per hour assuming 8,760 operating hours per year. Based upon the pilot test data, the PCE removal rate is expected to be less than 0.096 pound per hour after the first week assuming that 100 percent of the vapors are from the affected zone. The emission rate is anticipated to be greater than the maximum allowable rate for the first month; therefore, emission control technology will be used to reduce the PCE emission rate to well below the allowable limit.

Two canisters in series connected in parallel with another series of two canisters of granular activated carbon (Carbtrol® Model G-3P) vapor-phase GAC units will be installed to treat the system emissions. Based upon Carbtrol® Corporation's actual adsorption capacity for PCE of 0.595 pound of PCE per pound of GAC, each canister has 83 pounds of capacity. It is estimated that 177 pounds of PCE is present in the vadose zone; therefore, the canisters will have to be changed-out once. The calculations for the design of the emission control system are included as Appendix E. Specifications for the proposed GAC units are included in Appendix D and manufacturer cut-sheets are included in Appendix F-.

If, after 30 days of SVE system operation (i.e., the first monthly sampling event), the mass flow rate of chlorinated hydrocarbons is less than AGC, the original vapor-phase GAC will be left in the SVE process; however, the vapor-phase GAC units will not be replaced. GAC will be properly disposed of upon termination of the SVE system.

5.2.4 Soil-Vapor Extraction Piping

The vacuum supply line will be routed underground and manifolded to each of the SVE wells. The vacuum line will be constructed of 6-inch diameter Schedule 40 PVC pipe. This supply line will be buried only approximately 12 inches bgs since there is no traffic in this area. The vacuum lines will be sloped toward the SVE wells. The SVE wells will be manifolded to the vacuum line with 4-inch diameter Schedule 40 PVC pipe. The SVE piping network will be pressure tested for one hour at a pressure of 30 psi.

5.2.5 Control System

Because the proposed SVE system is mechanically simple, the control panel proposed for this application consists of simple relay logic components intended to shut down the SVE blower when the moisture separator tank is full and trip a visual alarm.

The control panel will be protected from power surges with surge protectors. Because JCI has personnel on site that will perform daily inspections of the system, a telemetry system was not included in the system design.

5.2.6 Cleanup Time

Using the pilot study data, a simple mathematical model was developed by performing a regression analysis to determine the best-fit equation for the plotted effluent VOC concentration versus the extraction time. Based upon the assumption that the plotted data followed a power-curve, an equation was generated that would allow the effluent concentration to be estimated at a given time. By knowing the effluent concentration at a given time, the mass removal rate over that time could be estimated by determining the area under the curve.

As shown in Appendix E, assuming a 75 percent efficiency of the system, 250 cfm per well flow rate, and 177 pounds of PCE to be extracted, the estimated cleanup time is 1.9 years.

A determination of when to shut-down the system will be made in the future based upon effluent monitoring results. Once the effluent concentrations reach asymptotic levels (vapor concentrations below laboratory detection levels), operation of the system will be varied to monitor rebound. Confirmation soil sampling will be performed to confirm that the cleanup objectives have been met.

5.3 Pump-and-Treat

Based on the Feasibility Study Report (LFR, 2000), groundwater extraction was the selected alternative for controlling the migration and reducing the mass of the dissolved-phase plume in the area of the former AST farm by achieving hydraulic

control. In the absence of continued advective mass transport of PCE and its degradation products from the source area to a downgradient dissolved-phase plume, it is anticipated that the VOC concentrations in the downgradient portions of the plume beyond the affects of the hydraulic control would be naturally attenuated (e.g., dilution, dispersion, irreversible adsorption, and/or chemical reaction). The extracted groundwater will be treated using the existing air stripper and will be used as non-contact cooling water in the plant before being discharged to the lagoons consistent with the technical requirements of the SPDES permit.

To achieve hydraulic control of the dissolved-phase plume, an extraction well or a "picket line" of extraction wells, as necessary, can be installed in the source area and along the longitudinal axis of the dissolved chemical plume. The objective of this hydraulic control configuration is to stop the migration of the plume by modifying the groundwater flow field so that the dissolved phase above natural attenuation levels is captured by the extraction system.

The long-term operation of a pump-and-treat remediation system is typically not effective cleaning up contaminated aquifers to health based concentration goals because of the presence of sorbed chemicals to soil that act as a continuing source. However, pump-and-treat implemented as part of a treatment train can be very effective as long as the limitations are understood, which may include long-term operation and potential groundwater concentration rebound during source area remediation.

5.3.1 Capture Zone

The main component to designing the effectiveness a pump-and-treat remediation system is accurately determining the capture zone of the groundwater extraction wells. Most failures of conventional pump and treat systems are due to inadequate characterization of aquifer properties, thereby miscalculating the capture zone and flow rates of the groundwater extraction wells.

LFR developed a groundwater model of the Site for the Feasibility Study Report (LFR, 2000) using the MODFLOW and MODPATH modules within the Groundwater Modeling System. The model was calibrated using site-specific information including water level elevations, groundwater gradients, and hydraulic conductivity estimates. Based upon this model, it was determined that two overburden wells and one bedrock well would be required in addition to the operation of the existing north well to capture the dissolved-phase plume. This model assumed that the existing west well would be turned-off. The extraction rates from each well were determined using the model to achieve the desired capture zone width of 400 feet. The groundwater model provided in the FS Report (LFR, 2000) determined the following extraction rates:

- north well – 130 gpm
- two proposed overburden wells – 100 gpm/well
- bedrock well – 70 gpm

Based upon new data generated concerning the depth to bedrock, the model was reconfigured to include 25 feet of overburden saturated thickness rather than 15 feet of thickness. With this increase in saturated thickness of the overburden, the proposed flow rates to maintain the 400-foot capture zone width are as follows:

- north well – 170 gpm
- two proposed overburden wells – 130 gpm/well
- bedrock well – 70 gpm

The proposed locations of the four (3 shallow and 1 deep) groundwater extraction wells along with dissolved VOC concentrations are shown in Figure 14. Also in Figure 14 is the estimated groundwater capture zone in comparison to the horizontal extent of chlorinated ethene affected groundwater. The groundwater capture zone of the remedial system will be confirmed at startup.

Extraction wells OEW-1 and BEW-1 will primarily be used as hydraulic containment wells for the source area preventing the continued migration of dissolved-phase compounds, while extraction wells OEW-2 and the North Well will primarily function to capture the dissolved compounds that have migrated downgradient from the source area.

5.3.2 Extraction Well Design

Two vertical, 10-inch diameter overburden extraction wells and one vertical double-cased bedrock extraction well, are proposed for this groundwater extraction system along with the continued operation of the existing north well. Two of the recovery wells will be installed to a depth of approximately 40 feet bgs and be designated as the shallow extraction wells (OEW-1 and OEW-2), while one recovery well will be installed to a depth of approximately 55 feet bgs and will be designated as BEW-1.

The north well is an existing hand dug extraction well that is 48 inches in diameter and twenty-four feet deep. The screened interval of this well is unknown. The two proposed overburden extraction wells will be installed to the top of the bedrock and constructed of 25 feet of 10-inch diameter 0.020-inch Schedule 40 PVC well screen and 15 feet of 10-inch diameter Schedule 40 PVC riser. The wells will be installed with a conventional drill rig using a hollow stem auger with an outside diameter of at least 13 inches. The annular space between the borehole and the screen will be filled with 20/30-grade sand to 1 foot above the top of the screen (14 to 40 feet bgs). A 1-foot bentonite seal will be placed above the sand filter pack and the remaining annular space to 18 inches below the surface will be filled with Type I Portland cement. A detail of a typical shallow extraction well is presented in the construction drawings.

The bedrock well will be a double-cased well to approximately 18 inches into bedrock (expected at 40 feet bgs). The outer casing will be 10-inch diameter steel. The annular space between the outer casing and borehole will be filled with a Type I Portland cement and allowed to cure for 24 hours. Following curing, the drilling contractor will

core into bedrock approximately 15 feet and set 15 feet of 8-inch diameter machine slotted Schedule 40 PVC well screen and 40 feet of 8-inch diameter Schedule 40 PVC riser. The annular space between the rock core and the screen will be filled with 20/30-grade sand to 1 foot above the top of the screen (40 to 55 feet bgs). A 1-foot bentonite seal will be placed above the sand filter pack and the remaining annular space to 18 inches below the surface will be filled with Type I Portland cement. A detail of a typical deep extraction well is presented in the construction drawings.

The extraction wells will be completed in locking 2-square-foot steel vaults. Each well will be equipped with a ball valve, flow meter, and sampling port as shown in the construction drawings.

It is assumed that OEW-2 piping can be tied into the North Well manifold so that a jack-and-bore under the rail spur will not be required.

5.3.3 Groundwater Extraction Pump Design

As determined by the groundwater model, the estimated groundwater flow rate from the overburden wells will be 130 gpm per well from the two proposed overburden wells and 170 gpm from the existing north well. The estimated groundwater flow rate from the bedrock extraction well is 70 gpm. Based on the design requirements, the recommended groundwater extraction pump for the overburden wells are Grundfos SP30-3 with 5.5 horsepower, 4-inch motors or equivalent pump and for the bedrock well a Grundfos SP-14A with 2 horsepower, 4-inch motor or equivalent pump. Performance information and headloss calculations for these pumps are included in Appendix H. The existing north well pump may be replaced if it cannot be efficiently operate at a reduced flow rate of 170 gpm.

The proposed pump motors wills operate on 220-VAC, three-phase, electrical power. The north well currently operates on 480-VAC, three-phase, electrical power. The power supply to each extraction well pump will be equipped with an amperage sensor. If a pump draws the groundwater surface to the level of the intake, the pump will begin to cavitate and the amperage will change significantly. This amperage increase will be detected by the sensor and the sensor will signal the control panel to shut down the extraction well pump. After a 5-minute time delay, the control panel will restart the extraction well pumps.

5.3.4 Treatment System Design

The extracted groundwater will be treated with the existing packed tower air stripper and discharged into a 3,000-gallon, 10-foot diameter, 5-foot high fiberglass sump. The existing air stripping unit is a 25-foot high, 6-foot diameter fiberglass reinforced plastic tower with 20 feet of 3.5-inch polypropylene LanpacTM random packing material. The air stripper has an 18-inch diameter discharge stack that is 50-foot high. The packed tower is equipped with a 7.5 horsepower, 480 volt/3-phase blower capable of delivering 5,500 standard cubic feet per minute against a back pressure of 6 inches of

water column back pressure. The treated water is then transferred via pump from the sump to the plant for use as non-contact cooling water. Since the volume of water used for non-contact cooling is highly variable and is dependent upon ambient temperature and production activities, the treated water may be directly discharged to the on-site lagoon system. The transfer pump is equipped with a variable frequency drive starter and is capable of 625 gpm at 50 pounds per square inch.

5.3.4.1 Air Stripper

To treat the extracted groundwater at the proposed design flow rate of 500 gpm, the efficacy of the existing air stripper was evaluated using engineering calculations. The weighted-average groundwater PCE concentration of the influent into the air stripper from the extraction wells was estimated to be 400 µg/l as shown in Appendix I. This weighted-average was conservatively estimated using the higher January 2002 groundwater concentrations from OP-9, OP-11, OP-16, and the North Well. At this PCE concentration and flow rate, the air stripper will treat the water to less than 1 µg/l, which is less than the groundwater standard of 5 µg/l. At a flow rate of 500 gpm, the stripper can effectively treat an influent PCE concentration of up to 1,000 µg/l. At an average PCE concentration of 400 µg/l, the maximum flow rate into the stripper should not exceed 650 gpm to effectively treat the groundwater to below the regulatory standard.

The estimated volumetric air to water ratio at the design flow rate for the stripper is 82 to 1 using maximum flow rate values (5,500 scfm for air and 500 gpm for water). The air stripping unit is equipped with influent and effluent sampling ports, an observation port, thermometer, demister, and a pressure gauge. The air stripper also has redundant blower pressure switches, a high water switch, and totalizing flowmeter. Additional specifications for the air stripper are in the Treatability Study Evaluation Report (LFR, 1997).

5.3.5 Stripper Air Emission

Although no air permit is required since remediation is being required under CERCLA, JCI is required to comply with the substantiative requirements of 6NYCRR Part 212 for General Process Emission Sources and the New York State Division of Air Resources (DAR) Guidelines for the Control of Toxic Ambient Air Contaminants (Guidelines; November 12, 1997). Based upon this requirement, an analysis was performed in accordance with Appendix B of the Guidelines to determine the allowable emission rate from the air stripper. This analysis is included in Appendix G.

The allowable emission rate was determined for the three compounds expected to be present in the vapor stream. These compounds are PCE, TCE, and cis-1,2-DCE. Since PCE is the most sensitive compound of the three based upon its much higher detected concentration in the aqueous-phase as demonstrated by the groundwater sampling data and lower Annual Guideline Concentration (AGC; 1.0 µg/m^3), it was selected for the emission rate analysis.

Using the Standard Point Source Method (Guidelines, Appendix B), the maximum allowable annual emission rate for PCE is 2,896 pounds per year or 0.33 pound per hour assuming 8,760 operating hours per year. Based upon the groundwater sampling data, the PCE removal rate is expected to be less than 0.10 pound per hour assuming that 100 percent of the PCE is removed from the aqueous phase. The emission rate is anticipated to be less than the maximum allowable rate; therefore, emission control technology will not be required to reduce the PCE emission rate to below the allowable limit.

5.3.6 Inorganic Fouling

There is the potential for scaling and fouling of the air stripper from inorganic precipitation. Historical operation of the air stripper has not indicated significant concerns with fouling. The potential for scaling and fouling can be observed by monitoring the back pressure and visually inspecting the packed media through the sight port or by removing a portion of the media. Therefore, a chemical feed system using a concentrated blend of sequestering agents and polymers specifically designed to prevent the precipitation of hardness salts (calcium and manganese) and metal oxides (ferrous iron) is not required.

Since the operation of the air stripper began in May 1996, the packing was washed once with very dilute hydrochloric acid in 2001. Periodic acid wash with very dilute hydrochloric acid maybe performed to keep the packing free of scaling/fouling.

5.3.7 State Pollutant Discharge Elimination System Discharge

The discharge of the treated groundwater to the lagoons will be covered under the current SPDES permit NY-0072079. A permit modification will be required to increase the allowable flow rate from the stripper to at least 720,000 gpd. Based upon the mathematical model of the air stripper in Appendix I, the effluent from the air stripper still be well within the SPDES permit limits and the Groundwater Standards and Criteria. Therefore, the other permit requirements for the SPDES discharge will continue to be met.

5.3.8 Control System

A new control cabinet, for the groundwater extraction wells, will be required and will contain motor starters, pump savers, hand switches, alarm lights, etc. This equipment will be connected to and controlled by the existing air-stripper programmable logic controller. The existing system features the following operational characteristics:

- Shut down the groundwater extraction pumps if the water level in the effluent wet well reaches a preset level. The extraction pumps will restart when the water level in the wet well reaches a low-level set point.

- Shut down the entire system if the air stripper's blower pressure switches (high or low pressure) are tripped. This actuates a latching failure condition requiring manual restart at the Site.
- Shut down the air-stripper blower at loss of the groundwater extraction pumps. The control panel is equipped with a zero to 30 minute time delay for restart of the stripper blower to protect the motor.

A new control panel will be added to tie the existing pressure and liquid level switches to the proposed pumps to control their operation at fail-safe conditions.

5.4 In Situ Chemical Oxidation

To address the potential presence of PCE dense non-aqueous phase liquid (DNAPL) in the source area, a chemical oxidative such as potassium permanganate ($KMnO_4$) may be injected to mineralize the PCE. Permanganate is an oxidizing agent with a unique affinity for oxidizing organic compounds containing carbon-carbon double bonds. The rate of oxidation is much faster than the rate of dissolution of PCE from DNAPL to the aqueous phase. However, the process is mass-transfer-limited by the slow dissolution from DNAPL PCE to the aqueous phase. The mass transfer coefficient is a property of the PCE-water system and is not changed by the addition of $KMnO_4$.

Understanding that the oxidation of DNAPL PCE is mass-transfer-limited, chemical oxidation does not provide rapid and aggressive remediation for a site that contains a large mass of DNAPL PCE. However, if the site contains a small mass or irregularly distributed stringers and thin lenses, then $KMnO_4$ injection can be an appropriate approach. Another type of site amenable to remediation by $KMnO_4$ injection is one in which the mass of DNAPL PCE is not mobile. The JCI Jones Chemical site falls under both categories of sites that are amenable to treatment of DNAPL PCE by $KMnO_4$ injection.

The vapors generated from the reaction of PCE with KMnO4 will be captured, extracted and treated by the SVE system.

5.4.1 Mass Estimate

The mass of PCE in the saturate zone at the source area is difficult to determine based upon available data. However, the mass can be conservatively estimated using the January 2002 groundwater sampling data and large safety factors. The mass of PCE in the groundwater and sorbed to soil beneath the groundwater table was made. These calculations are an order-of-magnitude approximation. To estimate the mass of PCE in the saturated zone, the following assumptions were made.

- The source area is 15 feet in diameter
- The organic content of the overburden and bedrock aquifers are conservatively estimated to be 0.6% and 0.1%, respectively; however, the organic content is expected to be less since the overburden consists predominantly of gravel.
- The groundwater table is 15 feet bgs and bedrock is located at 40 feet bgs
- The source extends to 55 feet bgs
- The bulk density of the overburden saturated soil is 110 lbs/ft^3 and the porosity is 0.35
- The bulk density of the bedrock is 125 lbs/ft^3 and the porosity is 0.15

Using these assumptions, the mass of PCE in the overburden is 0.34 pound and in the bedrock is 0.156 pound. Assuming a DNAPL safety factor of 100, the estimated mass of PCE in the overburden is 3.4 pounds and in the bedrock is 1.56 pounds. The mass estimation calculations are shown in Appendix I.

5.4.2 Injection Volume and Rate

The volume of potassium permanganate ($KMnO_4$) required to oxidize the PCE in the overburden and bedrock was estimated as shown in Appendix K. The balanced oxidation-reduction reaction of PCE and $KMnO_4$ is as follows:

$$4KMnO_4 + 3C_2Cl_4 + 4\,H_2O \rightarrow 6CO_2 + 4MnO_2 + 4K^+ + 12CL^- + 8H^+$$

Based upon the stoichiometric ratio of PCE to $KMnO_4$, 1.4 grams of $KMnO_4$ is required for every gram of PCE. Assuming that the chemical oxygen demand of the aquifer is ten times greater than the PCE demand due to naturally occurring organic matter and reduced inorganics and applying a safety factor of 5, then 70 grams of $KMnO_4$ is required for every gram of PCE. Therefore, the required volume of $KMnO_4$ to treat the overburden is estimated to be 108 kg and the volume to treat the bedrock is 50 kg.

It is assumed that the required volume of $KMnO_4$ will have to be added to a solution that is 30% of the volume of the affected area to ensure that the oxidant reaches the entire 15-foot diameter source area. Therefore, 3,470 gallons of a 0.81% $KMnO_4$

solution will be added to the overburden aquifer and 890 gallons of a 1.5% $KMnO_4$ solution will be added to the bedrock aquifer.

The $KMnO_4$ solution will be injected via gravity feed since the overburden and bedrock aquifers have high transmissivities and the groundwater table is 15 feet bgs. The transmissivity of the overburden aquifer is 233 gpm/ft and is 45 gpm/ft for the bedrock aquifer; therefore, the required volume of solution can be added in one day.

Soil samples

After completing the first injection, subsequent groundwater monitoring data from the area will be evaluated to determine if additional injections are required.

5.4.3 Injection Well and Piping

To facilitate contact of the oxidant with the affected soil and groundwater over the 25-foot saturated zone, five overburden injection wells will be installed as shown in the construction drawings. The 5 overburden wells will be installed to 20, 25, 30, 35, and 40 feet below ground surface (bgs) and constructed of 5 feet of 2-inch diameter 0.020-inch Schedule 40 PVC well screen and 2-inch diameter Schedule 40 PVC riser. The annular space between the borehole and the screen shall be filled with 20/30-grade sand to 1 foot above the top of the screen. A 1-foot bentonite seal shall be placed above the sand filter pack and the remaining annular space to the surface shall be filled with Type I Portland cement. The injection wells will be finished flush to grade in a locking 8-inch diameter steel vault.

One bedrock injection well will be a double-cased well to approximately 18 inches into bedrock (expected at 40 feet bgs). The outer casing will be 4-inch diameter steel pipe. The annular space between the outer casing and borehole will be filled with a Type I Portland cement and allowed to cure for 24 hours. Following curing, the drilling contractor will core into bedrock approximately 15 feet and set 15 feet of 2-inch diameter machine slotted Schedule 40 PVC well screen and 40 feet of 2-inch diameter Schedule 40 PVC riser. The annular space between the rock core and the screen will be filled with 20/30-grade sand to 1 foot above the top of the screen (40 to 55 feet bgs). The remaining annular space to 18 inches below the surface will be filled with Type I Portland cement. A detail of the typical deep injection well is presented in the construction drawings. The injection well will be finished flush to grade in a locking 12-inch diameter steel vault.

During bedrock well installation, a LFR geologist will be on-site to evaluate the rock cores to establish the proper screened interval across areas of fractures.

The injection wells will be connected to the oxidant injection equipment via 1-inch diameter Schedule 40 PVC piping buried a minimum of 36 inches bgs.

5.4.4 Injection Equipment

The injection equipment will be housed in the SVE treatment building as shown in the construction drawings included as Appendix C. The system will include a 1,000-gallon solution mix tank, mixer, manifold with ball valves to injection points, and connection to potable water source. The $KMnO_4$ solution will be manually batch-mixed as necessary for delivery to the injection points.

5.4.5 Injection Control Permit

The proposed injection wells are classified as Type V wells. The U.S. EPA Region 2 implements the Underground Injection Control (UIC) program in New York; therefore, it is assumed that a Class V UIC permit will not be required for the injection of the chemical oxidant and authorization will be granted in the form of approval of the Remedial Action Report.

5.5 Institutional Controls

Deed restrictions will be required for potable use of on-site groundwater. This deed restriction will be required to remain in affect until the groundwater cleanup objectives are met.

6.0 IMPLEMENTATION AND SYSTEM STARTUP

JCI Jones Chemical will request bids from qualified remedial action contractors to install the proposed remediation systems. The remedial action contractor will purchase and install the equipment as specified in the construction drawings. The groundwater and soil-vapor extraction wells and the injection wells will be installed by a licensed drilling contractor. Subcontractor personnel conducting intrusive work will be required to be trained in accordance with OSHA 29 CFR 1910.120. Personnel will be required to read and sign the site-specific health and safety plan.

6.1 System Construction

The remedial systems will be installed in general accordance with the construction drawings presented in Appendix C and specifications presented in Appendix D. The soil-vapor treatment and in situ chemical oxidation equipment will be installed in a prefabricated building. By enclosing the equipment in a building it will protect the equipment from rain, freezing temperatures, and direct sunlight and provide a sound barrier to nearby residences. Hazardous waste warning signs will be mounted on the building. The groundwater extraction control equipment will be housed in the existing air-stripper building. Specifications of the equipment to be installed are presented in Appendix H.

The PCE concentrations in soil where trenching for piping and electrical conduit will be placed are expected to be below the Universal Treatment Standard (UTS) criteria; however, minimal soil above the UTS concentration may be encountered in the source area. If this occurs this soil will be used as backfill material for the trenching in the source area and remediated by the SVE system.

LFR will oversee construction activities including the installation of piping, equipment, and electricity. LFR will also monitor health and safety and conduct health safety meetings. A daily record of field activities will be kept in a field notebook. The selected remedial action contractor will be responsible for the labor, materials, equipment, and subcontractors necessary to install the remedial systems. The contractor will also be responsible for providing and installing the equipment. The contractor will obtain local building permits as necessary to complete specified work.

Upon completing system installation, the contractor will be required to perform equipment start-up to verify that each component has been installed properly and is performing satisfactorily.

6.2 Well Installation

JCI Jones Chemical will obtain a quote for installation of the groundwater extraction wells, vapor extraction wells, and chemical oxidation injection wells from a licensed driller. Since the U.S. EPA Region 2 implements the UIC program in New York, a Class V UIC permit will not be obtained for the injection of the chemical oxidant and authorization will be granted by approval of the Remedial Action Report. IDW soil from the installation wells will be spread on site in the source area and remediated by the SVE system. Groundwater generated from the installation of the groundwater extraction wells will be treated on site with the air stripper then discharged to the lagoons.

6.3 System Startup

After completion of construction, the SVE and pump-and-treat systems will be started. The in situ chemical oxidation treatment will not be implemented until hydraulic containment has been achieved. It is projected that system startup activities will take five days to complete.

The flow rate from each groundwater extraction well will be adjusted to maximize flow rate and drawdown without causing cavitation of pumps and therefore, cycling of pump. Groundwater elevations will be measured in selected on-site monitoring wells at least twice per day for three days, for determining zone of influence of the remediation system. Based on the data collected, flow and pressure adjustments may be made to enhance the performance of the pump-and-treat system.

Monitoring wells OP-7, OP-8, OP-9, OP-11, OP-12, OP-15, L-1, and PZ-2 will be used to determine the capture zone of the overburden groundwater extraction system.

BP-4 will be used to confirm the capture zone of the bedrock groundwater extraction well.

Air samples will be collected from the SVE influent and effluent at start-up, and after 24 and 72 hours of operation. The air samples will be analyzed by a fixed-base laboratory for PCE, TCE, and cis-1,2-DCE. The system flow rate will be monitored and vacuum readings will be measured each day for two days at selected monitoring wells. Air samples and flow measurements will be collected periodically during start-up from each vapor extraction well to assess contaminant removal rates.

The groundwater remediation system will operate continuously for at least the first six months of operation. Treatment system water samples will be collected from the influent and effluent of the air stripper on a daily basis for at least the first three days then weekly for the first month then monthly for 6 months. The first three daily samples will be shipped overnight and analyzed using EPA Method 8021 on a 24-hour turnaround basis for PCE, TCE, cis-1,2-DCE, and trans-1,2-DCE. These data will be used to evaluate the mass recovery rate of the remediation system, to evaluate the performance of the air stripper, and to determine whether SPDES permit discharge standards are being met. Long-term sampling will be described in the OM&M Plan for the Remedial Work Element II – to be submitted to U.S. EPA 30 days prior to the construction completion of Work Element II.

7.0 OPERATION, MAINTENANCE AND MONITORING

Operation, maintenance, and monitoring (OM&M) of the proposed SVE remedial system will be required to ensure that the equipment is operating efficiently and removing PCE from soil at an acceptable rate. Large fluctuations in the SVE system flow rates, vapor concentrations or temperatures are likely indicators that occlusions or short circuiting may be occurring in the formation, piping system, knockout tank, or GAC vapor treatment vessels.

As required by the Decree, OM&M of Remedial Work Element II will submitted 30 days prior to its construction completion.

7.1 Work Element I: O&M Schedule and Activities

Operation and maintenance events will be conducted monthly for the first quarter and then quarterly thereafter (routine O&M). During each routine O&M event, the equipment should be inspected and preventive maintenance conducted in accordance with manufacture specifications provided in the O&M Manuals to be supplied by the equipment manufacutrers. Monitoring data should be collected during each routine O&M visit and equipment repairs should be made as necessary. The following tasks should be conducted during the routine O&M events:

- The depth to groundwater and vacuum will be measured in select on-site monitoring wells.
- The run-time hours, vacuum and temperature of influent vapor, pressure and temperature of effluent vapor should be recorded at SVE blower system.
- The vapor flow rate and vacuum at each extraction well should be measured.
- An organic vapor analyzer should be used to measure vapor concentrations from the extraction wells, the blower influent, and the system effluent.
- The volume of water collected in the knockout tank should be monitored and the water collected should be treated on site.

During routine O&M visits, fine tuning and adjustments of the soil-vapor extraction flow rates, pressures, operating time cycles, etc. will be made to the systems based on the data collected. These fine-tuning adjustments are intended to maximize the performance of the remediation systems. The field data collected during each event, modifications to the operational profile of the remedial systems, and repairs to the systems will be recorded on a site-specific O&M checklist. Semi-annual status reports shall be provided to the U.S. EPA.

The SVE system is expected to operate approximately two years. The GAC vessels for vapor phase treatment are predicted to be removed within the first six months of operations (Refer to Section 5.2.4).

7.2 Monitoring Program

To monitor the effectiveness of the remediation systems, soil vapor influent and SVE blower effluent (post GAC vapor phase treatment) air samples will be collected on a quarterly basis as necessary and analyzed for PCE, TCE, and cis-1,2-DCE by EPA Method TO14. The field monitoring and analytical data, along with any recommendations for modifications to the remediation system will be presented in quarterly monitoring reports.

7.3 Post-Remediation Monitoring

Post-remediation monitoring will be conducted upon discontinuing the active remedial SVE system. Six soil samples from the source area vadose zone would be collected using 3-inch split spoon samples and analyzed using EPA Method 8260. The soil samples would be collected from various depths to confirm meeting the soil cleanup objective.

The post-remediation groundwater monitoring will be conducted in accordance with the Post-Remediation Plan (PRM) to be submitted within 45 days after designated groundwater monitoring points have recorded readings less than or equal to remediation goals for the third consecutive year.

8.0 SCHEDULE

The following table presents the draft schedule for implementation and startup of the proposed remedial action systems and monitoring.

Task Description	Project Schedule Duration (Days)
Final RD Report for Elements I and II	30
EPA Approval of Final RD Report	*
Initiate Remedial Action	**
Solicit Bids/ Award Remedial Action Contract	45
Remedial Action Work Plan (RAWP) for Element I and II	45
Initiate Remedial Construction	***
Install Extraction and Injection Wells	20
Install Trenching/Piping/Equipment	45
Start-up	5
Construction of Remedial Action Elements I & II	180
Remedial Action Element I Completion	1,095[1]
Remedial Action Element II Completion	5,475[1]

Notes:

*EPA dependent
*time frame begins upon EPA approval of Final RD Report
***time frame begins upon EPA approval of RAWP
[1]After start-up

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Table 1
Monitoring Well Construction Data
Jones Chemicals, Inc.
Caledonia, New York

Well ID	TOC Elevation (feet NGVD)	Well Depth Depth (feet bgs)	Monitoring Zone	Screen Interval (feet bgs)	Well Diameter (inches)	Installation Date	Installed By
OP-1	648.465	30.0	Overburden	25-30	4	06/21/84	CRA
OP-2	650.555	25.3	Overburden	20.3-25.3	4	06/20/84	CRA
OP-3	649.800	31.0	Overburden	26-31	4	NA	CRA
OP-5	650.620	22.0	Overburden	17-22	2	04/24/96	LFR
OP-6	651.460	21.0	Overburden	16-21	2	08/23/94	LFR
OP-7	648.785	23.0	Overburden	18-23	2	04/23/96	LFR
OP-8	652.025	22.0	Overburden	17-22	2	04/23/96	LFR
OP-9	645.465	22.0	Overburden	17-22	2	04/26/96	LFR
OP-10	653.790	22.0	Overburden	17-22	2	04/25/96	LFR
OP-11	653.610	22.0	Overburden	17-22	2	04/25/96	LFR
OP-12	652.980	22.0	Overburden	17-22	2	04/29/96	LFR
OP-13	660.205	31.0	Overburden	26-31	2	11/18/97	LFR
OP-14	653.025	26.0	Overburden	21-26	2	11/19/97	LFR
OP-15	652.660	24.0	Overburden	19-24	2	11/19/97	LFR
OP-16	NS	44.0	Intermediate	39-44	2	08/19/98	LFR
BP-1	650.815	113.5	Bedrock	Open Hole (15 ft.)	6	06/26/84	CRA
BP-2	652.100	75.0	Bedrock	Open Hole (15 ft.)	4	06/18/84	CRA
BP-3	648.990	60.0	Bedrock	Open Hole (5 ft.)	2	02/06/87	CRA
BP-4	652.435	55.0	Bedrock	Open Hole (5 ft.)	2	02/11/87	CRA
BP-5	652.050	90.0	Bedrock	Open Hole (15 ft.)	2	05/02/96	LFR
BP-6	653.800	101.0	Bedrock	Open Hole (15 ft.)	4	05/02/96	LFR
L-1	650.420	21.0	Overburden	16-21	4	06/26/84	CRA
L-2	650.560	67.5	Bedrock	Open Hole (15 ft.)	4	05/30/84	CRA
L-3	649.755	20.0	Overburden	15-20	4	05/24/84	CRA
North Well	650.435	24.0	Overburden	NA	48	03/85	NA
East Well	651.090	55.5	Bedrock	NA	6	NA	NA
West Well	652.340	45.3	Bedrock	NA	6	NA	NA
V-1	NS	NA	NA	NA	NA	NA	NA
V-2	NS	NA	NA	NA	NA	NA	NA
PZ-1	649.885	22.0	Overburden	12-22	2	11/29/94	LFR

Table 1
Monitoring Well Construction Data
Jones Chemicals, Inc.
Caledonia, New York

Well ID	TOC Elevation (feet NGVD)	Well Depth Depth (feet bgs)	Monitoring Zone	Screen Interval (feet bgs)	Well Diameter (inches)	Installation Date	Installed By
PZ-2	649.510	23.0	Overburden	13-23	2	11/29/94	LFR
DEC-1	645.125	23.5	Overburden	21-23.5	NA	12/21/83	NYSDEC
DEC-2	642.930	25.5	Overburden	23-25.5	NA	12/22/83	NYSDEC
DEC-3	643.000	17.5	Overburden	15-17.5	NA	12/22/83	NYSDEC
DEC-4	645.445	34.0	Overburden	NA	NA	10/30/84	NYSDEC
DEC-5	657.095	37.0	Overburden	NA	NA	10/31/84	NYSDEC
DEC-6	643.985	26.0	Overburden	NA	NA	11/01/84	NYSDEC
DEC-7	655.445	27.5	Overburden	25-27.5	NA	11/01/84	NYSDEC
DEC-8	645.905	31.5	Overburden	NA	NA	09/10/85	NYSDEC
DEC-9	649.245	27.0	Overburden	24.5-27	NA	09/12/85	NYSDEC
DEC-10	649.535	19.0	Overburden	16.5-19	NA	09/12/85	NYSDEC

Notes:

bgs = below ground surface
CRA = Conestoga-Rovers & Associates
LFR = LFR Levine·Fricke
NA = not available
NGVD = National Geodetic Vertical Datum
NS = not surveyed
NYSDEC = New York State Department of Environmental Conservation
TOC = top of casing

Table 2
Groundwater Elevation Data
JCI Jones Chemicals, Inc.
Caledonia, New York

Well ID	Monitoring Zone	Measurement Date	TOC Elevation (feet NGVD)	Groundwater (feet BTOC)	Groundwater Elevation (feet NGVD)
OP-1	Overburden	09/11/98	648.47	13.72	634.75
		01/07/02		15.59	632.88
OP-2	Overburden	09/11/98	650.56	16.71	633.85
		01/07/02		18.96	631.60
OP-3	Overburden	09/11/98	649.80	16.20	633.60
		01/07/02		17.93	631.87
OP-5	Overburden	09/11/98	650.62	15.89	634.73
		01/07/02		17.67	632.95
OP-6	Overburden	09/11/98	651.46	15.95	635.51
		01/07/02		19.67	631.79
OP-7	Overburden	09/11/98	648.79	15.02	633.77
		01/07/02		16.78	632.01
OP-8	Overburden	09/11/98	652.03	17.45	634.58
		01/07/02		18.93	633.10
OP-9	Overburden	09/11/98	645.47	11.47	634.00
		01/07/02		13.08	632.39
OP-10	Overburden	09/11/98	653.79	21.03	632.76
		01/07/02		Dry	NA
OP-11	Overburden	09/11/98	653.61	18.93	634.68
		01/07/02		20.60	633.01
OP-12	Overburden	09/11/98	652.98	18.25	634.73
		01/07/02		19.93	633.05
OP-13	Overburden	09/11/98	660.21	27.55	632.66
		01/07/02		29.10	631.11
OP-14	Overburden	09/11/98	653.03	20.67	632.36
		01/07/02		22.15	630.88
OP-15	Overburden	09/11/98	652.66	17.93	634.73
		01/07/02		19.62	633.04
OP-16	Intermediate	09/11/98	Not Surveyed	17.87	638.27
		01/07/02		18.89	NA

Table 2
Groundwater Elevation Data
JCI Jones Chemicals, Inc.
Caledonia, New York

Well ID	Monitoring Zone	Measurement Date	TOC Elevation (feet NGVD)	Groundwater (feet BTOC)	Groundwater Elevation (feet NGVD)
BP-1	Bedrock	09/11/98	650.82	13.21	637.61
		01/07/02		14.03	636.79
BP-2	Bedrock	09/11/98	652.10	16.79	635.31
		01/07/02		17.81	634.29
BP-3	Bedrock	09/11/98	648.99	13.51	635.48
		01/07/02		14.62	634.37
BP-4	Bedrock	09/11/98	652.44	16.99	635.45
		01/07/02		18.11	634.33
BP-5	Bedrock	09/11/98	652.05	71.77	580.28
		01/07/02		18.25	633.80
BP-6	Bedrock	09/11/98	653.80	21.54	632.26
		01/07/02		21.68	632.12
L-1	Overburden	09/11/98	650.42	16.57	633.85
		01/07/02		18.97	631.45
L-2	Bedrock	09/11/98	650.56	15.19	635.37
		01/07/02		16.38	634.18
L-3	Overburden	09/11/98	649.76	15.84	633.92
		01/07/02		Dry	NA
PZ-1	Overburden	09/11/98	649.89	16.07	633.82
		01/07/02		18.22	631.67
PZ-2	Overburden	09/11/98	649.51	15.71	633.80
		01/07/02		17.61	631.90
East Well	Bedrock	09/11/98	651.09	17.32	633.77
		01/07/02		19.17	631.92

Notes:
BTOC = below top of casing
Dry = well was dry
NA = not applicable
NGVD = National Geodetic Vertical Datum
TOC = top of casing (surveyed to third decimal place)

Table 3
Soil Sample Analytical Results Summary
Volatile Organic Compounds
JCI Jones Chemicals, Inc.
Caledonia, New York

Soil Sample Identification	Depth (feet bgs)	Date Sampled	Parameter					
			Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
B-1	13	1/7/02	**4,200**	<1,500	<1,500	<1,500	<1,500	<1,500
B-2	15	1/7/02	**90,000**	**2,700**	**2,900**	<7,700	<7,700	<7,700
B-3	15	1/8/02	**510**	**13**	<30	<30	<30	<30
B-4	15	1/8/02	**15,000**	**13**	<23	<23	<23	<23
B-5	15	1/8/02	**9,100**	**14**	<15	<15	<15	<15
B-6	15	1/8/02	**5,800**	**13**	<19	<19	<19	<19
B-7	15	1/9/02	**4,900**	**9**	<29	<29	<29	<29
B-8	15	1/9/02	**3,500**	**10**	<23	<23	<23	<23
B-9	15	1/9/02	**2,600**	<3,100	<3,100	<3,100	<3,100	<3,100
B-10	15	1/9/02	**39,000**	<2,000	<2,000	<2,000	<2,000	<2,000

Notes:

Concentrations are presented in micrograms per kilogram.

< = below detection limit

Bold = positive detection

Table 4
Groundwater Analytical Results Summary
Volatile Organic Compounds
JCI Jones Jones Chemicals, Inc.
Caledonia, New York

Identification (Depth in Feet	Date Sampled	Parameter					
		Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
North Well	4/30/96	**570**	**45**	**210**	<1	<1	<1
	11/18/97	**61**	**4**	**6**	<2	<2	<2
	8/21/98	**140**	**16**	**9**	<0.5	<0.5	<0.5
	1/10/02	**35.6**	**2.5**	**3.1**	<1	<1	<1
West Well	4/30/96	**300**	**18**	**23**	<1	<1	<1
	11/20/97	**310**	**16**	**28**	<2	<2	<2
	8/21/98	**340**	**18**	**30**	<0.5	<0.5	<0.5
	1/10/02	**207**	**14.6**	**14.5**	<1	<1	<1
East Well	5/1/96	**18**	**3**	**17**	<1	<1	<1
	11/18/97	**26**	**2**	**18**	<1	<1	<1
	8/21/98	**31**	**3**	**30**	<0.5	<0.5	<0.5
	1/11/02	**23.4**	**5.3**	**22.9**	<1	<1	<1
L-2	4/30/96	<1	<1	<1	<1	<1	<1
	11/21/97	<1	<1	<1	<1	<1	<1
(DUP)	11/21/97	<1	<1	<1	<1	<1	<1
	8/22/98	<0.5	<0.5	**7**	<0.5	<0.5	<0.5
	1/11/02	<1	<1	**7.4**	<1	<1	<1
L-3	4/30/96	**1**	<1	**1**	<1	<1	<1
	11/21/97	**1**	<1	**1**	<1	<1	<1
	8/22/98	**0.8**	**0.6**	**1**	<0.5	<0.5	<0.5
	1/7/02	Dry	Dry	Dry	Dry	Dry	Dry
OP-1	4/30/96	<1	<1	<1	<1	<1	<1
	11/21/97	<1	<1	<1	<1	<1	<1
	8/21/98	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1/8/02	<1	**0.54J**	<1	<1	<1	<1
OP-2	4/30/96	<1	<1	**3**	<1	<1	<1
	11/21/97	<1	<1	**11**	<1	<1	<1
	8/20/98	<0.5	**0.6**	**3**	<0.5	<0.5	<0.5
	1/8/02	<1	**0.64J**	**8.4**	<1	<1	<1

Table 4
Groundwater Analytical Results Summary
Volatile Organic Compounds
JCI Jones Jones Chemicals, Inc.
Caledonia, New York

Identification (Depth in Feet	Date Sampled	Parameter					
		Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
OP-3	5/1/96	**10**	**13**	<1	<1	<1	<1
	11/21/97	**9**	**14**	<1	<1	<1	<1
	8/20/98	**14**	**18**	**0.7**	<0.5	<0.5	<0.5
	1/8/02	**6.6**	**9**	<1	<1	<1	<1
OP-5	4/29/96	<1	<1	<1	<1	<1	<1
	11/21/97	<1	<1	<1	<1	<1	<1
	8/20/98	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5
	1/10/02	<1	**0.62J**	<1	<1	<1	<1
OP-6	4/30/96	**29**	**9**	<1	<1	<1	<1
	11/20/97	**48**	**8**	**4**	<1	<1	<1
	8/21/98	**22**	**9**	<0.5	<0.5	<0.5	<0.5
	1/9/02	**359**	**21.4**	**17.2**	<1	<1	<1
	4/5/02	**67.6**	**3**	**1.3**	<1	<1	<1
OP-7	4/29/96	<1	**1**	<1	<1	<1	<1
	11/21/97	<1	**2**	<1	<1	<1	<1
	8/21/98	**0.8**	**1**	<0.5	<0.5	<0.5	<0.5
	1/9/02	**4.2**	**2.2**	**0.58J**	<1	<1	<1
OP-8	4/29/96	**300**	**26**	**72**	<1	<1	<1
	11/21/97	**40**	**20**	<2	<2	<2	<2
	1/11/02	**79**	**3**	**3**	<0.5	<0.5	<0.5
	1/11/02	**13.7**	**0.68J**	**1.2**	<1	<1	<1
OP-9	5/1/96	**120**	**110**	**2**	<1	<1	<1
	11/20/97	**64**	**17**	**31**	<2	<2	<2
	8/22/98	**120**	**86**	**1**	<0.5	<0.5	<0.5
	1/11/02	**74**	**38.8**	**2.3**	<1	<1	<1
OP-10	5/2/96	**25**	**1**	<1	<1	<1	<1
	11/21/97	**24**	**2**	<1	<1	<1	<1
	8/21/98	**8**	**2**	<0.5	<0.5	<0.5	<0.5
	1/7/02	Dry	Dry	Dry	Dry	Dry	Dry

Table 4
Groundwater Analytical Results Summary
Volatile Organic Compounds
JCI Jones Jones Chemicals, Inc.
Caledonia, New York

Identification (Depth in Feet	Date Sampled	Parameter					
		Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
OP-11	5/2/96	**3,100**	**70**	**9**	<1	<1	<1
	11/21/97	**1,300**	**24**	<20	<20	<20	<20
	8/22/98	**5,400**	**62**	**9**	<0.5	<0.5	<0.5
	1/12/02	**298**	**43.6**	**26.6**	<1	<1	<1
OP-12	5/2/96	**21**	<1	<1	<1	<1	<1
	11/20/97	**5**	**3**	**2**	<1	<1	<1
	8/22/98	**3**	**1**	<0.5	<0.5	<0.5	<0.5
	1/10/02	**1.6**	**0.71J**	**9.8**	<1	<1	<1
OP-13	11/20/97	<1	<1	<1	<1	<1	<1
	8/20/98	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1/10/02	<1	<1	<1	<1	<1	<1
OP-14	11/20/97	**5**	**1**	<1	<1	<1	<1
	8/20/98	**6**	**1**	<0.5	<0.5	<0.5	<0.5
	1/10/02	**3.4**	**1.3**	<1	<1	<1	<1
OP-15	11/20/97	<1	**1**	<1	<1	<1	<1
	8/20/98	<0.5	**0.8**	<0.5	<0.5	<0.5	<0.5
	1/10/02	<1	<1	<1	<1	<1	<1
OP-16	8/20/98	**62,000**	**100**	**2**	<0.5	2	<0.5
	1/12/02	**2,080**	**46.1**	**2.3**	<1	<1	<1
PZ-1	4/30/96	**120**	**16**	**40**	<1	<1	<1
	11/21/97	**2**	<1	<1	<1	<1	<1
	8/22/98	**16**	**2**	<0.5	<0.5	<0.5	<0.5
	1//11/02	**0.90J**	<1	<1	<1	<1	<1
BP-1	4/30/96	<1	<1	<1	<1	<1	<1
	11/19/97	<1	<1	**2**	<1	<1	<1
	8/20/98	<0.5	**8**	**13**	<0.5	<0.5	<0.5
	1/8/02	<1	**3.3**	**10**	<1	<1	<1

Table 4
Groundwater Analytical Results Summary
Volatile Organic Compounds
JCI Jones Jones Chemicals, Inc.
Caledonia, New York

Identification (Depth in Feet	Date Sampled	Parameter					
		Tetrachloroethene	Trichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
BP-2	4/29/96	<1	<1	<1	<1	<1	<1
	11/18/97	<1	<1	**7**	<1	<1	<1
	8/20/98	<0.5	<0.5	**16**	<0.5	<0.5	<0.5
	1/10/02	<1	<1	**22**	<1	<1	<1
BP-3	4/29/96	<1	**2**	**31**	<1	<1	<1
	11/21/97	<1	<1	<1	<1	<1	<1
	8/21/98	<0.5	<0.5	**11**	<0.5	<0.5	<0.5
	1/12/02	**1.5**	**7**	**22.1**	<1	<1	<1
BP-4	4/29/96	**15**	**14**	**21**	<1	<1	<1
	11/21/97	**11**	**10**	**29**	<1	<1	<1
	8/21/98	**2**	**1**	**21**	<0.5	<0.5	<0.5
	1/12/02	**2.9**	**5.4**	**21.4**	<1	<1	<1
BP-5	5/23/96	<5	<5	<5	<5	<5	<5
	11/21/97	<1	<1	**1**	<1	<1	<1
	8/20/98	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1/9/02	<1	<1	<1	<1	<1	<1
BP-6	5/23/96	<5	<5	<5	<5	<5	<5
	11/19/97	<1	<1	<1	<1	<1	<1
	8/21/98	<0.5	<0.5	**2**	<0.5	<0.5	<0.5
	1/9/02	<1	<1	**3.2**	<1	<1	<1

Notes:

Concentrations are presented in micrograms per liter.
Bold = positive detection
J = concentraton estimated; below detection limit

Table 5
Monitored Natural Attenuation Indicator Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York

Parameter	Method	Monitoring Well Identification, Screened Depth (feet bgs) and Date Sampled							
		OP-3	OP-5	OP-6	OP-7	OP-8	OP-8 (DUP)	OP-9	OP-11
		26 - 31	17 - 22	16 - 21	18 - 23	17 - 22	17 - 22	17 - 22	17 - 22
		1/8/02	1/10/02	1/9/02	1/9/02	1/11/02	1/11/02	1/11/02	1/12/02
pH (standard units)	Field	7.27	7.38	7.18	7.23	7.49	NA	7.35	7.09
Temperature (degrees Celcius)	Field	11.9	13.0	15.8	13.2	11.6	NA	11.0	13.9
Oxidation Reduction Potential (mV)	Field	NM	19.4	104.1	95.1	133	NA	1.1	83.0
Dissolved Oxygen (mg/l @ °C)	Field	2.81@12.7	3.62@13.5	5.0@16.6	9.24@13.6	9.33@12.3	NA	2.74@13.0	1.60@14.9
Total Alkalinity	EPA 310.1	245	265	250	190	152	155	232	283
Ferrous Iron	Field - Hach Kit	0.69	0.19	0.61	0	0.04	NA	1.32	0
Chloride	EPA 300	158	166	174	182	158	158	104	168
Sulfate	EPA 300	492	396	344	612	663	662	688	286
Sulfide	Field - Hach Kit	0.03	0.06	0	0.1	0.2	NA	3.5	0.1
Nitrate	EPA 353.2	4.52	5.08	4.74	3.99	3.11	3.13	2.18	3.62
Nitrate/Nitrite	EPA 353+35	4.53	5.1	4.74	3.99	3.11	3.13	2.22	3.63
Nitrite	EPA 353.2	0.012	0.0233	<0.0100	<0.0100	<0.0100	<0.0100	0.0393	0.015
Total Organic Carbon	EPA 9060	1.07	1.11	2.24	1.21	1.14	1.17	1.27	1.53
Methane	Modified RSK-175 (EPA)	0.014	<0.002	0.010	<0.002	<0.002	<0.002	<0.002	<0.002
Ethene	Modified RSK-175 (EPA)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethane	Modified RSK-175 (EPA)	<0.001	<0.001	0.0027	<0.001	<0.001	<0.001	<0.001	<0.001

Notes:

Concentrations are presented in milligrams per liter.

< = less than

bgs = below ground surface

Dup= duplicate

mV= millivolts

NM = not measured due to equipment malfunction

°C= degrees Celsius

ORP = Oxidation Reduction Potential

SU = standard units

Table 5
Monitored Natural Attenuation Indicator Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York

Parameter	Method	Monitoring Well Identification, Screened Interval and Date Sampled				
		OP-12	OP-13	OP-14	OP-15	PZ-1
		17 - 22	26 - 31	21 - 26	19 - 24	22-Dec
		1/10/02	1/10/02	1/10/02	1/10/02	1/11/02
pH (standard units)	Field	7.55	7.60	7.44	7.50	7.58
Temperature (degrees Celcius)	Field	11.7	12.5	13.1	10.8	9.2
Oxidation Reduction Potential (mV)	Field	72.8	45.2	34.3	100.1	41.0
Dissolved Oxygen (mg/l @ °C)	Field	0.92@12.4	9.93@12.8	6.06@13.8	1.08@13.3	11.11@9.6
Total Alkalinity	EPA 310.1	210	282	270	242	150
Ferrous Iron	Field - Hach Kit	1.59	0.08	0.06	0.86	0.38
Chloride	EPA 300	65.7	84.5	156	97.4	155
Sulfate	EPA 300	1,110	51.7	384	750	672
Sulfide	Field - Hach Kit	0.05	0.18	0.05	0.36	1.1
Nitrate	EPA 353.2	0.457	5.38	5.5	1.73	3.04
Nitrate/Nitrite	EPA 353+35	0.457	5.38	5.5	1.74	3.04
Nitrite	EPA 353.2	<0.0100	<0.0100	<0.0100	0.0118	<0.0100
Total Organic Carbon	EPA 9060	1.16	<1.00	1.1	1.52	<1.00
Methane	Modified RSK-175 (EPA)	0.0059	<0.002	<0.002	0.002	<0.002
Ethene	Modified RSK-175 (EPA)	<0.001	<0.001	<0.001	<0.001	<0.001
Ethane	Modified RSK-175 (EPA)	<0.001	<0.001	<0.001	<0.001	<0.001

Notes:

Concentrations are presented in milligrams per liter.

< = less than

bgs = below ground surface

Dup= duplicate

mV= millivolts

NM = not measured due to equipment malfunction

°C= degrees Celsius

ORP = Oxidation Reduction Potential

SU = standard units

Table 6
Groundwater Sampling Physical Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York

Well ID	Sampling Date	Time	Temperature °C	pH	Specific Conductance (micromhos/cm)	Dissolved Oxygen (mg/l@°C)	Eh (mv)	Turbidity (NTUs)
OP-1	04/30/96	17:00	NM	7.30	2,060			33
	11/19/97	12:30	10.7	7.35	1,340			7.66
	08/21/98	15:50	10.5	7.35	1,746			14.30
	01/08/02	10:11	11.3	7.20	1,366	1.33@12.3	NM	40.60
OP-2	04/30/96	16:03	NM	7.50	1,430			16
	11/19/97	11:10	10.1	7.32	1,469			14
	08/20/98	14:00	11.3	7.26	1,878			10.13
	01/08/02	11:15	11.4	7.29	1,282	0.23@12.3	NM	64.2
OP-3	05/01/96	08:52	NM	7.30	1,600			50
	11/19/97	14:10	10.3	7.50	1,146			16.3
	08/20/98	11:50	11	7.16	1,517			15.9
	01/08/02	15:45	11.9	7.27	1,041	2.81@12.7	NM	34.6
OP-5	04/29/96	11:00	NM	7.40	1,740			29
	11/19/97	09:41	10.8	7.41	1,022			28
	08/20/98	16:45	11.1	7.29	1,296			46.5
	01/10/02	8:59	13	7.38	962	3.62@13.5	19.4	16.2
OP-6	04/30/96	10:05	NM	7.30	1,570			29
	11/20/97	10:06	13.3	7.13	1,118			56.8
	08/21/98	15:10	16.1	7.14	1,075			40
	01/09/02	14:20	15.8	7.18	947	5.0@16.6	104.1	241
	04/5/02*	09:26	7.7	6.97	550	4.57@7.7	123	NR
OP-7	04/29/96	13:47	NM	7.30	1,660			28
	11/21/97	13:15	11.5	7.18	1,062			22
	08/21/98	14:05	13.2	7.31	1,163			45.8
	01/09/02	15:38	13.2	7.23	1,016	9.24@13.6	95.1	8.1
OP-8	04/29/96	16:15	NM	7.30	1,470			12
	11/21/97	13:30	10.8	7.00	1,132			10.6
	08/21/98	16:15	12.7	7.35	1,179			9.95
	01/11/02	17:58	11.6	7.49	958	9.33@12.3	133	24
OP-9	05/01/96	10:00	NM	7.30	1,250			2
	11/20/97	11:30	8.6	7.40	1,130			>200
	08/22/98	09:20	11.5	7.19	1,129			23.2
	01/11/02	11:22	11	7.35	955	2.74@13	1.1	37
OP-10	05/02/96	09:15	NM	7.40	1,180			45
	11/21/97	09:15	NA	NA	NA			NA
	08/21/98	08:40	12.7	7.45	891			87.5
	01/07/02	DRY	DRY	DRY	DRY	DRY	DRY	DRY

Table 6
Groundwater Sampling Physical Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York

Well ID	Sampling Date	Time	Temperature °C	pH	Specific Conductance (micromhos/cm)	Dissolved Oxygen (mg/l@°C)	Eh (mv)	Turbidity (NTUs)
OP-11	05/02/96	09:55	NM	7.40	1,140			35
	11/21/97	14:15	11.5	7.01	1,157			68.3
	08/22/98	11:30	16.5	6.99	1,054			71.5
	01/12/02	8:52	13.9	7.09	909	1.60@14.9	83	21
OP-12	05/02/96	10:15	NM	7.40	1,180			23
	11/20/97	14:30	10.6	7.43	901			>200
	08/22/98	10:00	13.4	7.27	881			>200
	01/10/02	15:26	11.7	7.55	936	0.94@12.4	72.8	335
OP-13	11/20/97	15:30	10.2	7.70	779			35.7
	08/20/98	09:20	9.6	7.33	874			27.5
	01/10/02	12:28	12.5	7.60	627	9.93@12.8	45.2	58
OP-14	11/20/97	15:50	10.6	7.54	1,151			>200
	08/20/98	10:00	9.2	7.38	996			43.4
	01/10/02	11:39	13.1	7.44	933	6.06@13.8	34.3	39.1
OP-15	11/20/97	16:05	10.9	7.70	1,234			156
	08/20/98	14:45	11.4	7.39	1,087			95.6
	01/10/02	14:47	10.8	7.50	1,001	1.08@13.3	100.1	95.1
OP-16	08/20/98	14:15	13.2	7.21	1,993			54.5
	01/12/02	10:08	12.6	7.17	912	0.47@13.6	-40	11.4
BP-1	04/30/96	11:12	NM	7.40	1,870			15
	11/19/97	15:10	9.4	7.36	1,399			2.94
	08/20/98	15:55	10.3	7.35	1,996			3.06
	01/08/02	17:20	10	7.35	1,034	0.25@10.9	NM	4.72
BP-2	04/29/96	10:07	NM	7.40	2,115			1
	11/18/97	16:05	10	7.34	1,469			2.48
	08/20/98	17:15	10.6	7.23	2,180			40.4
	01/10/02	9:35	11.2	7.49	992	0.27@11.7	-94.5	3.11
BP-3	04/29/96	11:55	NM	7.40	2,140			16
	11/21/97	11:40	10	6.99	1,942			22.5
	08/21/98	14:10	11.8	7.33	1,942			89.8
	01/12/02	15:39	10.5	7.24	885	0.32@11.0	-65	24
BP-4	04/29/96	17:00	NM	7.30	2,110			25
	11/21/97	13:50	9.6	7.01	1,986			5.73
	08/21/98	16:30	11.3	7.29	1,955			1.93
	01/12/02	17:10	10.4	7.24	893	0.28@10.7	82	6.1

Table 6
Groundwater Sampling Physical Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York

Well ID	Sampling Date	Time	Temperature °C	pH	Specific Conductance (micromhos/cm)	Dissolved Oxygen (mg/l@°C)	Eh (mv)	Turbidity (NTUs)
BP-5	05/23/96	10:54	NM	7.30	6,940			41
	11/21/97	14:50	10.0	10.67	9,456			20
	08/20/98	17:10	13.2	8.92	1,705			>1,000
	01/09/02	11:12	11.8	9.22	2,730	0.04@12.8	NM	27.70
BP-6	05/23/96	10:24	NM	7.30	1,880			1
	11/19/97	16:50	9.6	7.28	1,511			0.76
	08/21/98	10:45	11.3	7.30	2,420			2.14
	01/09/02	9:29	10.6	7.41	972	0.12@11.7	NM	215
PZ-1	04/30/96	12:40	NM	7.50	1,540			3
	11/21/97	10:30	9.4	7.40	1,492			42.2
	08/22/98	10:45	9.0	7.29	1,416			95.3
	01/11/02	16:32	9.2	7.58	981	11.11@9.60	41	25
L-2	04/30/96	15:07	NM	7.40	2,170			26
	11/21/97	09:30	11.4	9.30	1,633			22.7
	08/22/98	11:30	10.8	7.15	2,380			27.2
	01/11/02	14:42	10.7	7.22	934	0.19@11.2	-53.1	7.4
L-3	04/30/96	15:24	NM	7.40	1,590			29
	11/21/97	10:00	9.5	7.06	1,647			>200
	08/22/98	10:30	13.8	7.30	1,293			239
	01/07/02	DRY	DRY	DRY	DRY	DRY	DRY	DRY
North Well	04/30/96	09:06	NM	7.30	1,474			0
	11/18/97	11:01	11.5	7.55	1,253			0.08
	01/10/02	NM	NM	NM	NM	NM	NM	NM
	08/21/98	13:35	RE	7.11	1,366			3.69
West Well	04/30/96	09:21	NM	7.40	2,090			0
	11/20/97	10:30	10.5	7.15	1,476			25.2
	08/21/98	13:15	11.7	7.39	1,923			1.79
	01/10/02	NM	NM	NM	NM	NM	NM	NM
East Well	05/01/96	10:47	NM	7.50	1,840			2
	11/18/97	12:42	10.7	7.26	1,464			44.1
	08/21/98	11:40	10.8	7.32	2,250			170.8
	01/10/02	9:03	12.1	7.17	964	0.21@12.1	38.8	0

Notes:

*Sampled by Haley and Aldrich, Rochester, New York

°C = degrees Celsius

DRY = well was dry

mg/l@°C = milligrams per liter at degrees celcius

micromohos per centimeter

mV = millivolts

NA = not applicable

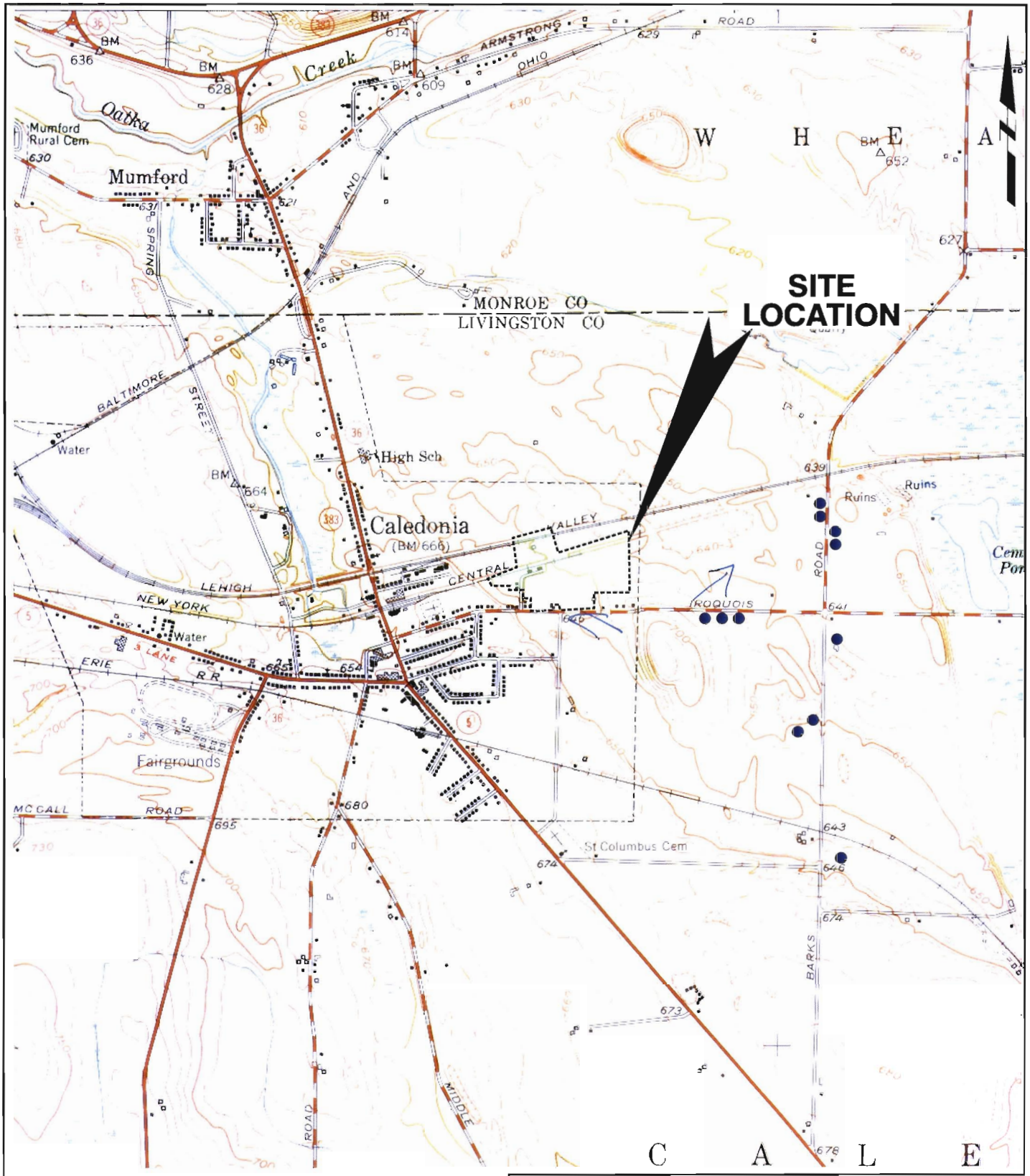
NM = not measured because equipment malfunction

NR = not reported

NTU = nephelometric turbidity unit

pH is presented in standard units.

RE = not reported because of recording error



Source USGS Quadrangle Caledonia, New York, 1950.
Photorevised 1987.

LEGEND

- Residential wells sampled NYSDOH, 1996.

0 2000 FEET

JCI Jones Chemicals, Inc. - Superfund Site

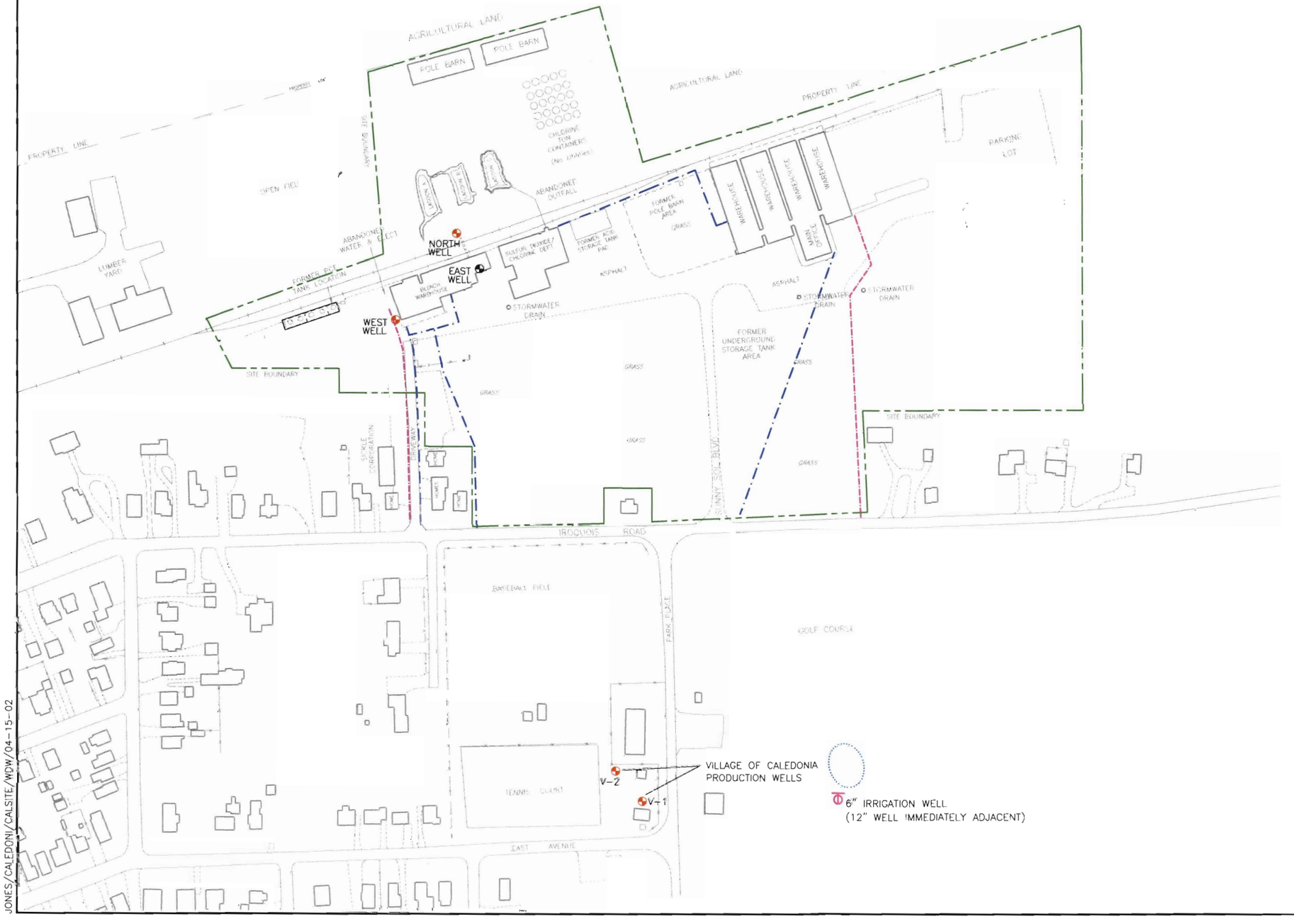
Site Location Map
Caledonia, New York

LFR
LEVINE · FRICKE

Project No 3165.02

Figure 1

ARC\GRACH\JONES\3165SITEWD\WO4-23-02



JONES/CALEDONI/CALSITE/MDW/04-15-02

LEGEND

- Production wells
- Former production well
- Irrigation well
- Current water line
- Current gas line
- Site boundary
  JCI Jones Chemicals, Inc.

Note: White house and shed were razed in 1998.

N

0 240 FEET

1" = 240'

JCI Jones Chemicals, Inc. – Superfund Site

Site Map

Caledonia, New York

LFR LEVINE•FRICKE

Project No. 3165.02

Figure 2

JONES/CALEDONI/CALSITE/WDW/04-23-02

LEGEND

- Monitoring well–Bedrock
- Monitoring well–Overburden
- Production well
- Former production well
- Irrigation well
- Site boundary
  Jones Chemicals, Inc.
- Direct–Push sample locations

Note: Monitoring Wells and Direct–Push points were installed for the RI Phase (LFR 1999).

N

0 240 FEET

1" = 240'

JCI Jones Chemicals, Inc – Superfund Site

Site Map With Monitoring Well Locations and Direct-Push Sample Locations Caledonia, New York

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Project No. 3165.02

Figure 3

WESTERN BOUNDARY | FORMER SOLVENT TANK LOCATION | WEST WELL | BLEACH WAREHOUSE | SULFUR DIOXIDE/ CHLORINE DEPT. | FORMER DRUM STORAGE AREA | WAREHOUSE/ OFFICE BUILDING | FORMER AGWAY PROPERTY

WEST — EAST

OP-12 DP-4 DP-3 DP-2 DP-1 OP-16 OP-11 OP-8 BP-4 WEST WELL NORTH WELL PZ-1 DP-5 OP-6 BP-5 OP-10 BP-6 OP-14

DEPTH BELOW GROUND SURFACE IN FEET

ELEVATION ABOVE MEAN SEA LEVEL IN FEET

0 650
10 640
20 630
30 620
40 610
50 600
60 590
70 580
80 570
90 560
100 550
110 540
120 530

(170) (330,000) (110) (120) (180) (7,100) (270) (260) (3) [1.6] (5,500) [298] (79) [13.7] (16) [0.9] (140) [35.6] (7.2) (22) [67.6] (8) [DRY] (6) [3.4] (1,600) (4.5) (20) (74) (3,300) (23) (32,000) [2,080] (<5) (340) [207] (5,800) (2) [2.9] (16) (2) (<0.5) [<1] (<0.5) [<1]

Gravel–Sand–Silt Mixture

Gravelly Silt

Weathered Bedrock

Dolomite Bedrock

Silty Sand With Gravel

LEGEND

- Gravel–Sand–Silt mixture
- Gravelly–Silt
- Silty Sand with Gravel
- Weathered Bedrock
- Bedrock (Dolomite)
- Screen interval and/or open hole
- Depth interval of soil sample

(7.2) April 1998 Tetrachloroethene (PCE) Concentration (µg/l)

[3.4] January 2002 Tetrachloroethene (PCE) Concentration (µg/l)

µg/l Micrograms per liter

<5 – Below detection limit; value shown is the detection limit.

N

0 200 FEET

APPROXIMATE HORIZONTAL SCALE

VERTICAL SCALE AS SHOWN

JONES/CALEDONI/XSECTJ/WDW/04-15-02

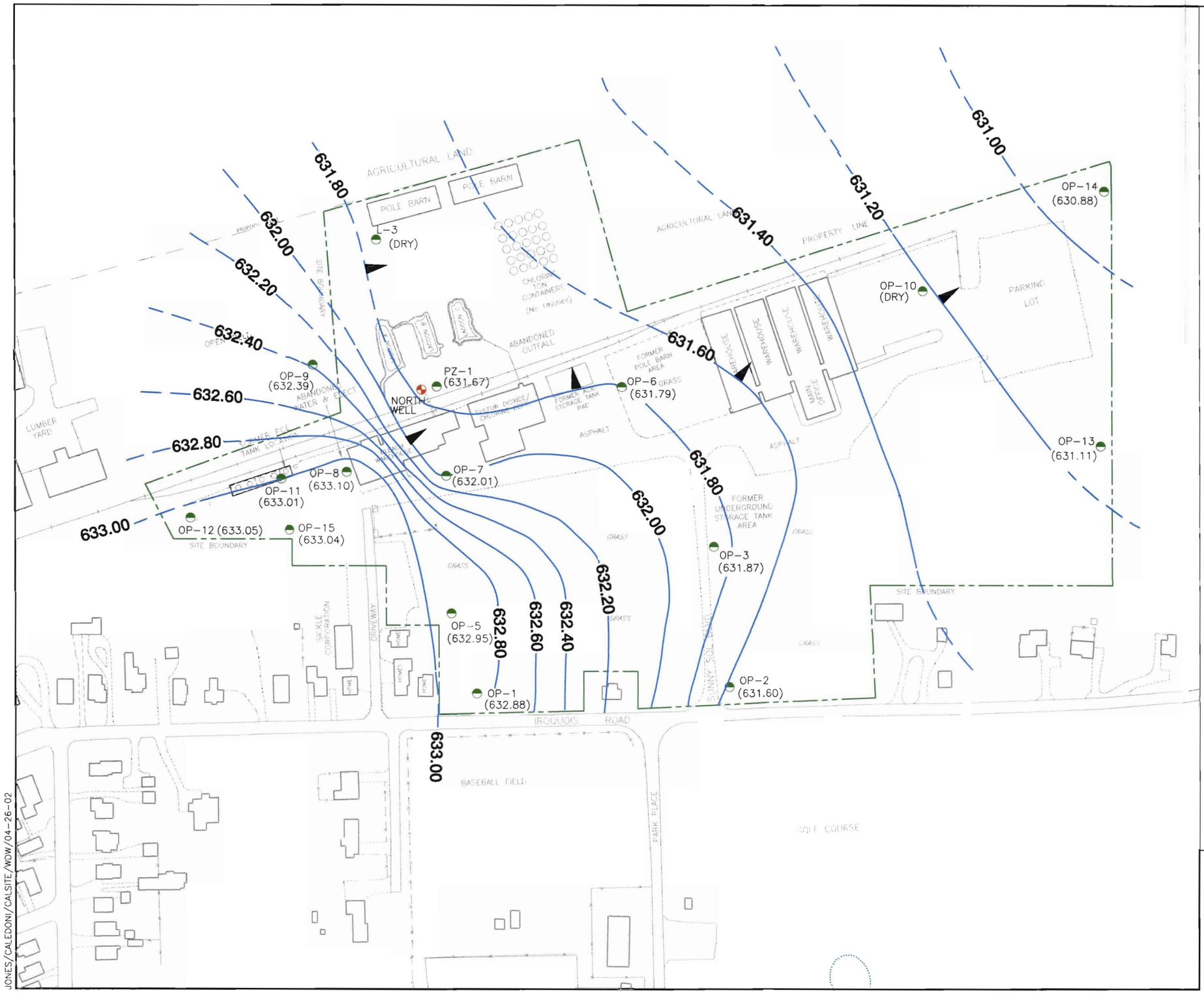
JCI Jones Chemicals, Inc. – Superfund Site

Generalized East-West Geologic Cross Section
Caledonia, New York

LFR LEVINE-FRICKE

Project No. 3165.02

Figure 4



JONES/CALEDONI/CALSITE/WDW/04-26-02

LEGEND

- Site boundary — Jones Chemicals, Inc.
- Monitoring well–Overburden
- (633.04) Groundwater elevation (FT NGVD)
- 633.00 Groundwater elevation contour Contour Interval = 0.20 Foot Dashed Denotes Inferred Contour (FT NGVD)
- NGVD National Geodetic Verticol Datum
- Groundwater flow direction

Notes: 1.) Pumping well (North Well) Groundwater Level Not Included.

2.) North Well pumping at approx. 300 gpm 24 hours/day, 7 days/week.

N

0 200 FEET

1" = 200'

JCI Jones Chemicals, Inc – Superfund Site

Groundwater Elevation Contour Map, Overburden Monitoring Wells January 7, 2002 Caledonia, New York

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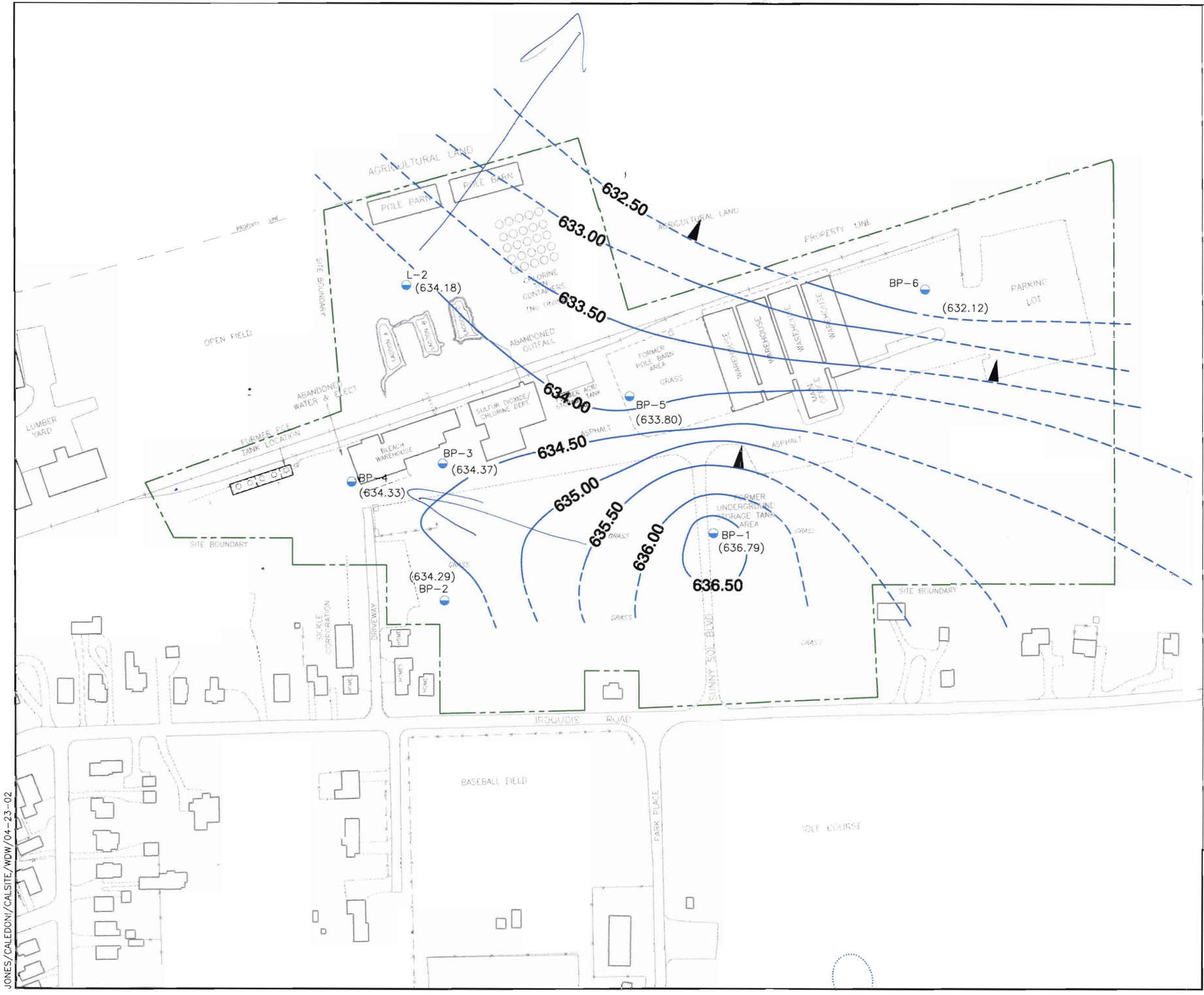
Project No. 3165.02

Figure 5



LEGEND

- Site boundary Jones Chemicals, Inc.
- Monitoring well--Bedrock
- (631.12) Groundwater elevation (FT NGVD)
- 632.50 Groundwater elevation contour Contour Interval = 0.50 Foot Dashed Denotes Inferred Contour (FT NGVD)
- NGVD National Geodetic Vertical Datum
- Groundwater flow direction

0 200 FEET

1" = 200'

JCI Jones Chemicals, Inc – Superfund Site

Groundwater Elevation Contour Map, Bedrock Monitoring Wells January 7, 2002 Caledonia, New York

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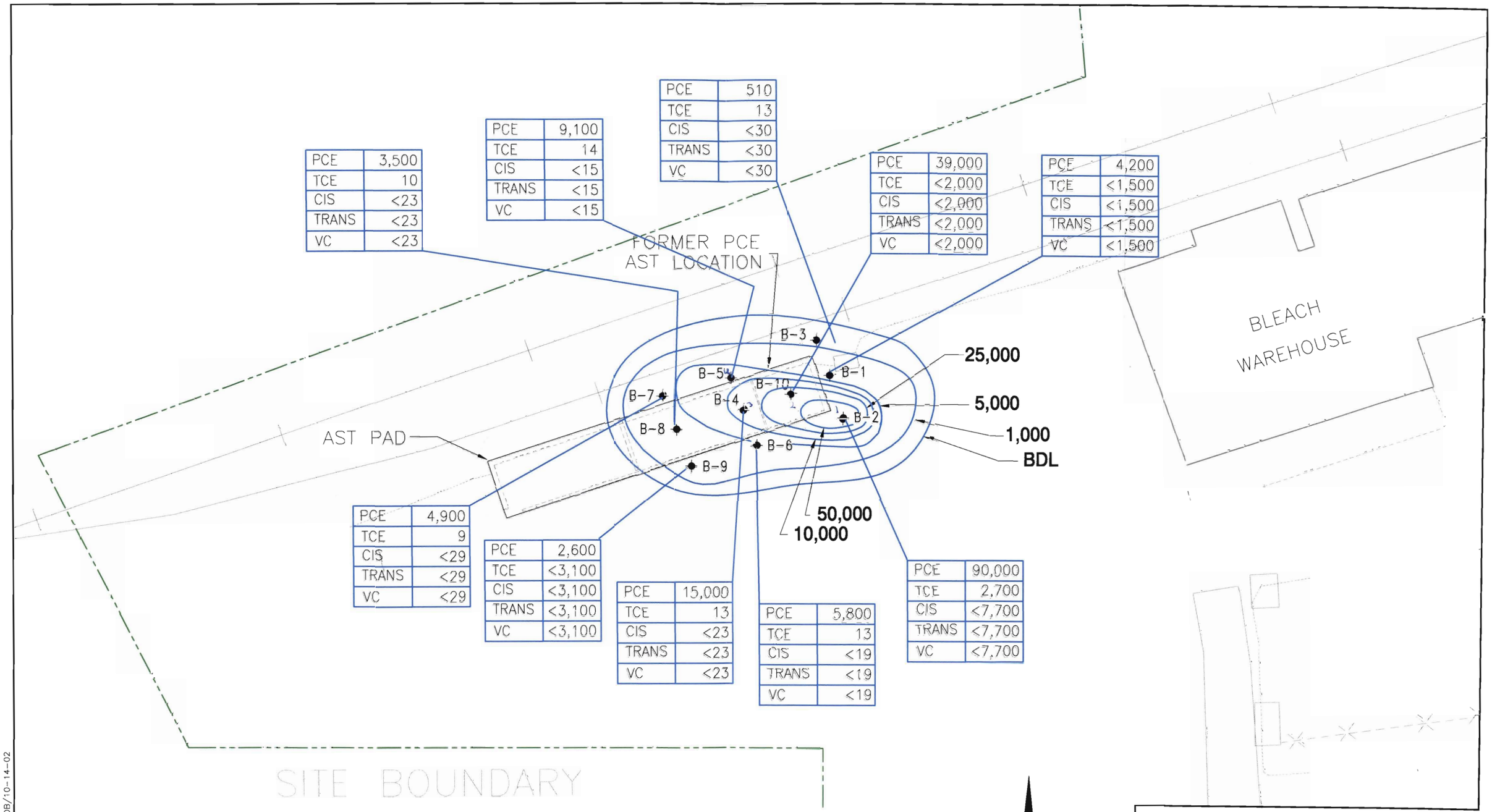
Project No. 3165.02

Figure 6

JONES/CALEDONI/CALSITE/WDW/04-23-02



JONES/CALEDONI/CALSITE/WDB/10-14-02

JCI Jones Chemicals, Inc – Superfund Site

Isoconcentration Map of PCE
Supplemental Soil Sampling
January 7-10, 2002
Caledonia, New York

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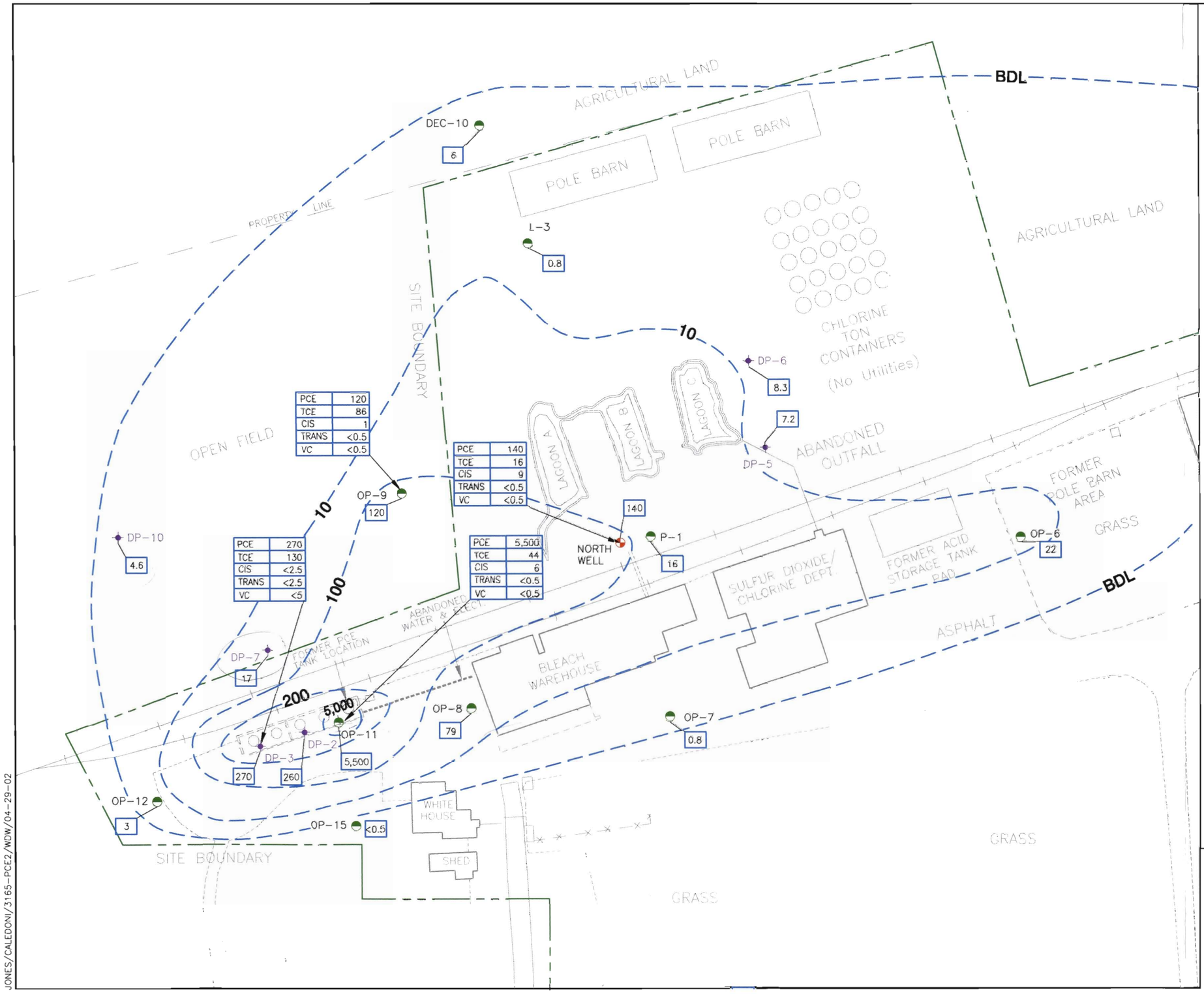
Project No. 3165.02

Figure 7



JONES/CALEDONI/3165-PCE2/WDW/04-29-02

LEGEND

- Site boundary, JCI Jones Chemicals, Inc.
- Monitoring well–Overburden
- Production well
- Direct–Push sample location
- PCE — Tetrachloroethene
- 22 — PCE Concentration (µg/l)

PCE	Tetrachloroethene (µg/l)
TCE	Trichloroethene (µg/l)
CIS	Cis–1,2–Dichloroethene (µg/l)
TRANS	Trans–1,2–Dichloroethene (µg/l)
VC	Vinyl Chloride (µg/l)

- 10 — PCE inferred isoconcentration contour (µg/l)
- µg/l — Micrograms per liter
- BGS — Below ground surface
- BDL — Below detection limit
- <1 — Value shown is the detection limit

Notes: Shallow monitoring wells are between 20 and 25 feet in total depth. Direct–push points sampled between 17 and 20 feet bgs.

0 100 FEET

1" = 100'

JCI Jones Chemicals, Inc – Superfund Site

Isoconcentration Map of PCE in Groundwater, 17 - 25 Feet BGS, August 17 - 22, 1998
Caledonia, New York

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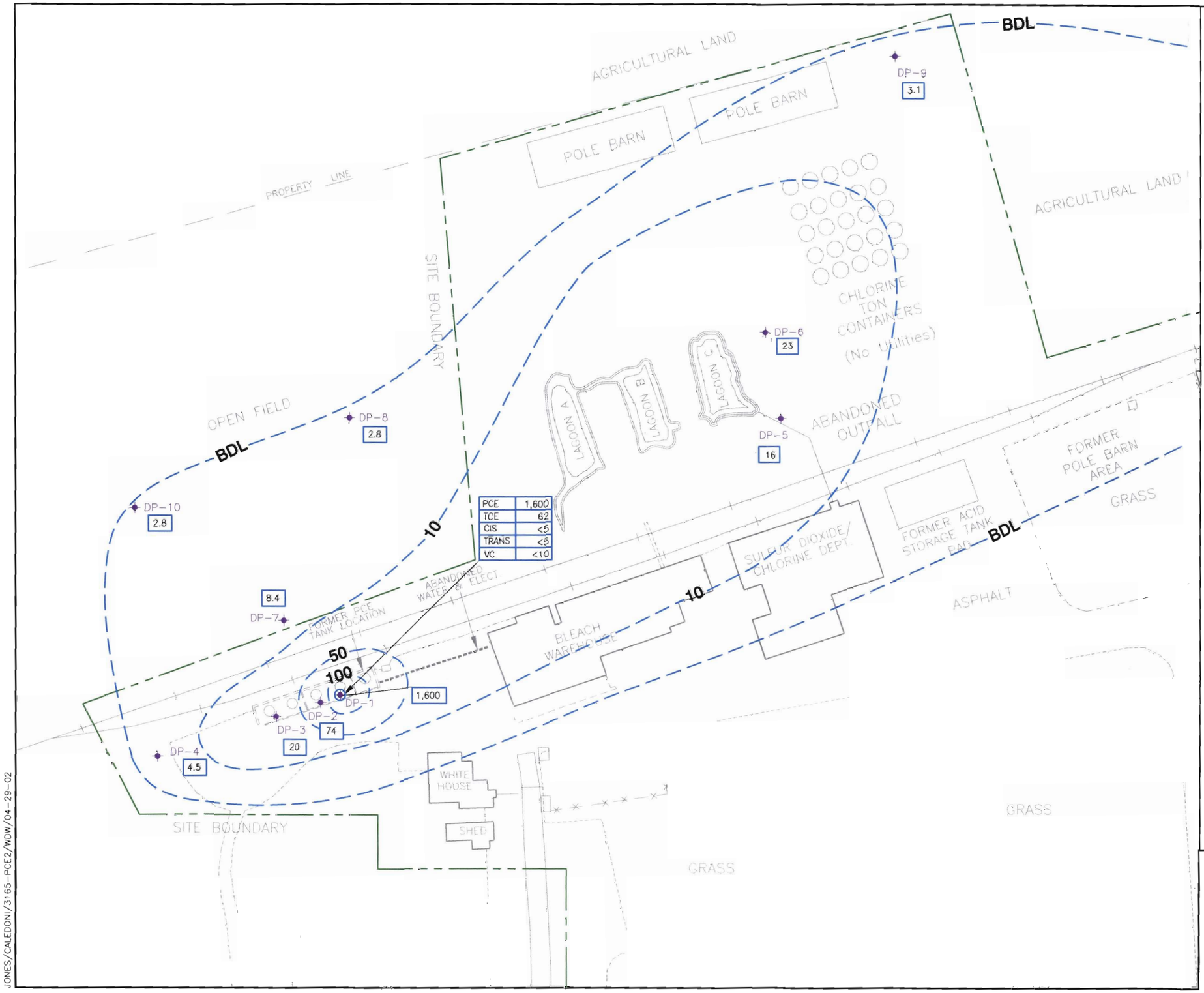
Figure 8

Project No. 3165.02



JONES/CALEDONI/3165-PCE2/WDW/04-29-02

LEGEND

- Site boundary — JCI Jones Chemicals, Inc.
- Direct-Push sample location
- PCE — Tetrachloroethene
- 1.8 — PCE Concentration (µg/l)

PCE	Tetrachloroethene (µg/l)
TCE	Trichloroethene (µg/l)
CIS	Cis-1,2-Dichloroethene (µg/l)
TRANS	Trans-1,2-Dichloroethene (µg/l)
VC	Vinyl Chloride (µg/l)

- 10 — PCE inferred isoconcentration contour (µg/l)
- µg/l — Micrograms per liter
- BGS — Below ground surface
- BDL — Below detection limit
- <1 — Value shown is the detection limit

Note: Direct-push points sampled between 27 and 30 feet bgs.

0 100 FEET
1" = 100'

JCI Jones Chemicals, Inc – Superfund Site

Isoconcentration Map of PCE in Groundwater, 27 - 30 Feet BGS, August 17 - 20, 1998 Caledonia, New York

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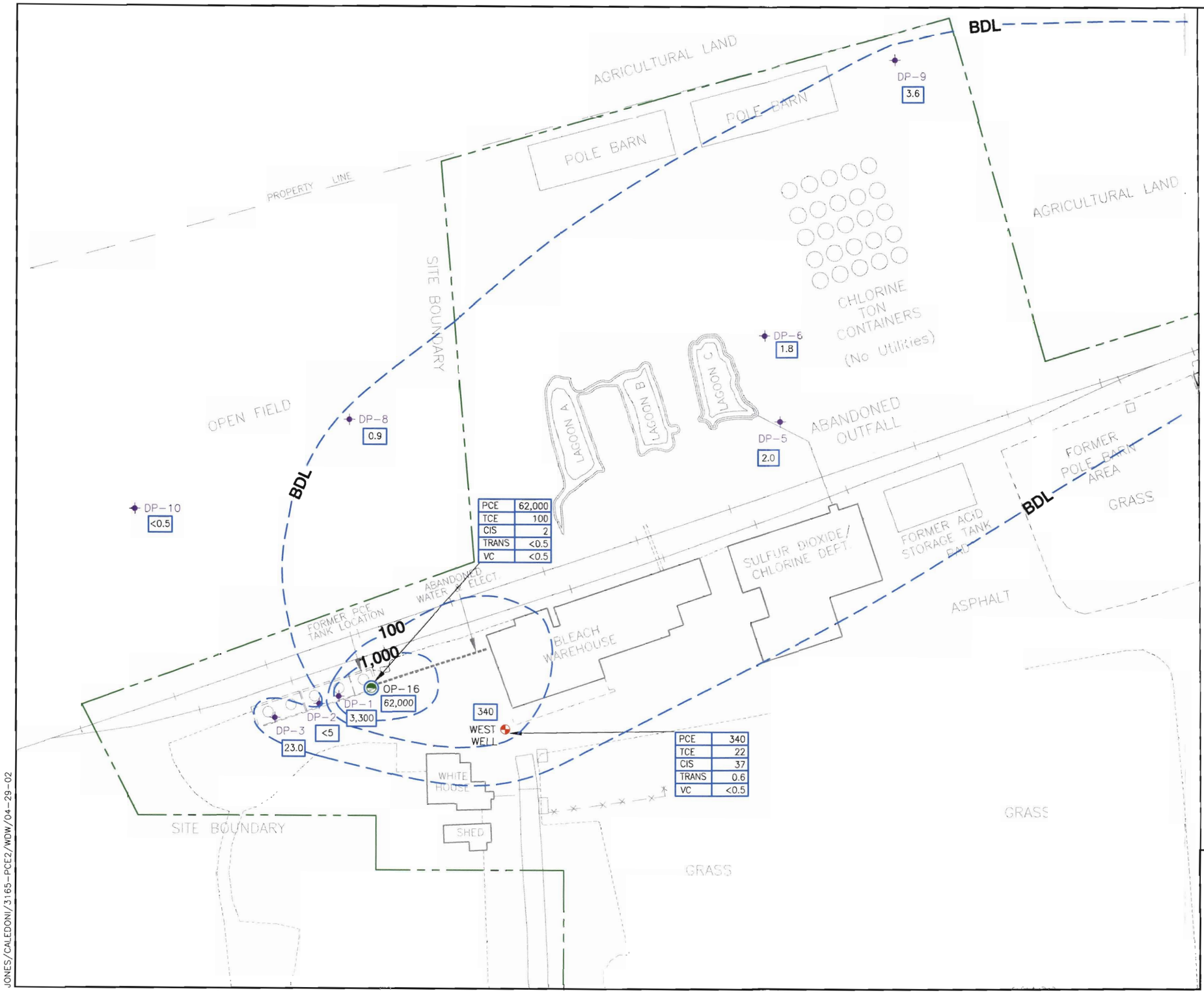
Project No. 3165.02

Figure 9



JONES/CALEDONI/3165-PCE2/WDW/04-29-02

LEGEND

- Site boundary JCI Jones Chemicals, Inc.
- Monitoring well-Overburden
- Production well
- Direct-Push sample locations
- PCE — Tetrachloroethene
- 1.8 — PCE Concentration (µg/l)

PCE	Tetrachloroethene (µg/l)
TCE	Trichloroethene (µg/l)
CIS	Cis-1,2-Dichloroethene (µg/l)
TRANS	Trans-1,2-Dichloroethene (µg/l)
VC	Vinyl Chloride (µg/l)

- 10 — PCE inferred isoconcentration contour (µg/l)

µg/l	Micrograms per liter
BGS	Below ground surface
BDL	Below detection limit
<1	Value shown is the detection limit

Note: OP-16 is 44 feet in total depth and West Well is 48.3 feet in total depth.
Direct-push points sampled between 35 and 40 feet bgs.

0 100 FEET
1" = 100'

JCI Jones Chemicals, Inc – Superfund Site

Isoconcentration Map of PCE in Groundwater, 35 - 48 Feet BGS, August 17 - 21, 1998
Caledonia, New York

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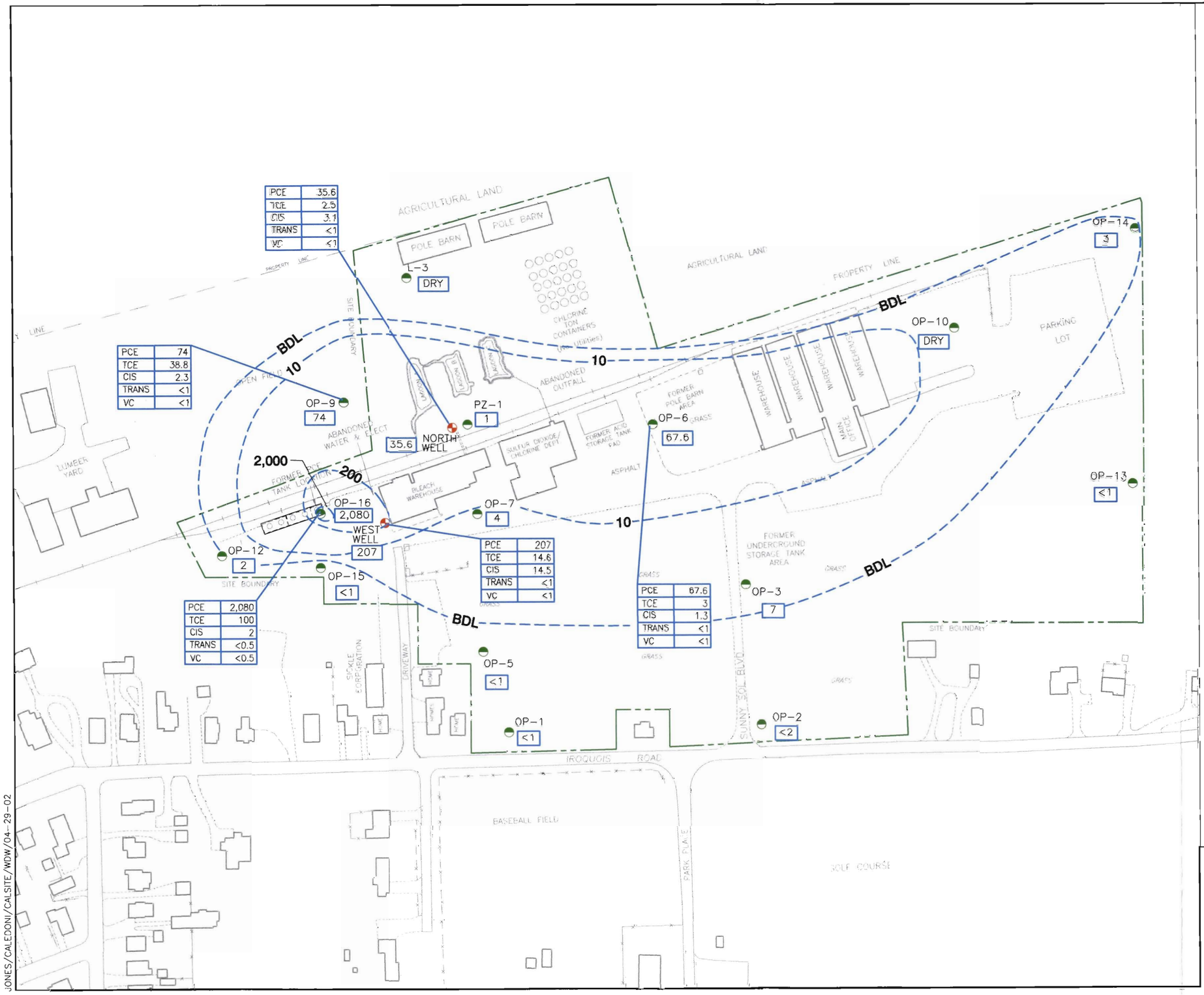
Figure 10

Project No. 3165.02



JONES/CALEDONI/CALSITE/WDW/04-29-02

LEGEND

- Site boundary Jones Chemicals, Inc.
- Production well
- Monitoring well–Overburden
- PCE — Tetrachloroethene
- 2 — PCE Concentration (µg/l)
- PCE — Tetrachloroethene (µg/l)
- TCE — Trichloroethene (µg/l)
- CIS — Cis–1,2–Dichloroethene (µg/l)
- TRANS — Trans–1,2–Dichloroethene (µg/l)
- VC — Vinyl Chloride (µg/l)
- 200 — PCE inferred isoconcentration contour (µg/l)
- µg/l — Micrograms per liter
- BDL — Below Detection Limits
- <1 — Value shown is the detection limit

Notes: 1.) OP–16 and West well are screened in the lower portion of the overburden/uppper bedrock zones.

2.) The concentration for OP–10 was 8 µg/l on August 19, 1999.

0 200 FEET

1" = 200'

JCI Jones Chemicals, Inc – Superfund Site

Isoconcentration Map of PCE in Groundwater, Overburden Monitoring Wells January 7, 2002 Caledonia, New York

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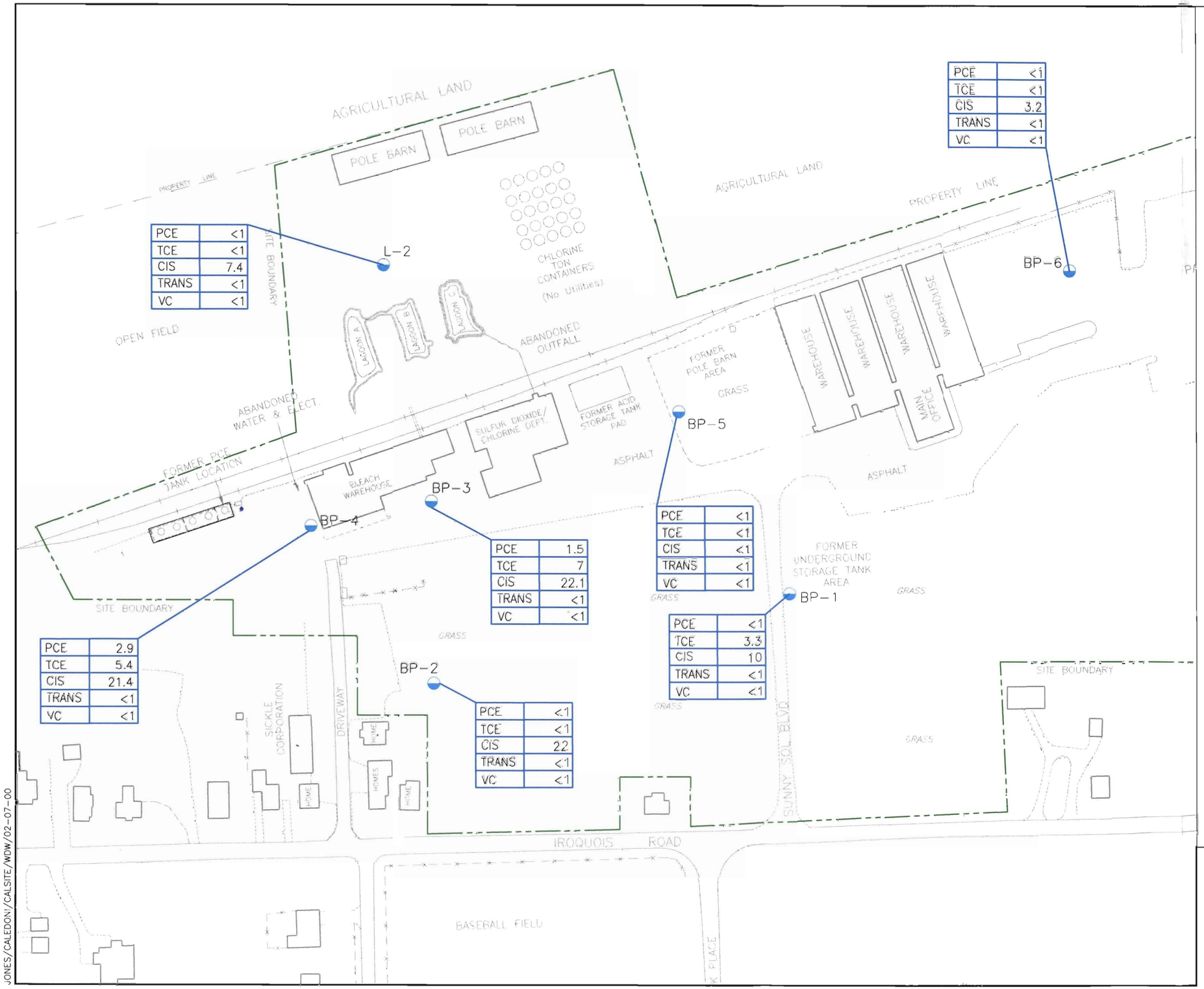
Project No. 3165.02

Figure 11



JONES/CALEDON1/CALSITE/WDW/02-07-00

LEGEND

Site boundary
Jones Chemicals, Inc.

Monitoring well-Bedrock

PCE	Tetrachloroethene (µg/l)
TCE	Trichloroethene (µg/l)
CIS	Cis-1,2-Dichloroethene (µg/l)
TRANS	Trans-1,2-Dichloroethene (µg/l)
VC	Vinyl Chloride (µg/l)

BDL Below Detection Limits

<1 Value shown is the detection limit

µg/l Micrograms per liter

N

0 150 FEET
1" = 150'

JCI Jones Chemicals, Inc – Superfund Site

Distribution of Chlorinated Solvents in Bedrock Monitoring Wells
February 7, 2002
Caledonia, New York

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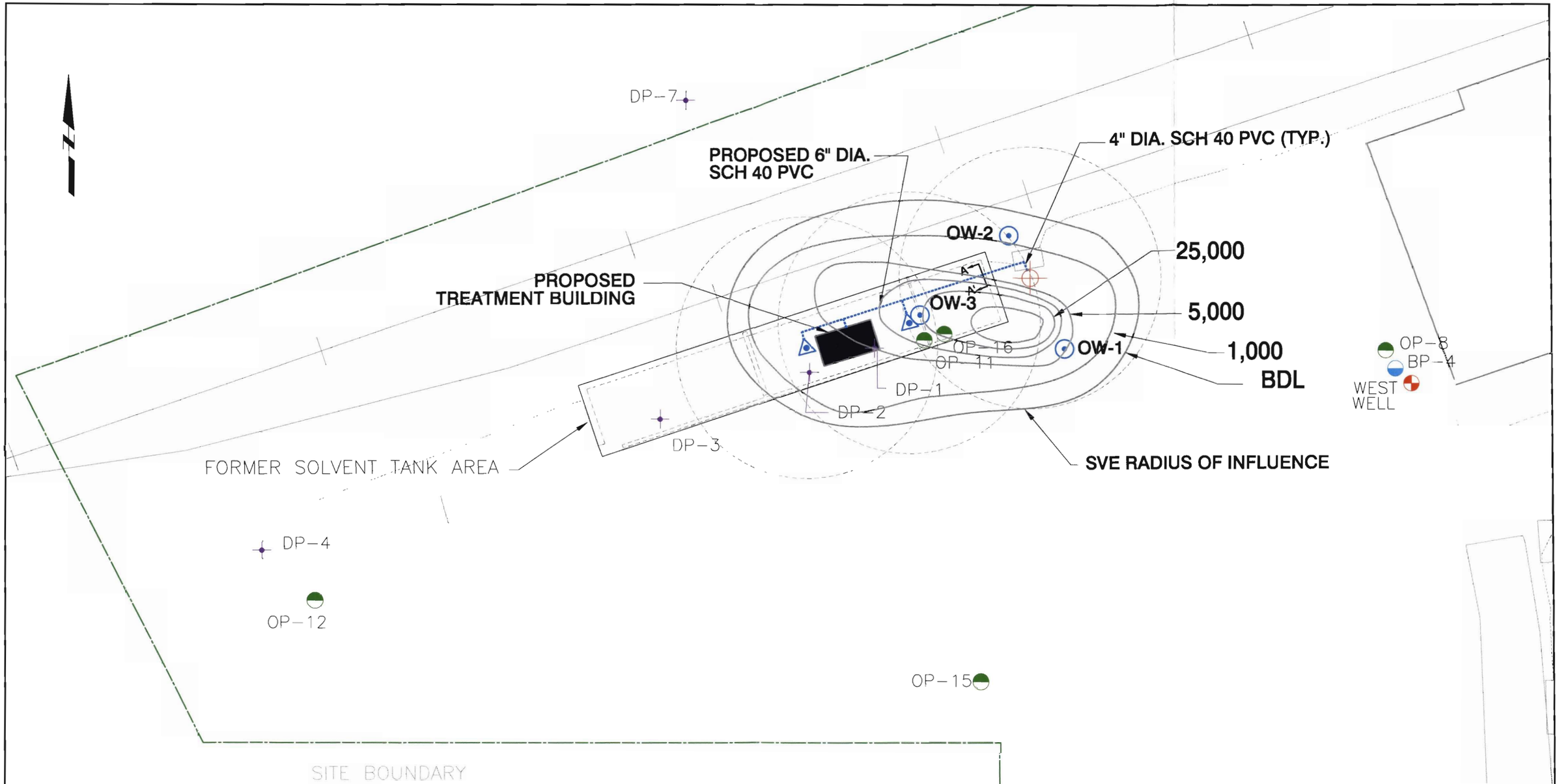
Project No. 3165.02

Figure 12



L E G E N D

- Monitoring well-Bedrock
- Shallow Monitoring well
- Production well
- Direct-Push sample locations
- Existing Extraction well
- Proposed Extraction well
- OW-1 Existing Vapor Observation well
- 1,000 PCE isoconcentration contour (µg/kg)

0 30 FEET
1" = 30'

JONES/CALEDONI/CALSITE/WDB/10-14-02

JCI Jones Chemicals, Inc – Superfund Site

SVE Extraction Well Location and Radius of Influence Map Caledonia, New York

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Project No. 3165.02

Figure 13

Arcgrach\jones\fig14iwdb\04-23-02

JCI Jones Chemicals, Inc. - Superfund Site

Groundwater Extraction Well Location Map
Caledonia, New York

LFR LEVINE • FRICKE

Figure 14

Project No. 3165.02

Appendix A

Construction Quality Assurance Project Plan

Construction Quality Assurance Project Plan
JCI Jones Chemicals, Inc. Superfund Site
Caledonia, New York

April 30, 2002
004-03165-02-005

Prepared for
JCI Jones Chemicals, Inc.
100 Sunny Sol Boulevard
Caledonia, New York 14423

Prepared by
LFR Levine·Fricke Inc.
3382 Capital Circle, N.E.
Tallahassee, Florida 32308-8702

CONTENTS

Page

FIGURE

1.0 INTRODUCTION

This Construction Quality Assurance Project Plan (CQAPP) is an integral component of the remedial measures being undertaken at the Site. The purpose of this document is to provide a written construction quality assurance (CQA) plan that identifies steps that will be used to monitor and document the quality of materials and the condition and manner of their installation. The CQA plan helps to ensure proper structural stability and integrity of all unit components, and proper construction of all units. The CQAPP procedures will be followed to ensure that the remedial construction activities at the Site comply with the approved design.

The CQAPP presents quality assurance procedures for the remedial construction of the following:

- an SVE system to treat the affected soils in unsaturated zone beneath the former solvent tank area
- a groundwater extraction system in the source area beneath the former solvent tanks area
- modification of the existing air stripper tower to treat the extracted groundwater
- a chemical oxidation system to treat potential DNAPLs, if present in the source area

A construction quality assurance (CQA) report will prepared and submitted along with the Remedial Action Reports for Elements I and II. The report will describe the construction quality procedures and provide documentation of relevant testing and construction observations.

1.1 Construction Quality Assurance Objectives

The CQA objectives for the Site include the following:

- assurance that the Remedial Subcontractor and other parties involved have a clear understanding of the design objectives
- verification that materials required are provided in accordance with the approved design
- verification that the various components of remedial system are installed in accordance with approved design
- maintenance of photographic logs, audit reports, and CQA reports as documentation that the quality of the remedial construction satisfies the requirements of the approved design

1.2 Definitions

Quality Assurance refers to a planned and systematic pattern of all means and actions designed to provide adequate confidence that material meet design and regulatory requirements and will perform satisfactorily.

Quality Control refers to those actions that provide a means to evaluate and measure the characteristics (quality) of materials and services as per the design requirements.

1.3 Design Documents

This section describes the procedures for controlling the receipt, processing and distribution of design documents, including revisions to these documents in the form of field changes. These procedures ensure that project personnel and subcontractors use the correct design document revision.

1.3.1 General Requirements

The General Contractor (GC) is defined as the general contractor awarded the remediation contract by JCI or its consultant LFR. The GC will identify the current revision of drawings, specifications, and other design documents prepared for the Site. It is the responsibility of the GC to receive, control, and distribute to his subcontractors the design documents and design document changes.

Through this CQAPP, a system for the receipt, control, and distribution of design documents, including contract drawings and specifications, as-built drawings, subcontractor submittals, and requests for information, is established.

The GC is responsible for design documents control in the field. As appropriate, three files will be maintained on site showing:

- master set (original contract drawings)
- current construction drawings
- drawings annotated to reflect as-built conditions

The GC is responsible for maintaining, on a day-to-day basis, complete set of contract drawings representing as-built conditions. The GC reviews all as-built drawings. All as-built data are stamped or marked as built and initialed by the GC and cosigned by the PRP's Project Manager (PM).

Revisions will be generally as follows:

- Revisions to design will be made in red ink.
- Deletion to/or non-completed work will be made in pencil.
- All survey measurements will be provided along the survey of items including final locations and/or elevations.

Any proposed design changes by the GC (such as pumps, blowers, tanks, piping, meters, electrical components, control boxes, etc.) shall be made in writing to the PM no later than 15 days after award of the contract.

During the construction of remedial activities, the PRP's Representative field staff may make changes, provided such changes do not affect the overall integrity of the design or violate regulatory requirements. Prior to making any changes, the field staff must contact and obtain PM's approval. The PM will evaluate any potential impacts of the proposed changes with JCI and U.S. EPA (and/or its representatives) and approve/disapprove such changes.

During the construction of the system and/or based on other field conditions, the GC can propose changes that can improve the overall efficiency of the system. Such Field Change Requests will be made in writing to the PM. The GC and/or its subcontractors can propose Field Change Requests as long as they do not result in unacceptable delays. The PM will consult with JCI and U.S. EPA (and/or representatives) and may approve/disapprove the Field Change Requests.

The GC will review all submittals including that of its subcontractor's for completeness and accuracy prior to forwarding to the PM. Such drawings may include shop drawing, samples, certifications, manuals, material lists, test reports, boring logs, etc. The PM or his/her representative will review, stamp and sign-off on the submittal in a timely manner.

1.3.4 Material Control

Materials required for the constructions will be reviewed and accepted as per the specified requirements. Receipt inspection ensures that material and equipment are in conformance to the specification and purchase order requirements. The receipt inspection process generally includes (1) visual inspection, (2) marking and tagging where appropriate, (3) documentation, and (4) preparation for proper storage. All items and material are stored, handled and maintained in accordance with manufacturer/supplier requirements.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

This section describes the project organization and identifies the major parties involved. A brief description of the roles of each party is also presented. Major groups involved in the remedial action are the U.S. EPA, the PRP and its representative LFR, and the GC (including its subcontractors). These groups must interact in a timely and efficient manner to achieve the remedial objectives. Effective management is critical in ensuring efficient, timely and credible execution of the project. The project organizational chart is presented on Figure A-1.

2.1 U.S. EPA

The U.S. EPA is the federal agency overseeing the implementation of the remedial measures. U.S. EPA and/or its representative will be onsite during remedial construction to ensure regulatory compliance.

2.2 Potentially Responsible Party (PRP)

The PRP is responsible for negotiating the Consent Decree and Statement of Work with the U.S. EPA, overseeing the performance of their remedial contractor and funding the remedial construction and subsequent monitoring. The PRP is also responsible for coordinating Site activities with existing site operations and address local community concerns.

JCI Jones Chemicals, Inc., Caledonia, New York (JCI) is the PRP for the Site. JCI is also the owner of the Site. The management and funding of the remedial construction and post-construction monitoring will be the ultimate responsibility of PRP. Implementation of the remedial construction at the Site will be performed through its hired environmental consultant LFR Levine·Fricke (LFR).

2.3 Remedial Contractor

The PRP's consultant, LFR, will be the remedial contractor for the Site. The PRP has entered into an agreement with LFR to initiate all activities related to the remedial construction at the Site. LFR is responsible for preparing the design for project construction and for furnishing record drawings and complete documentation to the agencies overseeing the project. LFR will also be responsible for all submittals by the subcontractors, manufacturers, and installers. LFR will schedule and coordinate the required work with the GC, manufacturers, and installers to ensure timely completion of the project. LFR's representative will be on site during key construction activities.

LFR is an environmental consulting firm qualified to perform all aspects of the remedial construction work. LFR's Project Manager and Project Engineer for the Site are listed below. The Project Engineer is a registered professional engineer in the State of New York.

Shekhar Melkote, P.G.
Project Manager
LFR Levine·Fricke (LFR)
413 Porter Road
East Longmeadow, MA 01028
(413) 525-2839

Scott Starr, P.E.
Project Engineer
LFR Levine·Fricke (LFR)
501 S. Falkenburg Road E8
Tampa, Florida 33619
(813) 661-1810

2.3.1 Project Manager

LFR's Project Manager (PM) Mr. Shekhar Melkote, P.G., will be the PRP's representative for the project and will have the general responsibility of assuring that the remedial construction activities are conducted in accordance with the U.S. EPA approved design. The PM in coordination with the PRP will select the GC and award the construction work. The PM or his designee will interface with the GC regarding daily operations and compliance with the approved design plans. The PM responsibilities typically include the following:

- Ensure that the remedial construction activities are conducted in accordance with the U.S. EPA approved design and plans.
- Coordinate remedial construction activities and document submittals with the Project Engineer.
- Ensure that the project scope and objectives are defines and that procedures, schedules, budgets, and resources are established.
- Establish project procedures and protocols, instructions, lines of communication, controls, and reporting requirements.
- Manage project scope, safety requirements, schedule, cost and quality, and taking corrective actions where necessary.
- Propose alternate methods, if necessary, to the Project Engineer.
- Review and discuss design changes with U.S. EPA, PRP, and other affected parties. Subsequently accept or reject design changes with appropriate documentation.
- Review all project-related data and documents, and submittals to regulatory agencies.

2.3.2 Project Engineer

The Project Engineer Mr. Scott Starr, P.E. will be responsible for the design content of the remedial construction. The Project Engineer or his representative will assist the PM in coordinating field activities related to the construction and will be present on onsite to observe the construction and startup of the remedial system.

The Project Engineer is responsible for reviewing all drawings including the daily as-built drawings and reporting any deviations from the approved design. The Project Engineer is a licensed New York State professional engineer.

2.3.3 CQA Officer

LFR's Project Engineer Mr. Scott Starr, P.E. will act as the CQA Officer for the remedial construction. Mr. Starr has sufficient practical, technical, communication and managerial skills to successfully oversee and implement CQA activities. The following list some of the specific responsibilities of the CQA officer:

- Review or request peer review of the design documents and specifications for completeness and accuracy.
- Verify that remedial construction materials meet design requirements.
- Schedule and coordinate CQA inspection activities.
- Conduct onsite inspection of construction work to ensure compliance with design documents, plans, and other regulatory requirements.
- Maintain CQA inspection logs.
- Coordinate selection of the GC and review all submittals made by the GC.
- Provide the PM with periodic CQA reports.

2.4 Communication

Project meetings will be held regularly to achieve a high degree of quality during construction and to ensure the end product meets the overall design requirements. Periodic meetings will help all parties understand their roles and responsibilities and resolve any problems that may arise.

2.4.1 Pre-construction Meeting

Prior to the start of any construction activity, a pre-conference meeting between PRP, LFR and GC will be held. At a minimum the PM, Project Engineer and the GC's representative will participate in the meeting. The general purpose of the pre-conference meeting is to discuss the responsibilities of each party such that their role is clearly understood. General topics may include review of project documents, any revisions or modifications to the approved design, proposed construction startup date,

and safety issues. The U.S. EPA will be notified of the pre-construction conference to provide them with the opportunity to attend. The following is a list of potential subjects for discussion during pre-conference meeting:

- design and other pertinent project-related documents
- methods for distributing and storing of documents and reports
- health and safety requirements of onsite personnel
- CQAPP procedures and each party's role and responsibilities
- lines of authority and communication
- protocols for inspection and audits
- discussion of material control and storage

2.4.2 Progress Meeting

Progress meetings between LFR, PRP, GC and other concerned parties will held weekly or as deemed necessary to review current project status, planned activities for next two weeks, problems requiring resolution, any new developments and/or potential changes to the design. Recorded summary progress meeting notes (Section 4) become part of the construction record.

3.0 INSPECTION AND TESTING

This section describes the procedures for conducting and documenting quality verification inspections. It includes pre-construction inspections, construction inspections, and post-construction inspections. Pre-construction inspections involve certification of materials and receipt of materials prior to installation. Construction inspections involve in-process verification of installations as per the requirements. The CQA Officer will conduct a post-construction inspection as final check to ensure that the remedial systems are meeting the required specifications. Appropriate documentation of the various inspections will be required as described in Section 4.

3.1 Pre-construction activities

The CQA Officer and GC shall review the design drawings and specifications prior to starting construction. During this review process, the GC shall return the design to the PM for clarification or modification if any part of the design is deemed unclear. A pre-construction conference shall be conducted where additional questions and comments may be addressed. During this pre-construction conference, field inspection personnel will be trained by the Project Engineer to provide staff with an understanding of expected conditions, methods of construction, and the scope of plans and specifications.

3.2 Inspection Schedule

General pre-construction, construction, and post construction quality assurance requirements are discussed in the following sections. Specific quality assurance testing requirements are included on the design drawings and specifications.

3.3 Inspection/Testing Requirements

3.3.1 Drilling and Well Installation

CQA activities will include visual inspection and oversight by the CQA Officer or assigned staff during drilling and installation of the wells. The inspection will include verifying that the wells are set at the designed depths and constructed with appropriate materials in accordance with the design drawings. This will include documenting appropriate screen length, screen opening size, material specification, and well-head specifications. The CQA Officer will record these activities in daily construction notes (Section 4.2) that will become part of the construction record.

3.3.2 Trenching and Piping

The CQA activities during trenching and piping will include visual inspection to verify that the piping and backfill material is in conformance with design specifications. The CQA Officer will inspect all trenching activities to ensure trenching is conducted according to the design specifications including correct depth, width, height as well as appropriate backfill and bedding materials. After installation, the piping will be pressure tested to design specifications prior to back filling. The CQA Officer will ensure proper backfill materials are used and that compaction of trench backfill is completed in accordance with design specifications. The CQA officer will record these activities in daily construction notes (Section 4.2) that will become part of the construction record.

3.3.3 Remediation System Equipment

Visual inspection during installation and a post-construction inspection will be conducted to verify that above-grade piping, equipment, structures, and supports have not been damaged by construction activities and remain in conformance with design specifications. The GC or subcontractor will perform tests in the presence of the CQA Officer to check components of the remedial systems. The tests will be performed in accordance with manufacturer recommendations to check equipment operational performance.

The CQA Officer will inspect all components of the remediation system equipment including, but not limited to:

- Groundwater extraction pumps, valves, pressure gauges, and flow meters
- SVE equipment including blower, knock out vessel, piping, valves, electrical, and appurtenances
- Modifications of the existing air stripper tower to treat the additional extracted groundwater, including additional piping, valves, flow gauges, and appurtenances
- Chemical oxidation system including chemical supply tanks, injection pumps, flow meters, pressure gauges, and appurtenances

Subsequent to construction completion, the CQA officer will complete start-up testing of the SVE, groundwater extraction system, the groundwater treatment and discharge system, and the chemical oxidation system. System components will be adjusted to obtain optimum and continuous operating condition. The CQA Officer will record these activities in daily construction notes (Section 4.2) that will become part of the construction record.

3.4 Waste Handling

As previously approved by the U.S. EPA for the Site, wastes such as drill cuttings or drilling mud generated during the installation of SVE and recovery wells will be returned the source area. Drill cuttings containing DNAPL or visible contamination will containerized in 55-gallon drums. These drums will be staged in fenced area, labeled as hazardous waste, profiled, and disposed off-site through a licensed hazardous waste disposal subcontractor.

Liquid waste such as well development water and decontamination or rinsate water will be containerized in 55-gallon drums. The liquid waste will be treated on-site prior to discharge to the lagoon system.

4.0 DOCUMENTATION

This section describes the documentation and record keeping that will be used during the remedial construction. Appropriate documentation and record keeping is required during the construction of each critical component of the remedial system. The records and checklist provide a means for the CQA Officer in meeting the quality assurance objectives.

4.1 CQAPP Review and Approval

The Pre-Final Remedial Design report including the CQAPP is under the control of LFR and no revisions, additions or deletions may be made to the contents, except as

requested by the PRP or its representative. The PM is responsible for the distribution and control of copies of this document.

This document shall be reviewed and approved by the PM and PRP, and submitted to U.S. EPA for its review and approval. Requests for revisions shall be forwarded to the PRP and/or LFR. The PM will determine the impact of a revision on the document. If the requested revisions are extensive, the document will be completely revised and will include the appropriate revision number and date. Minor revisions will be addressed in a letter and forwarded to U.S. EPA and all other affected parties.

4.2 Daily Record keeping

The CQA Officer shall maintain a Daily Quality Assurance Summary log. These reports shall various construction activities and quality assurance evaluation. Where necessary the CQA Officer may initiate corrective action in coordination with the PM. Problem identification and appropriate corrective action measures should also be documented as discussed below.

4.2.1 Daily Quality Assurance Summary Log

The Daily Quality Assurance Summary Log include the following key items:

- date, project name, location and identification code
- weather conditions
- minutes of any meetings held
- description and location of construction underway during the time frame of the Daily Summary Log
- equipment and personnel (including GC and its subcontractors) at each location
- description of areas or components being observed or inspected
- description of offsite materials received, including quality verification (vendor certification) documentation
- record of calibrations/re-calibrations of field equipment
- decisions made regarding approval of material or construction work, and/or any corrective actions initiated as a result of quality issues
- cataloging of inspection data sheets and/or other construction related reports
- results of any field measurements
- signature of CQA Officer

4.2.2 Inspection Data Sheets

The CQA Officer maintain Inspection Data Sheets which shall include the following general information:

- description of inspection activity
- location of inspection activity
- type of inspection activity including procedure and references
- field observations including supporting calculations
- results of inspection activity including any variance from specification requirements
- personnel involved in inspection activity
- signature of CQA Officer

4.3 Corrective Action Measures

CQA Officer initiates corrective action measures when construction material or construction activities deviate from specification requirements. A brief report of corrective action measures shall be forwarded to the PM, PRP, the U.S. EPA and other affected parties. The corrective action report shall typically include the following information:

- problem identification, location and description
- probable causes of the problem
- how, when and by whom the problem was identified
- length of time that the problem existed
- recommended corrective action measures with references (if appropriate)
- outcome of corrective action measures
- signature of the CQA Officers

4.4 Photographic Documentation

The CQA Officer shall take photographs during the various phases of the remedial construction. Each photograph shall be appropriately indexed, labeled, and captioned providing the viewing location, direction, object, and date and time. The photographs will be become part of the construction record and will made available to all interested parties upon request.

4.5 Final Documentation

Upon completion of the remedial construction, the CQA Officer will prepare a CQA Certification Report. The report shall include the Daily Quality Assurance Summary Logs, Inspection Data Sheets, field observations and results, corrective action measures (if any), and photographic documentation. The report shall be included with the Remedial Action Report for each work Element I and II.

Appendix B

Weighting of Natural Attenuation Indicator Parameter Worksheets

Table B-1
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-3

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	2.81	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	4.52	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.69	reductive pathway possible	3	0
Sulfate	<20	492	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.03	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	0.014	vinyl chloride oxidizes		0
Oxidation reduction potential	<50	NM	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.27	tolerated; suppresses reductive dechlorination at higher		0
Total Organic Carbon	>20	1.07	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	11.9	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	245	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	158	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		10	material released		0
Trichloroethene		13	material released or daughter product of perchloroethene	2*	2
Dichloroethene		<1	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-1**

Table B-1
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-3

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-2
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-5

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	3.62	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	5.08	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.19	reductive pathway possible	3	0
Sulfate	<20	396	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.06	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	19.4	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.38	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.11	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	13.0	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	265	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	166	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		<1	material released		0
Trichloroethene		<1	material released or daughter product of perchloroethene material	2*	0
Dichloroethene		<1	released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-2**

Table B-2
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-5

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-3
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-6

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	5	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	4.74	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.61	reductive pathway possible	3	0
Sulfate	<20	344	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	0.010	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	104.1	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.18	tolerated range for reductive pathway		0
Total Organic Carbon	>20	2.24	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	15.8	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	250	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	174	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		359	material released		0
Trichloroethene		21.4	material released or daughter product of perchloroethene	2*	0
Dichloroethene		17.2	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane	<0.1	<0.001	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-1**

Table B-3
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-6

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-4
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-7

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	9.24	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	3.99	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0	reductive pathway possible	3	0
Sulfate	<20	612	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.1	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	95.1	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.23	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.21	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	13.2	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	190	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	182	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		4.23	material released		0
Trichloroethene		2.2	material released or daughter product of perchloroethene material	2*	0
Dichloroethene		0.58J	released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-1**

Table B-4
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-7

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

*Points awarded only if the chemical is a breakdown product.

J = estimated, below detection limit

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-5
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-8

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	9.33	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	3.11	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.04	reductive pathway possible	3	0
Sulfate	<20	663	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.2	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	133	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.49	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.14	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	11.6	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	152	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	158	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		13.7	material released		0
Trichloroethene		0.68J	material released or daughter product of perchloroethene	2*	2
Dichloroethene		1.2	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**1**

Table B-5
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-8

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

*Points awarded only if the chemical is a breakdown product.

J = estimated, below detection limit

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-6
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-9

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	2.74	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	2.18	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	1.32	reductive pathway possible	3	3
Sulfate	<20	688	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	3.5	reductive pathway possible	3	3
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	1.1	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.35	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.27	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	11	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	232	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	104	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		74	material released		0
Trichloroethene		38.8	material released or daughter product of perchloroethene	2*	2
Dichloroethene		2.3	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**8**

Table B-6
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-9

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-7
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-11

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	1.60	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	3.62	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0	reductive pathway possible	3	0
Sulfate	<20	286	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.1	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	83	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.09	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.53	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	13.9	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	283	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	168	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		292	material released		0
Trichloroethene		43.6	material released or daughter product of perchloroethene	2*	2
Dichloroethene		26.6	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane	<0.1	<0.001	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**2**

Table B-7
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-11

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-8
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-12

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	0.92	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	NA	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	0
Nitrate	<1	0.457	may compete with reductive pathway at higher concentrations	2	2
Iron (II)	>1	1.59	reductive pathway possible	3	3
Sulfate	<20	1,110	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.05	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	0.0059	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	72.8	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.55	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.16	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	11.7	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	210	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	65.7	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		1.6	material released		0
Trichloroethene		0.71J	material released or daughter product of perchloroethene	2*	2
Dichloroethene		9.8	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichlorothene, it is likely a daughter product of trichloroethene	2*	2
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**9**

Table B-8
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-12

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

*Points awarded only if the chemical is a breakdown product.

J = estimated, below detection limit

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-9
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-13

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	9.93	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	5.38	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.08	reductive pathway possible	3	0
Sulfate	<20	51.7	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.18	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	45.2	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.60	tolerated range for reductive pathway		0
Total Organic Carbon	>20	<1.00	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	12.5	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	282	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	84.5	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		<1	material released		0
Trichloroethene		<1	material released or daughter product of perchloroethene	2*	0
Dichloroethene		<1	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-2**

Table B-9
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-13

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-10
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-14

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	6.06	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	5.5	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.06	reductive pathway possible	3	0
Sulfate	<20	384	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.05	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	34.3	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.44	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.1	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	13.1	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	270	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	156	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		3.4	material released		0
Trichloroethene		1.3	material released or daughter product of perchloroethene	2*	2
Dichloroethene		<1	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane	<0.1	<0.001	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**0**

Table B-10
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-14

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-11
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-15

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	1.08	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	1.73	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.86	reductive pathway possible	3	0
Sulfate	<20	750	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	0.36	reductive pathway possible	3	0
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	100.1	reductive pathway possible	<50 = 1 <-100 = 2	0
pH	5 < pH < 9	7.50	tolerated range for reductive pathway		0
Total Organic Carbon	>20	1.52	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	10.8	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	242	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	97.4	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		<1	material released		0
Trichloroethene		<1	material released or daughter product of perchloroethene	2*	0
Dichloroethene		<1	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**-3**

Table B-11
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
OP-15

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

* Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

NA = not applicable

NM = not measured because of equipment malfunction

Table B-12
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
PZ-1

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded
Oxygen	<0.5	NA	tolerated; suppresses reductive dechlorination at higher concentrations	3	0
Oxygen	>1	11.11	vinyl chloride may be oxidized aerobically, but reductive dechlorination will not occur	-3	-3
Nitrate	<1	3.04	may compete with reductive pathway at higher concentrations	2	0
Iron (II)	>1	0.38	reductive pathway possible	3	0
Sulfate	<20	672	may compete with reductive pathway at higher concentrations	2	0
Sulfide	>1	1.1	reductive pathway possible	3	3
Methane	>0.1	NA	ultimate reductive daughter product	2	0
	>1	NA	vinyl chloride accumulates	3	NA
	<1	<0.002	vinyl chloride oxidizes		NA
Oxidation reduction potential	<50	41	reductive pathway possible	<50 = 1 <-100 = 2	1
pH	5 < pH < 9	7.58	tolerated range for reductive pathway		0
Total Organic Carbon	>20	<1.00	carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0
Temperature	>20	9.2	at temperatures above 20°C, biochemical process is accelerated	1	0
Alkalinity	>2x background	150	results from interaction of carbon dioxide with aquifer minerals	1	0
Chloride	>2x background	155	daughter product of organic chlorine; compare chloride in plume to background conditions	2	0
Perchloroethene		0.90	material released		0
Trichloroethene		<1	material released or daughter product of perchloroethene	2*	0
Dichloroethene		<1	material released or daughter product of trichloroethene; if amount of cis-1,2-dichloroethene is greater than 80 percent of total dichloroethene, it is likely a daughter product of trichloroethene	2*	0
Vinyl chloride		<1	material released or daughter product of dichloroethenes	2*	0
Ethene/Ethane		<1	daughter product of vinyl chloride/ethene	>0.01 = 2* >0.1 = 3*	0
				Total Points Awarded:	**1**

Table B-12
Weighting of Natural Attenuation Parameters
JCI Jones Chemicals, Inc.
Caledonia, New York
PZ-1

Analyte	Concentration Criteria	Concentration Detected at the Site	Interpretation	Criteria Points Awarded	Actual Points Awarded

Notes:

Score	Interpretation
0 to 5	Inadequate evidence for biodegradation of chlorinated compounds.
6 to 14	Limited evidence for biodegradation of chlorinated organics.
15 to 20	Adequate evidence for biodegradation of chlorinated organics.
Greater than 20	Strong evidence for biodegradation of chlorinated organics.

All analyses are required, with the exception of alkalinity.

All concentrations are reported in milligrams per liter, except perchloroethene, trichloroethene, dichloroethene, and vinyl chloride are in micrograms per liter, oxidation reduction potential is in millivolts against silver/silver chloride, pH is in standard units, and temperature is in degrees Celsius (°C).

The source for weighting of natural attenuation parameters is Wiedemeier, T.H. et al., 1996.

*Points awarded only if the chemical is a breakdown product.

2x background = 2 multiplied by background

> = greater than

< = below detection limit (value shown)

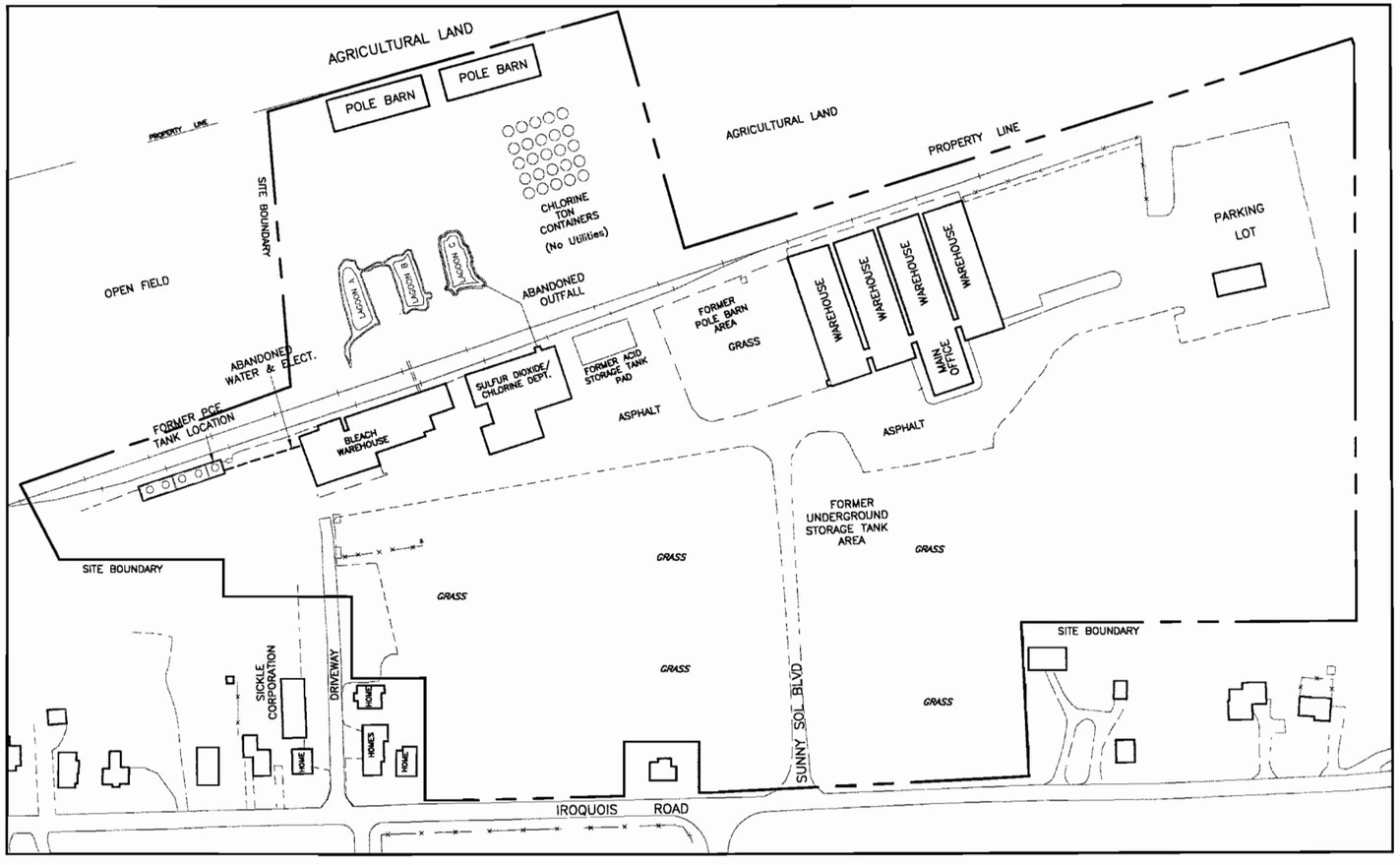
NA = not applicable

NM = not measured because of equipment malfunction

Appendix C

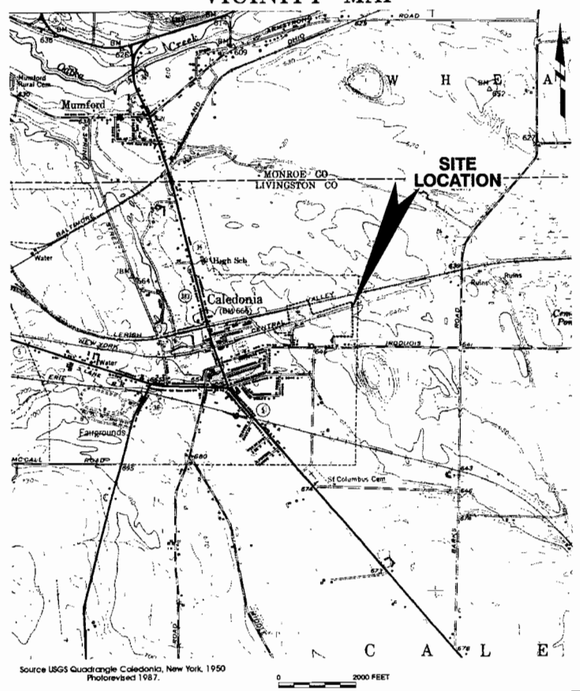
Construction Drawings and Specifications

CONSTRUCTION DRAWINGS FOR THE REMEDIAL WORK ELEMENT I (SOIL VAPOR EXTRACTION) AND REMEDIAL WORK ELEMENT II (PUMP AND TREAT, AND IN-SITU CHEMICAL OXIDATION)



JCI JONES CHEMICALS, INC.
SUPERFUND SITE
100 SUNNY SOL BOULEVARD
CALEDONIA, NEW YORK

VICINITY MAP



Source USGS Quadrangle Caledonia, New York, 1950 Photorevised 1987.

INDEX OF DRAWINGS

LFR LEVINE·FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Title Sheet
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE NTS
DATE 04-30-02
PROJECT NO. 3165.02
SHEET 1 OF 11

CADARC\JONES\CALEDONIA\3165COVER\WDB\04-30-02

GENERAL NOTES

1. CONTRACTOR RESPONSIBLE FOR OBTAINING AND COMPLYING WITH ALL REQUIRED PERMITS INCLUDING, BUT NOT LIMITED TO, CONSTRUCTION AND ELECTRICAL ACTIVITIES. CONTRACTOR EXPECTED TO COMPLY WITH APPLICABLE LOCAL, STATE, AND FEDERAL REGULATIONS.
2. CONTRACTOR RESPONSIBLE FOR COMPLIANCE WITH THE LATEST NATIONAL ELECTRIC CODE (NEC) NFPA 70, NFPA 30 AND 30A AND APPROPRIATE CITY, COUNTY, STATE, AND FEDERAL ELECTRICAL CODES.
3. CONTRACTOR RESPONSIBLE FOR PROVIDING SAFE ACCESS TO SITE AT ALL TIMES.
4. CONTRACTOR RESPONSIBLE FOR PROVIDING LIGHTED BARRICADES AND OTHER SAFETY EQUIPMENT AS NECESSARY TO PROTECT THE PUBLIC 24 HOURS A DAY DURING CONSTRUCTION. BARRICADES TO BE IN ACCORDANCE WITH MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS (MUTCD), FEDERAL HIGHWAY ADMINISTRATION (FHA).
5. CONTRACTOR ACCEPTS LIABILITY AND IS RESPONSIBLE FOR REPAIR AS NECESSARY TO ORIGINAL CONDITION OF ANY AND ALL DAMAGED UTILITIES, STRUCTURES, PAVEMENT, CURBS, AND VEGETATED AREAS; VEGETATED AREAS TO INCLUDE TREES, SHRUBS, AND GRASS.
6. CONTRACTOR TO CLEAN SITE TO ORIGINAL CONDITION, ACCEPTABLE TO THE ENGINEER.
7. CONTRACTOR'S WORKERS SHALL CONFORM WITH OSHA REGULATIONS CFR 29, PART 1910: 120, HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE.
8. THE FOLLOWING IS A LIST OF MATERIALS AND EQUIPMENT FOR WHICH MANUFACTURER'S OR SUPPLIER'S DATA SHEETS MUST BE SUBMITTED PRIOR TO COMMENCEMENT OF WORK:

   CONCRETE
   PIPING AND VALVES
   APPURTENANCES
   ANCHOR BOLTS AND GROUTING SYSTEMS FOR PIPING SUPPORTS
   PIPE SUPPORTS
   MODULAR BUILDING DESIGN LOADS

9. OUTSIDE WORK TO BE PERFORMED DURING NORMAL BUSINESS HOURS (7:00am - 5:00pm, MONDAY THROUGH FRIDAY) UNLESS SPECIFIC WRITTEN APPROVAL IS GIVEN BY THE ENGINEER. INSIDE WORK WILL BE CONDUCTED AFTER NORMAL BUSINESS HOURS. CONTRACTOR TO COORDINATE WITH OWNER AND ENGINEER TO CONDUCT INSIDE WORK.
10. ALL WORK UNDER THIS CONTRACT SHALL BE PERFORMED IN A MANNER WHICH DOES NOT DISRUPT THE OWNERS' NORMAL BUSINESS ACTIVITIES.
11. CONTRACTOR MUST PREPARE A SITE SPECIFIC HEALTH AND SAFETY PLAN.
12. CONTRACTOR TO PROVIDE RESTROOM FACILITY DURING CONSTRUCTION ACTIVITIES

ELECTRICAL

1. ALL ABOVEGROUND ELECTRICAL EQUIPMENT AND APPURTENANCES TO BE HOUSED IN GALVANIZED AND FLEX CONDUIT MEETING REQUIREMENTS IN NO. 2, GENERAL NOTES.
2. CONTRACTOR TO SUBMIT PROPOSED ELECTRICAL LAYOUT FOR EQUIPMENT AND APPURTENANCES TO ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION.
3. CONTRACTOR TO SUBCONTRACT WITH LOCAL POWER COMPANY OR ELECTRICIAN TO PROVIDE 460 VOLT THREE PHASE AND 110/220 VOLT SINGLE PHASE SERVICE. CONTRACTOR RESPONSIBLE FOR PROVIDING CORRECT AMPERAGE REQUIRED FOR EQUIPMENT SPECIFIED IN THE SVE TREATMENT BUILDING.
4. CONTRACTOR RESPONSIBLE FOR PROVIDING ALL ELECTRIC APPURTENANCES ASSOCIATED WITH POWER SERVICE, INCLUDING, BUT NOT LIMITED TO, POWER POLE, METER BOX, AND BREAKER BOX. CONTRACTOR TO PROVIDE LOCKABLE ON/OFF SWITCH ON POWER POLE.
5. CONTRACTOR TO INSTALL LOCKING LOCAL DISCONNECT ON/OFF SWITCHES TO ALL ELECTRICAL APPURTENANCES WITHIN COMPOUND AREA.
6. ALL ELECTRICAL EQUIPMENT SHALL BE UNDERWRITERS LABORATORY (UL) LISTED.

CIVIL

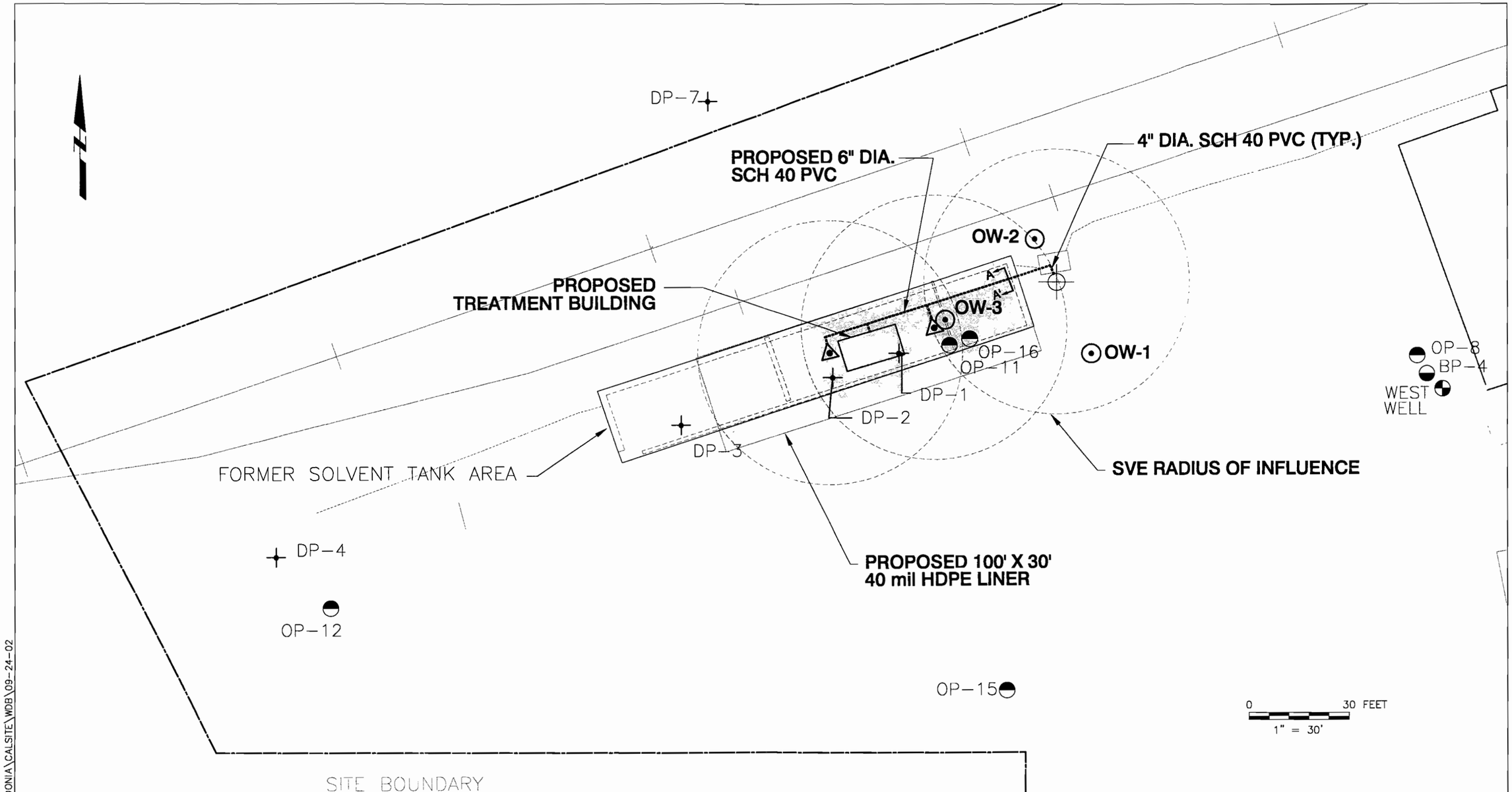
1. CONTRACTOR TO FIELD VERIFY ALL HORIZONTAL AND VERTICAL DIMENSIONS AND LOCATIONS; ANY DISCREPANCIES SHALL BE REPORTED TO THE ENGINEER PRIOR TO CONSTRUCTION.
2. ELEVATION POINTS AND CONTOURS ARE NOT SHOWN.
3. CONTRACTOR RESPONSIBLE FOR VERIFYING LOCATION OF ALL UNDERGROUND UTILITIES PRIOR TO EXCAVATION ACTIVITIES.
4. ALL CONCRETE TO BE 3,500 PSI, TYPE I, STANDARD DESIGN. USE A MINIMUM OF 3" COVER ON STEEL WHERE CONCRETE IS CONTACTING SOIL.
5. CONTRACTOR TO VERTICAL SAW CUT ASPHALT/CONCRETE PAVEMENT AT TRENCH/VAULT LOCATIONS PRIOR TO EXCAVATION.
6. CONTRACTOR RESPONSIBLE FOR OBTAINING ALL PERMITS NECESSARY FOR TRENCHING.
7. SLAB SUBGRADE AND PAVEMENT SUBGRADE, SHALL BE COMPACTED TO 98% ASTM D698 MAX. DENSITY.
8. SVE, GROUNDWATER EXTRACTION, AND IN-SITU CHEMICAL OXIDATION (ISCO) WELLS ARE TO BE INSTALLED BY ENGINEER. CONTRACTOR TO COMPLETE WELL HEADS AS SHOWN.

MECHANICAL

1. CONTRACTOR RESPONSIBLE FOR SUPPLY AND ASSEMBLY OF ALL PIPING AND APPURTENANCES FROM WELL HEADS TO TREATMENT SYSTEM BUILDINGS.
2. ALL LIQUIDS AND ISCO PIPING INCLUDING APPURTENANCES TO BE HYDROSTATICALLY PRESSURE TESTED FOR ONE HOUR @ 100 PSI. ALL SVE PIPING INCLUDING APPURTENANCES SHALL BE PRESSURE TESTED @ 30 PSI FOR ONE HOUR. ALL TESTING SHALL BE WITNESSED BY ENGINEER AND ENGINEER SHALL BE NOTIFIED 24 HOURS PRIOR TO TESTING.
3. ALL PIPING AND ELECTRICAL CONDUITS ON OR IN EXISTING FACILITY BUILDINGS TO BE SECURED TO SLAB OR WALL WITH UNISTRUT AND STRAPS OR EQUIVALENT. MAXIMUM UNSUPPORTED LENGTH OF PIPING SHALL BE LESS THAN 6 FEET.
4. EQUIPMENT/APPURTENANCES ON DETAILS ARE GENERIC ONLY. SIZE OF UNITS MAY BE DIFFERENT THAN SHOWN.
5. ALL APPURTENANCES, CONNECTIONS, GASKETS, SEALS ETC. TO BE PETROLEUM RESISTANT. LEVEL AND GROUT ALL SKIDS AS NECESSARY FOR PROPER SUPPORT.
6. CONTRACTOR TO PROVIDE ALL PIPE FITTINGS NOT SHOWN (REDUCERS, BUSHINGS, ETC.)
7. PIPE SUPPORTS TO BE PROVIDED WITHIN 6-INCHES OF ALL VALVES AND FITTINGS.
8. PIPE CONNECTIONS NOT SHOWN ON DRAWINGS. PROVIDE AND INSTALL UNION CONNECTIONS AS NECESSARY.

CADARC\JONES\CALEDONIA\3165NOTES\WDB\09-24-02

LFR LEVINE•FRICKE JCI JONES CHEMICALS, INC. SUPERFUND SITE CALEDONIA, NEW YORK	General Notes JCI Jones Chemicals, Inc. Superfund Site 100 Sunny Sol Boulevard Caledonia, New york	SEAL	SCALE NTS DATE 09-24-02 PROJECT NO. 3165.02 SHEET 2 OF 11



CADARC\JONES\CALEDONIA\CALSITE\WDB\09-24-02

LEGEND

- Monitoring well–Bedrock
- Shallow Monitoring well
- Production well
- Direct–Push sample locations
- Existing Extraction well
- Proposed Extraction well
- OW-1 Existing Vapor-Observation well

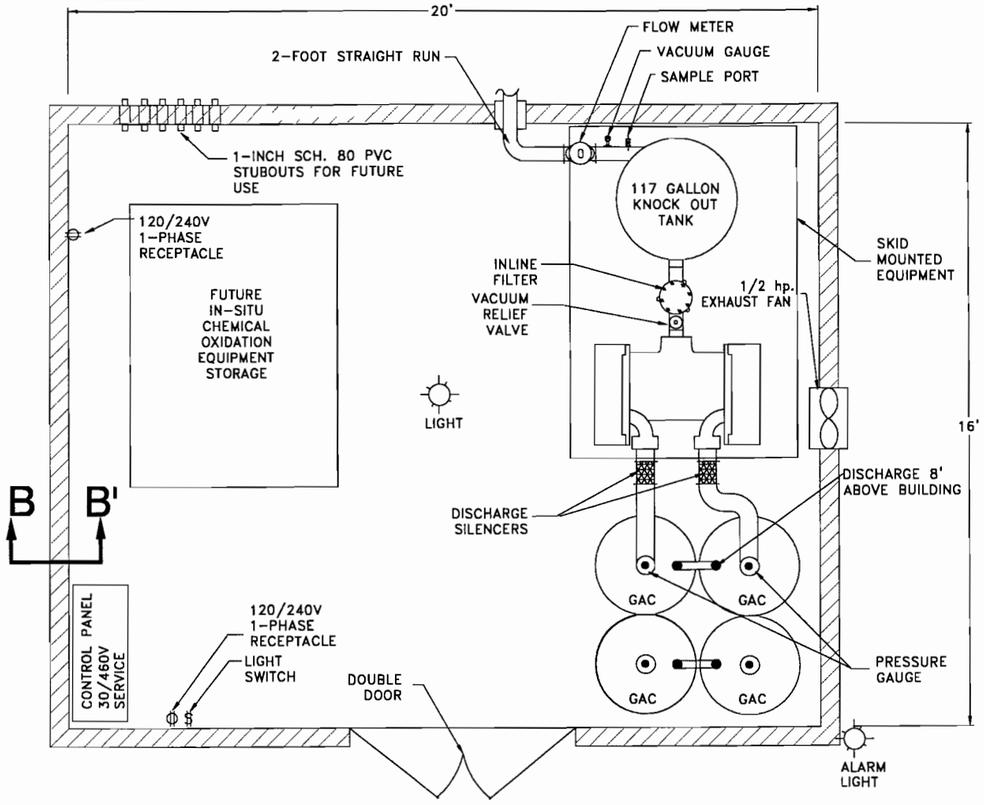
LFR LEVINE·FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Soil Vapor Extraction Layout
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE 1"=30'
DATE 09-24-02
PROJECT NO. 3165.02
SHEET 3 OF 11



TREATMENT BUILDING SCHEMATIC

APPROXIMATE SCALE 1"=4'

NOTES:

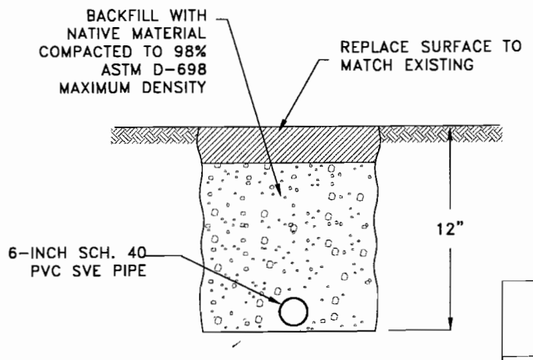
1.) ELECTRICAL LINES AND APPURTENANCES NOT SHOWN FOR CLARITY.

2.) CONTRACTOR SHALL INSTALL ALL ELECTRICAL DEVICES AND COMPONENTS IN COMPLIANCE WITH NEC.

3.) CONTRACTOR SHALL PROVIDE A MODULAR BUILDING THAT MEETS NEW YORK STATE BUILDING CODE REQUIREMENTS FOR SNOW AND WIND LOAD. DESIGN OF BUILDING SHALL BE CERTIFIED BY A REGISTERED NEW YORK P.E.

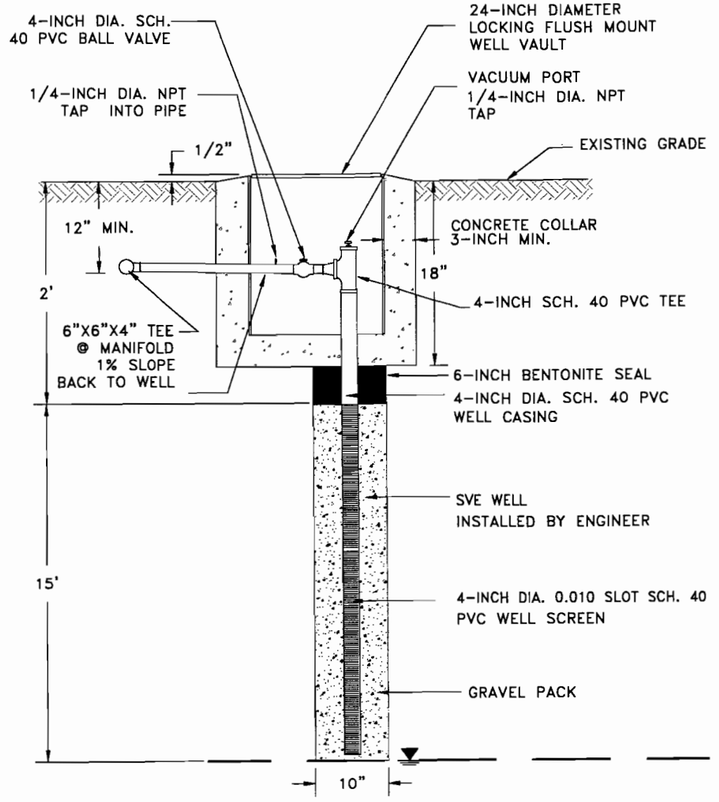
4.) PLANS SHALL BE SUBMITED TO THE ENGINEER FOR APPROVAL.

5.) CONTRACTOR SHALL CONSTRUCT A 6-INCH, 3,500 PSI CONCRETE SLAB WITH #4 REBAR AT 18-INCH O.C.E.W. THE TREATMENT BUILDING SHALL BE ANCHORED TO THE SLAB IN ACCORDANCE WITH STRUCTURAL ENGINEER SPECIFICATIONS.



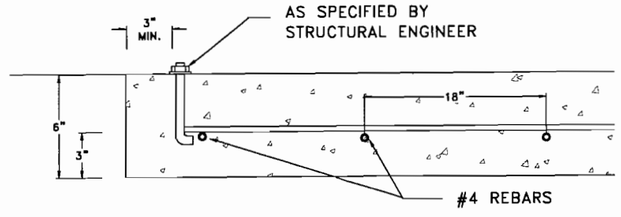
A-A' TRENCH DETAIL

NOT TO SCALE



TYPICAL SVE WELL AND VAULT DETAIL

NOT TO SCALE



B-B' SLAB DETAIL

NOT TO SCALE

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JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Treatment Building Layout, Trench Details, SVE Well Detail, and Slab Detail
JCI Jones Chemicals, Inc. - Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE NTS
DATE 09-24-02
PROJECT NO. 3165.02
SHEET 4 OF 11

CADARC\JONES\CALEDONIA\3165COM\WDB\09-24-02

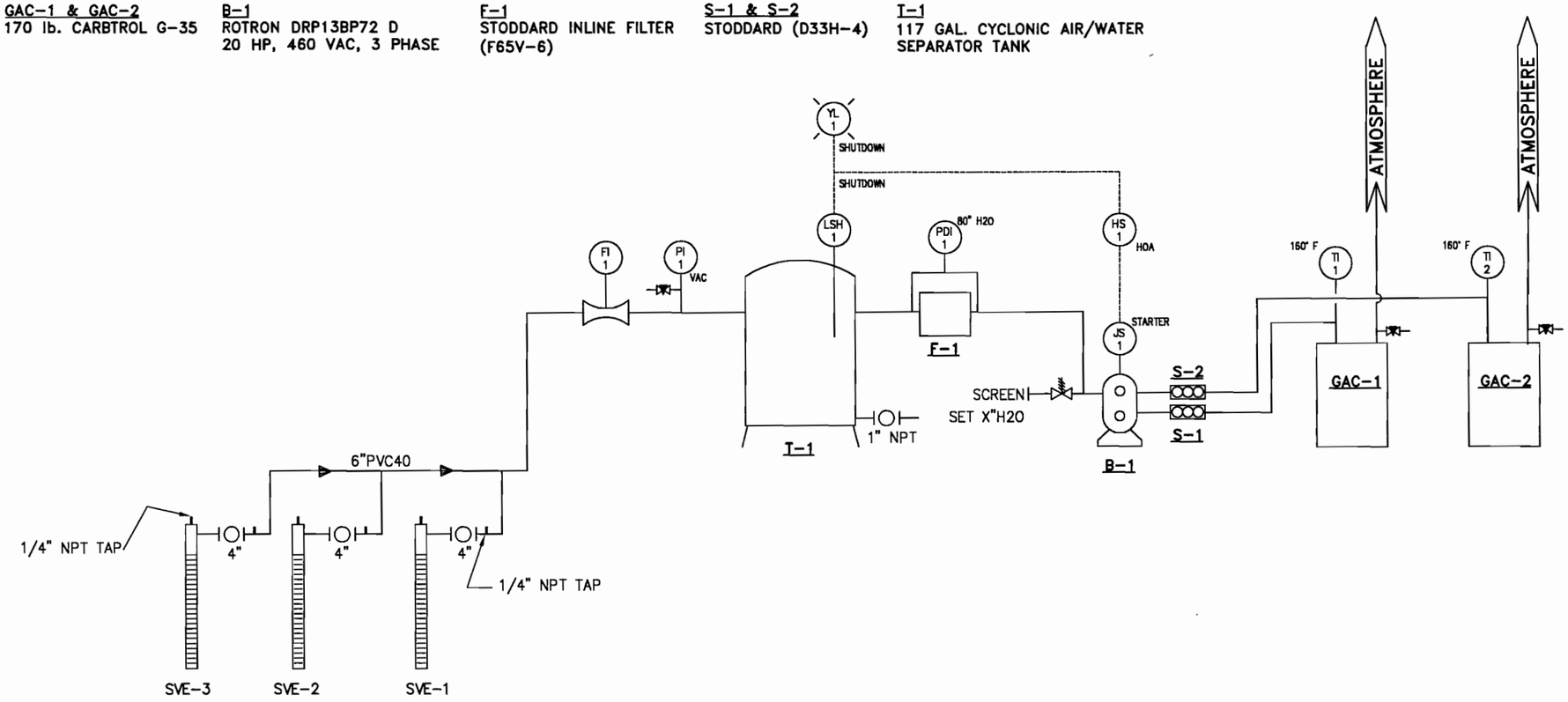
GAC-1 & GAC-2
170 lb. CARBTROL G-35

B-1
ROTRON DRP13BP72 D
20 HP, 460 VAC, 3 PHASE

F-1
STODDARD INLINE FILTER
(F65V-6)

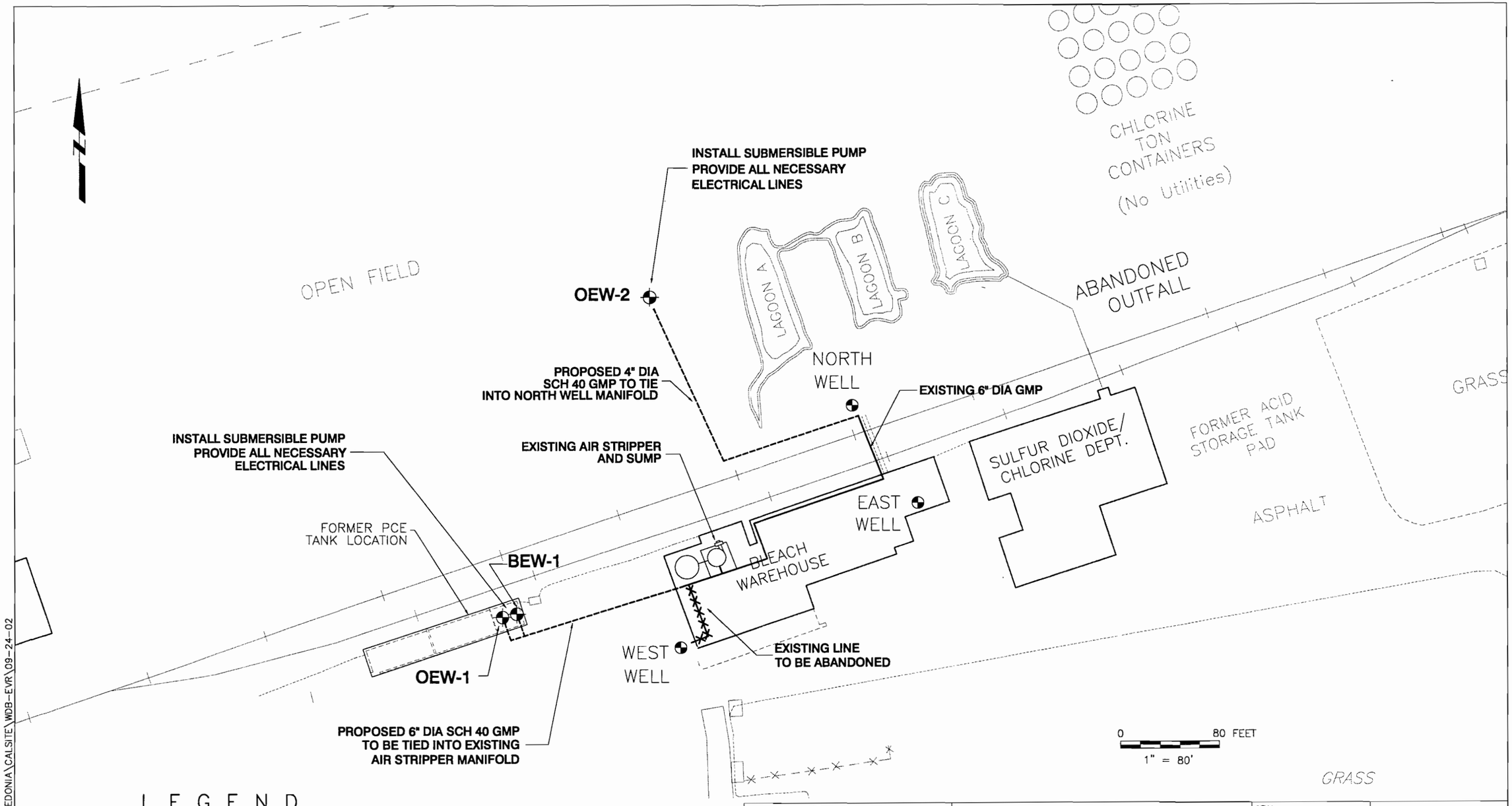
S-1 & S-2
STODDARD (D33H-4)

T-1
117 GAL. CYCLONIC AIR/WATER
SEPARATOR TANK



CADARC\JONES\CALEDONIA\3165PFD-jmc\EVR-WDB\09-24-02

LFR LEVINE•FRICKE JCI JONES CHEMICALS, INC. SUPERFUND SITE CALEDONIA, NEW YORK	System Process Flow Diagram JCI Jones Chemicals, Inc. Superfund Site 100 Sunny Sol Boulevard Caledonia, New York	SEAL	SCALE NTS DATE 09-24-02 PROJECT NO. 3165.02 SHEET 5 OF 11



L E G E N D

OEW-1 Proposed Overburdon Extraction Well

BEW-1 Proposed Bedrock Extraction Well

EAST WELL Existing Production Well

GMP Galvanized Metal Pipe

CADARC\JONES\CALEDONIA\CALSITE\WDB-EVR\09-24-02

LFR LEVINE·FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Proposed Extraction Wells and Piping Layout
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

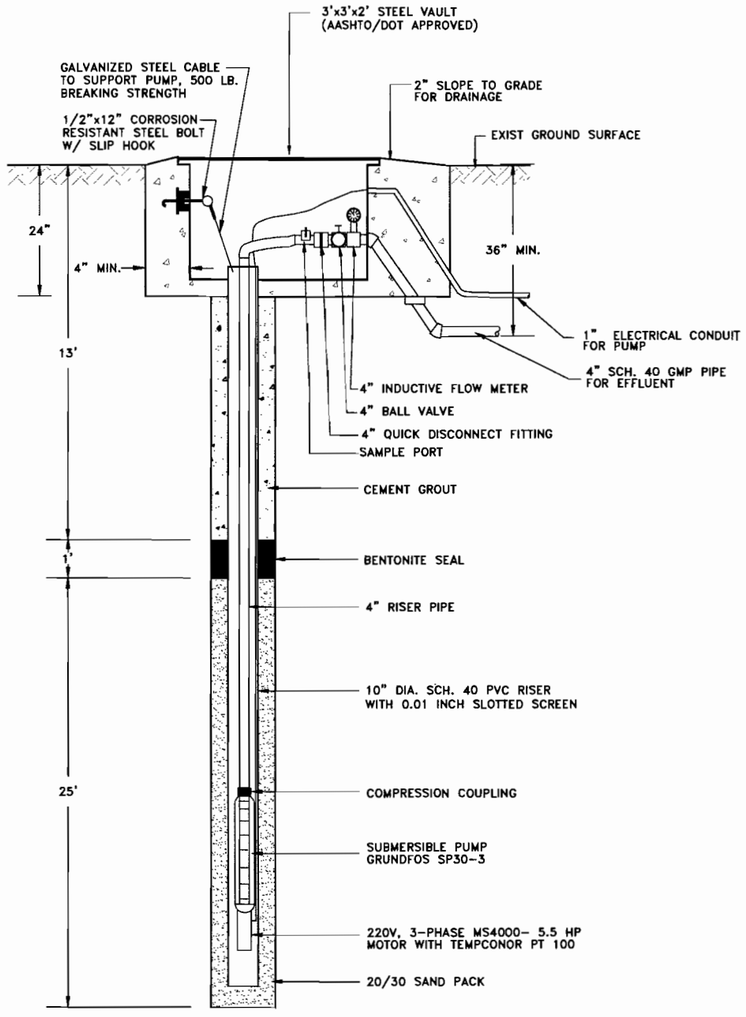
SEAL

SCALE 1"=80'

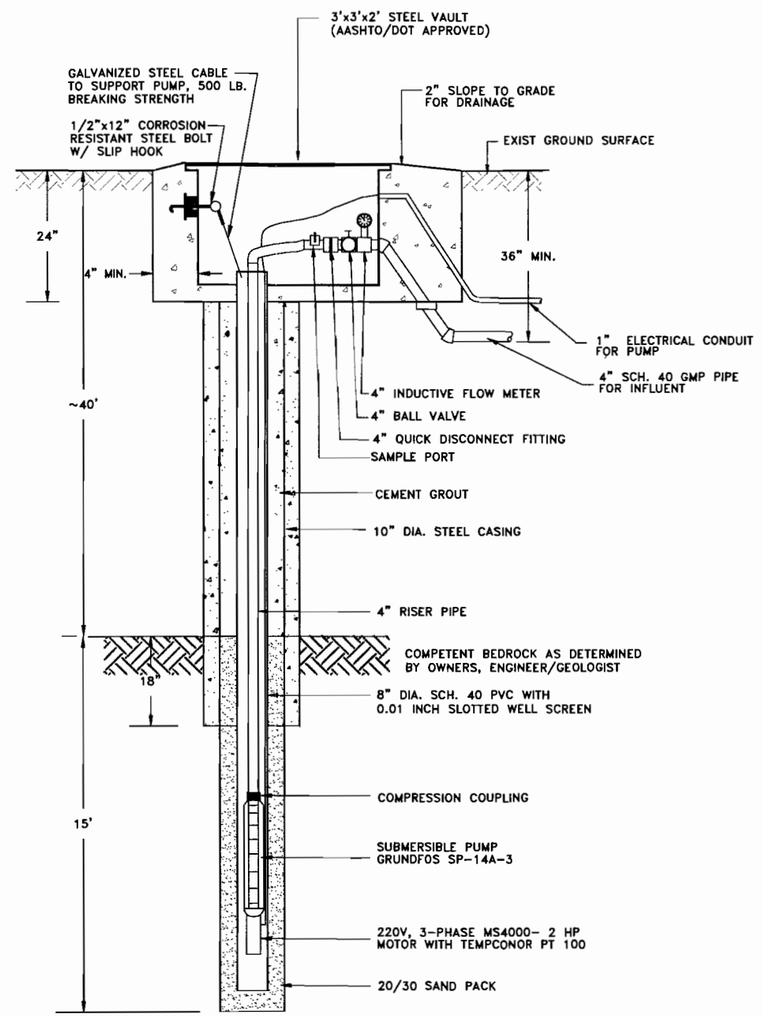
DATE 09-24-02

PROJECT NO. 3165.02

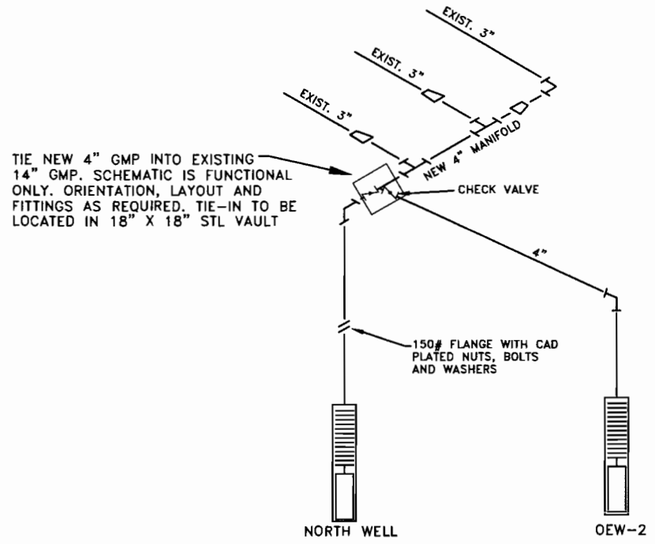
SHEET 6 OF 11



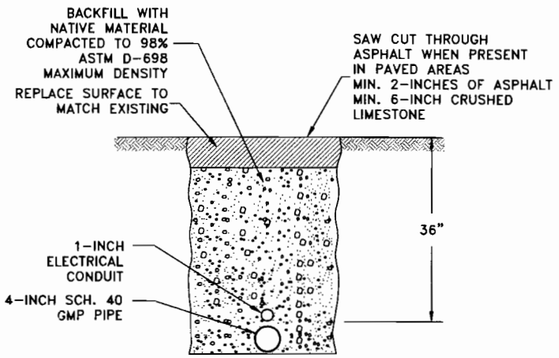
OVERBURDEN GROUNDWATER EXTRACTION WELL AND VAULT DETAIL
NOT TO SCALE



BEDROCK GROUNDWATER EXTRACTION WELL AND VAULT DETAIL
NOT TO SCALE



NORTH WELL TIE-IN DETAIL
NOT TO SCALE



TYPICAL GROUNDWATER EXTRACTION TRENCH DETAIL
NOT TO SCALE

CADARC\JONES\CALEDONIA\3165WELLS\EVR-WDB\10-10-02

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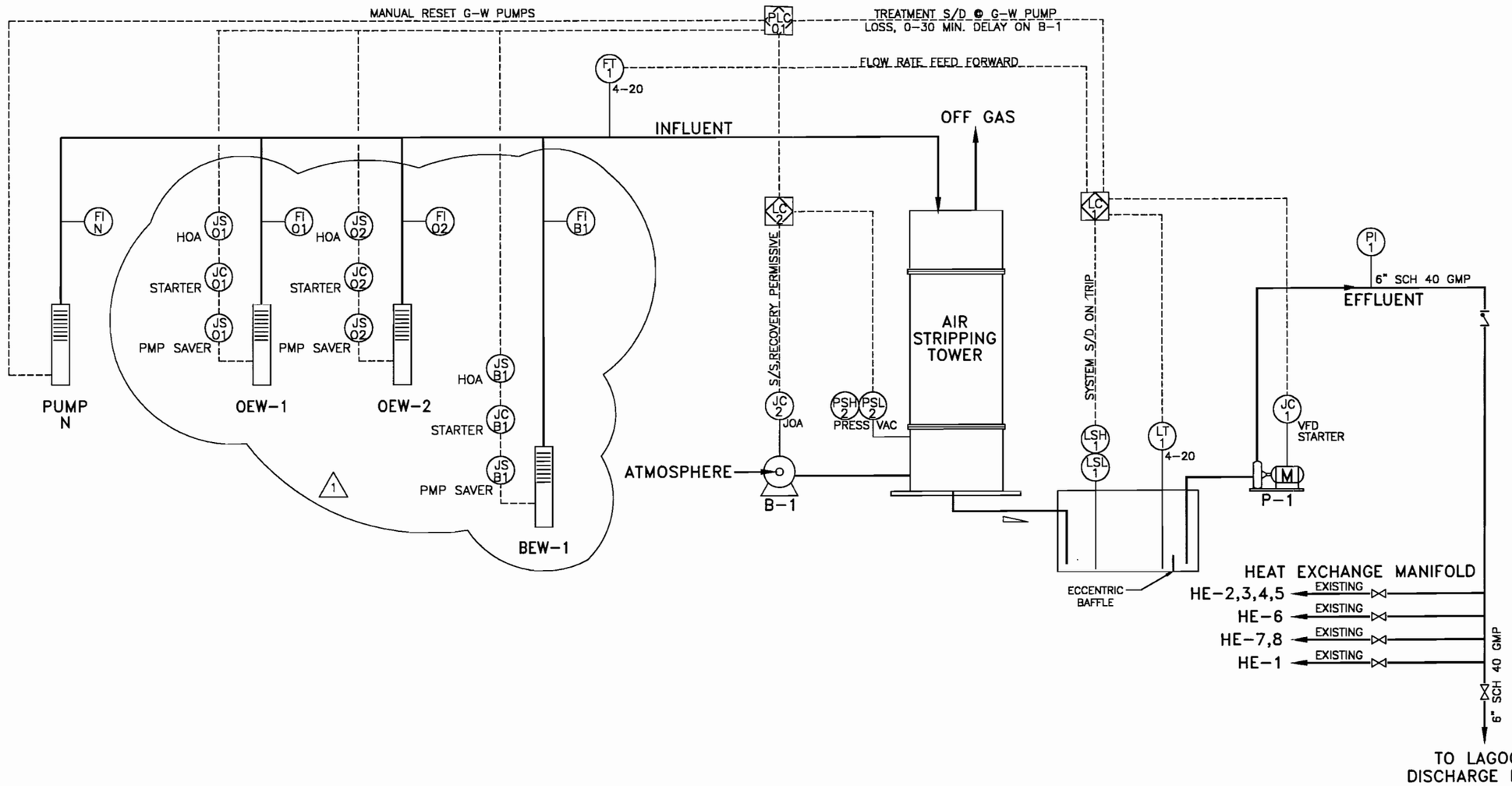
JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Extraction Wells and Trench Detail
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE NTS
DATE 10-10-02
PROJECT NO. 3165.02
SHEET 7 OF 11

OEW-1	OEW-2	OEW-1	B-1 BLOWER	P-1 PUMP
Grundfos SP30-3	Grundfos SP30-3	Grundfos SP14-A	5500 scfm @ 6 in H_2O	625 gpm @ 50 psid
5.5 hp	5.5 hp	2 hp		



1 SYSTEM ADDITIONS

CADARC\JONES\CALEDONIA\3165PIDJMC\EVR-WDW\04-30-02

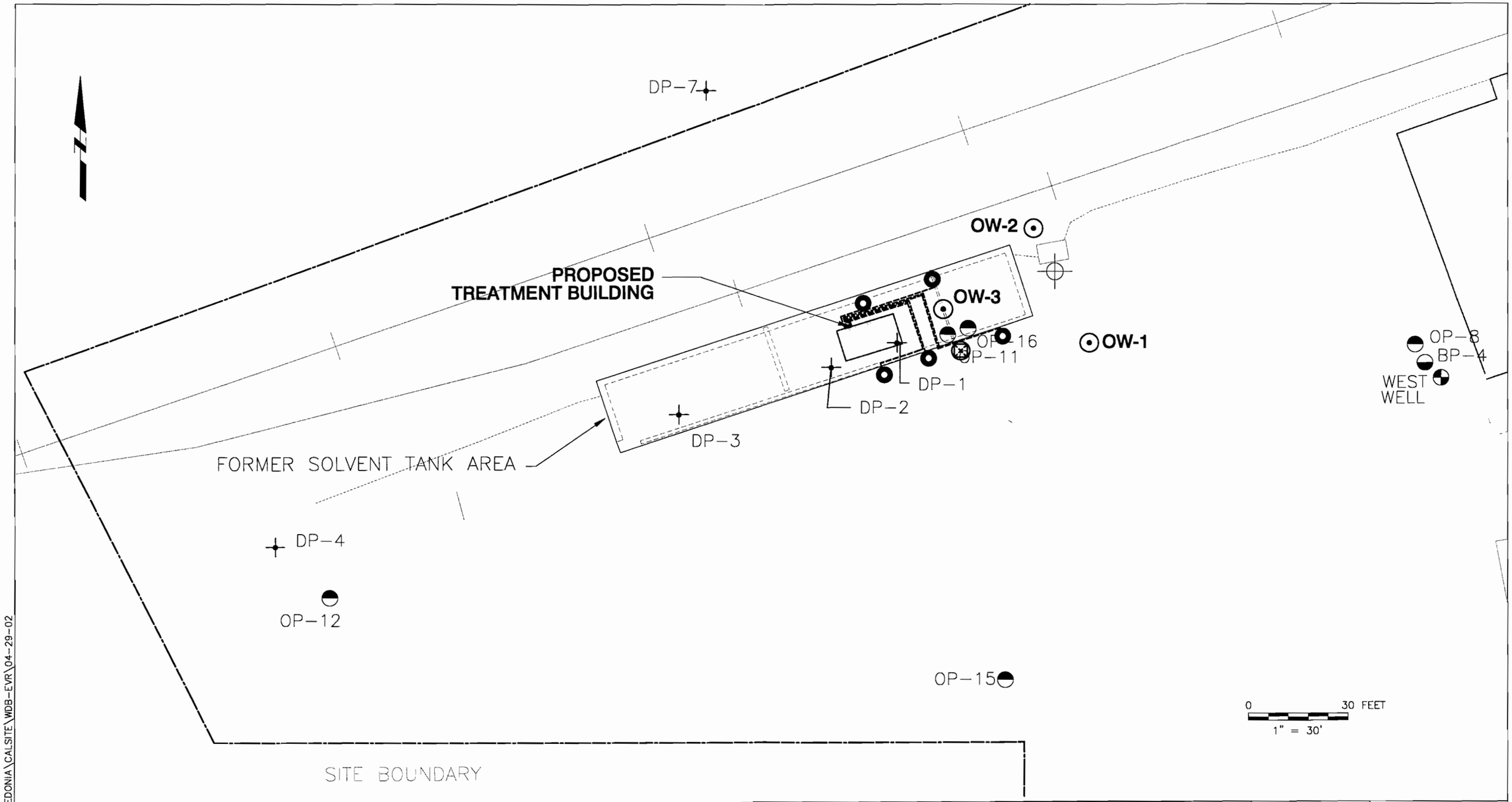
LFR LEVINE•FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Pump-and-Treat P&ID
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE NTS
DATE 04-30-02
PROJECT NO. 3165.02
SHEET 8 OF 11



CADARC\JONES\CALEDONIA\CALSITE\WDB-EVR\04-29-02

LEGEND

- Monitoring well-Bedrock
- Shallow Monitoring well
- Production well
- Direct-Push sample locations
- Existing Extraction well
- Proposed Overburden Injection well
- OW-1 Existing Vapor Observation well
- Proposed Bedrock Injection well

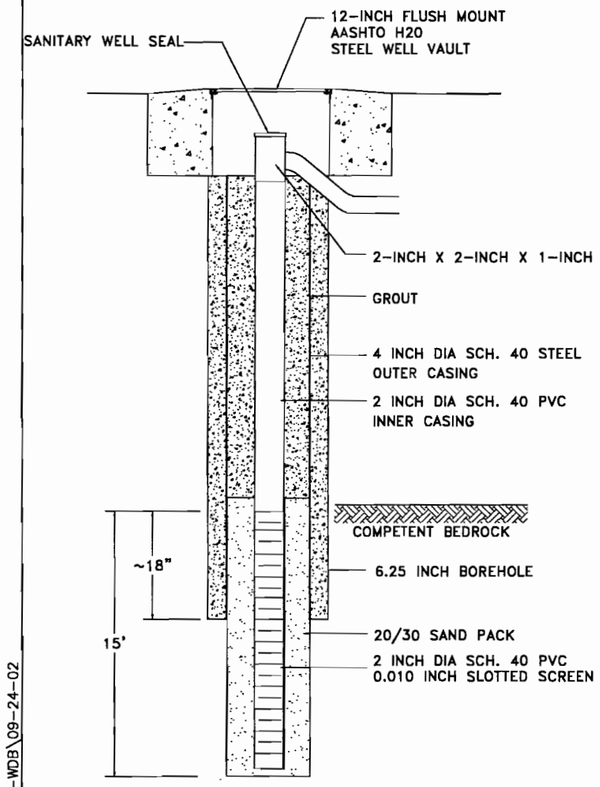
LFR LEVINE·FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

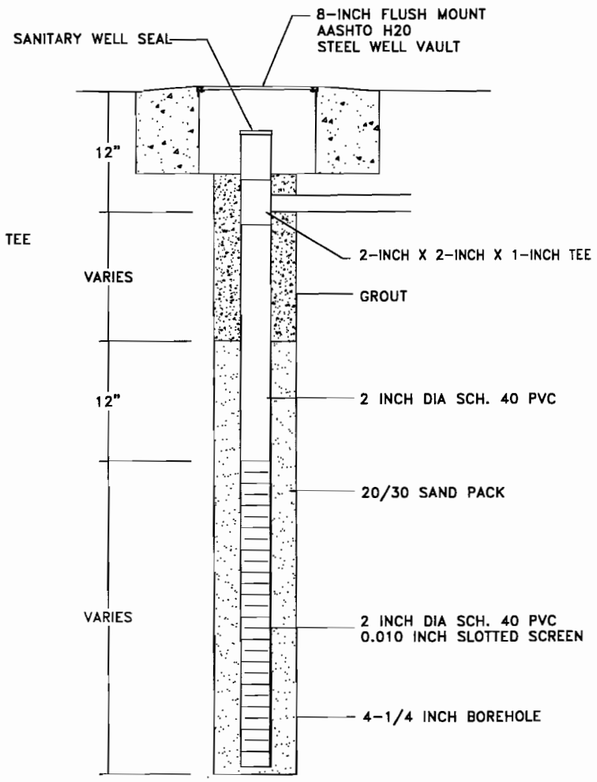
In-Situ Chemical Oxidation Layout
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

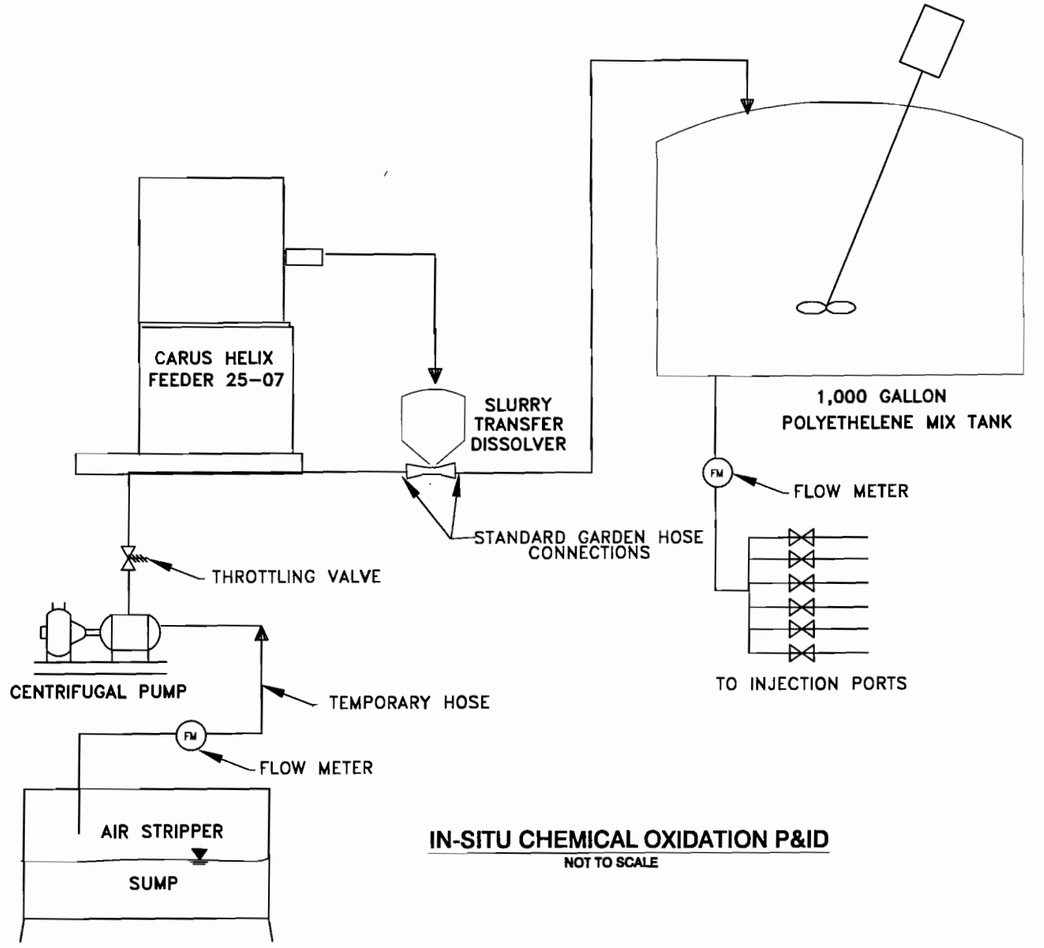
SCALE 1"=30'
DATE 04-29-02
PROJECT NO. 3165.02
SHEET 9 OF 11



TYPICAL BEDROCK INJECTION WELL
NOT TO SCALE



TYPICAL OVERBURDEN INJECTION WELL
NOT TO SCALE



IN-SITU CHEMICAL OXIDATION P&ID
NOT TO SCALE

CADARC\JONES\CALEDONIA\3165PID.JMC\EVR-WDB\09-24-02

LFR LEVINE·FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

ISCO P&ID, Overburden Injection,
and Bedrock Injection Well Details
JCI Jones Chemicals, Inc. - Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SEAL

SCALE NTS
DATE 09-24-02
PROJECT NO. 3165.02
SHEET 10 OF 11

FLOW DIAGRAM SYMBOLS

GENERAL INSTRUMENT OR FUNCTION SYMBOLS

- LOCALLY MOUNTED INSTRUMENT (IN FIELD)
- FRONT PANEL MOUNTED INSTRUMENT (IN CONTROL ROOM)
- BACK PANEL MOUNTED INSTRUMENT (IN CONTROL ROOM)
- FRONT PANEL MOUNTED INSTRUMENT (AUXILIARY LOCATION)
- BACK PANEL MOUNTED INSTRUMENT (AUXILIARY LOCATION)
- SHARED DISPLAY, SHARED CONTROL: DCS OR PLC INPUT/OUTPUT
- COMPUTER FUNCTION DCS OR PLC INPUT/OUTPUT
- PROGRAMMABLE LOGIC CONTROL FUNCTION DCS OR PLC INPUT/OUTPUT
- FRONT PANEL MOUNTED INDICATING LIGHT (IN CONTROL ROOM)

FLOW ELEMENTS

- ORIFICE PLATE W/FLG TAPS
- VORTEX
- POSITIVE DISPLACEMENT
- TURBINE
- PADDLEWHEEL
- AVERAGING PITOT TUBE
- STRAIGHTENING VANE

PIPING AND OTHER IN-LINE INSTRUMENTS

- RUPTURE DISC (PRESSURE)
- RUPTURE DISC (VACUUM)
- 1"x2" REDUCER
- FILTER
- STRAINER ("Y" TYPE)
- STRAINER (CONE OR FLAT TYPE)
- HOSE CONNECTION
- FLEXIBLE HOSE
- OPEN DRAIN
- SPECTACLE BLIND
- WELD CAP
- THREADED CAP
- THREADED PLUG

LINE SYMBOLS

- INTERNAL SYSTEM LINK (SOFTWARE OR DATA LINK)
- INSTRUMENT ELECTRICAL SIGNAL
- INSTRUMENT SIGNAL AIR LINE
- INSTRUMENT CAPILLARY LINE
- HYDRAULIC LINE
- ELECTROMAGNETIC OR SONIC SIGNAL (GUIDED)
- ELECTROMAGNETIC OR SONIC SIGNAL (UNGUIDED)
- ELECTRICAL HEAT TRACE
- STEAM HEAT TRACE
- INSULATION
- BATTERY LIMIT (BL)
- CONTINUATION ARROW (DWG. NO.)
- CONTINUATION OUTSIDE OF WORK PRODUCT (UTIL. DWG.)
- MATERIAL, INSULATION OR PIPING SPEC. CHANGE (HF2 | HF3)

VALVES AND ACTUATORS

- SLIDE GATE VALVE
- MANUAL GATE OR CONTROLLING GLOBE VALVE
- MANUAL GLOBE VALVE
- NEEDLE VALVE
- BALL VALVE
- BUTTERFLY VALVE
- DIAPHRAGM VALVE
- 3-WAY VALVE
- 4-WAY VALVE
- PLUG VALVE
- ANGLE VALVE
- CHECK VALVE
- PRESSURE RELIEF VALVE
- VACUUM RELIEF VALVE
- PRESSURE & VACUUM RELIEF VALVE
- CONTROL VALVE WITH DIAPHRAGM ACTUATOR (FAIL CLOSE) (FC)
- CONTROL VALVE WITH DIAPHRAGM ACTUATOR (FAIL OPEN) (FO)
- PRESSURE REDUCING REGULATOR SELF-CONTAINED
- PRESSURE REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
- BACK PRESSURE REGULATOR SELF-CONTAINED
- MOTOR ACTUATED VALVE
- PNEUMATICALLY ACTUATED VALVE
- SOLENOID ACTUATED 3-WAY VALVE (S)
- HANDWHEEL
- VANE ACTUATOR

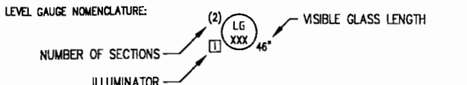
MISCELLANEOUS

- PURGE (P)
- LOGIC INTERLOCK (I)
- CHEMICAL SEAL
- SPECIALTY ITEM (SP)
- TIE IN TO EXISTING PIPING OR PIPING BY OTHERS (TIE IN)
- CORROSION COUPON (CC)

EXPLANATION OF IDENTIFICATION LETTERS

(1) ANY FIRST LETTER, IF USED IN COMBINATION WITH MODIFYING LETTERS D(DIFFERENTIAL), F(RATIO), M(MOMENTARY), K(TIME RATE OF CHANGE), Q(INTEGRATE OR TOTALIZE), OR ANY COMBINATION OF THESE IS INTENDED TO REPRESENT A NEW AND SEPARATE MEASURED VARIABLE, AND THE COMBINATION IS TREATED AS A FIRST LETTER ENTITY. THUS, INSTRUMENTS TDI AND TI INDICATE TWO DIFFERENT VARIABLES, NAMELY, DIFFERENTIAL TEMPERATURE AND TEMPERATURE. MODIFYING LETTERS ARE USED WHEN APPLICABLE.

(2) LEVEL GAUGE NOMENCLATURE:



(3) IDENTIFY RELAYS WITH FUNCTIONAL SUPERSCRIPT. (FY XXX)

(4) IDENTIFY ANALYZERS AND EQUIPMENT WITH SUPERSCRIPT OUTSIDE OF CIRCLE (AE XXX) 2
I.E. CO_2, PH, H_2S, ETC.

(5) FOR VACUUM OR DRAFT INSTRUMENTS ADD SUPERSCRIPT OUTSIDE OF CIRCLE (PI XXX)′ (PI XXX)

(6) EXCEPTIONS TO SCHEDULE OF IDENTIFICATION LETTERS:

FA – FLAME ARRESTOR	I/P – CURRENT TO PNEUMATIC CONVERTER
LD – LIQUID DRAINER	HSD – HAND SHUTDOWN
ST – STEAM TRAP	SS – SELECTOR SWITCH
SP – SET POINT	FC – FAIL CLOSED
BL – BATTERY LIMIT	FO – FAIL OPEN
TC – THERMOCOUPLE	NC – NORMALLY CLOSED
RTD – RESISTANCE TEMPERATURE DETECTOR	NO – NORMALLY OPEN
ESD – EMERGENCY SHUTDOWN	SC – SAMPLE CONNECTION
USD – UNIT SHUTDOWN	SO – STEAM OUT CONNECTION
SD – SHUTDOWN	TSO – TIGHT SHUT OFF
PB – PUSHBUTTON	TS – TEMPORARY STRAINER
HOA – HAND–OFF–AUTO SELECTOR SWITCH	VFD – VARIABLE FREQUENCY DRIVE
LOR – LOCAL–OFF–REMOTE SELECTOR SWITCH	
JOA – JOG–OFF–AUTO SELECTOR SWITCH	

(7) SUPPLY DESIGNATIONS:

AS – AIR SUPPLY	NS – NITROGEN SUPPLY
ES – ELECTRIC SUPPLY	SS – STEAM SUPPLY
GS – GAS SUPPLY	WS – WATER SUPPLY
HS – HYDRAULIC SUPPLY	PG – PROCESS GAS
IA – INSTRUMENT AIR	PW – PROCESS WATER

(8) ELECTRICAL RELAYS, SWITCHES AND MISC. ITEMS IDENTIFIED WITH AN INSTRUMENT TAG BALLOON AND AN (E) SHOWN IN PLACE OF THE INSTRUMENT TAG NUMBER ARE TO BE SPECIFIED AND FURNISHED BY ELECTRICAL.

(HDA (E)) (HDA XXX)

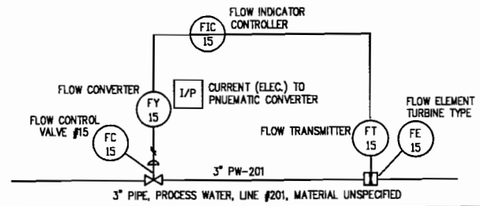
(9) INSULATION DESIGNATIONS:

H – HIGH TEMP. MAINTENANCE	NP – NOISE PROTECTION
C – LOW TEMP. MAINTENANCE	
PP – PERSONAL PROTECTION	
FP – FREEZE PROTECTION	

	FIRST LETTER (1)		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, FLAME		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY			CONTROL	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE		PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G	GAUGING (DIMENSIONAL)		GLASS VIEWING DEVICE		
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE RESTRICTION		
P	PRESSURE VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECH. ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE, PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

LINE NUMBER DESIGNATION EXAMPLE

TYPICAL LOOP IDENTIFICATION



CADARC\JONES\CALEDONIA\3165PFD-jmc\EVR-WDB\04-30-02

LFR LEVINE•FRICKE

JCI JONES CHEMICALS, INC.
SUPERFUND SITE
CALEDONIA, NEW YORK

Process & Instrumentation Legend
JCI Jones Chemicals, Inc.
Superfund Site
100 Sunny Sol Boulevard
Caledonia, New York

SCALE NTS
DATE 04-30-02
PROJECT NO. 3165.02
SHEET 11 OF 11

Appendix D

Remediation System Specifications

SECTION 00001

REMEDIAL SYSTEMS SPECIFICATIONS

JCI JONES CHEMICAL, INC. SUPERFUND SITE

CALEDONIA, NEW YORK

END OF PROJECT TITLE PAGE

SECTION 00010

TABLE OF CONTENTS

END OF TABLE OF CONTENTS

SECTION 01100

SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: JCI Jones Chemicals, Inc.

B. Owner's Name: JCI Jones Chemicals, Inc. (JCI)

C. Engineer's Name: LFR Levine-Fricke (LFR)

D. The Project consists of the construction of remediation systems to clean up tetrachloroethene affected soil and groundwater.

1.02 DESCRIPTION OF WORK

A. Project Informational Drawings.
   1. Construction drawings are provided for information to indicate the proposed layout and the overall equipment for the remediation systems.
   2. Process flow diagrams are provided. Proposed systems shall comply with concept shown on these drawings.

B. Performance Requirements
   1. Provide and install all equipment and supporting structures as specified for the soil vapor extraction (SVE) system, groundwater extraction system, and in-situ chemical oxidation system.
   2. Design and coordinate the tie-in of the proposed groundwater extraction pumps to the existing PLC controller.
   3. Test, check-out and calibrate all components of the supplied systems.
   4. Provide installation assistance, start-up assistance, and training as required by individual specification sections. Also, provide a minimum of 2 days installation and startup assistance.
   5. At system start-up provide three copies of the Operation and Manintenance Manuals for each remediation system. The O&M Manual shall include:
      a. Operational description
      b. Equipment cut sheets including manufacturer's O&M requirements
      c. System startup and shut-down requirements/procedures
      d. Weekly and monthly maintenance requirements
      e. System troubleshooting procedures

1.03 WORK BY OWNER

A. JCI will award a contract for installation of the soil vapor extraction, groundwater extraction, and chemical oxidation injection wells which will commence on or about two weeks prior to initiation of construction of the remediation systems.

1.04 OWNER OCCUPANCY

A. JCI intends to continue to operate normal business operations during the entire construction period.

B. Cooperate with JCI to minimize conflict and to facilitate JCI 's operations.

C. Schedule the Work to accommodate JCI operations.

1.05 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to areas noted on Drawings.

B. Arrange use of site and premises to allow:
   1. Work by JCI.

C. Provide access to and from site as required by law and by JCI:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.

D. Time Restrictions: work must be performed between 7:30 AM and 6:00 PM.

E. Utility Outages and Shutdown:
   1. Limit disruption of utility services to hours the building is unoccupied.
   2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to JCI and authorities having jurisdiction.
   3. Prevent accidental disruption of utility services to other facilities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 Project Schedule

A. Complete project per schedule presented in Request for Proposal.

END OF SECTION

SECTION 01155

ON-SITE HEALTH AND SAFETY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Construction/remediation activities may place Contractor's personnel, personnel of other Contractor's hired by Owner to perform work at site, and public in potentially hazrdous situations due to exposure to groundwater containing tetrachloroethene, trichloroethene, dichloroethenes, and vinyl chloride.

B. Contractor is responsible for implementation and enforcement of safe work practices including but not limited to personnel exposure to hazardous materials; use of trenching, sheeting, and shoring; operation of equipment; and safety of public during progress of work.

1.02 SUBMITTALS

A. Provide two copies of Health and Safety Plan (HASP) to Owner and Engineer within 5 days notice to proceed. Work on-site shall not proceed until Health and Safety Plan has been submitted to the Engineer.
   1. Submittal of HASP is to inform Engineer and Owner so they can comply with HASP during performance of their on-site responsibilities.
   2. Submittal of Contractor's HASP shall neither impose on Engineer responsibility for adequacy of HASP nor relieve Contractor from full responsibility therefor.

1.03 QUALITY ASSURANCE

A. Contractor shall plan for and ensure personnel comply with basic provisions of OSHA Safety and and Health Standards (29 CFR 1910.120), and General Construction Standards (29 CFR 1926) as appropriate[].
   1. Maintain one copy on project site.

B. Comply with applicable laws and regulations of any public body having jurisdiction for safety of persons or property.

1.04 OPERATIONS AND EQUIPMENT SAFETY

A. Contractor is resonsible for initiating, maintaining, and supervising safety precautions and programs in connection with the work. Contractor shall take necessary precautions for safety of employees on Project site and other persons and organizations who may be affected by Project.

B. Contractor's duties and responsibilities for safety in connection with Work shall continue until such time as Work is complete and Engineer has issued notice to Contractor that work is complete.

1.05 HEALTH AND SAFETY

A. Contractor is responsible for implementation and enforcement of health and safety requirements and shall take necessary precautions and provide protection for the following:
   1. Personnel working on or visiting Project site, irrespective of employer.
   2. Work and materials or equipment to be incorporated in Work area on or off site.
   3. Other property at or adjacent to Project site.
   4. Public exposed to job related operations or potential release of pollutants, contaminants, or toxic hazardous materials.

B. Contractor shall prepare site specific health and safety plan/contingency plan (HASP). If Contractor does not have capability to prepare HASP, Contractor shall employ consultants with appropriate capability. Contractor is soley responsible for adequacy of HASP's preparation, monitoring, management, and enforcement. At minimum, Contractor's HASP shall address the site description and history; project activities and coordination with other contractors; hazard

evaluation; on-site safety responsibilities; work zones; personnel training; atmospheric monitoring, if appropriate; personal protection, clothing, and equipment; emergency procedures; and a contingency plan.

C. If Owner contracts with others for Work on-site, Contractor shall amend HASP to include provisions for Work of others. Contractor shall also manage, enforce, and monitor health and safety activities of other Contractors during duration of other Contractor's work.

1.06 ENGINEER'S RESPONSIBILITIES

A. When Engineer is required to be present on Project site to perform engineering services, Engineer will comply with Contractor's safety plans, programs, and procedures.

B. If Engineer determines Contractor's safety plans, programs, and procedures do not provide adequate protection for Engineer, Engineer may direct its employees to leave Project site or implement additional safeguards for Engineer's protection. If taken, these actions will be in furtherance of Engineer's responsibility to its employees only, and Engineer will not assume responsibility for protection of any other persons affected by Work.

C. If Engineer observes situations which appear to have potential for immediate and serious injury to persons, Engineer may warn persons who appear to be affected by such situations. Such warnings, if issued, shall be given based on general humanitarian concerns, and Engineer will not by issuance of any such warnings assume any responsibility to issue future warnings or any general resoponsibility for protection of persons affected by Work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01300

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction meeting.

B. Construction progress schedule.

C. Submittals for review, information, and project closeout.

D. Submittal procedures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Engineer will schedule a meeting after Notice of Award.

B. Attendance Required:
   1. JCI .
   2. Engineer.
   3. Contractor.

C. Agenda:
   1. Execution of JCI-Contractor Agreement.
   2. Submission of list of Subcontractors, list of Products, schedule of values, and progress schedule.
   3. Designation of personnel representing the parties to Contract, Contractor and Engineer.
   4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
   5. Scheduling.

3.02 CONSTRUCTION PROGRESS SCHEDULE

A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.

B. If preliminary schedule requires revision after review, submit revised schedule within 5 days.

3.03 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.
   3. Samples for selection.
   4. Samples for verification.

B. Submit to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

C. Samples will be reviewed only for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below.

3.04 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Manufacturer's field reports.
   7. Other types indicated.

3.05 SUBMITTALS FOR PROJECT CLOSEOUT

A. When the following are specified in individual sections, submit them at project closeout:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   4. Other types as indicated.

B. Submit for JCI's benefit during and after project completion.

3.06 NUMBER OF COPIES OF SUBMITTALS

A. Documents for Review:
   1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Engineer.

B. Documents for Information: Submit two copies.

C. Documents for Project Closeout: Make one reproduction of submittal originally reviewed. Submit one extra of submittals for information.

D. Samples: Submit the number specified in individual specification sections; one of which will be retained by Engineer.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.07 SUBMITTAL PROCEDURES

A. Transmit each submittal with approved form.

B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.

E. Deliver submittals to Engineer at business address.

F. Schedule submittals to expedite the Project, and coordinate submission of related items.

G. For each submittal for review, allow 15 days excluding delivery time to and from the Engineer.

H. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

I. Provide space for Contractor and Engineer review stamps.

J. When revised for resubmission, identify all changes made since previous submission.

K. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

L. Submittals not requested will not be recognized or processed.

END OF SECTION

SECTION 01510

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities: Electricity, heat, water, potable water, and sanitary.

1.02 TEMPORARY ELECTRICITY

A. Equipment requiring electric power shall be powered by Contractor's generators or a temporary power drop by the electric utility.

1.03 TEMPORARY HEATING

A. Provide heating devices and heat as needed to maintain specified conditions for construction operations.

1.04 TEMPORARY WATER SERVICE

A. Connect to existing water source.

B. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

1.05 POTABLE WATER

A. Contractor shall supply and provide potable water for their use.

1.06 SANITARY FACILITIES

A. Contractor shall supply and maintain temporary sanitary facilities for their use.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Materials and equipment incorporated into work:
   1. Conform to applicable specifications and standards.
   2. Comply with size, make, type, and quality specified or as specifically approved by Shop Drawing, Engineer, or other submittal.

B. Manufactured and Fabricated Materials and Equipment:
   1. Design, fabricate, and assemble in accordance with engineering and shop practices standard with industry.
   2. Manufacture like parts of duplicate units to standard size and gauges, to be interchangeable.
   3. Material and equipment shall be suitable for service condition.
   4. Equipment capabilities, sizes, and dimensions shown or specified shall be adhered to, unless variations are specifically approved in writing, in accordance with General Conditions.
   5. Equipment shall be adapted to best economy in power consumption and maintenance. Parts and components shall be proportioned for stresses occurring during continuous or intermittent opreration, and components shall be proportioned for stresses occurring during fabrication and installation.
   6. Design so working parts readily accesible for inspection and repair, easily duplicated, and replaced.

C. Do not use material or equipment for purposes other than for which it is designed or specified.

1.02 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Shop Drawing Submittals: Prepared specifically for this Project.

D. Indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment.

PART 2 PRODUCTS

2.01 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.02 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance, and extra products of types and in quantities specified in individual specification sections.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

A. Engineer will consider requests for substitutions only within 15 days after date of Agreement.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

C. Substitution Submittal Procedure:
   1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
   2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   3. The Engineer will notify Contractor in writing of decision to accept or reject request.

3.02 TRANSPORTATION AND HANDLING

A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

B. Transport and handle products in accordance with manufacturer's instructions.

C. Deliver materials and equuipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify

products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01700

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Pre-installation meetings.

C. Cutting and patching.

D. Surveying for laying out the work.

E. Cleaning and protection.

F. Starting of systems and equipment.

G. Demonstration and instruction of JCI personnel.

H. Closeout procedures, except payment procedures.

1.02 SUBMITTALS

A. Description of Major Equipment
   1. Manufacturers equipment data including operation, materials, dimensions, operating weights, etc,
   2. Pump curves and descriptons of wetted components.
   3. Electrical requirements
   4. Other equipment data required for submittal by other specification sections.

B. Drawings

C. Process and instrumentation diagrams indicating equipment size, utility requirements and control function.

D. As built drawings showing equipment and piping placement.

1.03 PROJECT CONDITIONS

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

C. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

D. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.

E. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where

necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01600.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or mis-fabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Engineer four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

3.03 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Engineer of any discrepancies discovered.

C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

D. Promptly report to Engineer the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

F. Utilize recognized engineering survey practices.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

3.05 CUTTING AND PATCHING

A. Execute cutting and patching to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.

B. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

C. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

D. Restore work with new products in accordance with requirements of Contract Documents.

E. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

F. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material, to full thickness of the penetrated element.

G. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

H. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

3.06 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.07 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

3.08 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.09 DEMONSTRATION AND INSTRUCTION

A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

B. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.

3.10 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean site; sweep paved areas, rake clean landscaped surfaces.

C. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.12 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.

B. Notify Engineer when work is considered ready for Substantial Completion.

C. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Engineer's review.

D. Notify Engineer when work is considered finally complete.

E. Complete items of work determined by Engineer's final inspection.

3.13 WARRANTY SERVICE

A. Furnish warranty of all components supplied for one year from date of Substantial Completion.

END OF SECTION

SECTION 02150

OFF GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The off-gas piping system shall consist of buried and above ground pipe, pipe supports, fittings, equipment and accessories..

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only...

B. AMERICAN GAS ASSOCIATION (AGA)..AGA Manual(1994; Addenda/Correction Jan 1996) A.G.A. Plastic Pipe Manual for Gas Service

C. AMERICAN PETROLEUM INSTITUTE (API)..API Spec 5L(2000) Line Pipe.

D. API Spec 6D(1994; Supple 1 Jun 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

E. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) ASTM A 153/A 153M(2001) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

F. ASTM A 181/A 181M(2001) Carbon Steel Forgings, for General-Purpose Piping

G. ASTM A 307(2000) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

H. ASTM A 53(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

I. ASTM C 920(1998) Elastomeric Joint Sealants

J. ASTM D 1248(2000) Polyethylene Plastics Molding and Extrusion Materials

K. ASTM D 1598(1986; R 1997) Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

L. ASTM D 1693(2000) Environmental Stress-Cracking of Ethylene Plastics

M. ASTM D 1784(1999a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

N. ASTM D 2241(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

O. ASTM D 2447(1999) Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter

P. ASTM D 2466(1999) Poly(Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40

Q. ASTM D 2467(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

R. ASTM D 2513(2000) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

S. ASTM D 2517(2000) Reinforced Epoxy Resin Gas Pressure Pipe and Fittings

T. ASTM D 2564(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

U. ASTM D 2672(1996a) Joints for IPS PVC Pipe Using Solvent Cement

V. ASTM D 2683(1998) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

W. ASTM D 2774(1994) Underground Installation of Thermoplastic Pressure Piping

X. ASTM D 2855(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and

Fittings

Y. ASTM D 2992(1996el) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

Z. ASTM D 3139(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

AA. ASTM D 3915(1999a)Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications

AB. ASTM E 515(1995) Leaks Using Bubble Emission Techniques

AC. ASTM F 1055(1998) Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing

AD. ASTM F 402(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

AE. ASTM F 442/F 442M(1999) Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

AF. ASTM F 656(1996a) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

AG. AMERICAN WATER WORKS ASSOCIATION(AWWA)..AWWA C218Coating the Exterior of Aboveground Steel Water Pipelines and Fittings

AH. ASME INTERNATIONAL (ASME)..ASME B1.20.1(1983; R 1992) Pipe Threads, General Purpose (Inch)

AI. ASME B16.11(1996) Forged Fittings, Socket-Welding and Threaded

AJ. ASME B16.21(1992) Nonmetallic Flat Gaskets for Pipe Flanges

AK. ASME B16.5(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24

AL. ASME B16.9(1993) Factory-Made Wrought Steel Buttwelding Fittings

AM. ASME B31.8(1995) Gas Transmission and Distribution Piping Systems

AN. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

AO. MSS SP-25(1998) Standard Marking System for Valves, Fittings, Flanges and Unions

AP. MSS SP-58(1993) Pipe Hangers and Supports - Materials, Design and Manufacture

AQ. MSS SP-69(1996) Pipe Hangers and Supports - Selection and Application

AR. MSS SP-72(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service

AS. MSS SP-89(1998) Pipe Hangers and Supports - Fabrication and Installation Practices

AT. NACE INTERNATIONAL (NACE)..NACE RP0185(1996) Extruded, Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

AU. NACE RP0274(1998) High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

AV. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)..NFPA 325-1(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

AW. NFPA 49(1994) Hazardous Chemicals Data

AX. NFPA 58(1998; Errata 58-98-1) Liquefied Petroleum Gas Code..NFPA 704(1996) Identification of the Fire Hazards of Materials for Emergency Response

AY. PLASTICS PIPE INSTITUTE (PPI)..PPI AW-32 TR21(2001) Thermal Expansion and Contraction of Plastic Pipe

AZ. THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)..SSPC SP 6(1994) Commercial Blast Cleaning

BA. UNDERWRITERS LABORATORIES (UL)..UL Gas&Oil Dir(1999) Gas and Oil Equipment Directory

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.
   1. Drawings containing graphical relationship of various components of the work, schematic diagrams of the systems, details of fabrication, layouts of particular elements, connections, clearance required for maintenance and operation, and other aspects of the work to demonstrate that the system has been coordinated and will properly function as a unit.
   2. Manufacturer's descriptive data and technical literature for each piping system, including design recommendations, pressure and temperature ratings, dimensions, type, grade and strength of pipe and fittings, thermal characteristics (coefficient of expansion and thermal conductivity) and chemical resistivity for each chemical constituent in the off-gas stream.
   3. Manufacturer's recommended installation procedures including materials preparation, and installations
   4. Pressure Testing
   5. Three copies, in indexed booklet form, of site specific operation and maintenance manual for the piping system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below.
   6. Warranty

1.04 QUALIFICATIONS

A. Contractor shall have a minimum of 3 years of experience in the construction of piping systems for sour gas, condensable gas, off-gas or vapor

B. Single Source Supplier
   1. The Contractor shall assign to a single supplier full responsibility for the furnishing of the off-gas piping system. The designated single supplier, however, need not manufacture the system but shall coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

C. Manufacturer's Representative
   1. Services of a manufacturer's field service representative who is experienced in the installation of the materials and equipment furnished and who has complete knowledge of the proper operation and maintenance of the system shall be provided.

D. Jointing Plastic and Fiberglass Reinforced Pipe
   1. Manufacturer's prequalified joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA Manual. Joiners and inspectors shall be qualified at the job site by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA Manual.

1.05 GENERAL REQUIREMENTS

A. Piping material and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Materials and equipment shall be new and unused, except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer.

B. Standard Products
   1. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have

been in satisfactory use for at least 2 years prior to bid opening. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site

C. Verification of Dimensions
   1. The Contractor shall become familiar with details of the work, verify all dimensions in the field, and shall advise the Engineer of any discrepancy before performing the work.

1.06 DELIVERY AND STORAGE

A. Packaging
   1. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D 3892

B. Cleaners, Solvents and Glues
   1. A material safety data sheet in conformance with ANSI Z400.1 shall accompany each chemical delivered for use in pipe installation. Handling shall be in accordance with ASTM F 402.

C. Storage
   1. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Piping bundles shall be stored on a prepared surface and should not be stacked more than two bundles high.

1.07 SEQUENCING AND SCHEDULING

A. Blowers and control valves are specified in 11215 FANS/BLOWERS/PUMPS; OFF-GAS. Installation shall be as specified in Section 02315 and 02316 TRENCH EXCAVATION and FILL AND BACKFILL, except as modified herein or required by ASTM D 2774, ASTM D 2855, ASTM D 3839, or ASTM F 402, as appropriate for the pipe material.

PART 2 PRODUCTS

2.01 DESIGN STRENGTH

A. Design strength of piping shall be suitable for the operating pressure and temperature ranges indicated and/or shown.

B. STEEL PIPE
   1. For exposure potential to pressures less than 70 kPa (10 psig) and temperatures less than 100 degrees C (212 degrees F) and mild chemical exposure surface shall be blasted in accordance with SSPC SP 6. Steel pipe shall be Schedule 40 conforming to Grade A or B, Type E or S of ASTM A 53. Pipe threads shall conform to ASME B1.20.1. Fittings for pipe 1-1/2 inches and smaller shall conform to ASME B16.11. Buttweld fittings for pipe 1-1/2 inches or less shall conform to ASME B16.9. Joint sealing compound shall conform to UL Gas&Oil Dir, Class 20 or less. Polytetrafluoroethylene tape shall conform to ASTM D 3308. Weld neck flanges shall be used. Connections shall conform to ASTM A 181/A 181M, Class 60, carbon steel. Carbon steel components shall be coated with corrosion resistant materials. Coatings and finishes shall be 100 percent holiday free.
   2. Carbon Steel Located Above Grade
      a. Surfaces of aboveground carbon steel components shall be coated in accordance with AWWA C218.

C. POLYVINYL CHLORIDE (PVC) PIPING
   1. Design and fabrication of below grade components of the off-gas piping system shall be in accordance with ASTM D 2513 except as modified herein.
   2. PVC Pipe
      a. Pipe shall be in accordance with ASTM F 442/F 442M, ASTM D 2241, SDR 26. Materials shall conform to ASTM D 3915, ASTM D 1784, Type IV, Grade 1, rigid

(23447-B). The maximum eccentricity of the inside and outside circumferences of the pipe walls shall be 12 percent. Pipe shall be provided which does not fail, balloon, burst, or weep as defined in ASTM D 1598.

3. PVC Joints
   a. Joints shall be pressure rated solvent cemented bell joints in accordance with ASTM D 2672 except where flanged or threaded fittings are required at expansion joints, valves, flowmeter, equipment connections or otherwise shown. Flanges shall be joined to pipe by solvent cementing. Primer shall conform to ASTM F 656. Solvent cement shall conform to ASTM D 2564.
4. PVC Fittings
   a. Fittings shall be in accordance with ASTM D 2466.

D. FLANGED CONNECTIONS
1. Flanges
   a. Flanges shall be Class 150, socket weld, flat face in accordance with ASME B16.5. Drilling and dimensions of flanges, bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class 150. Bolts and nuts shall conform to ASTM A 307.
2. Gaskets
   a. High temperature gaskets for above 160 degrees C (320 degrees F) should be aramid fibers bonded with nitrile butadiene rubber (NBR) or glass fibers bonded with polytetrafluoroethylene. EPDM is suitable for 100 degrees C (212 degrees F) or less. Chloroprene rubber is suitable for 80 degrees C (176 degrees F) or less. Florin rubber (i.e. Viton) and nitrile are suitable for 160 degrees C (320 degrees F) or less. Gaskets shall be full face, non-asbestos compressed material compatible with the expected condensates in accordance with ASME B16.21, 1/16 inch minimum thickness, full face or self-centering flat ring type. Gaskets shall be aramid fibers bonded with nitrile butadiene rubber (NBR) or glass fibers bonded with polytetrafluoroethylene suitable for 200 degrees F service and meeting applicable requirements of ASME B31.8 NFPA 58. High temperature gaskets shall be suitable for above 160 degrees C 320 degrees F.

E. Sealants
1. Sealants shall conform to ASTM C 920.

2.02 EQUIPMENT AND APPURTENANCES

A. Manually Operated Valves
1. Ball valves shall be in accordance with MSS SP-72. Gate, plug, ball, and check valves shall be in accordance with API Spec 6D. Thermoplastic gas shutoffs and valves shall be in accordance with ASME B16.40.

B. Relief Valves
1. Relief valve with manually adjustable pressure differential shall be provided for each blower or vacuum pump. Relief valve diameter shall be line sized or as otherwise indicated and shall be rated to relieve 750 cubic feet per minute at a set vacuum of 70 inches water. Materials shall be aluminum, bronze, or cast iron body, bronze or 316 stainless steel trim, and Buna-N, EPR, nitrile, Viton, or Teflon elastomers. Maximum operating temperature and pressure shall be 200 degrees F and 20 pound per square inch.

C. Insulation
1. Insulation of above grade exterior pipe, fittings and valves shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS

D. Supports for Aboveground Piping
1. Pipe hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and accessories. Design and construction shall be in accordance with MSS SP-58. Specific application shall be in accordance with MSS SP-69. Hanger and supports shall be capable of adjustment after placement of piping. Hangers and supports shall be

the product of one manufacturer. Hangers, supports and accessories shall be hot dip galvanized in accordance with ASTM A 123/A 123 Munless copper or plastic coated. Restrained joints and thrust protection shall be provided. Concrete and metal cradles, collars, floor stands, supports, kickers, and block shall be provided as recommended by manufacturer. Pipe cradle cushion material shall be elastomer sheet strapped to pipe to prevent chafing at pipe support. Elastomer sheet shall be utilized around top of pipe to prevent chafing of pipe strap.

PART 3 EXECUTION

3.01 CONDENSATE CONTROL

A. Off-gas piping shall be sloped uniformly between control elevations to enhance the removal of liquids. Provisions shall be made to collect and drain liquids from condensation in each pipe run by sloping the piping back to teh extraction wells.

3.02 PRESSURE REGULATOR AND METER INSTALLATION

A. Vents
   1. Discharge stacks, vents, or outlet ports of devices shall be located where gas can be discharged into the atmosphere without undue hazard. Vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding. Stacks and vents shall be provided with fittings to preclude entry of water.

3.03 INSTALLING PIPE UNDERGROUND

A. Installation shall be as specified in Section 02315 and 02316 TRENCH EXCAVATION and FILL and BACKFILL, except as modified herein; and as required by ASTM F 402 and ASTM D 2855 for using solvents and cleaners, ASTM D 2774 for polyvinyl chloride and polyethylene pipe, and ASTM D 3839 for fiberglass pipe.

B. Valve Boxes
   1. Valve boxes shall be installed at each underground valve except where concrete or other type of housing is indicated. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 3 square feet. When in a sidewalk, the top of the box shall be in a concrete slab 2 feet square and set flush with the sidewalk. Valve boxes shall be separately supported, not resting on the pipe, so that traffic loads cannot be transmitted to the pipe.

C. Magnetic Tape
   1. When non-metallic piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector.

3.04 INSTALLING PIPE ABOVEGROUND

A. With the exception of vacuum pipe segments as indicated and/or shown, thermoplastic pipe shall not be installed aboveground. Vertical pipe shall be installed plumb in all directions. Perpendicular piping shall be installed parallel to building walls. Piping at angles and 45 degree runs across corners will not be accepted unless specifically shown. Small diameter piping shall be installed generally as shown when specific locations and elevations are not indicated. Piping shall be located to avoid ducts, equipment, and beams. Piping shall be installed to avoid obstructing corridors, walkways, work areas, and like spaces. A minimum headroom clearance of 7 feet shall be provided under piping unless otherwise indicated. Temporary caps or plugs shall be provided at pipe openings at the end of each day's work. Piping shall be run in groups where practicable. Minimum clearance shall be 1 in between pipe and other work.

B. Hangers and Supports
   1. Pipe hangers and supports shall be installed in accordance with MSS SP-89 and MSS SP-69. Hangers or supports shall be installed at locations where pipe changes direction.

Hanger rods shall be installed straight and vertical. Chain, wire, strap or perforated bar hangers will not be permitted. Hangers shall not be suspended from piping. Where proper hanger or support spacing does not correspond with joist or rib spacing, pipe shall be suspended from structural steel channels attached to joists or ribs. Contact between dissimilar metals shall be prevented when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports. Thin walled stainless steel piping shall be isolated from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl. Galvanized or stainless steel hangers and supports shall be used in basins or submerged locations. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

a. Pipe Size Spacing
b. Up to size 1-1/2 in 6 feet.
c. 2 to 3 in 10 feet.
d. Greater than 3-1/2 in 12 feet

2. Maximum support spacing for pipe other than standard weight steel shall be two-thirds of the corresponding spacing for steel pipe unless otherwise shown or approved.

C. JOINTING PIPE

1. Non-metallic piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA Manual. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA Manual.
2. O-Ring Joints
   a. Jointing surfaces and adjacent areas shall be cleaned before making joint. Gaskets and "O"-rings shall be lubricated and adjusted in accordance with manufacturer's recommendations. Each gasket shall be checked for proper position around full circumference aof the joint after "O"-rings are compressed and before pipe is brought fully home. Jointing pipe shall be done in accordance with ASTM D 3139 and manufacturer's recommendations.
3. Mechanical Joints
   a. The plain end shall be centered and pushed into the bell. The gasket shall be firmly pressed evenly into the bell. The gland shall be slipped to the bell for bolting. The bolt threads shall be oiled. Bolts shall be tightened alternately 180 degrees opposite to each other to seat the gasket evenly. Bituminous coating shall be applied to ferrous bolts and nuts before assembly. The maximum torque on bolts shall be as follows:

	Bolt Size	Applied Torque
1)	5/8 in	50 ft-lb
2)	3/4 in	80 ft-lb
3)	1 in	90 ft-lb.
4)	1-1/4 in	110 ft-lb

D. Expansion Couplings

1. Expansion couplings in tension shall be provided to facilitate their removal. Stretcher bolts shall be set for maximum allowable elongation of expansion coupling as recommended by the manufacturer. Expansion couplings shall be provided as shown and as recommended by the manufacturer.

3.05 CONNECTIONS

A. Transitions Between Types of Pipe

1. Necessary adapters, specials and connector pieces shall be provided when connecting different types and sizes of pipe or pipe furnished by different manufacturers. Underground connecting joints shall be encased with, 6 inches minimum, Class B concrete unless otherwise shown, or recommended by manufacturer. Connections between piping and equipment, where required, shall be made using proper fittings to suit the actual conditions.

B. Connections to Off-Gas Source and Discharge Points
   1. Contractor shall connect the off-gas pipelines to the source and discharge locations. The Contractor shall notify the Engineer, in writing, 10 days before final connections and activation of the system.

C. Connection to Equipment
   1. The Contractor shall provide connections to the equipment in accordance with approved procedures. Isolation of equipment shall only be done at the valve location shown on the drawings.

D. Location of Existing Piping
   1. Locations of existing piping shown should be considered approximate. Contractor shall be responsible for determining exact location of existing piping which may be affected by his work during earth moving operations.

3.06 PRESSURE AND LEAKAGE TESTS

A. Tests shall be performed on sections that can be isolated. Joints shall be tested in sections prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. Labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection during the tests. The Contractor shall be responsible for the cost of repair, replacement, and retesting required because of failure to meet testing requirements. Prior to testing the system, the interior shall be blown out, cleaned and cleared of foreign materials. Meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of foreign materials. The Contractor shall maintain safety precautions for pressure testing during the tests. Contractor shall notify Engineer 48 hours in advance of pressure, leakage and/or vacuum testing. Tests shall be conducted in the presence of the Engineer unless otherwise directed. During the test, the entire system shall be completely isolated from compressors and other sources of pressure. Testing shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. Leakage test shall be conducted only after satisfactory completion of pressure test.
   1. Bubble Tests
      a. Each joint shall be tested in accordance with ASTM E 515 prior to backfilling or concealing any work.
   2. Pressure Testing
      a. Test pressure shall be not less than 1.5 times the design pressure, but shall not exceed 1.5 times the maximum rated pressure of the lowest-rated component in the system. Test pressures should recognize the weakest component of each segment tested for the design pressure and the maximum allowable operating pressure. Backfill shall be placed and compacted to at least the pipe centerline before testing. Concrete for blocking shall be allowed to reach design strength and shall be backfilled and compacted to assure restraint by harnessed joints before testing. Section to be tested shall be slowly filled with air. Corporation cocks shall be installed as necessary to remove air. Test pressure shall be applied for one hour and gauge pressure shall be observed. Leaks shall be continuously checked while test pressure is being maintained. The off-gas piping system shall be tested after construction and before being placed in service using air as the test medium. The pressure test shall continue for at least 1 hour from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of the test pressure, 100 psig, applied at the lowest elevation of the pipeline section, during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship $T(1)P(2)=T(2)P(1)$, in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. Lines which fail to

hold specified test pressure or which exceed the allowable leakage rate shall be repaired and retested.

3. Vacuum Testing
   a. Test shall be performed on individual sections as approved by the Engineer. Openings shall be sealed in system or section to be tested. Vacuum 30 inches water shall be pulled for one hour (isolating system from vacuum by closing valves). System shall be allowed to normalize and then the initial vacuum readings shall be recorded. The vacuum shall be recorded at intervals of 1/4 hour for the duration of the 1 hour test. Measurable leakage (loss of vacuum) after corrections have been made for changes in atmospheric conditions in conformity with the relationship T(1)P(2)=T(2)P(1), in which T and P denote absolute temperature and total pressure, respectively, and the numbers denote initial and final readings, shall be repaired and retested.
4. Hanger Acceptance Testing
   a. Pipe systems shall be brought up to operating pressures and temperatures. Systems shall be recycled to duplicate operating conditions.

3.07 Demonstration

A. Upon completion of the work and at a time designated by the Engineer, the services of qualified presonnel shall be provided by the contractor for a period of not less than 8 hours to instruct a representative of the Owner in the operation and maintenance of equipment furnished under this section.

END OF SECTION

SECTION 02200

SITE PREPARATION

PART 1 GENERAL - NOT USED

PART 2 PRODUCTS - NOT USED

2.01 MATERIALS

A. Fill Material: As specified in Section 02316 - Fill and Backfill

PART 3 EXECUTION

3.01 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to JCI.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to JCI.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.02 DEBRIS

A. Remove concrete rubble in area of soil vapor extraction system and move to JCI designated area on-site to allow for placement of geotextile as specified in Section 02372.

3.03 West Well Piping Abandonment

A. Contractor will cut the exisitng galvanized metal pipe on each ends leading from the West well to the air stripper. Any liquids in the piping shall be removed and containerized for treatment by Owner. The ends of the piping shall be capped and the pipe abandoned in-place.

END OF SECTION

SECTION 02315

TRENCH EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for slabs-on-grade, paving, site structures, and groundwater and vapor piping.

B. Trenching for utilities outside the building to utility main connections.

1.02 RELATED SECTIONS

A. Section 02316 - Fill and Backfill: Fill materials, filling, and compacting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

3.02 TRENCH EXCAVATING

A. Trench bottoms shall be over-excavated to accommodate the installation of granular bedding as detailed on the drawings. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 1-inch or greater in any dimension or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing or unless otherwised indicated by Engineer.

B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Where rocks and gravelly soils with stones greater than 4 inches in any dimension or as defined by the pipe manufacturer are encountered in the bottom of the trench, such material shall be removed 6 inches below the required grade and replaced with suitable materials as provided in Section 02316.

D. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored. Furnish, place and maintain such sheeting, bracing and shoring as may be required to support the sides and ends of excavations in such manner as to prevent any movement which could, in any way, damage the pipe, structures, or other work; diminish the width necessary for construction; otherwise damage or delay the work of the Contract; endanger existing structures, pipes or pavements; or cause the excavation limits to exceed the right-of-way limits.

E. Cut trenches wide enough to allow inspection of installed utilities.

F. Hand trim excavations. Remove loose matter.

G. Discontinue machine excavation in the vicinity of pipes, conduits and other underground structures and facilities and complete the excavation with hand tools as required by Industrial Code Rule 53. When determination of the exact location of a pipe or other underground structure is necessary for completing the work properly, excavate test holes to determine such locations.

H. Where unsuitable or unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in Section 02316. When removal of unsuitable or unstable material is required due to the fault or neglect of the Contractor in his performance of the Work, the

resulting material shall be excavated and replaced by the Contractor without additional cost to the Owner.

I. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and remove all such water as fast as it may collect, in such a manner as shall not interfere with the progression of the work or the proper placing of pipes, or other work.

J. Minimize the creation and dispersion of dust.

K. Stockpile excavated material to be re-used in area designated on site.

3.03 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

SECTION 02316

TRENCH FILL AND BACKFILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for slabs-on-grade, paving, and water and soil vapor piping.

B. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED SECTIONS

A. Section 02315 - Excavation: Removal and handling of soil to be re-used.

B. Section 03300 - Cast-In-Place Concrete.

1.03 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 1997.

B. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2000a.

C. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.

D. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2000.

E. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994.

F. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2000.

G. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2001.

H. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2001.

I. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2000.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

3.02 TRENCH BACKFILLING AND COMPACTION

A. Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified.

B. Each layer shall be compacted to not less than 98% of laboratory maximum density.

C. Trenches shall be backfilled to the grade shown on construction drawings. The trench shall not

be backfilled until all specified tests are performed.

D. Initial backfill material shall be placed and compacted with approved tampers to a height of at aleast one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

E. Bedding shall conform to the details shown of the drawings. Material shall be deposited in 6 inch loose layers and compacted with approved methods to at least 98 percent maximum density. Bedding shall consist of select native material.

F. Other areas: Use native material, flush to required elevation, compacted to minimum 98 percent of maximum dry density.

3.03 SPECIAL REQUIREMENTS

A. Under paving, slabs-on-grade, and similar construction: 98 percent of maximum dry density.

B. Special requirements for both excavation and backfill relating to the specific utilities are as follows:
   1. Electrical Distribution Conduit: Direct burial cable and conduit shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated.

END OF SECTION

SECTION 02372

GEOMEMBRANE SURFACE LINER

PART 1 GENERAL

1.01 REFERENCES

A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) (1999) Tensile Properties of Plastics

B. ASTM D 6497 (2000) Mechanical Attachment of Geomembrane to Penetrations or Structures

C. ASTM D 792 (1998) Density and Specific Gravity (Relative Density) of Plastics by Displacement

D. ASTM D 1204 (1994) Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

E. ASTM D 1505(1998) Density of Plastics by the Density-Gradient Technique

1.02 SYSTEM DESCRIPTION

1.03 SUBMITTALS

A. The following submittals must be forwarded to the Engineer 7 days prior to geomembrane placement upon request:
   1. Shop Drawings Layout and Detail Drawings
   2. Geomembrane penetration detail drawings
   3. Manufacturer's and fabricator's QC manuals
   4. Field Seaming procedures

1.04 QUALIFICATIONS

A. Manufacturer
   1. Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects having a total minimum area of 5 million square feet.

B. Fabricator
   1. The fabricator is responsible for seaming geomembrane sheets into panels. Fabricator shall have fabricated the proposed geomembrane panels for at least 5 completed projects having a total minimum area of 2 million square feet.

C. Installer
   1. The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 100,000 square feet. At least one seamer shall have experience seaming a minimum of 10,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Poly-Flex, Inc.

B. Substitutions: See Section 01600 - Product Requirements.

2.02 MATERIALS

A. HDPE Liner: 40 millimeter.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Preparation:
   1. Surface preparation shall be performed in accordance with Section 02200. Rocks larger than 4 inch in diameter and any other material which could damage the geomembrane shall be removed from the surface to be covered with the geomembrane. Construction equipment tire or track deformations beneath the geomembrane shall not be greater than 1.0 inch in depth. Each day during placement of geomembrane, the Engineer and installer shall inspect the surface on which geomembrane is to be placed and certify that the surface is acceptable. Repairs to the subgrade shall be performed at no additional cost to the Owner.

B. Anchor Trenches
   1. Where an anchor trench is required, it shall be placed 24 inches back from the edge of the slope to be covered. The anchor trench shall be 24 inches deep and 18 inches wide. If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of geomembrane in a single day shall be excavated. Ponded water shall be removed from the anchor trench while the trench is open. Trench corners shall be slightly rounded to avoid sharp bends in the geomembrane. Loose soil, rocks larger than 1/2 inch in diameter, and any other material which could damage the geomembrane shall be removed from the surfaces of the trench. The geomembrane shall extend down the front wall and across the bottom of the anchor trench. Backfilling and compaction of the anchor trench shall be in accordance with Section

3.02 GEOMEMBRANE DEPLOYMENT

A. The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Geomembrane damaged during installation shall be replaced or repaired. Only geomembrane panels that can be anchored and seamed together the same day shall be deployed. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. No equipment shall be operated on the top surface of the geomembrane without permission from the Engineer. Seams shall be oriented parallel to the line of maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel.
   1. Wrinkles: The methods used to deploy and backfill over the geomembrane shall minimize wrinkles and tensile stresses in the geomembrane. The geomembrane shall have adequate slack to prevent the creation of tensile stress. The wrinkle height to width ratio for installed geomembrane shall not exceed 0.5. In addition, geomembrane wrinkles shall not exceed 6 inches in height. Wrinkles that do not meet the above criteria shall be cut out and repaired.

3.03 FIELD SEAMING

A. Trial Seams
   1. Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D 6392. One sample shall be obtained from each trial seam. This sample shall be at 36 inches long by 12 inches widewith the seam centered lengthwise.

B. Field Seams
   1. Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. In sumps, corners and odd-shaped geometric locations, the number of

field seams shall be minimized. Seaming shall extend to the outside edge of panels. Soft subgrades shall be compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. Fish mouths in seams shall be repaired.

C. Polyethylene Seams
   1. Polyethylene geomembranes shall be seamed by thermal fusion methods. Extrusion welding shall only be used for patching and seaming in locations where thermal fusion methods are not feasible. Seam overlaps that are to be attached using extrusion welds shall be ground prior to welding. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement. Extrusion welding shall begin within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks shall be no greater than 10 percent of the sheet thickness.

D. Non-Polyethylene Seams
   1. Non-polyethylene geomembranes shall be seamed by methods as recommended by the geomembrane manufacturer. Seaming adhesives, solvents, or chemical cleaning agents shall be stored away from the geomembrane and only spill-resistant containers shall be used while working on the geomembrane. If low temperatures slow the curing process of chemically fused seams and delay seam testing, shall be used to accelerate sample curing.

3.04 DEFECTS AND REPAIRS

A. Destructive Seam Test Repairs: Seams that fail destructive seam testing may be overlaid with a strip of new material and seamed (cap stripped). Alternatively, the seaming path shall be retraced to an intermediate location a minimum of 10 feet on each side of the failed seam location.

B. Patches, Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming.

C. VISUAL INSPECTION AND EVALUATION
   1. Immediately prior to covering, the geomembrane, seams, and non-seam areas shall be visually inspected by the Engineer for defects, holes, or damage due to weather conditions or construction activities. At the Engineer's discretion, the surface of the geomembrane shall be brushed, blown, or washed by the installer if the amount of dust, mud, or foreign material inhibits inspection or functioning of the overlying material.

D. PENETRATIONS
   1. Geomembrane penetration details shall be in accordance with ASTM D 6497 or as recommended by the geomembrane manufacturer. Factory fabricated boots shall be used wherever possible. Field seams for penetrations shall be non-destructively tested in accordance with the installer"s QC manual.

E. PROTECTION AND BACKFILLING
   1. The deployed and seamed geomembrane shall be covered with the specified material within 14 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of cover materials. Cover soil shall not be dropped onto the geomembrane or overlying geosynthetics from a height greater than 3 feet. The soil shall be pushed out over the geomembrane or overlying geosynthetics in an upward tumbling motion. Soil shall be placed from the bottom of the slope upward. The initial loose soil lift thickness shall be 12 inches. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the geomembrane. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

END OF SECTION

SECTION 02526

GROUNDWATER AND VAPOR EXTRACTION WELLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide extraction wells including drilling, casing, well screen, gravel packing, grouting, development, monitoring device, and incidental related work complete and ready for operation].

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)..ASTM A 53(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

C. ASTM A 312/A 312M(1995; Rev. A) Seamless and Welded Austenitic Stainless Steel Pipes..ASTM C 117(1995) Materials Finer than 75-Micrometer (No. 200) Sieve in Mineral Aggregates by Washing

D. ASTM C 136(1996; Rev. A) Sieve Analysis of Fine and Coarse Aggregates

E. ASTM C 150(1997) Portland Cement

F. ASTM D 1586(1984; R 1992) Penetration Test and Split-Barrel Sampling of Soils

G. ASTM D 1587(1994) Thin-Walled Tube Geotechnical Sampling of Soils..ASTM D 1785(1996; Rev. B) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

H. ASTM D 2487(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

I. ASTM D 2488(1993) Description and Identification of Soils (Visual-Manual Procedure)

J. ASTM D 4397(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

K. ASTM D 5088(1990) Decontamination of Field Equipment Used at Nonradioactive Waste Sites

L. ASTM D 5092(1990; R 1995) Design and Installation of Ground Water Monitoring Wells in Aquifers

M. ASTM F 480(1995) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

N. ASTM F 883(1997) Padlocks

O. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

P. 29 CFR 1910 Occupational Safety and Health Standards

Q. U.S. ARMY CORPS OF ENGINEERS (USACE)..EM 385-1-1(1996) Safety and Health Requirements Manual

R. U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)..EPA 600-4-89-034(1989) Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells

S. EPA 600/4-79/020(1976) Contaminant Monitoring

1.03 SYSTEM DESCRIPTION

A. Each system, including equipment, materials, installation, and performance, shall be in accordance with local, State, and Federal regulations, ASTM D 5092, and EPA 600-4-89-034 except as modified herein.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data on:
   1. Well casing
   2. Well screen
   3. Filter pack
   4. Neat cement grout
   5. Bentonite seal
   6. Well Development Report
   7. Well Construction Permit

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store plastic piping and jointing materials, and rubber gaskets under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

1.06 QUALITY ASSURANCE

A. Well Construction Permit
   1. Submit a completed permit application and a proposed method of construction to the appropriate state agency prior to construction of the well. Construction of the well[s] will not be allowed until an approved Well Construction Permit has been submitted to the Engineer.

PART 2 PRODUCTS

2.01 WELL CASING

A. Stainless Steel Piping
   1. ASTM A 312/A 312M, Type 304, Schedule 40S, with flush threaded joint end fittings. Threaded joints shall be wrapped with flouropolymer tape, and provided with nitrile O-ring gaskets.

B. PVC Piping
   1. ASTM F 480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule [40] [80], with flush threaded joint fittings. Threaded joints shall be wrapped with flouropolymer tape, and provided with nitrile O-ring gaskets.

2.02 WELL SCREEN

A. Well screens shall be located as indicated. The length of the screen shall be as indicated. Slot size shall be 0.01 or 0.02 inch as indicated on costruction drawings. Slotted openings shall be distributed uniformly around the circumference of the screen. Open area shall approach the formation's natural porosity.

B. Stainless Steel Screens
   1. ASTM A 312/A 312M, Type 304, Schedule 40S, continuous slot construction, wire wound, with flush threaded joint ends.

C. PVC Screens

1. ASTM D 1785, PVC 1120, NSF wc or NSF pw, Schedule [40] [80], screen, Schedule 80, machine-slotted construction, flush threaded joint ends. Slots shall be even in width, length, and separation.

2.03 FILTER PACK

A. Provide clean, durable, well-rounded, and washed quartz or granite, with less than 5 percent non-siliceous material. The filter pack shall not contain organic matter or friable materials. The filter pack shall allow free flow of water in the well, and shall prevent the infiltration of aquifer materials. Filter pack shall have a uniformity coefficient less than 1.5, in accordance with and ASTM C 136.

2.04 ANNULAR SEALANTS

A. Bentonite Seal

B. Provide powdered, granular, pelletized, or chipped sodium or calcium montmorillonite in sealed containers from a commercial source, free of impurities. Diameter of pellets shall be less than one fifth the diameter of the borehole annular space to prevent bridging. Bentonite base grout shall be in accordance with ASTM D 5092.

C. Neat Cement Grout

D. Provide neat cement grout in accordance with ASTM D 5092. Cement shall be in accordance with ASTM C 150. Quick setting admixtures shall not be allowed. Drilling mud or cuttings shall not be used as a sealing material.

2.05 BOTTOM PLUGS

A. Provide flush threaded solid plug at the bottom of the well. Plug shall be the same material as the well screen to which it is attached. Joints shall be wrapped with fluoropolymer tape and provided with nitrile O-ring gaskets.

2.06 LOCKING WELL CAP

A. Provide flush threaded, and weatherproof well cap on the top of the well. Well cap shall be of the same material as the well casing to which it is attached. Well cap shall accommodate padlock.

2.07 WELL HEAD COMPLETIONS

A. Clearly mark and secure the well to avoid unauthorized access and tampering.

B. At-Grade Completions
1. Provide cast iron vault box, 36 by 36 inches or 24 by 24 inches as specified with watertight frame and cover. Vault shall support H-20 loading. The frame shall be 12 inches deep, and shall be set in a concrete collar a minimum of 8 inches thick, and extending 4 inches beyond the edge of the frame in all directions. Frame and concrete collar shall be set flush with the level of the existing pavement. Locking well cap shall be provided on top of the well casing, which will terminate inside the vault as indicated.

PART 3 EXECUTION

3.01 GENERAL

A. Notify the Contracting Officer at least 15 days prior to commencement of work. Location[s] of well[s] shall be as indicated. Drilling, installation, and development of the extraction well[s] shall be supervised, directed, and monitored by the Engineer. Drilling, sampling, and well development equipment introduced to the well shall be decontaminated before and after each use in accordance with ASTM D 5088.

3.02 DRILLING

A. Borehole shall be advanced using conventional hollow-stem auger drilling methods. If it is the

opinion of the Engineer that an alternate drilling method is required, justification for a boring method change shall be submitted to the Engineer, and approval for the change granted prior to drilling. Drill crew shall be experienced and trained in drilling and safety requirements for contaminated sites.

B. **Alignment**
   1. Verify that the well is straight by lowering a 10 foot section of 2 inch diameter steel pipe in to the well.

3.03 WELL INSTALLATION

A. Well installation shall be in accordance with ASTM D 5092 and EPA 600-4-89-034, and as indicated on the well construction drawings. Borehole shall be stable and shall be verified straight before beginning installation.

B. Casings and Screens
   1. Well casings, screens, plugs, and caps shall be decontaminated prior to delivery by the manufacturer and shall be certified clean. Materials shall be delivered, stored, and handled in such manner as to ensure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly prior to installation. If directed by the Engineer, the well screen and casing assembly shall be cleaned with high pressure water prior to installation. Personnel shall wear clean cotton or surgical gloves while handling the assembly. Centralizers shall be used to ensure that the well screen and casing assembly is installed concentrically in the borehole. When the assembly has been installed at the appropriate elevation, it shall be adequately secured to preclude movement during placement of the filter packs and annular seals. The top of the well casing shall be capped during filter pack placement.

C. Filter Packs
   1. Primary and secondary filter packs shall be placed as indicated on the approved well construction drawings to fill the entire annular space between the screen and casing assembly and the outside wall of the borehole. Place both the primary and secondary filters with a tremie pipe in accordance with EPA 600-4-89-034 and ASTM D 5092. Placement of the primary and secondary filters by gravity or free fall methods is not allowed. Control speed of filter placement to prevent bridging and to allow for settlement. Prior to commencement of work, equipment and methods required to place filters shall be approved by the Engineer

D. Bentonite Seal
   1. Bentonite shall be placed as a slurry through a tremie pipe. Control speed of bentonite placement to prevent bridging or segregation of slurry. Additional water shall be added to the annular space as directed by the Engineer to ensure complete hydration of the bentonite. Bentonite shall cure a minimum of 48 hours before the placement of cement grout to ensure complete hydration and expansion of the bentonite.

E. Neat Cement Grout
   1. Cement grout shall be placed in the annular space above the bentonite seal as indicated on the well construction drawings. Cement grout shall be placed as a slurry through a tremie pipe, and injected under pressure to reduce chance of voids. Grout shall be injected in one continuous operation until full strength grout flows out at the ground surface without evidence of drilling cuttings or fluid. Cement grout shall cure a minimum of 48 hours before beginning well development operations.

F. Well Head Completions
   1. Well head completions shall be as indicated and as specified herein.

3.04 WELL DEVELOPMENT

A. Well development shall be in accordance with EPA 600-4-89-034 and ASTM D 5092 except as modified herein. Bailing, surging, and pumping/overpumping/backwashing are acceptable

development methods. Air surging and jetting are prohibited. Method of development shall be chosen by the Engineer. Well development shall not begin until the well installation is complete and accepted by the Engineer. Well development operations shall be conducted continuously until development water flows clear and free of drilling fluids, cuttings, or other materials.

3.05 WATER FROM WELL DEVELOPMENT OPERATIONS

A. Water from the well development operations shall be containerized for processing by the Owner.

3.06 INSTALLATION SURVEY

A. Upon completion of well installation and development and acceptance by the Engineer, the vertical and horizontal position of each well shall be determined by a registered land surveyor licensed in the State of New York. The survey shall document the vertical elevations of the top of the casing pipe and the ground surface elevation adjacent to each well. The survey shall also determine the horizontal location of each well. Survey shall be accurate to the nearest 0.01 foot.

3.07 CLEANUP

A. Upon completion of the well construction, remove debris and surplus materials from the jobsite.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete foundations and anchor bolts for pre-engineered building.

B. Concrete reinforcement.

PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A 615/A 615M Grade 40 (280).

2.02 CONCRETE MATERIALS

A. Cement: ASTM C 150, Type I - Normal Portland type.

B. Fine and Coarse Aggregates: ASTM C 33.

C. Water: Clean and not detrimental to concrete.

D. Fiber Reinforcement: Synthetic fiber shown to have long-term resistance to deterioration when exposed to moisture and alkalis; 1/2 inch length.

2.03 CONCRETE MIX DESIGN

A. Concrete Strength: Establish required average strength as specified on drawings for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

B. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.

PART 3 EXECUTION

3.01 INSTALLING REINFORCEMENT

A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.02 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

C. Place concrete continuously between predetermined expansion, control, and construction joints.

D. Do not interrupt successive placement; do not permit cold joints to occur.

3.03 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

END OF SECTION

SECTION 11181

GROUNDWATER EXTRACTION PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 REFERENCES

A. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

B. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 1998.

C. Local and state regulations and codes

D. Electrical codes (NEC)

E. Underwriters Laboratories, Inc. (UL)

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide equipment dimensions, piping and controls.

C. Manufacturer's Instructions

D. Maintenance Data.

E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in JCI's name and registered with manufacturer.

PART 2 PRODUCTS

2.01 ELECTRIC GROUNDWATER PUMPING EQUIPMENT

A. Provide quantity and description as shown on drawings.

B. Manufacturers:
   1. Grundfos Model SP14A-3.
   2. Grundfors Model SP30-3.
   3. Substitutions: See Section 01600 - Product Requirements.

2.02 ELECTRICAL AND CONTROLS

A. Design, provide and install electrical equipment and wiring as needed to operate the well pump motors. Equipment to be provided includes:
   1. Current sensor motor controls to automatically run motors until low current is sensed at low well water level.
   2. Current sensor control units to include adjustible delay after low level is sensed. Minimum adjustable range from 9 minutes to 6 hours.

2.03 ACCESSORIES

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and applicable code requirements.

3.02 WELL PUMP/MOTOR

A. Well pump/motor assembly will be installed per manufacturers specifications and as shown in the Drawings.

3.03 ELECTRICAL AND CONTROLS

A. Design and provide all electrical wiring to operate the well pumps, controls, current sensing unit, and install the same in accordance with manufacturer's specifications and as shown on the Drawings.

B. Connect proposed pump motors to existing PLC unit.

END OF SECTION

SECTION 11215

FANS, BLOWERS, AND PUMPS; OFF-GAS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Capacity and design of the air moving equipment and accessories shall be suitable for 24-hour full load service in an indoor location.

B. **Service Conditions**
   1. Service vapor collected from subsurface remediation unit.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)..AMCA 99(1986) Standards Handbook

C. AMCA 210(1985) Laboratory Methods of Testing Fans for Rating

D. AMCA 300(1996) Reverberant Room Method for Sound Testing of Fans

E. AMCA 301(1990) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

F. AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)ABMA 9(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

G. ABMA 11(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings

H. AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)..ACGIH-2092(1998) Industrial Ventilation: A Manual of Recommended Practice (24th ed.)

I. AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA) AGMA 6011(1997; Rev H) Specifications for High Speed Helical Gear Units

J. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)B109.2(2000) Diaphragm Type Gas Displacement Meters (500 Cubic Feet per Hour Capacity and Over)

K. ANSI S2.19(1989; R 1997) Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Residual Unbalance

L. AMERICAN PETROLEUM INSTITUTE (API) Spec 6D(1994; Supple 1 June 1996; Supple 2 Dec 1997) Pipeline Valves (Gate, Plug, Ball, and Check Valves)

M. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) ASTD 4167(1997) Fiber-Reinforced Plastic Fans and Blowers

N. ASTM F 1139(1988; R 1998) Standard Specification for Steam Traps and Drains..ASTM F 1508(1996) Specification for Angle Style, Pressure Relief Valves for Steam, Gas, and Liquid Services

O. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)..ASHRAE 52.1(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

P. ASME INTERNATIONAL (ASME)..ASME B16.1(1998) Cast Iron Pipe Flanges and Flanged Fittings

Q. ASME B16.5(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24

R. ASME B16.40(1985; R 1994) Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

S. ASME B40.1(1991) Gauges - Pressure Indicating Dial Type - Elastic ElementASME PTC 19.3(1974; R 1998) Instruments and Apparatus: Part 3 Temperature Measurement

T. ASME BPVC SEC VIII D1(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

U. ASME PTC 25(1994) Pressure Relief Devices

V. INSTRUMENT SOCIETY OF AMERICA (ISA)..ISA MC96.1(1982) Temperature Measurement Thermocouples

W. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)..MSS SP-25(1998) Standard Marking System for Valves, Fittings, Flanges and Unions

X. MSS SP-72(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service

Y. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)..NEMA ICS 1(1993) Industrial Controls and Systems

Z. NEMA ICS 6(1993) Industrial Control and Systems, Enclosures

AA. NEMA MG 1(1998) Motors and Generators

AB. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)..NFPA 70(1999) National Electrical Code

AC. NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)..NIST SP 250(1995) Calibration Service Users Guide

AD. WATER ENVIRONMENT FEDERATION (WEF)..WEF MOP OM-5(1984)Prime Movers: Engines, Motors, Turbines, Pumps, Blowers & Generators

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.
   1. Drawings showing dimensions of the equipment and layout of the off-gas system and subsystems, including location of components, layout and anchorage of equipment and appurtenances, equipment relationship to other parts of the work, clearances for maintenance and operation.
   2. Detailed Process Flow Diagram
   3. Piping and instrumentation diagram (P&ID) indicating: process equipment; instrumentation; piping and valves; stacks, vents and dampers; control equipment (including sensors, process controllers, control operators, valves, interlocks, and alarms); labels and other necessary information to correlate to the process flow diagram. The P&ID shall include blowers and pumps, valves and other in-line devices.
   4. Control System
      a. Wiring and ladder diagrams.
      b. Control sequences showing the control of the entire system
      c. Instrumentation; Detailed manufacturer"s data on the overall controls, sensors, process controllers, control operators, valves, interlocks and alarms. Data describing in detail the equipment used
   5. Air Moving Equipment; Capacities and pressure differentials; performance charts and curves (including the complete selection of impeller sizes for a given casing for centrifugal blowers). Make and model, catalog cuts, manufacturer's descriptive and technical literature, including installation instructions.
   6. Diagrams and instructions, framed under glass or in approved laminated plastic, shall be posted where directed before acceptance testing of the systems.
   7. Condensed operating instructions in typed form explaining preventative maintenance

procedures, safe methods of checking the equipment for normal operation, and safe procedures for starting and stopping the equipment.

8. Complete list of equipment and materials. A listing covering component items forming a system or items that are interrelated and scheduled to be coordinated and submitted concurrently.
9. Three complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. The operating instructions shall include the following for system components: manufacturer"s name, model number, service manual, parts list, and brief description of each piece of equipment and its basic operating features; flow diagrams; system layout showing piping, valves, and controls; as-built wiring and control diagrams; control sequence describing startup, operation, and shutdown; manufacturer"s bulletins, cuts, and descriptive data.
10. Three complete copies of maintenance instructions for each piece of equipment including the following: manufacturer"s complete list of parts, recommended spare parts and supplies, with current unit prices and source of supply; routine maintenance procedures, including the requirements of WEF MOP OM-5, as a minimum; possible breakdowns and repairs; a troubleshooting guide to help the operator determine what steps must be taken to correct any equipment problems.
11. Warranty: Submit manufacturer warranty and ensure that forms have been completed in JCI's name and registered with manufacturer.

1.04 QUALIFICATIONS

A. Contractor
   1. Contractor shall have a minimum of 2 years of experience in the construction of systems for handling sour gas, condensable gas, off-gas or vapor.

B. Single Source Supplier
   1. The Contractor shall assign to a single supplier full responsibility for the furnishing of the off-gas moving system. The designated single supplier, however, need not manufacture the system but shall coordinate the selection, assembly, installation, and testing of the entire system as specified herein.

C. Manufacturer's Representative
   1. Services of a manufacturer's field service representative who is experienced in the installation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system shall be provided.

1.05 GENERAL REQUIREMENTS

A. Standard Products
   1. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate equipment that has been in satisfactory operation at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site. Pieces of equipment of the same types shall be products of the same manufacturer. Equipment shall be new and unused, except for test equipment. Materials may be reprocessed/recycled with equivalent durability and product warranty/guarantee.

B. Nameplates
   1. Each piece of equipment shall have a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each air moving unit shall show the capacity in standard cubic feet per minute (SCFM) at rated speed in rpm and head in inches of water. Nameplate for each electrical motor shall show, at least, the minimum information required by paragraph 10.38 of NEMA MG 1. Any other information that the manufacturer may consider necessary to complete identification shall be shown on the nameplate.

C. Verification of Dimensions
   1. After becoming familiar with details of the work, the Contractor shall verify all dimensions in the field and shall advise the Engineer of any discrepancy before performing the work.

1.06 DELIVERY AND STORAGE

A. Equipment delivered and placed in storage shall be stored in a clean, dry location and covered for protection against dust and moisture. Equipment stored longer than 60 days shall have silica bags suspended in the outlet and inlet of unit, bearings shall be filled full of grease, unit shall be filled with oil, machine surfaces shall be coated with grease, and entire unit shall be enclosed with plastic or tarps. Shaft of rotating equipment including motors shall be turned every two weeks to prevent flat spots on bearings.

1.07 SEQUENCING AND SCHEDULING

A. Details of and requirements for vapor extraction well construction and treatment equipment are included in other sections of this specification. The Contractor shall notify the Engineer of any deviations from head conditions specified for the source and discharge to ensure coordination with this Section. Pipe and valves not specified in this Section shall be in accordance with Section 02150 PIPING; OFF-GAS.

1.08 EXTRA MATERIALS

A. Auxillary equipment, tools and spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall protect and safeguard the equipment, tools and parts until completion of the work, at which time they shall be delivered to the Engineer. Auxiliary equipment and spare parts shall be furnished as follows:
   1. Spare parts for each different item of material and equipment specified including the parts recommended by the manufacturer to be replaced after 1 year service.
   2. For each air mover: one extra of each part used that is made from glass, hard rubber, or clear plastic; one complete set of gaskets; 2 air intake filter replacement cartridges.
   3. One complete set of special tools, calibration devices, and instruments as required for operation, calibration, and maintenance of the equipment shall be provided. Special tools are considered to be those tools which, because of their limited use, are not normally available but which are necessary for the particular equipment. Special tools shall be high-grade, smooth, forged, alloy, tool steel.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Contractor shall provide skid-mounted soil vapor extraction system enclosed in UL approved pre-engineered building in accordance with construction drawings. Acceptable manufacturers include:
   1. Maple Leaf
   2. BISCO Environmental
   3. Product Level Control Inc.

2.02 AIR MOVING EQUIPMENT

A. Air moving equipment shall be furnished and installed complete with drive units, filters, controls and appurtenances indicated or specified. Equipment shall be capable of operating at partial-load conditions without increased vibration over the normal vibration at full load operation and shall be capable of continuous operation down to the lowest step of unloading. Each unit shall be provided with unloading, vibration isolators, thermal overloads, high-and-low pressure safety cutoffs, low oil pressure cutout, internal motor-winding temperature sensing protection device, internal pressure relief valve, a complete oil charge, and protection against short cycling.

B. FANS
   1. Regenerative
      a. A EG&G Rotron regenerative blower shall be provided capable or delivering 750 scfm

at 67 inches of water vacuum.

2.03 INTAKE FILTER

A. Intake filter shall be installed on inlet to each unit.

B. Efficiency
   1. Intake filter shall be at least 90 percent efficient when tested in compliance with ASHRAE 52.1 dust spot method.

C. Surface Area
   1. Minimum filter surface area shall be 1 square foot per 25 cubic feet per minute to produce a filter flow through velocity of less than 0.127 meters per second. 25 feet per minute.

D. NOISE MINIMIZATION
   1. Silencer
      a. Each blower shall be provided with inletand discharge silencers. Silencers shall be for standard grade silencing. Intake silencers shall be of the absorption, canister, or chamber type. Discharge silencers shall be of the absorption, canister, or chamber type. Canister type silencer shall be constructed of two concentric perforated cylinders lined with high temperature acoustical packing forming an annular flow path, with an internal plug creating a blocked line of sight. Silencer size shall be as recommended by the silencer manufacturer and shall be compatible with the blower requirements. Silencer connections shall match the adjacent piping. Mounting brackets shall be provided as required for silencer support. Silencer shall be constructed of heavy-duty rolled and welded steel plate with the inner liner welded to the outer shell to acoustically deaden the outer shell.

2.04 MONITORING

A. Each unit shall be equipped for monitoring the flow downstream of any bypass connections. Calibration of sensors shall be with standards traceable to NIST and in conformance with NIST SP 250.

B. Flow
   1. A turbine type flow meter shall be provided for measuring the process flow. Accuracy shall be within 0.5 percent of full scale.

C. Temperature
   1. Thermometers shall conform to ASME PTC 19.3 with wells and temperature range suitable for the use encountered. Thermometers shall be provided to indicate inlet air temperature, discharge air temperature. Thermometers shall be either red-reading mercury-in-glass type or dial type. Scale range shall include full range of expected operation and up to 125 percent, but not more than 150 percent of maximum. Accuracy shall be within 0.5 percent of full scale.

D. Pressure
   1. High and low pressure connections shall be 1/4 inch NPT female with a suitable shutoff cock at each connection. The high pressure connection to the gauge shall have a 10 micrometer (10 micron) 10 micron pleated paper filter and the low pressure connection shall have a fine mesh stainless steel strainer.

E. Draft Gauge
   1. Gauge shall conform to ASME B40.1 with a diaphragm or bellows actuating system, a circular scale and a zero adjustment screw. Inlet gauges shall have a range 0 to 100 inches water gauge vacuum. Gauges shall include the accessories for pipe mounting.

F. Pressure Gauge
   1. Gauges shall conform to ASME B40.1 with a single Bourdon tube style actuating system, a circular scale and a zero adjustment screw. Discharge gauges shall have a range of 0 to 11 psi. Gauges shall include the accessories for pipe mounting.

G. Differential Pressure Gauge
   1. The housing of each unit shall be equipped with a direct-reading gauge that measures the differential pressure range 0 to 14.5 psi with an accuracy of plus or minus 2 percent of full scale, calibrated linearly with 0.34 psi scale graduations. During operating conditions the pointer shall be within the mid-range of the gauge. Accuracy shall be within 0.5 percent of full scale.

H. Sampler
   1. Sampling port and equipment for collecting discrete and composite samples shall be provided with adequate access for personnel and equipment.

2.05 CONTROL SYSTEM

A. Unit shall have an automatic control system. Automatic controls shall be responsible for the balancing of the capacity with system requirements. These controls shall automatically balance the equipment capacity with the load. The system shall be provided with the necessary control devices required for normal operation. The automatic controls shall also include each of the following: a safe system operating mode when controls fail, indications for system failure, protective mechanisms and controls that are required for the safe operation of system equipment in an enclosure conforming to NEMA ICS 4.

B. Sequence of Control
   1. The sequence of control shall be as follows:
      a. Shut-down blower when moisture separator is full and trip visual alarm
      b. Timer to automatically turn-on and off the SVE blower.

C. Sequence of Equipment Operation
   1. Logic shall be included to allow for automatic or manual alternation of lead/lag/standby assignments of units installed in parallel. Instrumentation to modulate the pressure and volume output as well as start or stop units shall be included to meet pressure and/or volume demands. Controls shall include start and stop push button switches, hand-off-automatic (H-O-A) switches where the system controls operation.

2.06 Panel

2.07 Protective Devices

A. Blower protective devices, upon alarm condition, shall cause immediate de-energization of the motor, shall initiate the automatic shutdown sequence, and shall provide audible and visual alarm indication.

B. Surge and Overload Protection
   1. A set-point controller shall monitor current input to the motor. The controller shall initiate automatic shutdown sequence and give visual indication of reason for shutdown if surge conditions are indicated by the motor current. Manual control and override shall be provided to enable equipment startup and shutdown.

C. Oil Temperature and Pressure
   1. Temperature and pressure sensors with switches shall be installed on each oil pump. The control relay, selector switch, test push buttons, and running indicator, or light, on the panel shall indicate status. High oil temperature, high oil pressure or low oil pressure shall initiate protective shutdown and the indicator, or light, shall indicate the affected setting.

2.08 ELECTRICAL EQUIPMENT

A. Electrical motor driven equipment herein specified shall be provided complete with motors, motor starters, and controls. Electrical equipment and wiring shall be in accordance with NFPA 70, with proper consideration given to environmental conditions such as moisture, dirt, corrosive agents, and hazardous area classification.

B. Electric Motors

1. Each electric motor-driven unit shall be driven by a weather-protected, Type I or II totally-enclosed fan cooled continuous-duty electric motor. Motor shall have a 1.15 service factor. Motors shall be squirrel-cage induction or synchronous having normal-starting-torque and low-starting-current characteristics, and shall be sized to avoid exceeding the nameplate power rating throughout the entire published characteristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of the rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during starting conditions specified. Motors shall be rated 460 volts, 3 phase, 60 Hz and such rating shall be stamped on the nameplate. Motors shall conform to NEMA MG 1.

C. Control Equipment
1. Automatically controlled units shall have three-position MANUAL-OFF-AUTOMATIC selector switch in cover. Additional controls or protective devices shall be as indicated.

2.09 APPURTENANCES

A. Dielectric Fittings
1. Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

B. Isolation Joints
1. Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

C. Sleeve-type Couplings
1. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

D. Split-sleeve Type Couplings
1. Split-sleeve type couplings shall be used in aboveground installations when approved in special situations, and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

E. Valves
1. Valve diameter shall be equal to the diameter of the pipe in which the valve is located unless otherwise indicated. Valves shall be screw, socket weld, buttweld, sweat, or flange connected. Valves shall be marked in accordance with MSS SP-25 to identify the manufacturer, valve sizes, pressure rating, body and seat material.

F. Relief Valve
1. Relief valve capable of maintaining a constant upstream pressure regardless of the downstream demand shall be provided for each air mover. Valve shall be ASTM F 1508 angle spring loaded, weighted, or pilot-operated diaphragm differential pressure relief valve. Valve shall be rated to relieve the full capacity of the air moving equipment 750 cubic feet per minute. Valve shall be factory-set to open at the vacuum of 80 inches of Hg and shall be field adjustable within a minimum range of plus or minus 20 percent. Valve shall be located within 5 feet upstream of vacuum equipment or downstream of pressure equipment.

G. Manual Valve
1. Ball valves shall be in accordance with MSS SP-72. Gate, plug and ball valves shall be in accordance with API Spec 6D. Thermoplastic gas shutoffs and valves shall be in

accordance with ASME B16.40. Manual valve shall be wrench operated, rising stem, with cap. Non-automatic valve shall be as required by Section 02150 PIPING; OFF-GAS.

H. **Inlet and Discharge Elbows**
   1. Inlet and discharge elbows shall be of the long sweep type with ASME B16.1, Class 125 flanges.

I. Expansion Coupling
   1. The inlet and the outlet of each unit shall be provided with flexible expansion couplings of extra heavy gauge rubber, wire reinforced type suitable for temperature range of minus 20 to plus 250 degrees F and pressure range from 15 inches of mercury vacuum to 15 psig.

J. Liquid Receiver
   1. Liquid receivers shall be designed, fitted, and rated 50 psi working pressure. Each receiver shall have a storage capacity not less than 85 gal. Each receiver shall be equipped with inlet and outlet drop pipe, drain with valve, relief valve and two bull's-eye liquid-level sight glasses. Sight glasses shall be in the same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver, and not over 3 inches horizontally from the drop pipe measured along the axis of the receiver. In lieu of bull"s-eye sight glass, external gauge glass with metal glass guard and automatic closing stop valves shall be provided. The outside of liquid receivers shall be galvanized or supplied with commercial enamel finish.

2.10 BASE PLATE

A. Each unit shall be mounted on all-welded structural steel or cast iron base complete with vibration isolators with published load rating. The base plate shall have vertical jacking screws to facilitate leveling. The entire unit shall be isolated from the building structure.

2.11 WEATHERPROOF ENCLOSURE

A. A weatherproof enclosure shall be provided for the air moving equipment and motor assembly. The enclosure shall have lockable access doors and shall be louvered for ventilation. The enclosure shall be insulated and equipped with a thermostatically controlled electric heating and ventilation.

2.12 ATTACHMENTS

A. Shafts, chains or gear driven equipment shall be provided with all-metal guards enclosing the drive mechanism. Guard shall be constructed of galvanized sheet steel, or galvanized woven wire, or expanded metal set in galvanized steel frame. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment.

2.13 COATINGS OR FINISHES

A. Motors, casings and similar parts of equipment finished in the shop shall be cleaned, primed and given two finish coats with paint suitable for the environment in which the unit is to be placed at the factory. Ferrous surfaces not painted at the factory shall be given a shop coat of grease or other suitable rust resistant coating.

PART 3 EXECUTION

3.01 INSTALLATION

A. Vibration dampener shall be installed in sufficient quantity to isolate each unit from the structural base on which the unit is installed. Each air moving unit and motor shall be installed, aligned and leveled in accordance with the written instruction of the manufacturer. Deviation from horizontal shall be below limits of measurement. Flexible couplings shall not be used to compensate for misalignment between driver and driven unit. Blower venting shall not violate the provisions of either ACGIH-2092 or AMCA 99.

B. Concrete Foundations

1. Concrete for equipment foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE have a minimum compressive strength of at least 3,500 psi. Concrete foundations shall be integral with and of the same class as that of the building floor. Foundation bolts, as required, shall be furnished for proper positioning during the placement of the concrete.

3.02 TESTING

A. Deficiencies
   1. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

B. Correct Installation
   1. Tests shall assure that the units and appurtenances have been installed correctly, there is no objectionable heating or vibration, noise from any part is not excessive, and manual and automatic controls function properly.

C. Field Equipment Test
   1. After installation of the air moving units and appurtenances is complete, operating tests shall be carried out to ensure that the installation operates properly. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow and pressure.

D. Noise Suppression
   1. Sound level shall be less than 80 dB measured at 5 feet from the source

3.03 FIELD TRAINING

A. The Contractor shall conduct a field training course for designated operating, maintenance and supervisory staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover the items contained in the operating and maintenance instructions.

END OF SECTION

SECTION 11226

GRANULAR ACTIVATED CARBON

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The vapor phase activated carbon adsorption system shall be a complete once-through forced flow system. The system shall be capable of reducing the levels of the listed organic contaminants to the values shown in paragraph Performance Requirements. The unit shall be filled with granular activated carbon for removal of organic contaminants from soil vapor extraction air/gas. Equipment shall include, but shall not be limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology is in conformance with ASTM D 2652. The system shall be complete with 2 parallel trains of 2 carbon vessels in series, blower, instruments, controls, valves, piping, and other specified appurtenances. The piping shall be arranged as shown on the drawings.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)..ASTM D 2652(1994) Activated Carbon
   2. ASTM D 2854(1996) Apparent Density of Activated Carbon

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.
   1. Warranty: Submit manufacturer warranty and ensure that forms have been completed in JCI's name and registered with manufacturer.

1.04 GENERAL REQUIREMENTS

A. Standard Products
   1. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

B. Nameplates
   1. Major equipment items such as adsorption vessels, blowers and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

C. Verification of Dimensions
   1. The Contractor shall, after becoming familiar with the details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work

D. Operation
   1. The system shall be designed to operate continuously, 24 hours per day, 7 days per week.

1.05 DELIVERY, STORAGE AND HANDLING

A. Parts shall be preassembled to the largest extent possible, compatible with transportation limitations and equipment protection considerations. Field assembly, if any, shall require merely bolting together of match-marked components. Equipment shall be crated and delivered to protect against damage during shipping. Flange faces shall be protected from damage. All openings shall be covered to prevent entrance of dirt, water and debris. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and until the units and equipment are ready for operation. Finished iron or steel surfaces shall be properly protected to prevent rust and

corrosion. All equipment delivered and placed in storage shall be stored with protection from the weather (humidity and temperature), dirt and dust, and other contaminants.

1.06 SPARE PARTS

A. Within 30 days of approval, the Contractor shall furnish a spare parts list for each different item of material and equipment specified with the shop drawings submitted. The list shall include parts, supplies, prices and sources schedule. The Contractor shall furnish those spare parts and special tools which are recommended by the manufacturer. The Contractor shall also provide 12 months supply of any expendable items and frequently replaced parts, except for carbon, as identified by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carbtrol

B. Substitutions: See Section 01600 - Product Requirements.

2.02 VAPOR PHASE ACTIVATED CARBON

A. Material shall conform to the following:
   1. The initial charge of carbon shall be virgin carbon.
   2. Activated carbon particle size shall be uniform for consistent pressure drop characteristics. Maximum particle size shall be 4.6 mm 0.2 inch diameter as determined by ASTM D 2862
   3. The granular activated carbon shall be of the type that can be accepted for offsite regeneration of the spent activated carbon by an approved carbon regeneration facility.
   4. Material shall be free from impurities that affect the serviceability and appearance of the finished product

2.03 VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS

A. Vessel
   1. Contractor shall provide Carbtrol G-3S activated carbon adsorption units that meet the follwing requirements:
      a. Minimum Number of Vessels: 4
      b. Minimum Adsorber Diameter: 2 ft
      c. Material of Construction: carbon steel
      d. Minimum Carbon Quantity per Vessel: 140 lbs
      e. Minimum Carbon Bed Depth: 34 inches
      f. Flow Direction: downflow
      g. Each unit shall be provided with an inlet air/gas distributor,if required. Sampling ports shall be provided on the inlet and outlet pipes of each vessel to allow independent sampling and measurement of breakthrough for each unit.

2.04 ACCESSORIES

A. Blowers
   1. The blowers shall conform to Section 11215 FANS/BLOWERS/PUMPS; OFF-GAS

B. Sampling Valves
   1. Sampling valves shall be provided at the inlet and outlet of each carbon unit.

C. Piping
   1. Piping shall be in accordance with Section 02150 PIPING; OFF-GAS.

D. Thermometers

E. Thermometers shall be dial type, 3-1/2 inch diameter, chromium plated case; remote or direct-type bulb as required; plus or minus 0.5 degree C 1 degree F accuracy; white face with black digits graduated in 1 degree C 2 degree F increments. Thermometer wells of the separable

socket type shall be provided for each thermometer with direct-type bulb. Range of thermometers shall be -20 to 100 degrees C.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Equipment shall be installed as shown and in accordance with written instructions of the manufacturer. Each vessel shall be mounted on a skid base. Reinforced concrete foundations for each carbon unit shall be designed to support the unit and shall be in accordance with Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.02 PAINTING FOR CORROSION PREVENTION

A. Equipment which did not receive a factory finish shall be painted, unless specified otherwise. Surfaces that have not been factory primed shall be primed and top coated with the manufacturer's standard factory finish. Factory painting shall conform to manufacturer's standard factory finish. Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required, unless otherwise specified.

3.03 FIELD QUALITY CONTROL

A. Equipment Tests
   1. After installation of the carbon adsorption system is complete, operating tests shall be carried out to ensure that the unit installed operates properly. All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of all equipment; all operating mechanisms shall be tested to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced. Tests shall assure that there is no vibration, or noise from any parts. If deficiencies are revealed during tests, such deficiencies shall be corrected and the tests shall be reconducted at the Contractor's expense.

END OF SECTION

SECTION 13121

METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. AISC S335 - Specification for Structural Steel Buildings--Allowable Stress Design, Plastic Design; American Institute of Steel Construction, Inc.; 1989.

B. AISC S342L - Load and Resistance Factor Design Specification for Structural Steel Buildings; American Institute of Steel Construction, Inc.; 1999.

C. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2001.

D. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2001a.

E. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength; 2000.

F. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2002.

G. ASTM A 325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric); 2000.

H. ASTM A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; 2002.

I. ASTM A 490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); 2000

J. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2001a.

K. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2001.

L. ASTM A 529/A 529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality; 2001.

M. ASTM A 572/A 572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; 2001.

N. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2001a.

O. ASTM A 792/A 792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2001a.

P. ASTM A 992/A 992M - Standard Specification for Structural Steel Shapes; 2002.

Q. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2001.

R. ASTM C 991 - Standard Specification for Flexible Glass Fiber Insulation for Metal Buildings; 2000.

S. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 1999.

T. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2001.

U. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 1998.

V. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2002.

W. MBMA (LR) - Low Rise Building Systems Manual; Metal Building Manufacturers Association; 1996, with Rev 1 (4/97).

X. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 1982 (Ed. 2000).

Y. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies; Underwriters Laboratories Inc.; 1994.

1.02 DESCRIPTION OF BUILDING

A. Dimensions
   1. Building dimensions shall be as standard with manufacturer, not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto. Eave height shall be measured from the top of finished floor to intersection of insides of roof and sidewall sheets. The clear height between finished floor and bottom of roof steel shall be as indicated.

B. Framing
   1. Provide building with vertical walls and single-slope roof. Building shall be single-span or multiple-span structures with one of the following framing systems: self-framing, column with single-span or continuous trusses, continuous beam frames, column with rigid frame, or rigid frame type, similar to AISC S335, Type I construction. End walls shall be of beam and column design. Roof slope shall be a minimum of 1 to 24. Roof slope greater than that indicated may be furnished if the required materials are provided and appropriate drawings are submitted and approved. Design framed openings structurally.

C. Foundation Requirements
   1. Design foundations for allowable soil bearing pressure and a minimum bottom of footing depth as indicated. Use a factor of safety of 1.5 for overturning, sliding and uplift, and a concrete compressive strength as specified in Section 03300N, "Cast-In-Place Concrete." The foundation loads are supplied by the building manufacturer.

1.03 DESIGN REQUIREMENTS

A. Design members to withstand dead load, applicable snow load, and design loads due to pressure and suction of wind calculated in accordance with applicable code.

B. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.

C. Permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of 120 degrees F.

D. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

E. **Deflection**
   1. Structural Members
      a. The maximum deflection of main framing members shall not exceed 1/240th of their respective spans. The maximum deflection due to live load in roof panels and purlins shall not exceed 1/180th of their respective spans.
   2. Roof Panels
      a. UL 580, Class 90. The design analysis shall establish that the roof when deflected under dead plus live or snow loads, will not result in a negative gradient. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. In addition, the roof decking shall be

designed for a 200-pound concentrated load at midspan on a 12 inch wide section of deck. Panels thinner than 0.03 inches are not permitted for diaphragms used to resist seismic loads in Seismic Zones 2 through 4.

3. Wall panels
   a. The maximum deflection due to wind on wall panels and girts shall be limited to 1/120th of their respective spans except that when interior finishes are used the maximum allowable deflection shall be limited to 1/180th of their respective spans.
4. Openings
   a. Limit deflections of steel framing above and along the side of rolling door openings to a maximum of 1/2 the allowable movement in the telescoping top roller of the doors to ensure proper operation. Frame all equipment openings over 12 by 12 inches.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on profiles, component dimensions, fasteners.

C. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections; wall and roof system dimensions, panel layout, general construction details, anchorages and method of anchorage, installation; framing anchor bolt settings, sizes, and locations from datum, foundation loads; indicate welded connections with AWS A2.4 welding symbols; indicate net weld lengths; provide professional seal and signature.

D. Manufacturer's Instructions: Indicate preparation requirements and anchor bolt placement.

1.05 QUALITY ASSURANCE

A. Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of New York.
   1. Conform to applicable code for submission of design calculations as required for acquiring permits.
   2. Cooperate with regulatory agency or authority and provide data as requested.
   3. Submit complete design drawings for the preengineered building. Submit drawings for the foundations and anchorage.
   4. Submit design calculations for the entire preengineered building and foundations, prepared and stamped by a professional engineer. Also submit for components requested, and stamp with the seal of a professional engineer. Include sizes and location of anchor bolts.

B. Perform work in accordance with AISC "Specification for Structural Steel Buildings--Allowable Stress Design, Plastic Design".

C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.06 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for water leaks arising out of or caused by ordinary wear and tear by the elements. Such warranty shall start upon final acceptance of the work or the date the Owner takes possession, whichever is earlier.
   1. Include coverage for exterior pre-finished surfaces to cover pre-finished color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading. Include coverage for weather tightness of building enclosure elements after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pre-Engineered Buildings:

1. Butler Manufacturing Co: www.butlermfg.com.
2. Ceco Building Systems: www.cecobuildings.com.
3. VP Buildings: www.vp.com/home2.html.
4. Substitutions: See Section 01600 - Product Requirements.

2.02 MATERIALS - FRAMING

A. Structural Steel Members: ASTM A 572/A 572M, Grade 50.

B. Structural Tubing: ASTM A 500, Grade B cold-formed.

C. Plate or Bar Stock: ASTM A 529/A 529M, Grade 50.

D. Anchor Bolts: ASTM A 307, galvanized to ASTM A 153/A 153M.

E. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M, Class C.

F. Welding Materials: Type required for materials being welded.

G. Primer: SSPC-Paint 20, Red Oxide.

H. Grout: ASTM C 1107, Non-shrink type, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 2400 psi in two days and 7000 psi in 28 days.

2.03 MATERIALS - WALLS AND ROOF

A. Design roof and wall panels, accessories, and flashings to be completely weathertight and free of abrasions, loose fasteners, and deformations.

B. **Panels**
1. Fabricated of aluminum/zinc-coated steel or aluminum
2. Preformed
3. Factory-insulated to provide weathertight joint upon installation, with:
4. Outer sheet designed to overlap adjacent panel a minimum of one configuration.
5. If designed as diaphragm, roof decks shall be designed in accordance with SDI Diaphragm Mnl.
6. Insulation in the cores of the panels shall be asbestos-free composition and provide an overall "U" value of not more than 0.10 for wall panels and 0.05 for roof panels.
7. Insulation in factory-insulated panels shall have a flame spread rating of 75 or less and a smoke development factor of 150 or less

C. **Zinc-Coated Steel Sheet**
1. ASTM A 755/A 755M, Coating Class Z 350 G-90 or ASTM A 653/A 653M, SQ, Grade 33, Coating Class Z 350 G-90.

D. **Aluminum/Zinc-Coated Steel Sheet**
1. ASTM A 792/A 792M, AZ 55.

E. **Aluminum Sheet**
1. Alloy 3004 Alclad conforming to ASTM B 209M ASTM B 209.

F. **Liner Panels**
1. Formed of same type material as used for wall panels to closely approximate configuration of panels indicated.

2.04 COMPONENTS

A. Doors and Frames: Manufacturer's standard.

B. Windows: Manufacturer's standard.

C. CIRCULAR ROOF VENTILATORS

1. Provide circular roof ventilators fabricated of aluminum or zinc-coated steel with manufacturer"s standard factory finish, color as indicated, furnished with removeable bird screens and chain or cable operated dampers. Provide rigid weathertight ventilators free from vibration upon installation.

2.05 FINISHES

A. **Shop Painting**
   1. Ferrous metal work, except factory-finished work, zinc-coated work, aluminum-coated work, and work specified to be painted herein, shall be (1) cleaned of dirt, rust, scale, loose particles, grease, oil, and other deleterious substances; (2) phosphate treated; and (3) then be given one coat of an approved rust-inhibiting primer paint of the type standard with the metal building manufacturer.

B. **Factory Color Finish**
   1. Provide exterior and interior exposed surfaces of metal roof and wall panels, roof ventilators, louvers, and metal accessories with a thermal-cured factory finish. Color shall be selected from manufacturer"s standard colors. Provide an exterior finish top coat of the building manufacturer"s standard paint. Provide standard dry film thickness of 0.8 mil for exterior coating exclusive of primer. Provide exterior primer thickness standard with building manufacturer. Interior color finish shall consist of the same coating and dry film thickness as the exterior.

PART 3 EXECUTION

3.01 EXAMINATION

A. Check concrete dimensions, anchor bolt size and placement, and slab elevation with the metal building manufacturer's templates and drawings before setting any steel.

3.02 ERECTION

A. Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes in panels shall be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces shall be kept clean and free from sealant, metal cuttings, excess material from thermal cutting, and other foreign materials. Exposed surfaces which have been thermally cut shall be finished smooth within a tolerance of 1/8 inch. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to AWS D1.1; welding of aluminum shall conform to AA Design Manual.

B. Framing Members and Anchor Bolts
   1. Onsite flame cutting of framing members, with the exception of small access holes in structural beam or column webs, will not be permitted. Concrete work is specified in Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE. Anchor bolts shall be accurately set by template while the concrete is in a plastic state. Members shall be accurately spaced to assure proper fitting of panels. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses.

C. Roofing and Siding Installation
   1. Siding shall be applied with the longitudinal configurations in the vertical position. Roofing shall be applied with the longitudinal configurations in the direction of the roof slope. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided where necessary to provide weathertight construction. Fastener and fastener spacing shall be in accordance with manufacture design.

D. Louvers and Ventilators
   1. Louvers and ventilators shall be rigidly attached to the supporting construction to assure a weather tight installation.

E. Doors and Windows
   1. Doors and windows, including frames and hardware, shall be securely anchored to the supporting construction, shall be installed plumb and true, and shall be adjusted as necessary to provide proper operation. Joints at doors and windows shall be sealed according to manufacturer"s recommendations to provide weathertight construction.

F. Insulation Installation
   1. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.
      a. Board Insulation with Blanket Insulation
         1) Rigid or semirigid board insulation shall be laid in close contact. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer.
      b. Blanket Insulation
         1) Blanket insulation shall be installed over the purlins and held tight against the metal roofing. It shall be supported by an integral facing or other commercially available support system.

G. Vapor Retarder Installation
   1. Integral Facing on Blanket Insulation
   2. Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

H. Wall Liner
   1. Wall liner shall be securely fastened into place in accordance with the manufacturer"s recommendation and in a manner to present a neat appearance

I. Do not field cut or alter structural members without approval.

J. Field Welding
   1. Steel, AWS D1.1. Aluminum, AA 30

K. Field Bolting
   1. AISC S329

3.03 FIELD PAINTING

A. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same color and material used for the shop coat.

END OF SECTION

Appendix E

Soil-Vapor Extraction System Design Calculations

SVE System
Design Calculations

1. Determine radius of influence (ROI) of extraction well.

$$P_r^2 - P_w^2 = \left(P_{RI}^2 - P_w^2\right)\frac{\ln\left(r/R_w\right)}{\ln\left(R_I/R_w\right)}$$

Where:

P_r = pressure at a radial distance, r, from the vapor extraction well
P_w = pressure at the vapor extraction well
P_{RI} = pressure at the ROI; assumed equal to atmospheric pressure
r = radial distance from the vapor extraction well
R_I = radius of influence where pressure is equal to atmospheric pressure
R_w = well radius of vapor extraction well

Pw= 0.963 atm

Observation Well	r (ft)	P_r (atm)	R_I (ft)
OW-1	25	0.9998	68.33
OW-2	15	0.9997	41
OW-3	41	0.99997	73.7

Pw= 0.916 atm

Observation Well	r (ft)	P_r (atm)	R_I (ft)
OW-1	25	0.997	70.7
OW-2	15	0.9994	41.1
OW-3	41	0.99993	111

Pw= 0.899 atm

Observation Well	r (ft)	P_r (atm)	R_I (ft)
OW-1	25	0.9996	68.3
OW-2	15	0.9993	41.1
OW-3	41	0.9999	111.7

Based on the pilot study data, 40 ft is selected as the design ROI.

2. Estimate the mass of tetrachloroethene in the vadose zone.

   Based on Figure 14 of the Feasibility Study Report (LFR, February 22, 2000), the following volume of affected soil above the remedial goal was estimated:

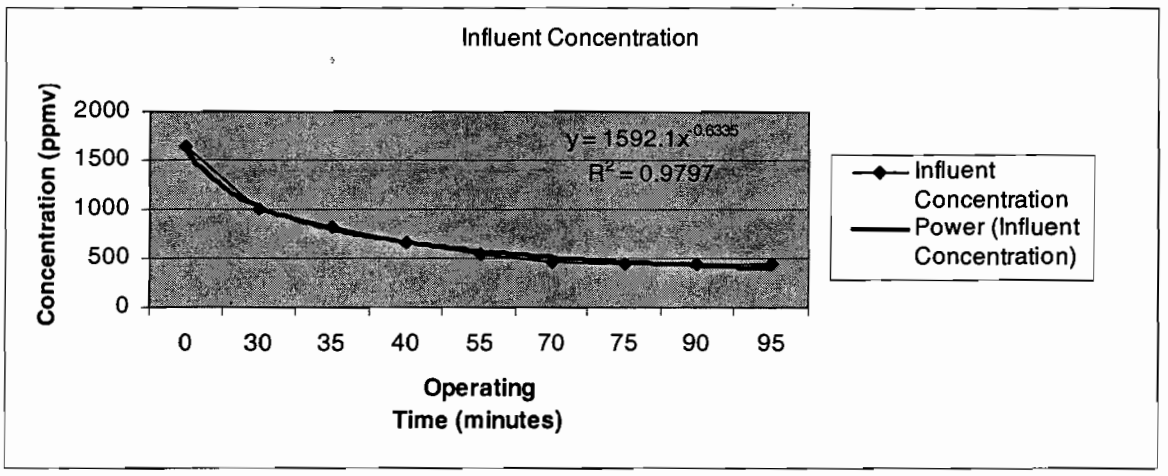
   V(1-5 mg/kg) = 30-L x 17-D x 40-W = 20,400 ft^3
   V(5-10 mg/kg) = 30-L x 17-D x 40-W = 20,400 ft^3
   V(10-100 mg/kg) = 30-L x 17-D x 30-W = 15,300 ft^3
   V(> 100 mg/kg) = 8-L x 40-W x 8-D = 2,560 ft^3

   Assuming a density of 110 lbs/ft^3 and an average soil concentration of each zone, the mass of tetrachloroethene was estimated as follows:

   V(1-5 mg/kg): 20,400 ft^3 x 110 lbs/ft^3 x 2.5 mg/kg x .454 kg/lb = 2.55 x 10^6 mg
   V(5-10 mg/kg): 20,400 ft^3 x 110 lbs/ft^3 x 7.5 mg/kg x .454 kg/lb = 7.64 x 10^6 mg
   V(10-100 mg/kg): 15,300 ft^3 x 110 lbs/ft^3 x 50 mg/kg x .454 kg/lb = 38.2 x 10^6 mg
   V(> 100 mg/kg): 2,560 ft^3 x 110 lbs/ft^3 x 250 mg/kg x .454 kg/lb = 31.96 x 10^6 mg
   Total Estimated PCE = 80.35 kg

3. Estimate the removal rate using the pilot study data.

   The pilot study effluent concentrations were plotted versus the operating time as shown below. Based on this data, a regression analysis was performed to determine the best-fit equation for the curve.



   Assuming the subsurface is homogeneous and the PCE concentrations are similar across the area to be remediated, the effluent concentration, y, can be estimated at any time, x, using the following best-fit equation for the curve:

$$y = 1592.1x^{-0.6335}$$

Note that the expected concentration in the effluent will decrease during the operation of the system. Next, insert the above equation into the following contaminant removal rate equation to generate a cumulative mass removal rate:

$$R_{removal} = \eta \cdot G \cdot Q \cdot 4.6x10^{-7}$$

where:

$R_{removal}$ = removal rate (lbs/min)
G = vapor concentration (ppm_v)
η = efficiency (unitless)
Q = vapor flow rate (cfm)
$4.6x10^{-7}$ = conversion factor from ppm_v to lbs/ft^3

$$M_{removal} = \eta \cdot Q \cdot 4.6x10^{-7} \cdot 1592.1 \int_0^x x^{-0.6335}$$

where:

$M_{removal}$ = cumulative mass removal rate (lbs)
x = time (minutes)

Assuming an efficiency of 75% due to variability in subsurface strata and PCE concentrations and a flow rate of 250 cfm/well, the cumulative mass removal rate may be calculated at time x as follows:

$$M_{removal/well} = 0.375 \cdot x^{0.3665} \Big|_0^x$$

It is likely that the above equation conservatively estimates the mass removal rate since it is based on the regression analysis of the pilot study data. The data collected as part of the pilot study was collected from the perimeter of the affected area; therefore, the removed concentrations were likely less than the concentrations that can be expected from the "hot" spot.

4. Estimate the time to remediate to the cleanup standard.

If we assume that 177 lbs of PCE will need to be removed from the vadose zone and that 3 extraction wells will be used, then the time to achieve the clean up standard can be calculated as follows:

$$\frac{177 lbs}{3 wells} = 0.375x^{0.3665}$$

The estimated time is 1.9 years.

5. Will 3 extraction wells provide sufficient coverage?

$$N_{wells} = \frac{SF(A_{contamination})}{\pi R_I^2}$$

where:

N_{rwells} = Number of extraction wells
SF = safety factor (1.2)
$A_{contamination}$ = 120 ft x 40 ft = 4,800 ft^2
R_I = design radius of influence

The minimum number of wells required based upon area is 1.1 wells which is less than the proposed 3 extraction wells.

6. Estimate volume of condensation to be managed.

Assume average ambient air temperature = 65° F (18° C), then concentration of water in air is 0.013 kg-water/kg dry air (psychometric chart).
Assume average extracted air is 100% relative humidity at 55° F (13° C), then concentration of water in air is 0.0095 kg-water/kg dry air (psychometric chart).
The resulting concentration due to the change in temperature is 0.0035 kg-water/kg dry air.

The density of air is:

$$\rho = \frac{PM}{RT}$$

Where:

ρ = density of air (Kg/l)
P = pressure at knockout (0.866 atm)
M = molecular weight of air (29 kg/mol)
R = Gas Constant (82.1 l-atm/kg-mol K)
T = temperature (273 + 25 °K)

$$\rho = 0.001 kg/l$$

Next, determine the rate of condensation generation as flow rate times the concentration of water in the vapors assuming maximum flow rate of 1,000 cm:

$$R_{water} = Q \cdot C_{influent} \cdot 1l/kg$$

Where:

ρ = density of air (Kg/l)
Q = air flow rate (1000 cfmx0.035 l/ft^3 =35.1 l/min)
C = ρ x 0.0035 = 3.5 x10^{-6} kg water/l air
R = water removal (l/min)

The estimated removal rate of water is 0.05 gallons per day (gpd).

7. Determine activated carbon usage

From Carbtrol, the adsorption capacity of granular activated carbon (GAC), q, is 0.595 lbs of PCE/lbs GAC, the density is 30 lbs/ft^3, and the surface area is 1,400 m^2/g. Therefore, the amount of PCE that can be retained by 2-140 lb canisters in parallel before it becomes exhausted is:

(280 lbs/container)(0.595 lbs PCE/lbs GAC) = 166.6 lbs PCE/container which is less than the expected total mass of PCE to be removed (177 lbs). Therefore, the canisters will need to be replaced once.

8. Determine headloss.

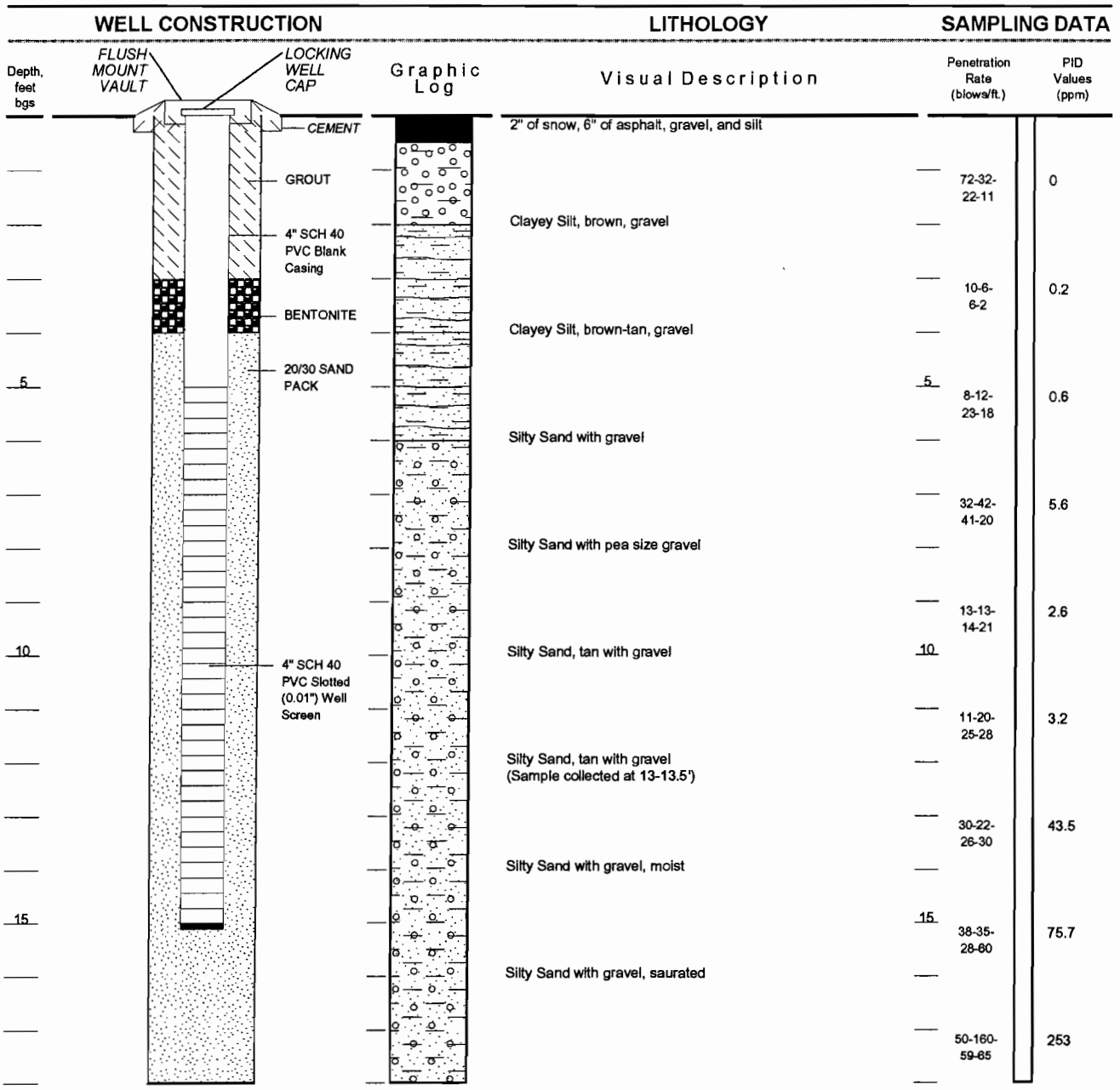
Assume 150 ft of 66-in.diameter pipe at 750 cfm plus 10 ft of 4 in. pipe at 250 cfm. There will be the following fittings and equipment with corresponding headlosses:

air filter: 4 in H_2O
water knockout: 2 in H_2O
Flow Meter: 2 in H_2O
Ball Valves: 3 @ 1 in H_2O/valve
Expansions: 4-4x6 and 1-6x10 @ 10 equivalent ft of pipe/expansion
90 Elbows: 2- 4 in @ 10 equivalent ft of pipe/ el+ 4-6 in @ 15 equivalent ft of pipe/el

Using the attached nomograph, there is approximately 6.8 in H_2O headloss across the piping and 16.94 in H_2O headloss across the fittings and equipment for a total headloss of 23.75 in H_2O.

9. Determine Blower Capacity

Based upon pilot test, 3 in. Hg is required for 250 cfm. To operate a 3 well system at 250 cfm/well would require a blower capable of delivering 750 cfm at 65 in H_2O. An example blower is Rotron DR P13BP72D with 30 horsepower motor.



Date well drilled: 1/7/02

LFR Geologist/Engineer: Scott Starr

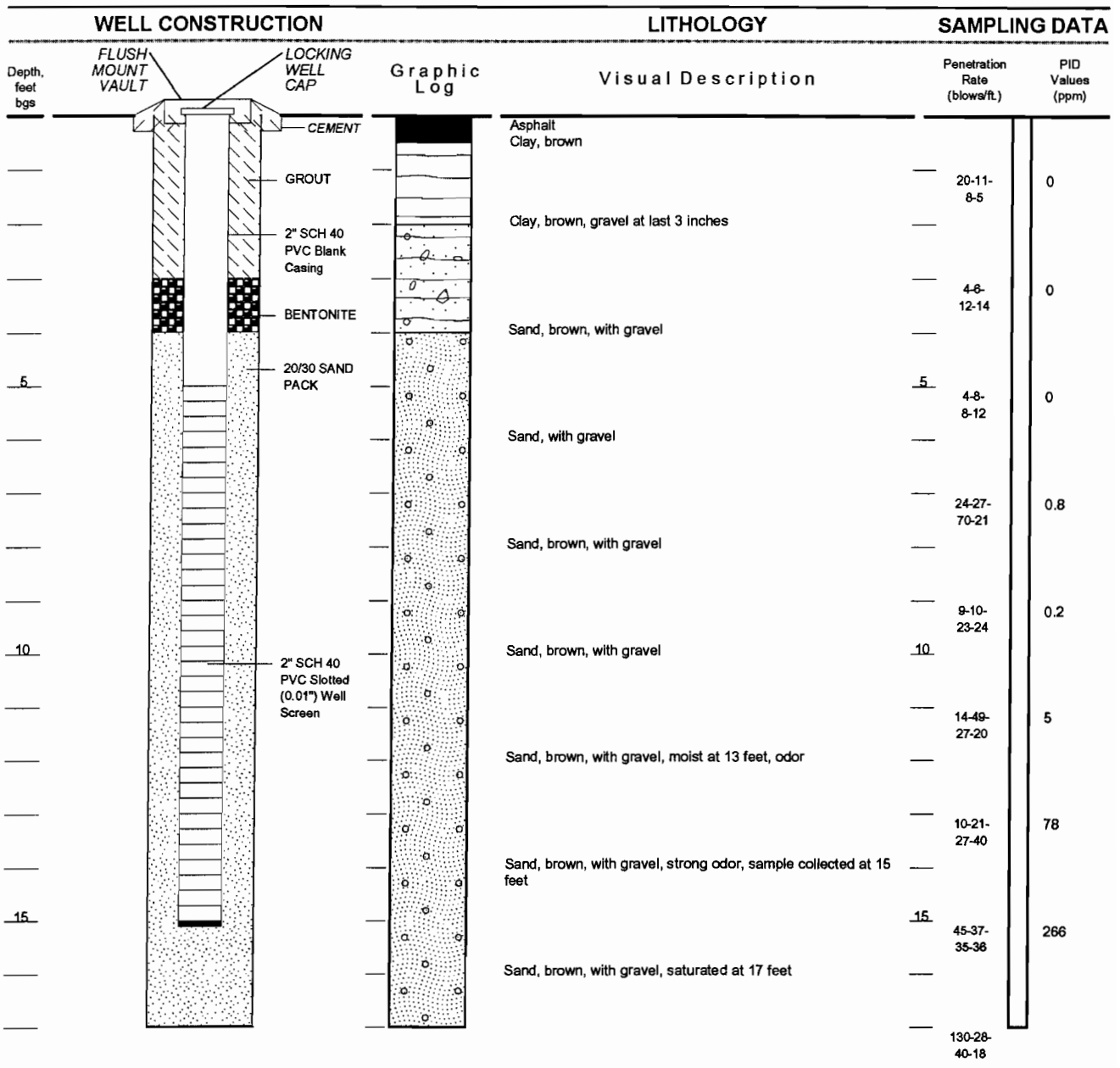
WELL CONSTRUCTION FOR MONITORING WELL B-1/SVE-1

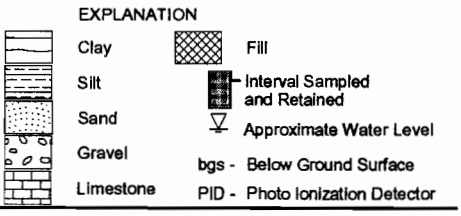
Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB





Date well drilled: 1/7/02

LFR Geologist/Engineer: Scott Starr

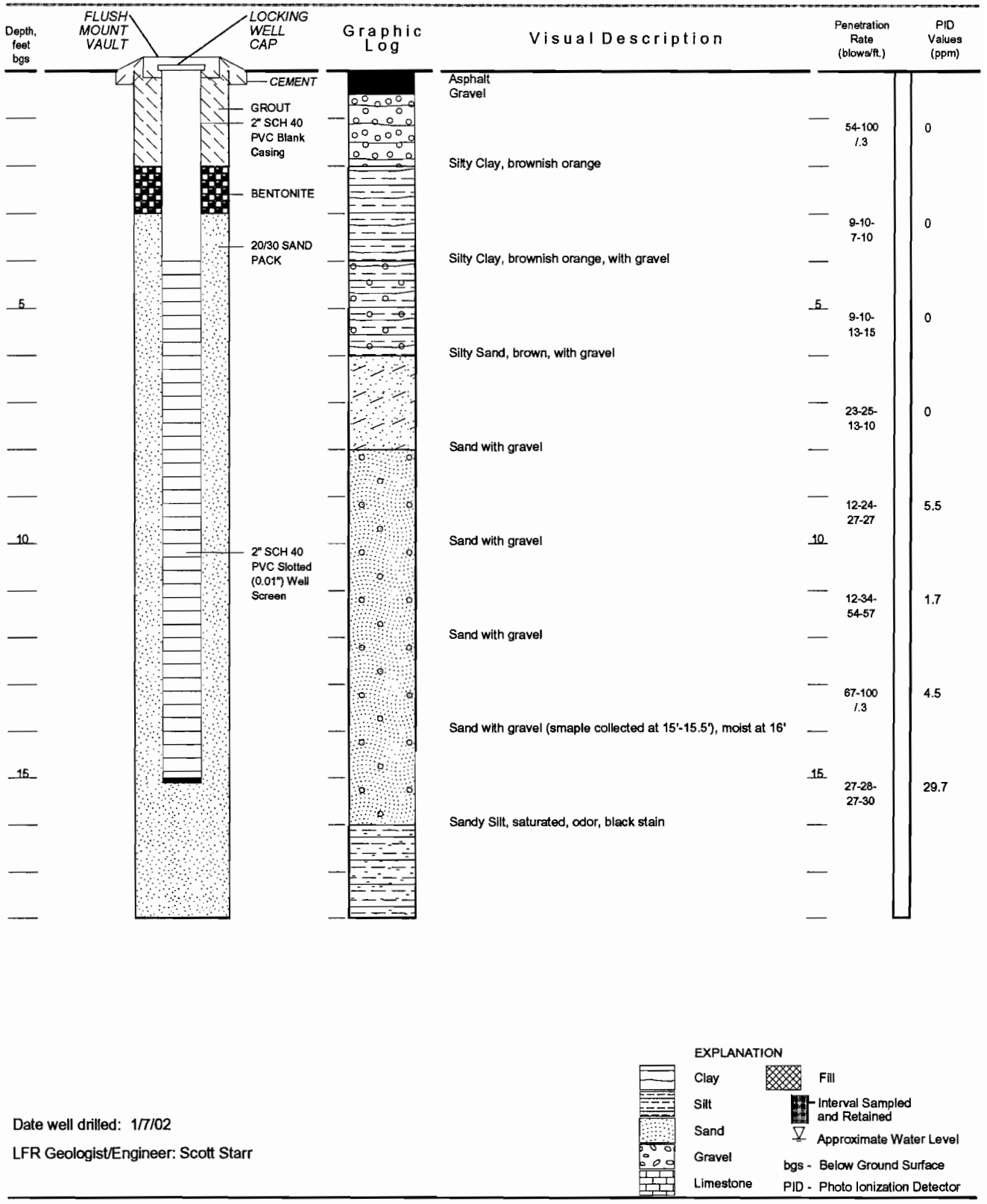
WELL CONSTRUCTION FOR MONITORING WELL B-2/OW-1

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



Date well drilled: 1/7/02

LFR Geologist/Engineer: Scott Starr

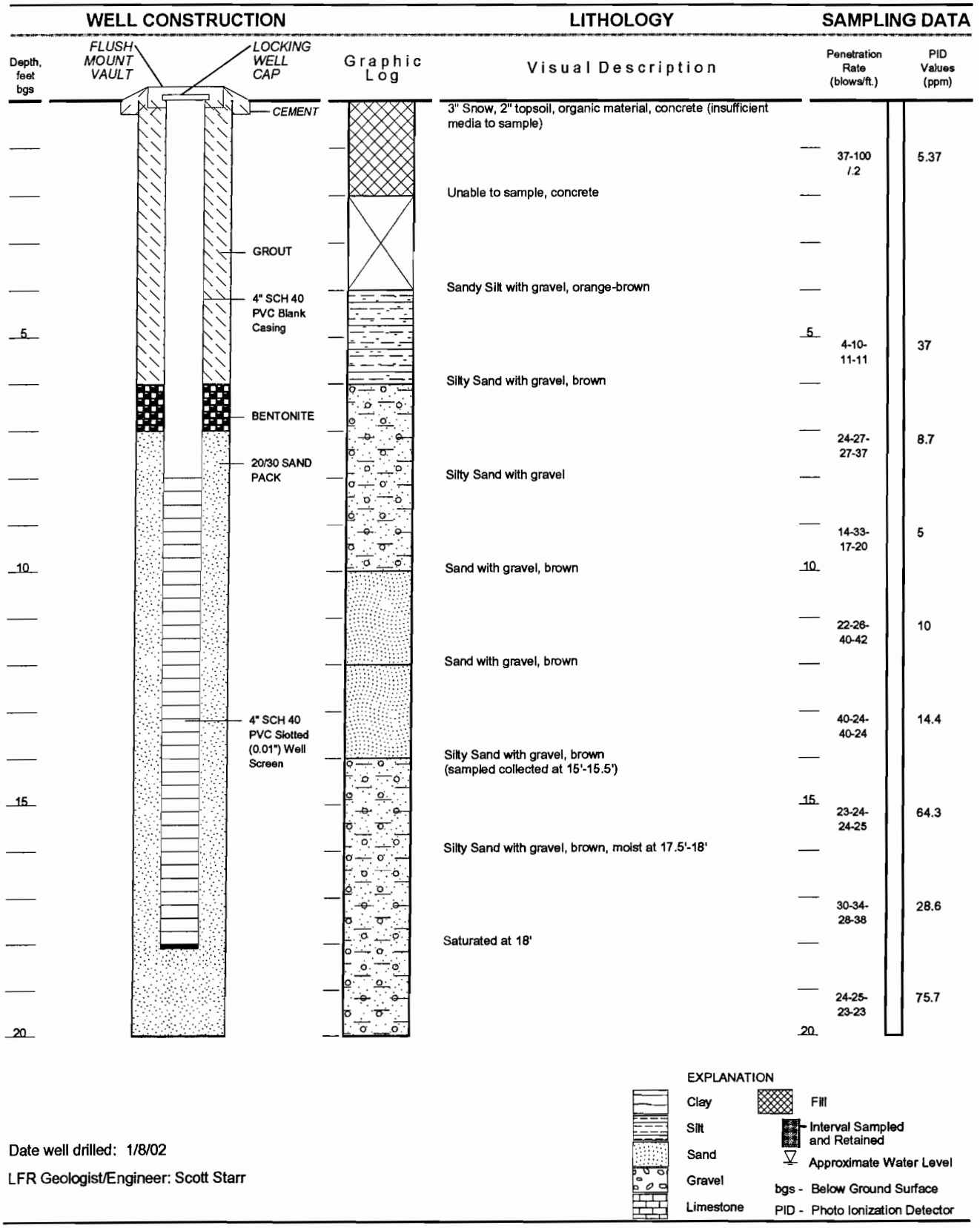
WELL CONSTRUCTION FOR MONITORING WELL BW-3/OW-2

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



Date well drilled: 1/8/02

LFR Geologist/Engineer: Scott Starr

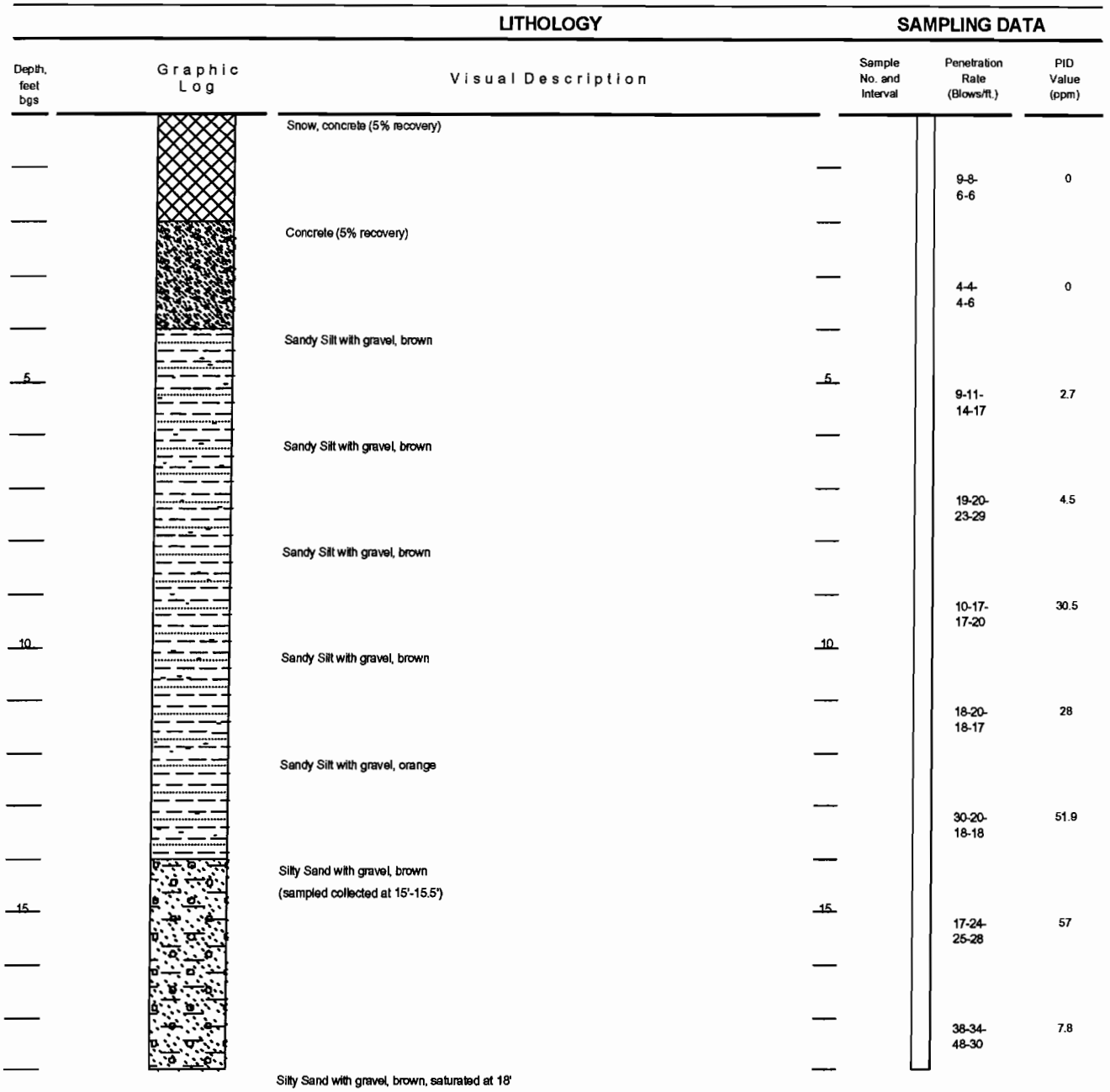
WELL CONSTRUCTION FOR MONITORING WELL B-4/OW-3

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



Date boring drilled: 1/8/02

LFR Geologist/Engineer:Scott Starr

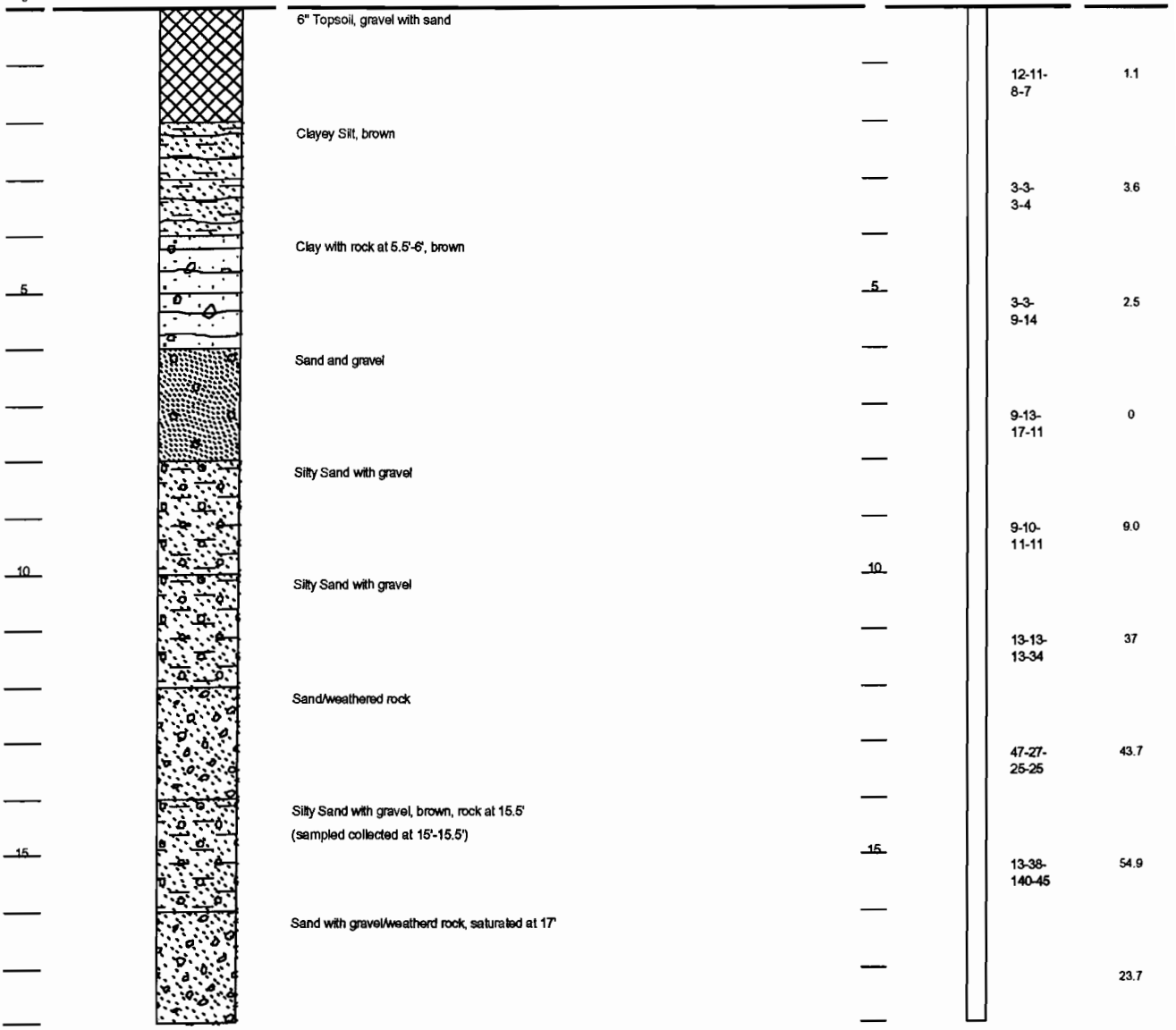
LITHOLOGY FOR SOIL BORING B-5

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



EXPLANATION

Clay
Silt
Sand
Gravel
Limestone

Fill
Interval Sampled and Retained
Approximate Water Level
bgs - Below Ground Surface
PID - Photo Ionization Detector

Date boring drilled: 1/9/02

LFR Geologist/Engineer:Scott Starr

LITHOLOGY FOR SOIL BORING B-6

Project No. 3165.02
JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB

	LITHOLOGY		SAMPLING DATA		
Depth, feet bgs	Graphic Log	Visual Description	Sample No. and Interval	Penetration Rate (Blows/ft.)	PID Value (ppm)
		Clayey Silt, dark brown, roots			
				3-3-5-5	0.3
		Silty Clay, brownish orange, with gravel			
				6-13-35-65	0.3
		Silty Sand with small pebbles, brown-orange, wet at 4'			
5			5	29-39-69-74	1.3
		Silty Sand with gravel, tan-brown			
				36-34-45-29	10.2
		Silty Sand with gravel, tan-brown			
				11-14-17-18	20.9
10		Silt with rounded/weatherd gravel, light brown	10		
				29-19-52-29	25.5
		Clayey Silt with weathered gravel, tan			
				17-100-21-27	18.6
		Silty Sand with gravel, (sampled collected at 15'-15.5')			
15			15		49
		Silty Sand with gravel, brown, saturated at 17.5'			
				57-55-45-50	23.7

EXPLANATION

Clay
Silt
Sand
Gravel
Limestone

Fill
Interval Sampled and Retained
Approximate Water Level
bgs - Below Ground Surface
PID - Photo Ionization Detector

Date boring drilled: 1/9/02

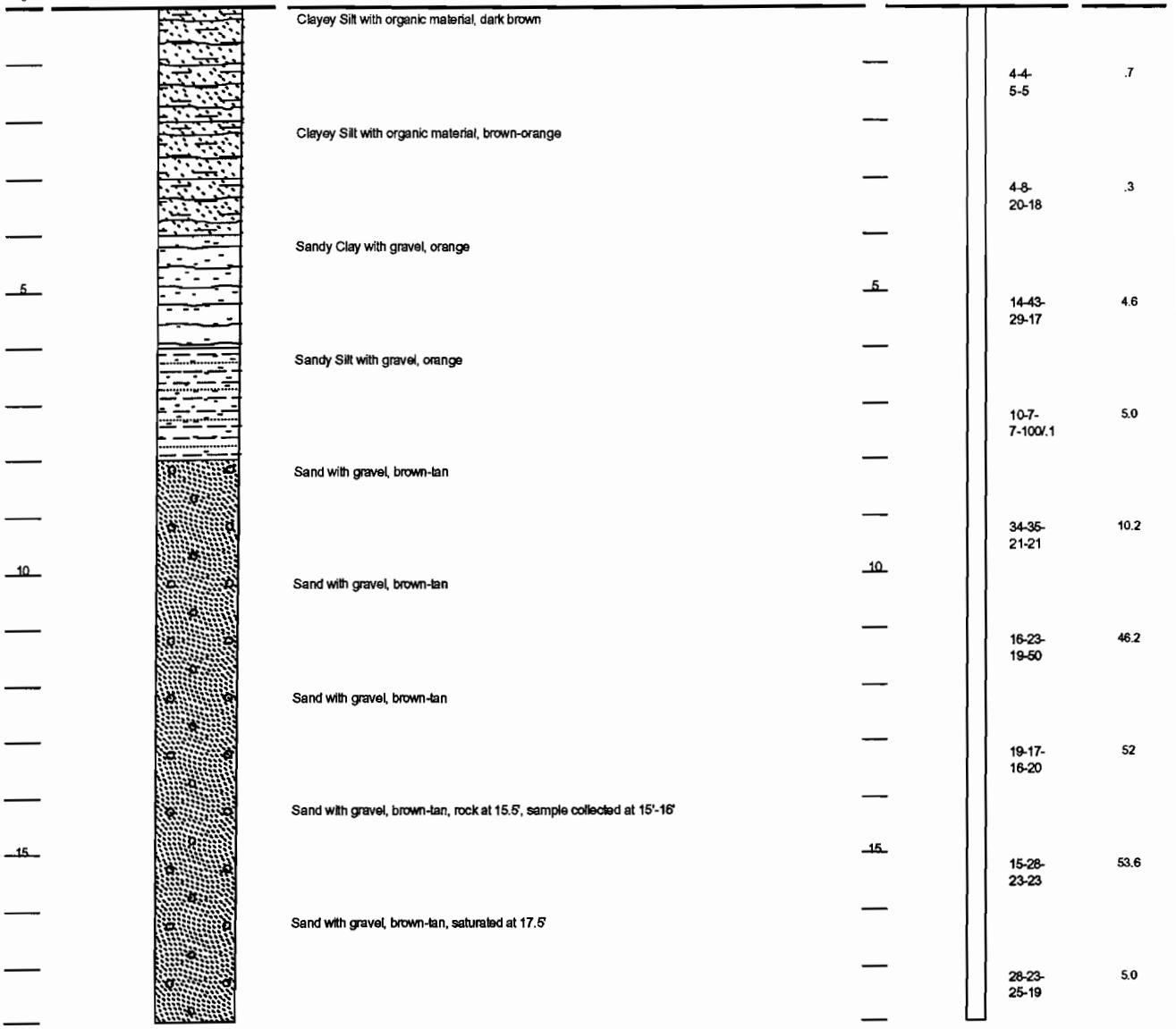
LFR Geologist/Engineer:Scott Starr

LITHOLOGY FOR SOIL BORING B-7

Project No. 3165.02
JCI Jones Chemicals, Inc.

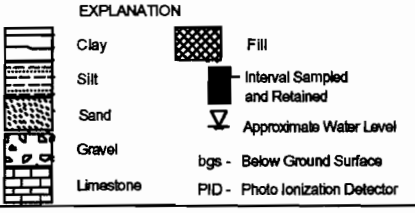
LFR Levine-Fricke

Drawn by: WDB



Date boring drilled: 1/9/02

LFR Geologist/Engineer:Scott Starr



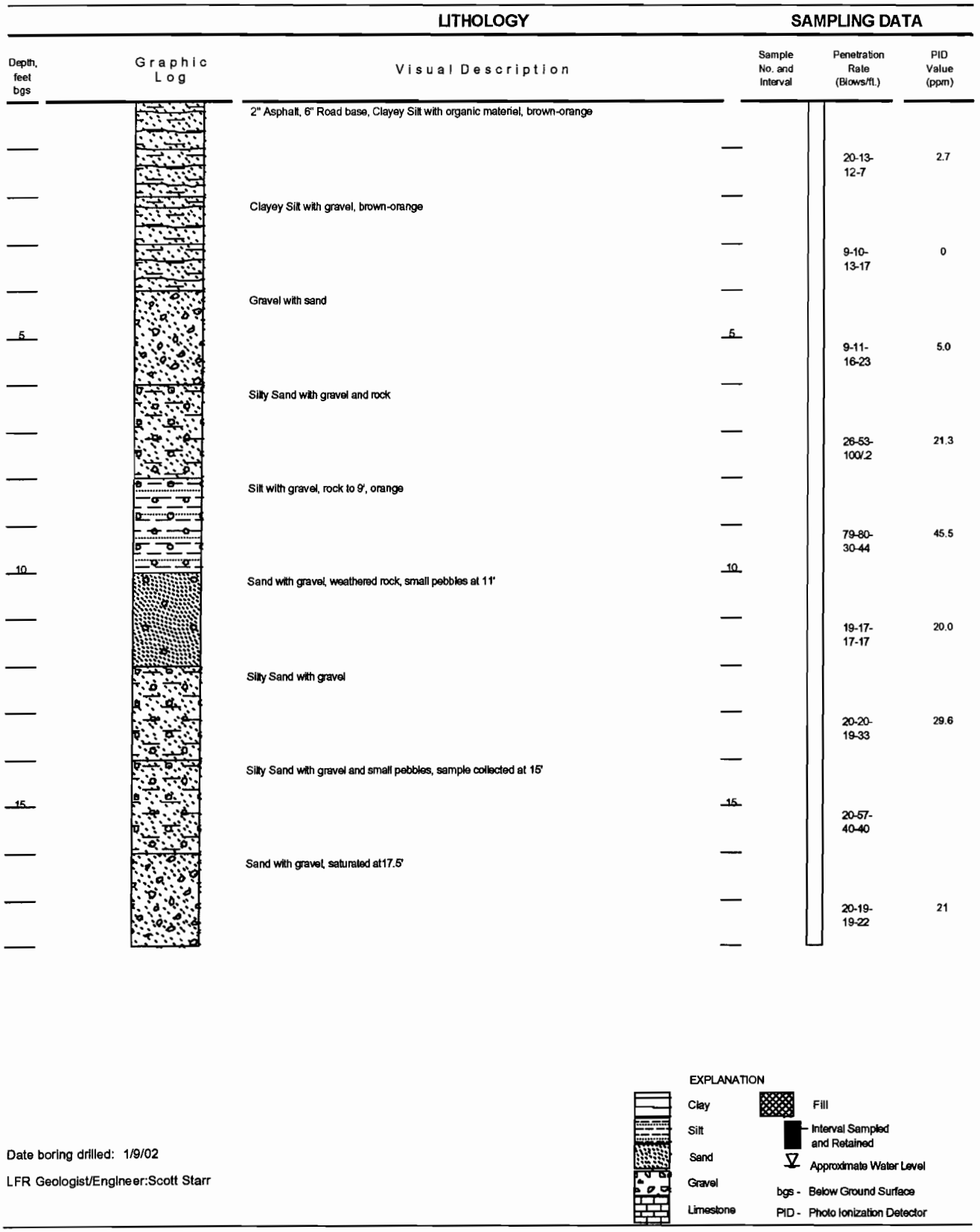
LITHOLOGY FOR SOIL BORING B-8

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



Date boring drilled: 1/9/02

LFR Geologist/Engineer:Scott Starr

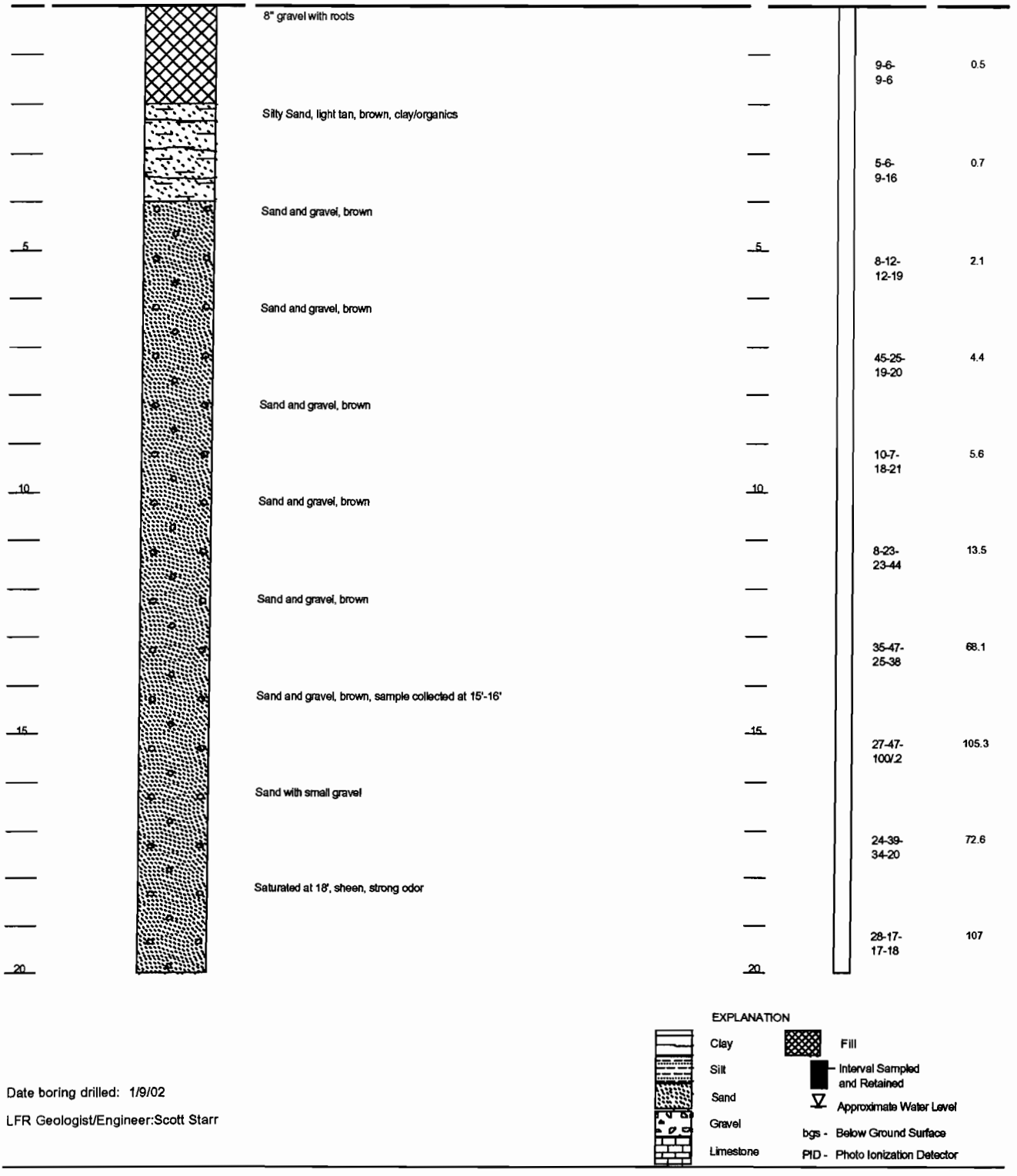
LITHOLOGY FOR SOIL BORING B-9

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB



Date boring drilled: 1/9/02

LFR Geologist/Engineer:Scott Starr

LITHOLOGY FOR SOIL BORING B-10

Project No. 3165.02

JCI Jones Chemicals, Inc.

LFR Levine-Fricke

Drawn by: WDB

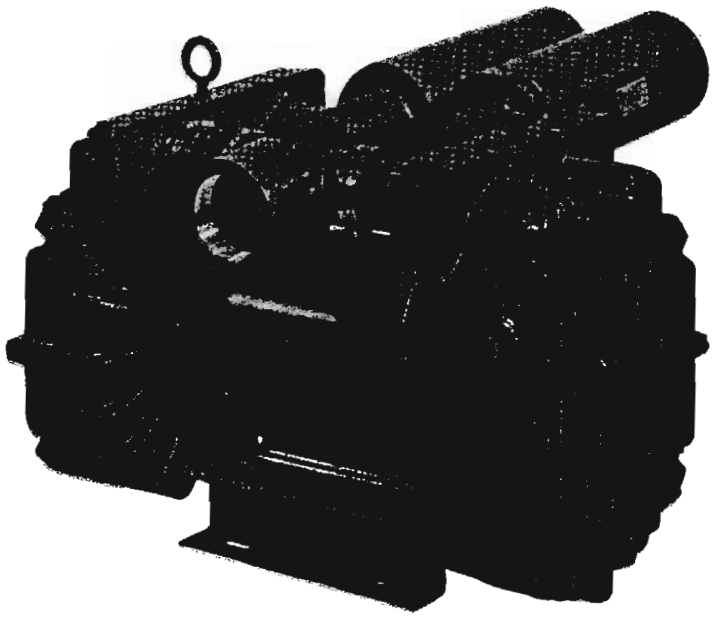
Appendix F

Soil-Vapor Extraction System Equipment Specifications

DR P13
Regenerative Blower

FEATURES

- Manufactured in the USA
- Maximum flow 1160 SCFM
- Maximum pressure 122″ WG
- Maximum vacuum 7.3″ Hg
- 30 HP ODP motor standard
- Blower construction — cast aluminum housing, impeller and cover
- Motor construction — permanently sealed ball bearings
- Quiet operation within OSHA standards when properly piped or muffled — 2 mufflers included
- Shipping weight 687 lbs (311 Kg)

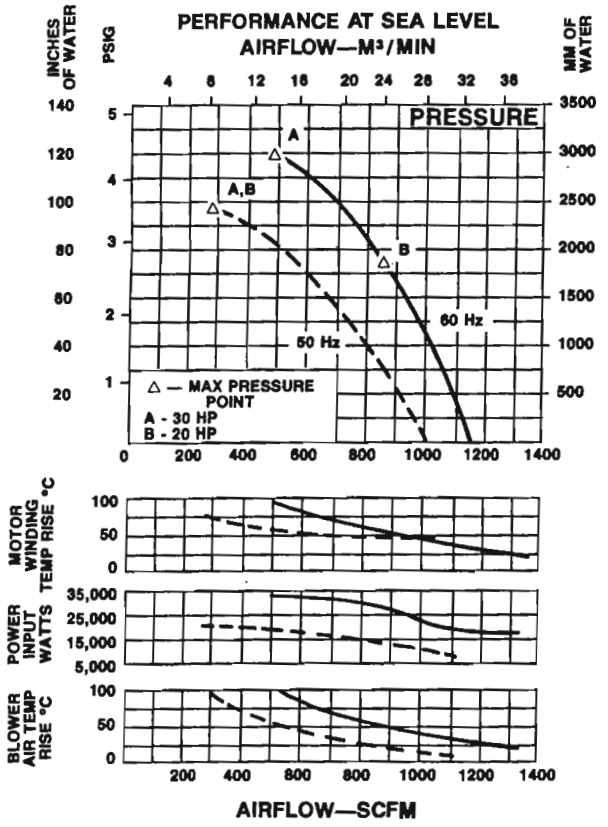


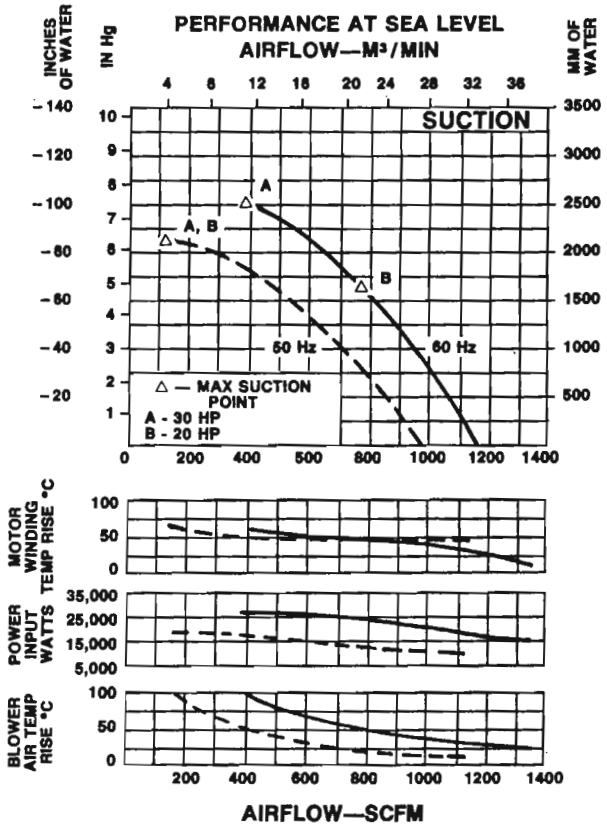
ACCESSORIES

- Additional inlet/outlet mufflers
- Inlet or inline filters
- For details see Accessories Section

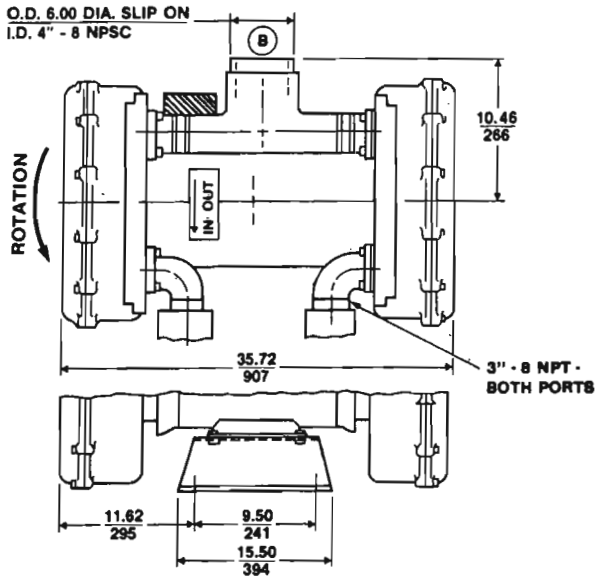
OPTIONS

- Smaller and larger HP motors
- 575-volt motors
- Surface treatments
- Gas tight sealing

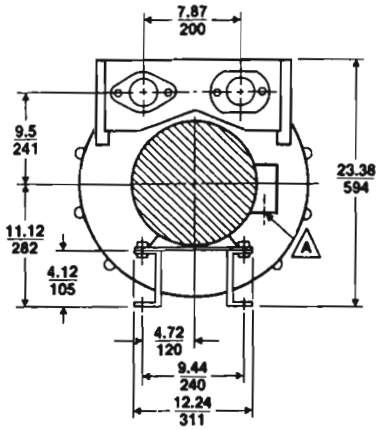




DR P13
Regenerative Blower



CUTOFF SIDE VIEW SHOWING MTG. DIM.



END SECTION VIEW

(A) 2.0 IN DIA. TERM BOX CONNECTOR HOLE(30 HP MOTOR)

(B) OUTLET (PRESSURE) ON DRP13BP72C
INLET (SUCTION) ON DRP13BP72D

DIMENSIONS IN / MM

TOLERANCES: .XX ± .1 / 2.5

Specifications Subject to Change Without Notice.

SPECIFICATIONS

Pressure / Mode	Model / Part No.	DRP13BP72C	DRP13BP86C	DRP13BM72C	DRP13BM86C
	Part No.	036711	036923	036708	036929
Suction / Mode	Model	DRP13BP72D	DRP13BP86D	DRP13BM72D	DRP13BM86D
	Part No.	036712	036924	036707	036930
Motor Enclosure Type		ODP	ODP	ODP	ODP
Motor Horsepower		30	30	20	20
Voltage[1]		230/460	575	230/460	575
Phase		3	3	3	3
Frequency[1] (Hz)		60	60	60	60
Insulation Class[2]		F	F	F	F
NEMA Rated Motor Amps		74/37	28	52/26	20
Service Factor		1.15	1.15	1.15	1.15
Locked Rotor Amps		416/208	174	288/144	115
Max. Blower Amps		90/45	36	72/36	28.8
Recommended NEMA Starter Size		3/3	3	3/2	2
Shipping Weight lbs (Kg)		687 (311)	687 (311)	592 (269)	592 (269)

BLOWER LIMITATIONS FOR 60 Hz (50 Hz)

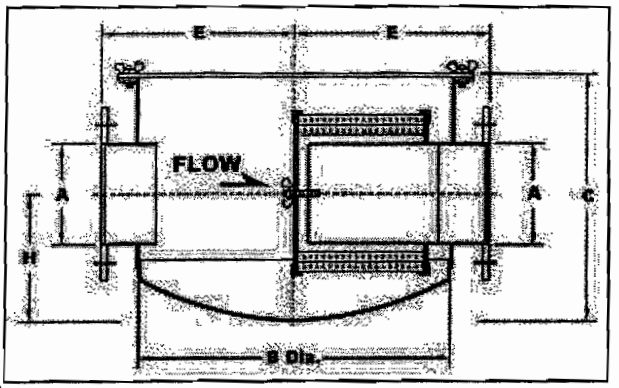
Max. Pressure — In. of water	122 (100)	122	75 (100)	75
Max. Suction — In. of water	100 (83)	100	68 (83)	68
Min. Flow — Pressure — SCFM	510 (230)	510	880 (230)	880
Min. Flow — Suction — SCFM	360 (120)	360	780 (120)	780

[1]All dual voltage 3 phase motors are factory tested and certified to operate on 200-230/400-460 VAC-3 ph-60 Hz and 220-240/380-415 VAC-3 ph-50 Hz. All dual voltage 1 phase motors are factory tested and certified to operate on 110-120/200-230 VAC-1 ph-60 Hz and 220-240 VAC-1 ph-50 Hz.
[2]Maximum operating temperatures: Motor winding temperature (winding rise plus ambient) should not exceed 140°C for Class F insulation or 120°C for Class B insulation. Blower outlet air temperature should not exceed 140°C (air temperature rise plus ambient).

Series F65

INLINE AIR FILTERS F65V
VACUUM SERVICE ONLY

The Series F65V Inline Filter is designed to mount directly in the air piping system for vacuum blowers or compressors. The filter element, which is fabricated from a pleated paper media, has an efficiency of 99% on 1 micron particle and larger. The Housing is designed to withstand a full vacuum. Pressure taps are provided on the intake and discharge nozzles for installation by the customer of a pressure drop indicator or switch.



ALTERNATE FILTRATION MEDIA AVAILABLE FOR F65:
Cleanable Polyester Felt - 98% on 3 micron particles.
Galvanized Wire Mesh - 90% on 10 micron particles (when oil wetted).
Cleanable Polyurethane Foam - 98% on 10 micron particles

FOR PRESSURE SERVICE USE F65

Model	A	B	C	E	H
F65V - 2	2 NPT	12	10 3/4	9	5
F65V - 2 1/2	2 1/2 NPT	12	10 3/4	9	5
F65V - 3	3 NPT	16	15 1/4	11	7
F65V - 4	NPT or FLG	16	15 1/4	11	7
F65V - 5	* 5 FLG	16	15 1/4	11	7
F65V - 6	* 6 FLG	18	18 5/8	12	10
F65V - 8	* 8 FLG	24	19 3/8	15	10
F65V - 10	* 10 FLG	36	36 1/4	22	17
F65V - 12	* 12 FLG	36	36 1/4	22	17
F65V - 14	* 14 FLG	36	36 1/4	22	17

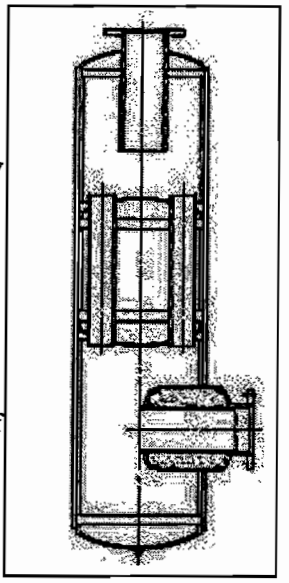
Model	RATED CFM	WEIGHT	REPLACEMENT ELEMENT NUMBER
F65V - 2	135	34	F8-108
F65V - 2 1/2	180	35	F8-108
F65V - 3	285	69	F8-109
F65V - 4	520	71/77	F8-109
F65V - 5	750	81	F8-109
F65V - 6	1075	95	F8-110
F65V - 8	1800	176	F8-111
F65V - 10	3335	385	F8-137
F65V - 12	4675	405	F8-137
F65V - 14	5655	425	F8-137

* Flanges match 125# ASA. Diameter and Drilling.
Rated CFM based on maximum exit velocity of 5500 FPM

STODDARD SILENCERS INC.

ROTARY BLOWER DISCHARGE SILENCERS

Series D



Discharge silencers are essential to a good system performance on all rotary blower systems. The belief that the discharge creates less noise than the inlet is erroneous because the discharge pulsations and noise are normally contained in a closed system.

The rotary positive blower does not compress the air as it moves from the blower inlet to the blower discharge. Compression takes place when line pressure backs up into the open port - thus compressed air is then pushed out into the line. This action takes place in a very short period of time and produces steep wave forms that can be destructive to piping and other equipment unless properly treated.

Blower displacement and speed are the major parameters in designing discharge silencers that perform their assigned function and will live throughout the useful life of the blower. Normally for good silencing the discharge silencer should have an internal volume to blower displacement ratio of 18 to 1.

Blower speed dictates the model used. When the blower speed is below the transition speed, the multi-chamber type is recommended to properly treat the noise emitted from the blower discharge. When the blower speed is above the transition speed, the intensity of the high frequencies is increased, requiring a modified design incorporating acoustic materials to absorb these frequencies. Normally acceptable discharge silencer pressure drop is in the range of 10 to 12 inches of water.

DESCRIPTION OF PRODUCTS

- **D32 - Chamber-Absorption Silencers**
- **D32H - Chamber-Absorption Silencers**
- **D32T - Chamber-Absorption Silencers**
- **D33 - Chamber-Absorption Silencers**
- **D33H - Chamber-Absorption Silencers**
- **D33T - Chamber-Absorption Silencers**
- **D13 - Chamber Silencers**
- **D13H - Chamber Silencers**
- **D90 - Rotary Blower Combination Silencers**
- **D93 - Rotary Blower Combination Silencers**

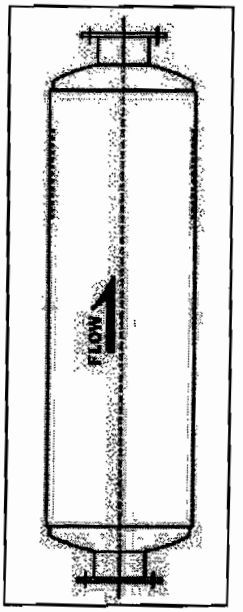
Back

Back to Home page

Series D

D33 CHAMBER-ABSORPTION SILENCERS

Application
Blower Discharge Silencer for maximum silencing at blower speeds above transition speed.



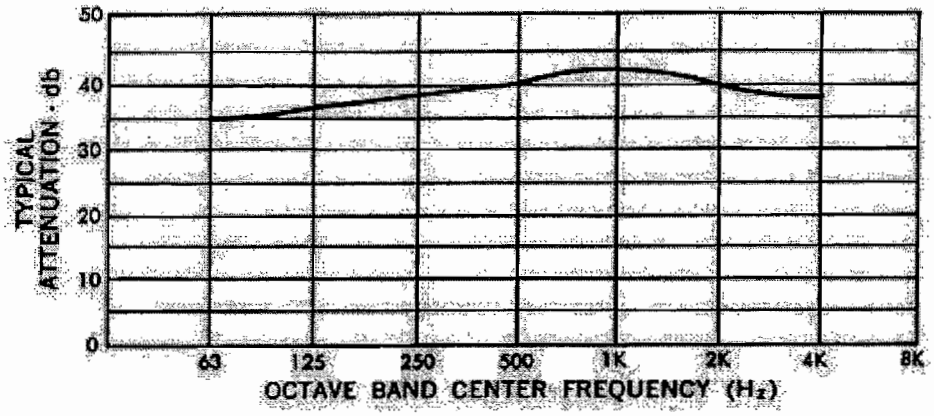
Design
A multi-chamber silencer containing a high frequency absorption device in addition to a special arrangement of volumes and air passageways to effectively reduce both pulsation and excessive high frequency through the process of converting noise energy into heat. D33 may be installed horizontally or vertically. Design parameters permit nozzle orientation to suit installation requirements.

Construction
All welded steel sheet and plate construction for long service life. Standard acoustic absorption material temperature limit is 300°F. Exterior surfaces are prime coated. Flanges are drilled to match 125 lb. American Standard Flanges. Inspection openings, mounting brackets, relief valve nozzles or special paint are available at extra charge.

Model	A	B	C	Wt.
D33 - 2	2*	8	33	25
D33 - 2 1/2	2 1/2*	10	33	53
D33 - 3	3*	10	51	75
D33 - 4	4**	14	53	139
D33 - 5	5**	16	65	200
D33 - 6	6**	18	72	281
D33 - 8	8	22	98	715
D33 - 10	10	26	123	958
D33 - 12	12	30	136	1353
D33 - 14	14	36	168	1826
D33 - 16	16	42	182	2906
D33 - 18	18	48	189	4175
D33 - 20	20	48	201	4525
D33 - 22	22	54	214	5337
D33 - 24	24	54	232	6560

* NPT Connections
** Available in NPT or Flange Connections

TYPICAL ATTENUATION CURVE



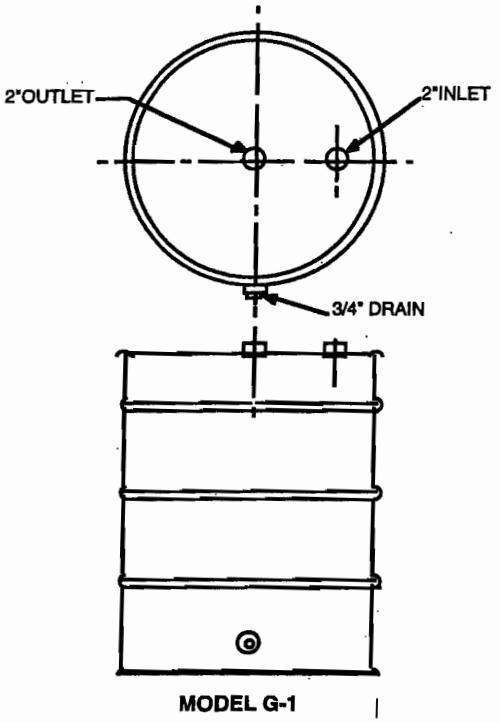
Back

Back to page SERIES D

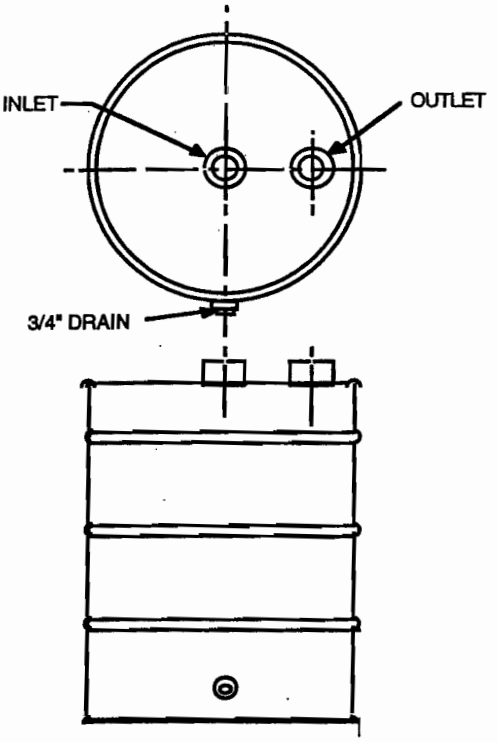
CARBTROL®

AIR PURIFICATION CANISTERS 140-200 LB. ACTIVATED CARBON

G-1
G-2
G-3



MODEL G-1



MODEL G-2,G-3

SPECIFICATIONS

MODEL	DIAMETER/HEIGHT	CARBON WEIGHT	INLET/OUTLET	MAXIMUM RATED FLOW	APPROXIMATE SHIP WEIGHT
G-1*	24"/36"	200 lbs.	2"/2"	100 CFM	240 lbs.
G-2*	24"/36"	170 lbs.	4"/4"	300 CFM	210 lbs.
G-3P	24"/36"	140 lbs.	6"/6"	500 CFM	180 lbs.
G-3S	24"/34"	140 lbs.	4"/4"	500 CFM	180 lbs.

* Specify: Polyethylene (P) or Epoxy Lined Steel (S)

SAFETY

Certain chemical compounds in the presence of activated carbon may oxidize, decompose or polymerize. This could result in temperature increases sufficient to cause ignition of the activated carbon or adsorbed material. If a compounds reaction with activated carbon is unknown, appropriate tests should be considered.

CARBTROL® CORPORATION
51 Riverside Avenue
Westport, CT 06880
1-800-242-1150 • Fax # (203) 226-5322
Web Address: http://www.carbtrol.com

Appendix G

Ambient Air Quality Impact Screening Evaluation

Air Quality Impact Screening Analysis

Although no air permit is required, JCI Jones Chemical, Inc. is required to comply with the substantiative requirements of 6NYCRR Part 212 for General Process Emission Sources (date) and the New York State Division of Air Resources (DAR) Guidelines for the Control of Toxic Ambient Air Contaminants (Guidelines; Issued November 12, 1997). Therefore, LFR has evaluated the requirements for emissions controls on the air stripper and proposed SVE system. Our analysis was performed in accordance with Appendix B of the Guidelines.

Air Stripper

1. Evaluate building cavity impacts.

   Building cavity impacts occur when the stack height is less than 2.5 times the building height. According to the Basic Cavity Impact Method (Appendix B.II.A.), if the shortest distance from the building to the nearest property line is greater than 3 times the height of the building then the building cavity impact does not need to be evaluated. Since the height of the building where the air stripper is located is19 feet and the nearest property line is 57 feet from the building, cavity impacts are not considered.

2. Use the Standard Point Source Method (Appendix B.III.A) to estimate actual and potential annual impact.

   a) Since the stack height is 50 ft which is greater than 2.5 times the building height (19 ft), the buoyancy flux parameter is calculated.

$$F = 0.276\frac{VR^2}{T}(T - 510)$$

   Where:

   F = buoyancy flux parameter (m^4/sec^3)
   V = exit velocity (ft/s) = Q_{air}/A_{stack}
   R = stack outlet radius (ft)
   T = stack exit temperature (° Rankine = °F +460)

   Given a stack diameter of 18 inches and an air flow of 5,500 standard cubic feet per minute (scfm), V has a value of 51.88 ft/sec. Assuming an operating temperature of 55° F, then F is estimated to be 0.0782 m^4/sec^3.

   b) Estimate effective stack height, h_e.

   Since F is less than 55, h_e is estimated in accordance with Appendix B.III.A.1.d. as follows:

$$h_e = h_s + 7F^{0.75}$$

Given a stack height, h_s, of 50 ft, h_e is 51 ft.

c) Estimate maximum allowable emission rate using the annual guideline concentration (AGC; 1.0 µg/m³) for PCE.

$$C_a = \frac{6xQ_a x0.4}{h_e^{2.25}}$$

Where:

Q_a = annual emission rate (lbs/yr)
Ca = actual annual impact set to the AGC (1.0 µg/m³)
0.4 = rate reduction factor per Appendix B.III.A.4

The maximum allowable annual emission rate, Q_a, is equal to 2,896 lbs/yr or 0.33 lbs/hr assuming 8760 hours of operation per year.

d) Estimate the maximum allowable emission rate using the short-term guideline concentration (SGC; 1,000 µg/m³) for PCE.

$$C_{ST} = \frac{52500xQ_a x0.4}{h_e^{2.25}} x65$$

Where:

Q_a = annual emission rate (lbs/hr)
C_{ST} = short-term impact set to the SGC (1,000 µg/m³)
0.4 = rate reduction factor per Appendix B.III.A.4

The maximum allowable annual emission rate, Q_a, is equal to 5.09 lbs/hr which is higher than the emission standard based on the C_a; therefore, select the C_a based annual allowable emission rate of 0.33 lbs/hour.

e) Estimate the maximum allowable water flow rate to the stripper given an average PCE concentration of 400 µg/l (as determined based upon the January 2000 groundwater sampling data) and an allowable annual emission rate of 0.33 lbs/hr.

Assume that the stripper removes 100% of the PCE from the groundwater.

$$Q_w\left(\frac{gal}{\min}\right) = \frac{0.33lbs/hr(453.6g/lb)(1000mg/g)}{3.785l/gal(60\min/hr)(0.400mg/l)} = 1{,}648gal/\min$$

Since the proposed water flow rate to the stripper is 500 gpm, the actual annual emission rate is calculated as follows assuming 100% of the PCE is removed.

$$C_a = \frac{500gal/\min(3.785l/gal)(60\min/hr)(0.400mg/l)}{1000mg/g(453.6g/lb)} = 0.10lbs/hr$$

Applying the 40% reduction factor in accordance with Appendix III.A.4.b, the C_a is 0.04 lbs/hr which is less than the allowable emission rate of 0.33 lbs/hr. Therefore, emissions control technology is not required on the stripper.

Soil Vapor Extraction

Given the expected high concentration of PCE in the vapors at SVE start-up over the first week, granular activated carbon will be used to treat the extracted vapors prior to discharge to the atmosphere. After the first week, the extracted vapors are estimated to have an emission rate without treatment of less than 0.1 lbs/hr of PCE. This emission rate was calculated as follows using the pilot study data:

$$R_{removal} = \eta \cdot G \cdot Q \cdot 4.6x10^{-7}$$

where:

$R_{removal}$ = removal rate (lbs/min)
G = vapor concentration (ppm_v)
η = efficiency (unitless)
Q = vapor flow rate; 750 cfm
$4.6x10^{-7}$ = conversion factor from ppm_v to lbs/ft^3

The vapor concentration, G, in ppm_v is estimated using the best-fit equation from the pilot study for any time, x (minutes) as follows:

$$G = 1592.1x^{-0.6335}$$

After seven days of operation, the expected vapor concentration is 4.6 ppm_v. Inputting this value into the removal rate equation and assuming that 100% of the vapors are from the affected zone, the removal rate is estimated to be 0.0016 lbs/min or 0.096 lbs/hr.

The activated carbon is expected to capture greater than 99% of the PCE in the air stream prior to discharge to the atmosphere.

1. Evaluate building cavity impacts.

   Building cavity impacts occur when the stack height is less than 2.5 times the building height. According to the Basic Cavity Impact Method (Appendix B.II.A.), if the shortest distance from the building to the nearest property line is greater than 3 times the height of the building then the building cavity impact does not need to be evaluated. Since the height of the proposed remediation building where the SVE system will be located is12 feet and the nearest property line is over 70 feet from the building, cavity impacts are not considered.

2. Use the Standard Point Source Method (Appendix B.III.A) to estimate actual and potential annual impact.

a) Since the proposed stack height is 18 ft which is 1.5 times the building height (12 ft), the effective height is calculated is calculated.

$$h_e = h_s + 1.1F_m^{0.33}$$

Where:

F_m = momentum flux (ft^4/sec^2)

$$F_m = \frac{V^2 R^2 T_a}{T}$$

V = exit velocity (ft/s) = Q_{air}/A_{stack}
R = stack outlet radius; 0.75 ft
T = stack exit temperature (° Rankine = 77 °F +460)
T_a = ambient temperature (° Rankine = 55° F +460)

Given a stack diameter of 8 inches and an air flow of 750 standard cubic feet per minute (scfm), V has a value of 28.3 ft/sec, then F_m is estimated to 108 ft^4/sec^2 and the effective height is equal to 23 ft.

b) Estimate maximum allowable emission rate using the annual guideline concentration (AGC; 1.0 µg/m^3) for PCE.

$$C_a = \frac{6xQ_a x.75}{h_e^{2.25}}$$

Where:

Q_a = annual emission rate (lbs/yr)
Ca = actual annual impact set to the AGC (1.0 µg/m^3)
0.75 = rate reduction factor per Appendix B.III.A.4

The maximum allowable annual emission rate, Q_a, is equal to 257 lbs/yr or 0.029 lbs/hr assuming 8760 hours of operation per year.

c) Estimate the maximum allowable emission rate using the short-term guideline concentration (SGC; 1,000 µg/m^3) for PCE.

$$C_{ST} = \frac{52500xQ_a x0.75}{h_e^{2.25}} x65$$

Where:

Q_a = annual emission rate (lbs/hr)
C_{ST} = short-term impact set to the SGC (1,000 µg/m^3)
0.75 = rate reduction factor per Appendix B.III.A.4

The maximum allowable annual emission rate, Q_a, is equal to 0.45 lbs/hr which is higher than the emission standard based on the C_a; therefore, select the C_a based annual allowable emission rate of 0.029 lbs/hour.

Since the emission rate is anticipated to be greater than 0.029 lbs/hr, emission control technology is required. Activate carbon is proposed to treat the effluent to below 0.029 lbs/hr before discharge.

Appendix H

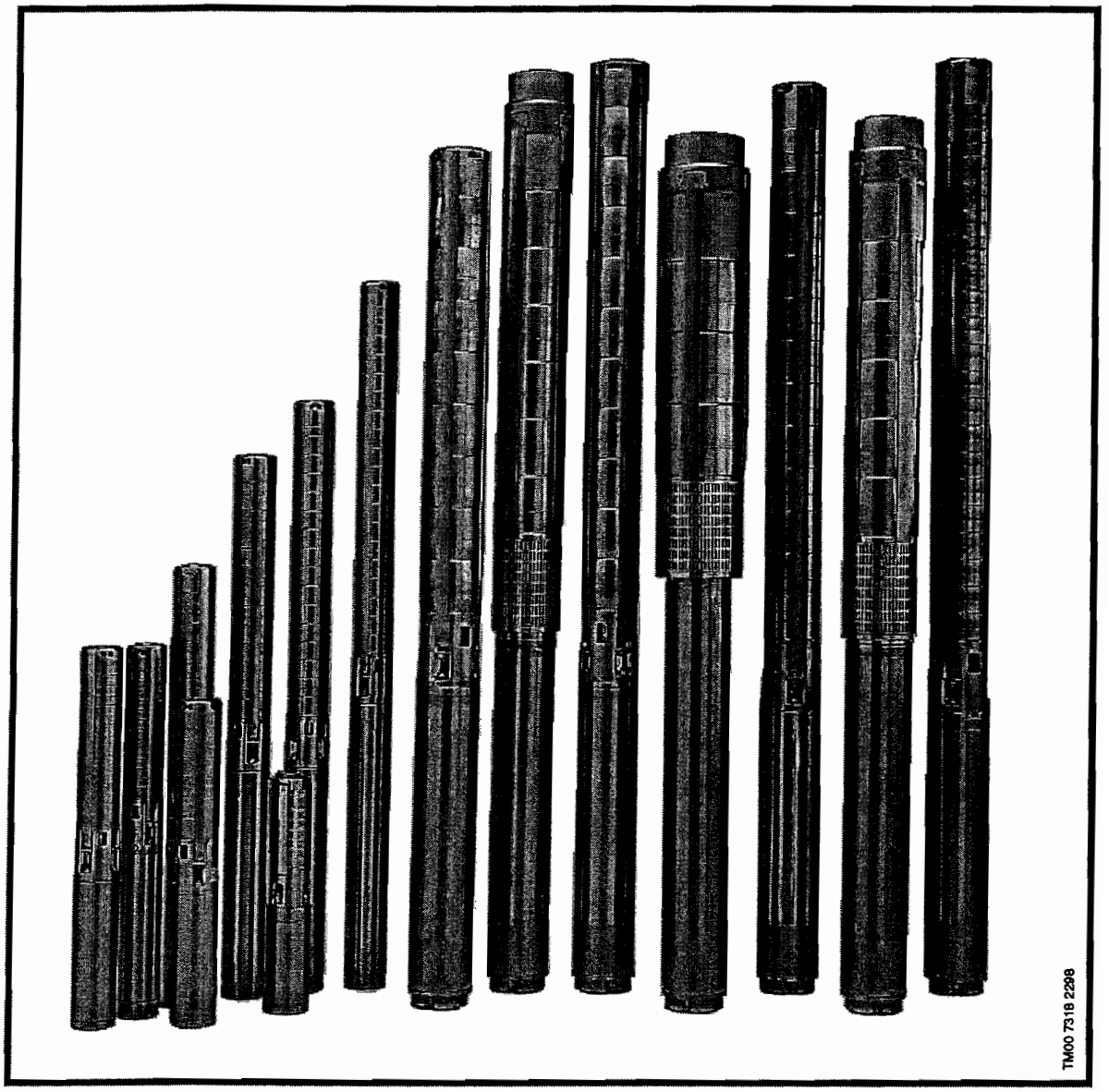
Groundwater Extraction Well Pump Specifications

SP A, SP

Submersible pumps
Submersible motors
Accessories

For raw-water supply, irrigation systems, groundwater lowering, pressure boosting and various industrial applications.

60 Hz

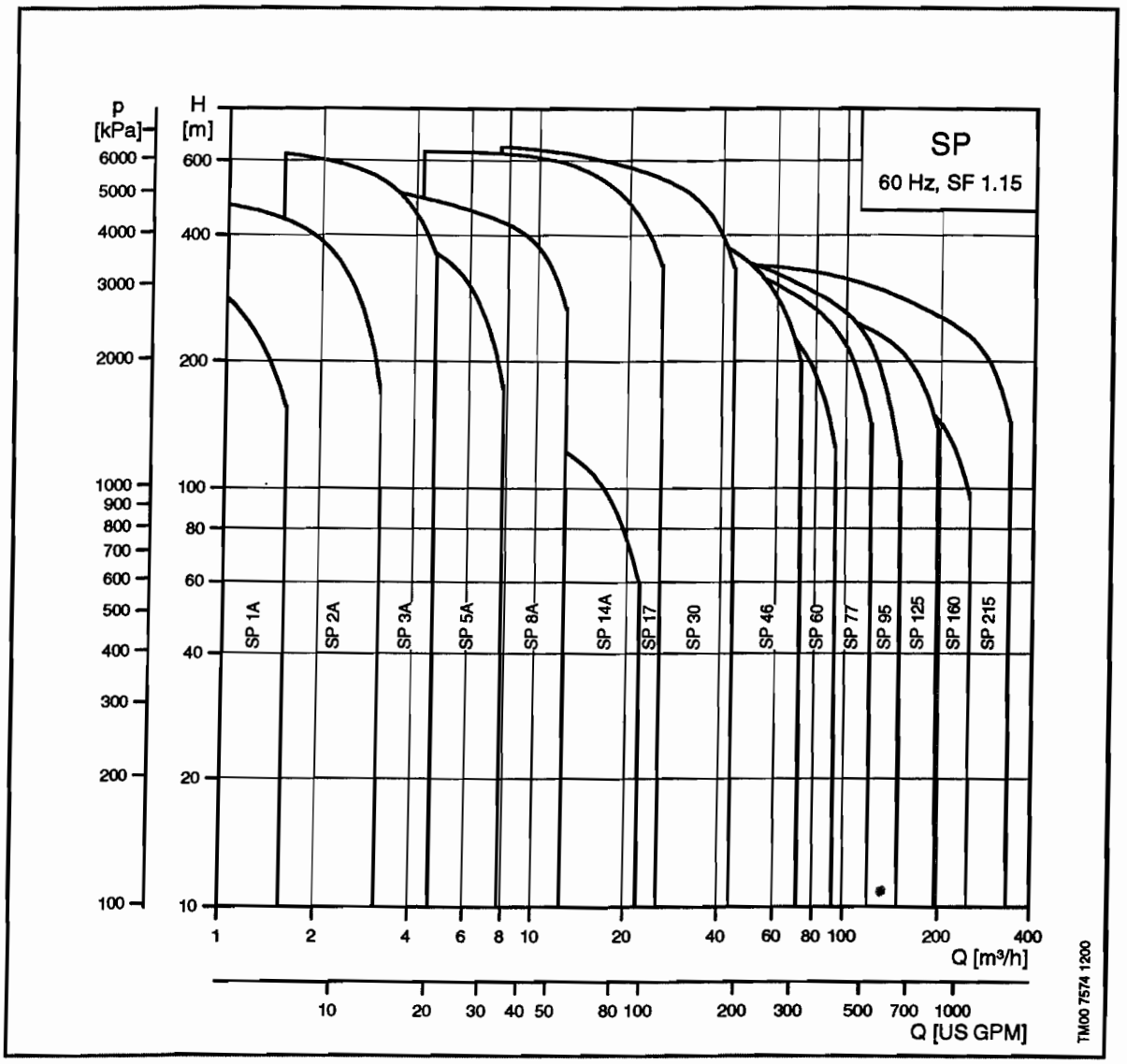


GRUNDFOS

Contents

General data

Performance range



GRUNDFOS

General data

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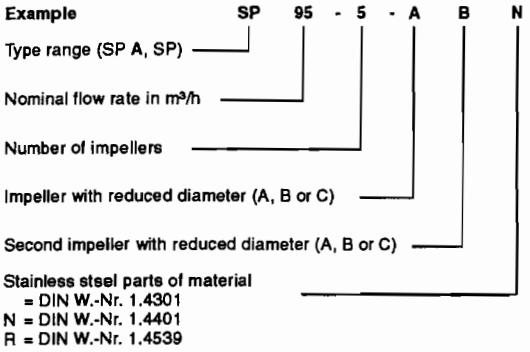


Pumped liquids

Clean, thin, non-aggressive liquids without solid particles or fibres.

The special SP A-N and SP-N versions made of stainless steel to DIN W.-Nr. 1.4401 and SP A-R and SP-R versions made of stainless steel to DIN W.-Nr. 1.4539 are available for applications involving aggressive liquids.

Operating conditions

Flow rate, Q: 0.1-335 m³/h.
Head, H: Maximum 646 m.

Maximum liquid temperature:

Motor	Installation		
	Flow velocity past motor	Vertical	Horizontal
Grundfos MS 4" and 6"	Free convection 0 m/s	20°C	Flow sleeve-recommended
Grundfos MS 4" and 6"	0.15 m/s	40°C	40°C
Grundfos MS industry versions 4" and 6"	0.15 m/s	60°C	60°C
Grundfos MMS 6" to 12" rewindable	Free convection 0 m/s	20°C	20°C
	0.15 m/s	25°C	25°C
	0.50 m/s	30°C	30°C

Note: For MMS 6000, 37 kW, MMS 8000, 110 kW, and MMS 10000, 170 kW, the maximum liquid temperature is 5°C lower than the values stated in the table above. For MMS 10000, 190 kW the temperature is 10°C lower.

Operating pressure:

Motor	Maximum operating pressure
Grundfos MS 4" and 6"	6 MPa (60 bar)
Grundfos MMS 6" to 12" rewindable	2.5 MPa (25 bar)

Curve conditions

The conditions below apply to the curves shown on the following pages:

General

- Curve tolerances according to ISO 9906, Annex A.
- The performance curves show pump performance at actual speed cf. standard motor range.

  The speed of the motors is approximately:
  4" motors : $n = 3470\ min^{-1}$
  6" motors : $n = 3460\ min^{-1}$
  8" to 12" motors : $n = 3525\ min^{-1}$
- The measurements were made with airless water at a temperature of 20°C. The curves apply to a kinematic viscosity of 1 mm²/s (1 cSt). When pumping liquids with a density higher than that of water, motors with correspondingly higher outputs must be used.
- The bold curves indicate the recommended performance range.
- The performance curves are inclusive of possible losses such as non-return valve loss.

SP A curves

- **Q/H:** The curves are inclusive of valve and inlet losses at the actual speed.
- **Power curve:** P_2 shows pump power input at the actual speed for each individual pump size.
- **Efficiency curve:** Eta shows pump stage efficiency.

SP curves

- **Q/H:** The curves are inclusive of valve and inlet losses at the actual speed.
  Operation without non-return valve will increase the actual head at nominal performance by 0.5 to 1.0 m.
- **NPSH:** The curve is inclusive of suction interconnector and shows required inlet pressure.
- **Power curve:** P_2 shows pump power input at the actual speed for each individual pump size.
- **Efficiency curve:** Eta shows pump stage efficiency.

General data

Pump range

Type	SP1A	SP2A	SP3A	SP5A	SP8A	SP14A	SP17	SP30	SP46	SP60	SP77	SP95	SP125	SP160	SP215
Steel: DIN 1.4301 AISI 304	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Steel: DIN 1.4401 AISI 316			+	+	+		+	+	+	+	+	+	+	+	+
Steel: DIN 1.4539 AISI 904L					+		+	+	+	+					
Connection *	Rp 1¼	Rp 1¼ (R 1¼)	Rp 1¼	Rp 1½ (R 1½)	Rp 2 (R 2)	Rp 2	Rp 2½ (R 3)	Rp 3 (R 3)	Rp 3 Rp 4 (R 4)	Rp 3 Rp 4	Rp 5	Rp 5	Rp 6	Rp 6	Rp 6
Flange connection: Grundfos flange											5"	5"	6"	6"	6"

* Figures in brackets () indicate connection for pumps in sleeve.

Motor range

Motor output [kW]	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3.0	3.7	4.0	5.5	7.5	9.2	11	13	15	18.5	22	26	30	37	45	55	63	75	92	110	132	147	170	190
Single-phase	+	+	+	+	+	+	+																								
Three-phase		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Industrial motor							+	+	+	+	+	+	+	+	+	+	+	+													
Rewindable motor									+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Steel: DIN 1.4301 AISI 304	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+											
Steel: DIN 1.4301 and cast iron									+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Steel: DIN 1.4401 AISI 316									+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Steel: DIN 1.4539 AISI 904L				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+											
Built-in temperature transmitter in motor				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+											

Direct-on-line starting is recommended up to 75 kW.

Soft starter or autotransformer is recommended above 75 kW.

Motors with star/delta are available from 5.5 kW.

Motor protection and controllers

Motor output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3.0	3.7	4.0	5.5	7.5	9.2	11	13	15	18.5	22	26	30	37	45	55	63	75	92	110	132	147	170	190
MTP 75 *			+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+											
CU 3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pt100								+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zinc anode				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Vertical flow sleeve	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Horizontal flow sleeve	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+											
SA-SPM	+	+	+	+	+	+																								
R100	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
RS-485 communi-cation module	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
G100	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
SM100 sensor module	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

* Requires motor with built-in temperature transmitter.

Motor protection af single-phase motor, see "Technical data" page 71.

Features and benefits

A wide pump range

Grundfos offers submersible pumps with energy-efficient duty points ranging from 0.1 to 335 m³/h. The pump range consists of many pump sizes - and each pump size is available with an optional number of stages to match any duty point.

High pump efficiency

Often pump efficiency is a neglected factor compared to the price. However, the observant user will notice that price variations are without importance to water supply economics compared to the importance of pump and motor efficiencies.

Example:

When pumping 200 m³/h with a head of 100 m for a period of 10 years EURO 60,000 will be saved if a pump/motor having a 10% higher efficiency is chosen and the price is EURO 0.10 per kWh.

Applications

Grundfos offers a complete range of pumps and motors which as a standard are made completely of stainless steel to DIN W.-Nr. 1.4301 (AISI 304). This provides for good wear resistance and a reduced risk of corrosion when pumping ordinary cold water with a minor content of chloride.

A pump range made of upgraded stainless steel is available for more aggressive liquids:

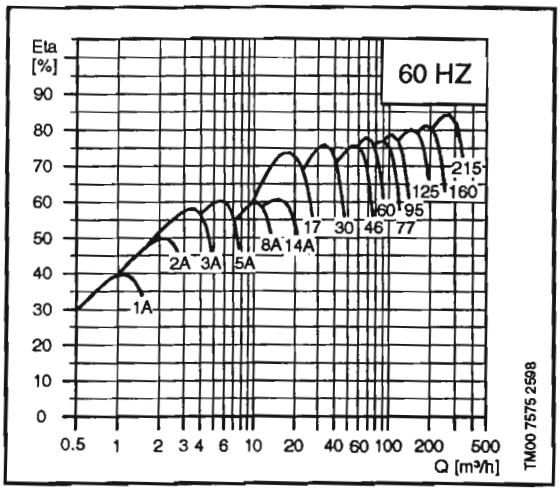
SP N: DIN W.-Nr. 1.4401 (AISI 316)
SP R: DIN W.-Nr. 1.4539 (AISI 904L)

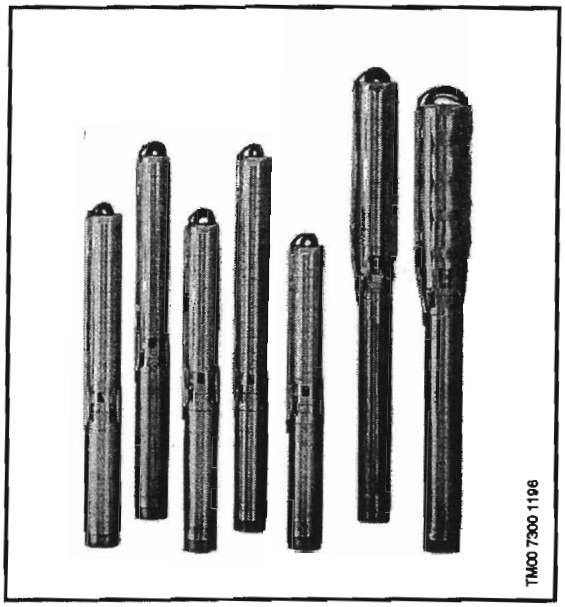
Alternatively, a complete range of zinc anodes for cathodic protection is available, see page 88. For example this may be advisable for sea water applications.

For slightly polluted liquids containing for example oil, Grundfos offers a complete range (SP NE) in stainless steel to DIN W.-Nr. 1.4401 (AISI 316) with all rubber parts made of FKM.

Low installation costs

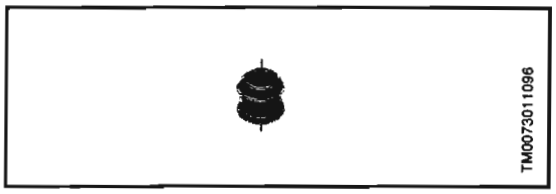
Stainless steel means low weight facilitating the handling of pumps and resulting in low equipment costs and reduced installation and service time. In addition pumps will be as new after service due to the high wear resistance of stainless steel.





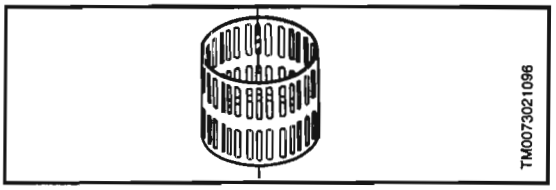
Bearingswithsandchannels

All bearings are water-lubricated and have a squared shapeenablingsandparticles,ifany,toleavethepump togetherwiththepumpedliquid.



Inletstrainer

Theinletstrainerpreventsparticlesoveracertainsize fromenteringthepump.

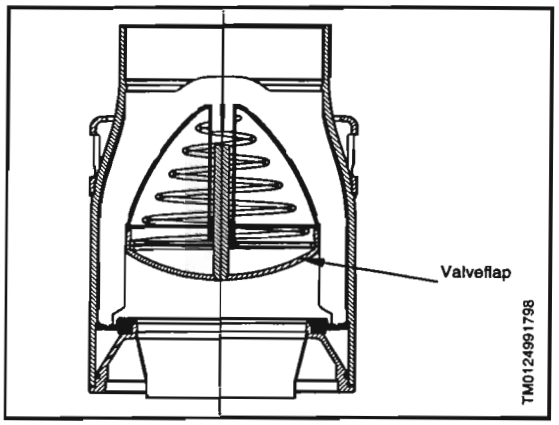


Non-returnvalve

Allpumpsareequippedwithareliablenon-returnvalve in the vale casing preventing back flow in connection withpumpstoppage.

Furthermore, the short closing time of the non-return valvemeansthattheriskofdestructivewaterhammer isreducedtoaminimum.

The valve casing is designed for optimum hydraulic properties, to minimize the pressure loss across the valveandthuscontributestothehighefficiencyofthe pump.

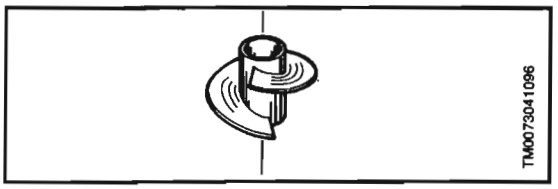


Primingscrew

All SP A and SP 17 pumps are fitted with a priming screw. Consequently, dry running is prevented, because the priming screw will make sure that pump bearingsarealwayslubricated.

Due to the semi-axial impellers of large SP pumps (except for SP 17) this priming is automatically provided.

However, itappliestoallpumptypesthatifthewater tableisloweredtoalevelbelowthepumpinletneither pumpnormotorwillbeprotectedagainstdryrunning.



Stopring

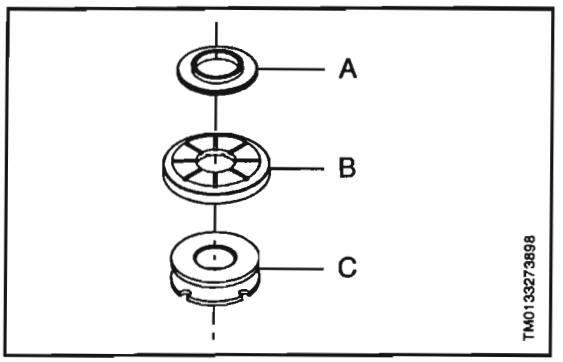
The stop ring prevents damage to the pump during transport and in case of up-thrust in connection with start-up.

The stop ring, which is designed as a thrust bearing, limitsaxialmovementsofthepumpshaft.

Example:SP77

Thestationarypartofthestopring(A)issecuredinthe upperintermediatechamber.

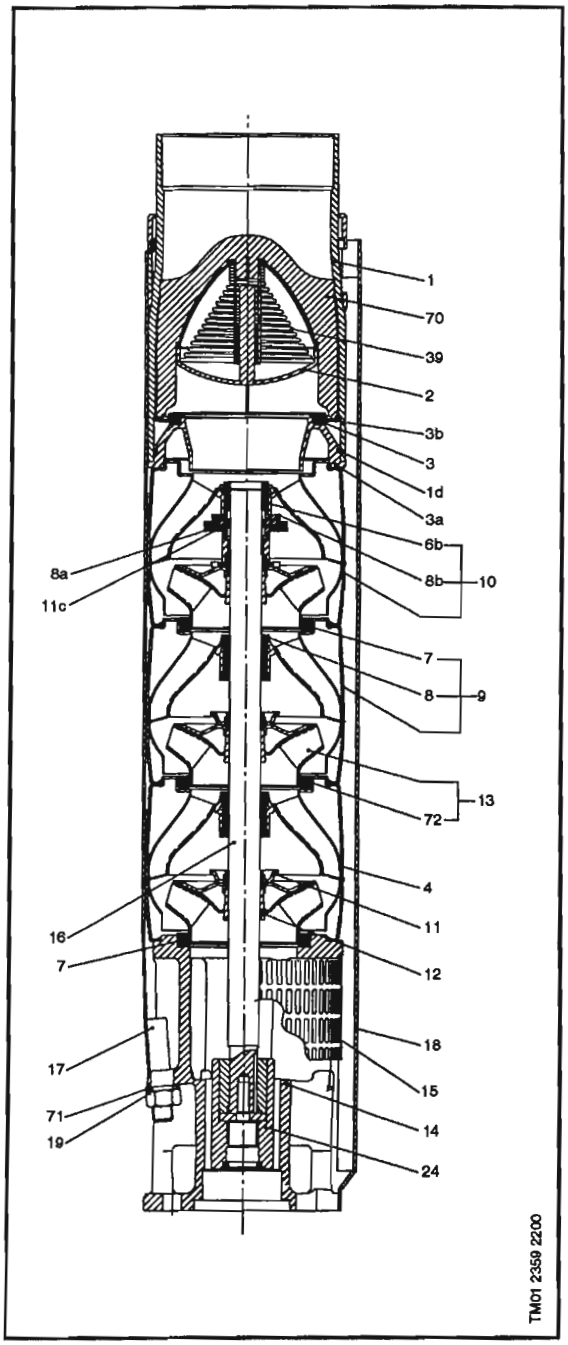
Therotatingpart(B)isfittedabovethesplitcone(C).



Material specification

Pos.	Components	Materials	Standard		N-version	
1	Valve casing	Stainless steel	1.4301	304	1.4401	316
1d	O-ring	NBR				
2	Valve cup	Stainless steel	1.4301	304	1.4401	316
3	Valve seat	Stainless steel	1.4301	304	1.4401	316
3a	Lower valve seat retainer	Stainless steel	1.4301	304	1.4401	316
3b	Upper valve seat retainer	Stainless steel	1.4301	304	1.4401	316
4	Bottom chamber	Stainless steel	1.4301	304	1.4401	316
6b	Lower bearing	Stainless steel/ NBR	1.4301	304	1.4401	316
7	Neck ring	NBR/PPS				
8	Intermediate bearing	NBR				
8a	Spacing washer for stop ring	Carbon/graphite HY22 in PTFE mass				
8b	Stop ring	Stainless steel	1.4401	316	1.4401	316
9	Intermediate chamber	Stainless steel	1.4301	304	1.4401	316
10	Upper inter-mediate cham-ber with stop ring	Stainless steel	1.4301	304	1.4401	316
11	Split cone nut	Stainless steel	1.4301	304	1.4401	316
11c	Nut for stop ring	Stainless steel	1.4401	316	1.4401	316
12	Split cone	Stainless steel	1.4301	304	1.4401	316
13	Impeller	Stainless steel	1.4301	304	1.4401	316
14	Suction interconnector	Stainless steel	1.4301	304	1.4401	316
15	Strainer	Stainless steel	1.4301	304	1.4401	316
16	Shaft	Stainless steel	1.4057	431	1.4460	329
17	Strap	Stainless steel	1.4301	304	1.4401	316
18	Cabel guard	Stainless steel	1.4301	304	1.4401	316
19	Nut for strap	Stainless steel	1.4301	304	1.4401	316
24	Coupling	Stainless steel	1.4460	329	1.4460	329
39	Spring for valve cup	Stainless steel	1.4301	304	1.4401	316
70	Valve guide	Stainless steel	1.4301	304	1.4401	316
71	Washer	Stainless steel	1.4401	316	1.4401	316
72	Wear ring	Stainless steel	1.4301	304	1.4401	316

Example: SP 77



Submersible motors

Features and benefits

A complete motor range

Grundfos offers a complete submersible motor range in different voltages:

Submersible motors, MS:

- 4" motors, single-phase up to 2.2 kW:
  2 wire
  3 wire
  PSC (permanent split capacitor)
- 4" motors, three-phase up to 7.5 kW
- 6" motors, three-phase from 5.5 kW to 30 kW

Submersible rewindable motors, MMS:

- 6" motors, three-phase from 3.7 kW up to 37 kW
- 8" motors, three-phase from 22 kW up to 110 kW
- 10" motors, three-phase from 75 kW up to 190 kW

High motor efficiency

Within the area of high motor efficiency Grundfos is a market leader. This is due to a newly developed motor concept which is introduced with the MS 4000 and MS 6000 motors.

Rewindable motors

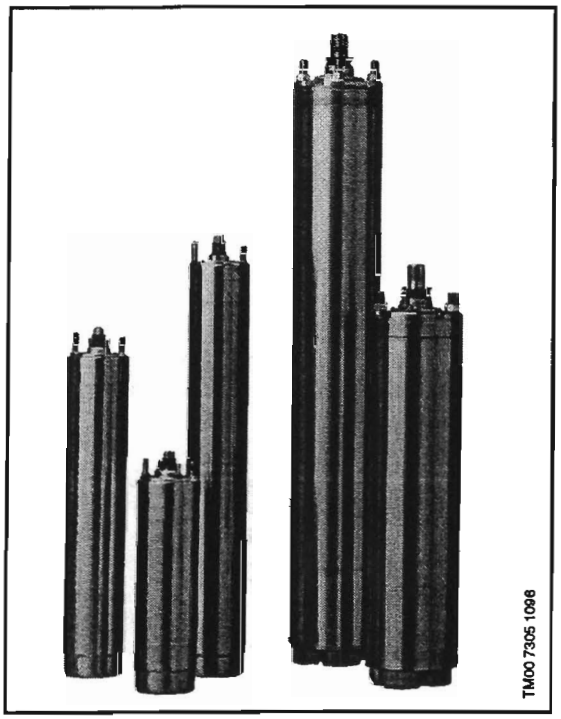
The two pole Grundfos MMS submersible motors, which are all of the canned-rotor type, are easily rewinded. The windings of the stator are made of a special water-proof wire of pure electrolytic copper sheathed with special non-hydroscopic thermoplastic material. The high dielectric strength properties of this material allow direct contact between the windings and the liquid for efficient cooling of the windings.

Industrial motors

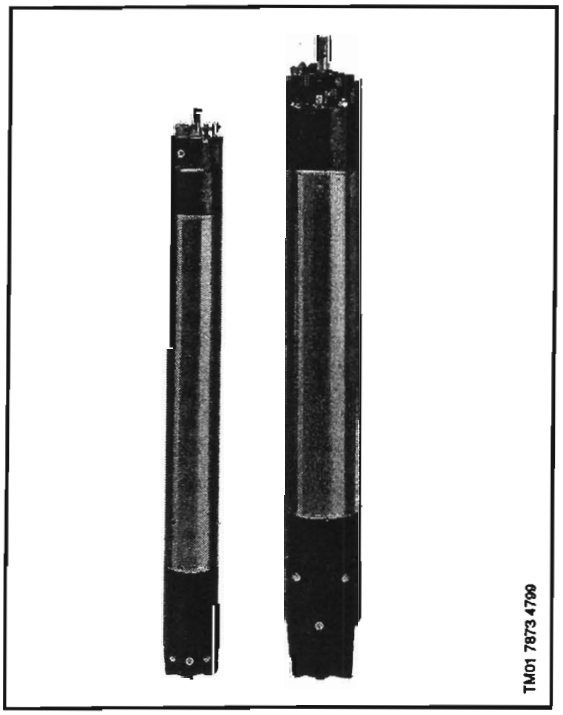
For heavy-duty applications Grundfos offers a complete motor range of industrial motors with up to 5% higher efficiency than that of Grundfos' standard motors. The industrial motors are available in sizes from 2.2 kW up to 22 kW. The cooling of the motor is very efficient due to the large motor surface. The efficient cooling makes it possible to increase the liquid temperature to 60°C at a flow of minimum 0.15 m/s past the motor.The industrial motors are for customers who value low operating costs and long life higher than price.

Grundfos industrial motors are developed for difficult operating conditions. These motors will stand a higher thermal load than standard motors and thus have a longer life when subjected to high load. This applies whether the high load is caused by bad power supply, hot water, bad cooling conditions, high pump load etc.

MS motors



MMS motors



Submersible motors

Overtemperature protection

Both for Grundfos MS and MMS submersible motors accessories for protection against overtemperature is available. When the temperature becomes too high, the protection device will cut-out and damage to the pump and motor be avoided.

Restart of the motor after cut-out can be achieved in two ways:

- manual restart or
- automatic restart.

Automatic restart means that the CU 3 control unit attempts to restart the motor after 15 min. If the first attempt is not successful, restarting will be reattempted at 30-minute intervals.

MS:
The Grundfos MS submersible motors are available with a built-in Tempcon temperature transmitter for protection against overtemperature. By means of the transmitter it is possible to read out and/or monitor the motor temperature via an MTP 75 or a CU 3 control unit.

The Grundfos MS 6000 submersible motors can be fitted with a Pt100. The Pt100 is fitted in the motor and connected via a relay (EDM 35 or PR 2202), which can be connected to the CU 3 control unit.

MMS:
For the protection of the Grundfos MMS submersible motors against overtemperature Grundfos offers the Pt100 temperature sensor as an optional extra.

The Pt100 is fitted in the motor and connected via a relay (EDM 35 or PR 2202), which can be connected to the CU 3 control unit.

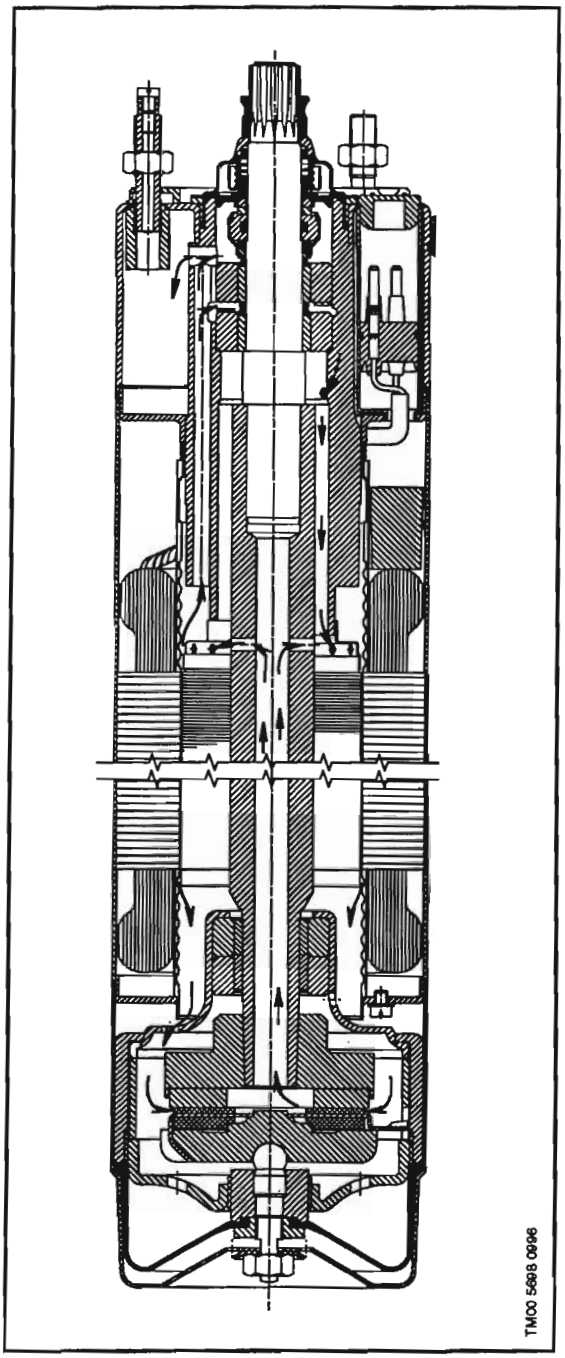
Protection against upthrust

In case of a very small counter pressure in connection with start-up there is a risk that the entire pump body may rise. This is called upthrust. Upthrust may damage both pump and motor. Therefore both Grundfos pumps and motors are protected against upthrust as standard, preventing upthrust from occurring in the critical start-up phase. The protection consists of either a built-in stop ring or hydraulic balancing.

Built-in cooling chambers

In all Grundfos MS submersible motors an efficient cooling is ensured by cooling chambers at the top and at the bottom of the motor, and by an internal circulation of motor liquid. See drawing in right column. As long as the required flow velocity past the motor is maintained (see "Operating conditions" page 4) cooling of the motor will be efficient.

Example: MS 4000



Submersible motors

Lightning protection

The smallest Grundfos submersible motors, i.e. of the type MS 402, are all insulated in order to minimize the risk of motor burnout caused by stroke of lightning.

Reduced risk of short-circuit

The embedded stator winding in the Grundfos MS submersible motor is hermetically enclosed in stainless steel. The result is high mechanical stability and optimum cooling. Also, this eliminates the risk of short-circuit of the windings caused by condensed water.

Shaft seal

MS 402

The shaft seal is of the lip seal type characterized by low friction against the rotor shaft.
The choice of rubber offers good wear resistance, good elasticity and resistance to particles. The rubber material is approved for use in drinking water.

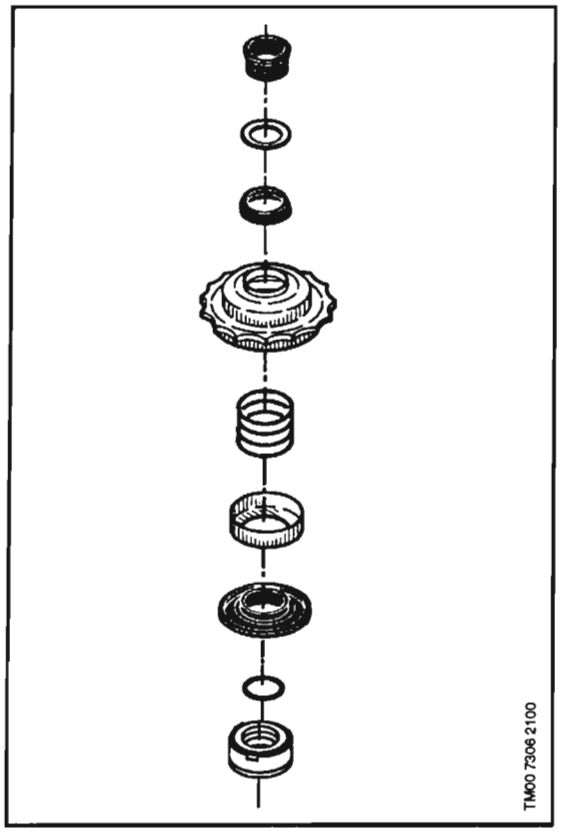
MS 4000, MS 6000

The choice of material is ceramic/tungsten carbide providing optimum sealing, optimum wear resistance and long life.
The spring loaded shaft seal is designed with a large surface and a sand shield. The result is a minimum exchange of pumped and motor liquids and no penetration of particles.

MMS rewindable motors

The standard shaft seal is a rubber lip type. The shaft seal is replaceable.
The material features good wear resistance and resistance to particles.
Together with the shaft seal housing, the sand shield forms a labyrinth seal, which during normal operating conditions prevents penetration of sand particles into the shaft seal.
On request, motors can be supplied with a SiC/SiC seal, according to DIN 24960.

Example: MS 4000



Submersible motors

Material specification for MS motors

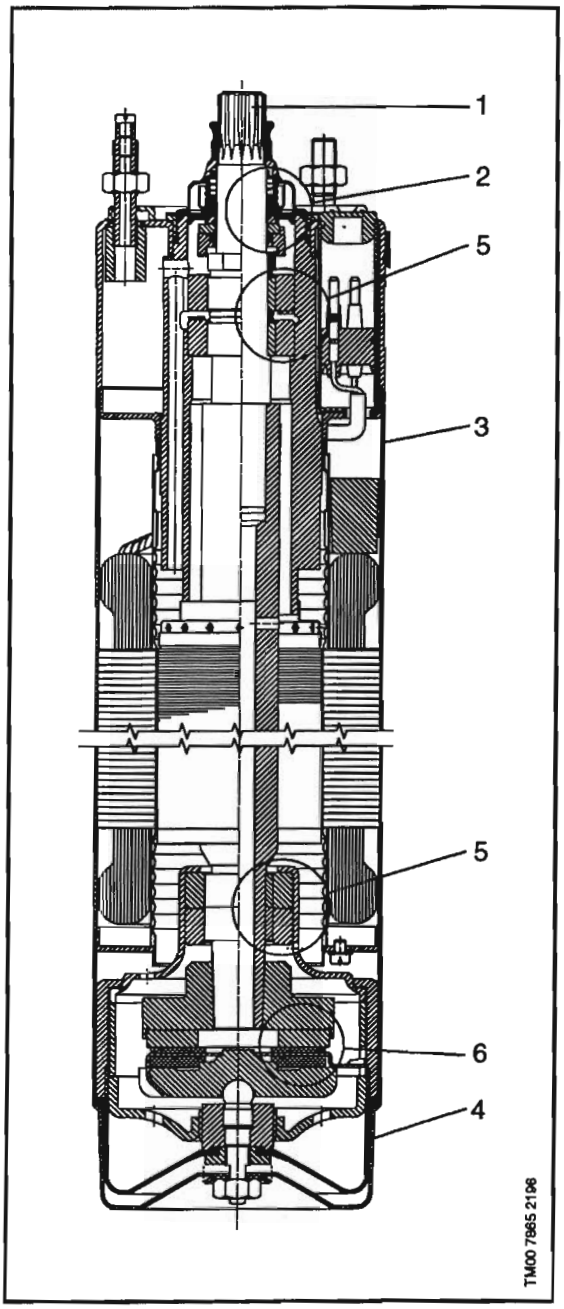
Submersible motors

Pos.	Part	MS 402	MS 4000 MS 6000
1	Shaft (DIN W.-Nr.)	1.4057	1.4057
2	Shaft seal (DIN W.-Nr.)	NBR rubber	Tungsten carbide/ ceramic
3	Motor sleeve (DIN W.-Nr.)	1.4301	1.4301
4	Motor end shield (DIN W.-Nr.)		1.4301
5	Radial bearing	Ceramic	Ceramic/ tungsten carbide
6	Axial bearing	Ceramic/ carbon	Ceramic/ carbon
	Rubber parts	NBR rubber	NBR rubber

R-version motor

Pos.	Part	MS 4000 MS 6000
1	Shaft (DIN W.-Nr.)	1.4462
2	Shaft seal	NBR/ceramic
3	Motor sleeve (DIN W.-Nr.)	1.4539
4	Motor end shield (DIN W.-Nr.)	1.4539
5	Radial bearing	Ceramic/ tungsten carbide
6	Thrust bearing	Ceramic/carbon
	Rubber parts	NBR

Example: MS 4000



Material specification for MMS motors

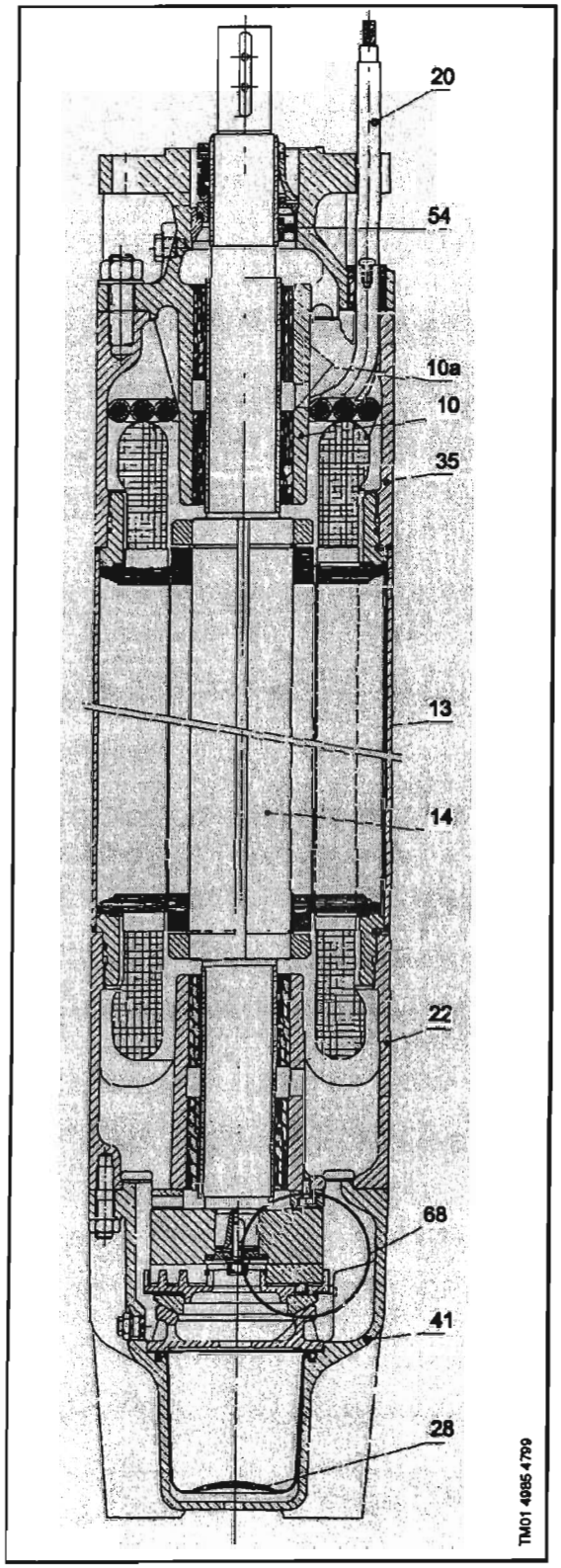
Submersible rewindable motors

Pos. no.	Component		Material	DIN W.-Nr.
10	Bearing housing, upper		Cast iron	EN-JL-1040
10a	Radial bearing	6"-10"	Graphite	
		12"	Stainless steel/NBR	
13	Motor sleeve		Stainless steel	1.4301
14	Shaft	Up to 75 kW	Stainless steel	1.4401
		From 75 kW		1.4462
20	Motor cable		EPDM	
22	Bearing housing, lower		Cast iron	EN-JL-1040
28	Diaphragm		CR	
35	Intermediate housing		Cast iron	EN-JL-1040
41	Motor end shield		Cast iron	EN-JL-1040
54	Shaft seal		Rubber lip type	
68	Thrust bearing		Hardened steel EPDM	

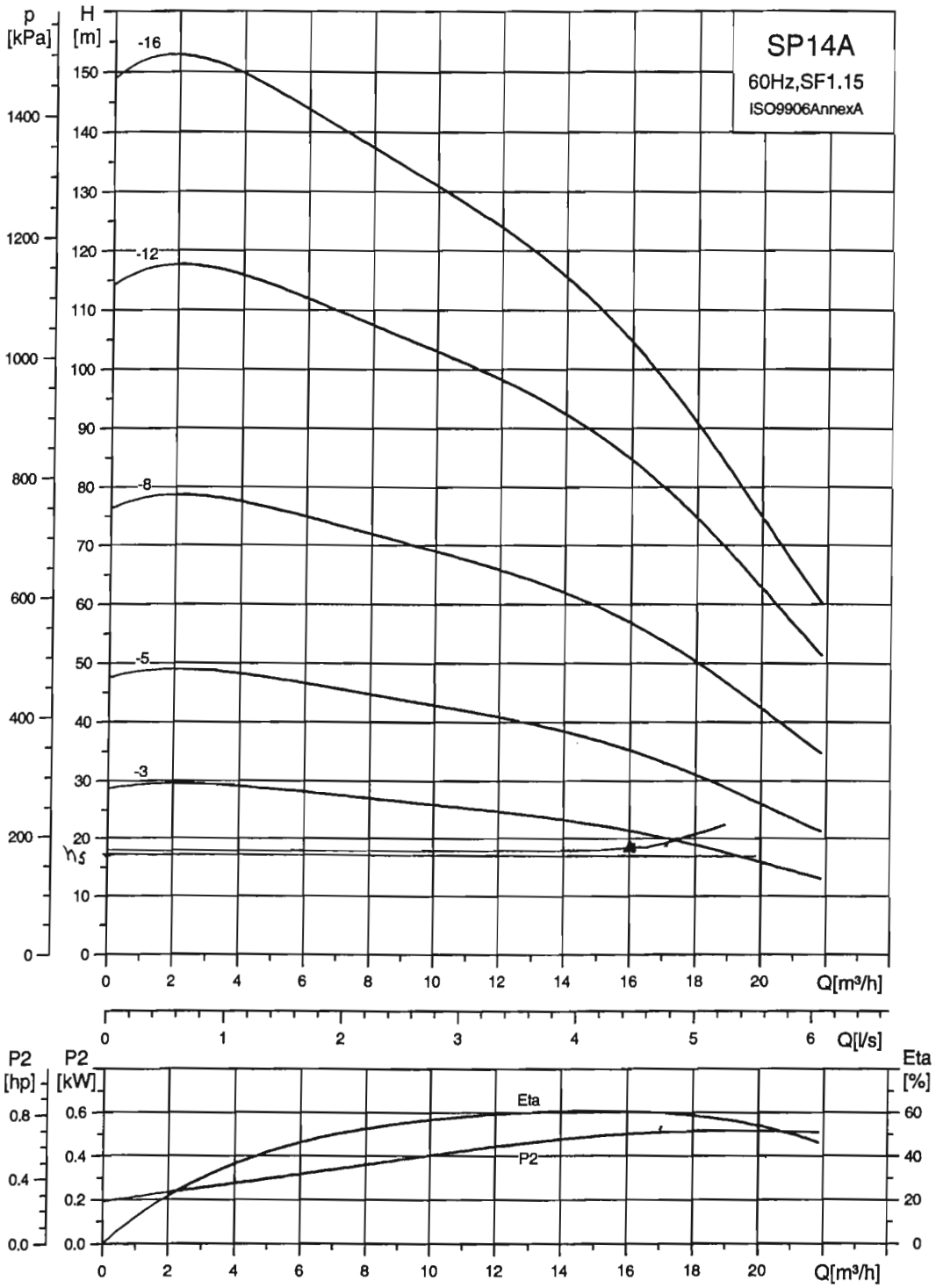
N-version motor

Pos. no.	Component		Material	DIN W.-Nr.
10	Bearing housing, upper		Stainless steel	1.4401
10a	Radial bearing	6"-10"	Graphite	
		12"	Stainless steel/ NBR	
13	Motor sleeve		Stainless steel	1.4401
14	Shaft	Up to 75 kW	Stainless steel	1.4401
		From 75 kW		1.4462
20	Motor cable		EPDM	
22	Bearing housing, lower		Stainless steel	1.4401
28	Diaphragm		CR	
35	Intermediate housing		Stainless steel	1.4401
41	Motor end shield		Stainless steel	1.4401
54	Shaft seal		Rubber lip type	
68	Thrust bearing		Hardened steel EPDM	

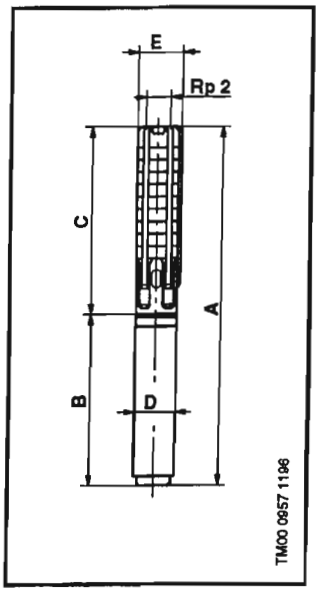
Example: MMS 10000



Performancecurves



Dimensions and weights

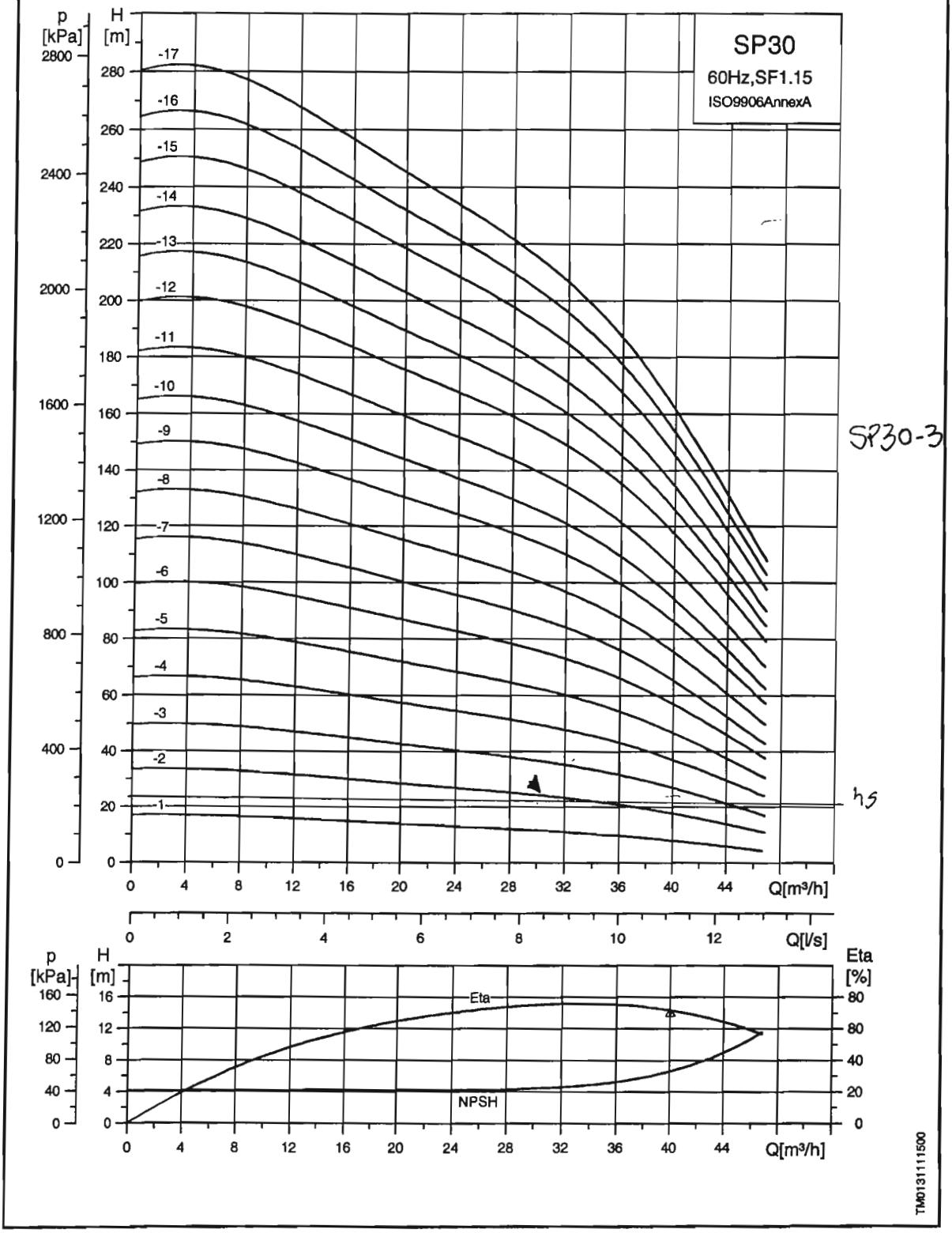


Pump type	Motor		Dimensions [mm]					Net weight [kg]
	Type	Power [kW]	C	B	A	D	E	
				3x220V 3x380V 3x460V	3x220V 3x380V 3x460V			3x220V 3x380V 3x460V
SP 14A-3	MS 402	1.5	380	346	726	95	101	16
SP 14A-5	MS 4000	2.2	510	453	963	95	101	23
SP 14A-8	MS 402	4.0	705	573	1278	95	101	30
SP 14A-12	MS 4000	5.5	965	673	1638	95	101	37
SP 14A-16	MS 4000	7.5	1225	773		95	101	50
SP 14A-12	MS 6000	5.5	1027	541	1568	138	138	48
SP 14A-16	MS 6000	7.5	1287	571	1858	138	138	54

E = Maximum diameter of pump inclusive of cable guard and motor.

Performancecurves

OEW-2

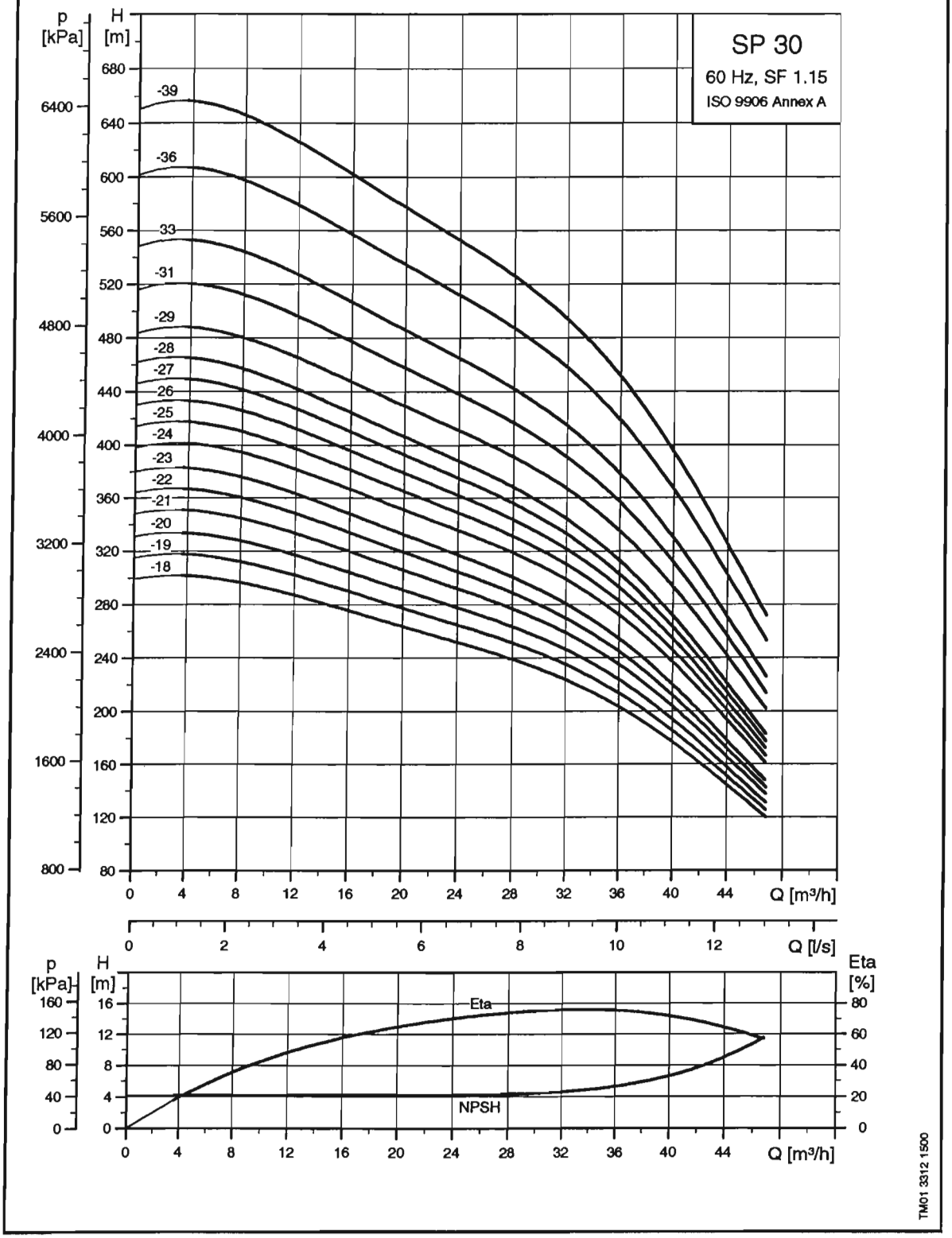


SP30-3

h5

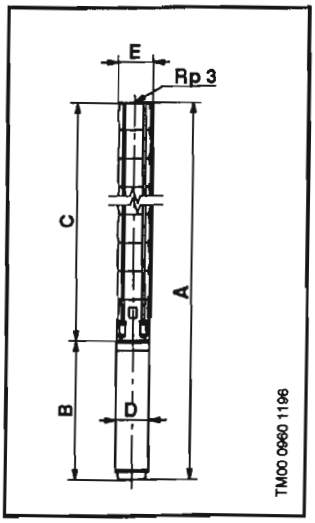
GRUNDFOS

Performance curves



GRUNDFOS

Dimensions and weights



SP 30-24 to SP 30-39 are mounted in sleeve for R 3 connection.

Pump type	Motor		Dimensions [mm]						Net weight [kg]
	Type	Power [kW]	C	B	A	D	E*	E**	
SP 30-1	MS 4000	1.5	349	413	762	95	131		21
SP 30-2	MS 4000	3	445	494	939	95	131		24
SP 30-3	MS 4000	4	541	574	1115	95	131		29
SP 30-4	MS 4000	5.5	637	674	1311	95	131		36
SP 30-5	MS 4000	7.5	733	773	1506	95	131		43
SP 30-4	MS 6000	5.5	653	544	1197	138	142	142	47
SP 30-5	MS 6000	7.5	749	574	1323	138	142	142	50
SP 30-6	MS 6000	9.2	845	604	1449	138	142	142	57
SP 30-7	MS 6000	9.2	941	604	1545	138	142	142	59
SP 30-8	MS 6000	11	1037	634	1671	138	142	142	63
SP 30-9	MS 6000	13	1133	664	1797	138	142	142	68
SP 30-10	MS 6000	13	1229	664	1893	138	142	142	70
SP 30-11	MS 6000	15	1325	699	2024	138	142	142	75
SP 30-12	MS 6000	18.5	1421	754	2175	138	142	142	83
SP 30-13	MS 6000	18.5	1517	754	2271	138	142	142	84
SP 30-14	MS 6000	18.5	1613	754	2367	138	142	142	86
SP 30-15	MS 6000	22	1709	814	2523	138	142	142	94
SP 30-16	MS 6000	22	1805	814	2619	138	142	142	95
SP 30-17	MS 6000	22	1901	814	2715	138	142	142	97
SP 30-18	MS 6000	26	1997	874	2871	138	142	142	104
SP 30-19	MS 6000	26	2093	874	2967	138	142	142	106
SP 30-20	MS 6000	26	2189	874	3063	138	142	142	108
SP 30-21	MS 6000	30	2285	944	3229	138	144	145	117
SP 30-22	MS 6000	30	2381	944	3325	138	144	145	119
SP 30-23	MS 6000	30	2477	944	3421	138	144	145	121
SP 30-24	MMS 6000	37	2573	1425	3998	144	142	142	170
SP 30-25	MMS 6000	37	2669	1425	4094	144	142	142	171
SP 30-26	MMS 6000	37	2765	1425	4190	144	142	142	173
SP 30-27	MMS 6000	37	2861	1425	4286	144	142	142	175
SP 30-28	MMS 6000	37	2957	1425	4382	144	142	142	176
SP 30-29	MMS 8000	45	3249	1270	4519	192	192	192	280
SP 30-31	MMS 8000	45	3441	1270	4711	192	192	192	285
SP 30-33	MMS 8000	45	3633	1270	4903	192	192	192	290
SP 30-36	MMS 8000	55	3921	1350	5271	192	192	192	313
SP 30-39	MMS 8000	55	4209	1350	5559	192	192	192	322

* Maximum diameter of pump with one motor cable.

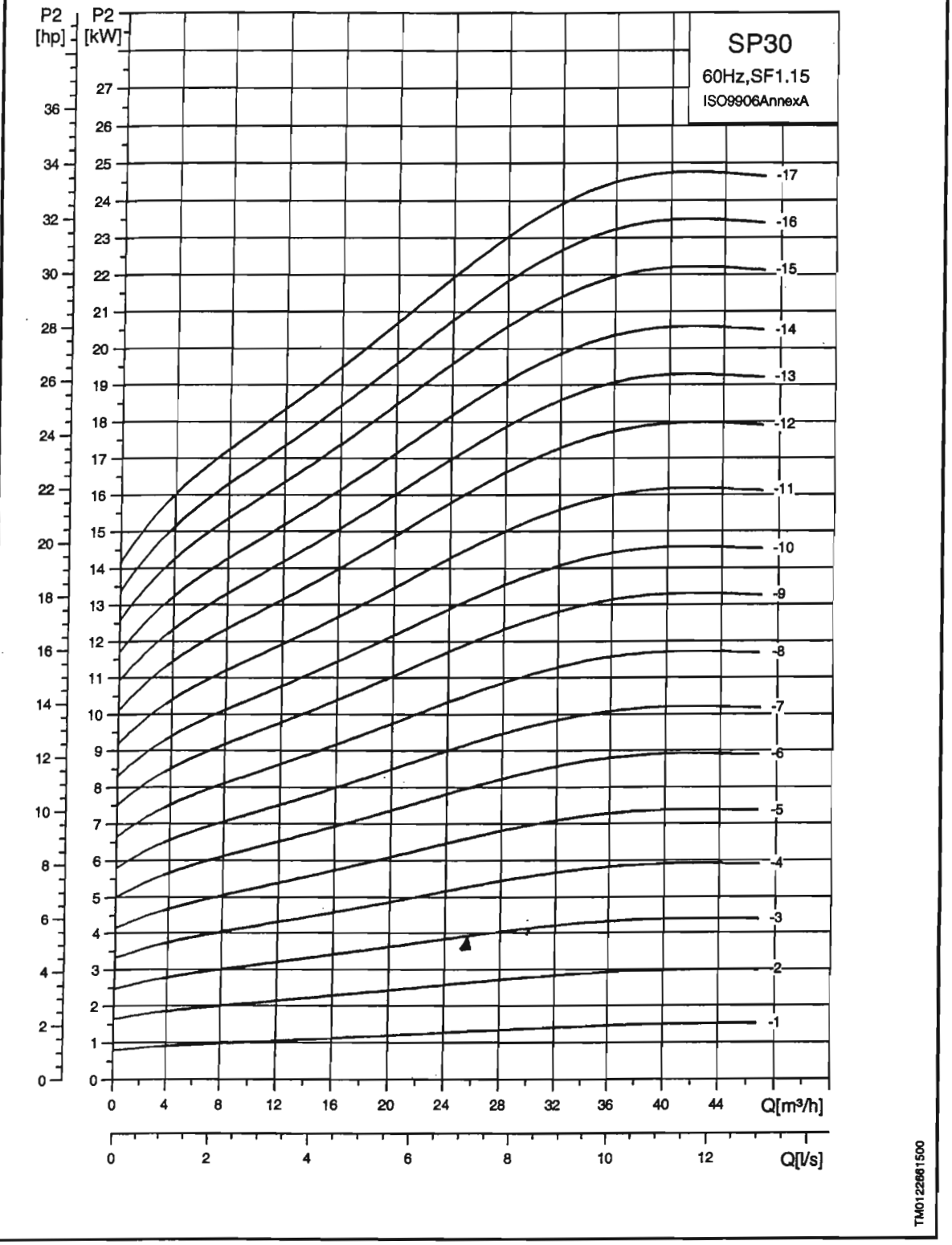
** Maximum diameter of pump with two motor cables.

SP 30-1 to SP 30-23 are also available in N and R versions with motors in R version. Dimensions as above.

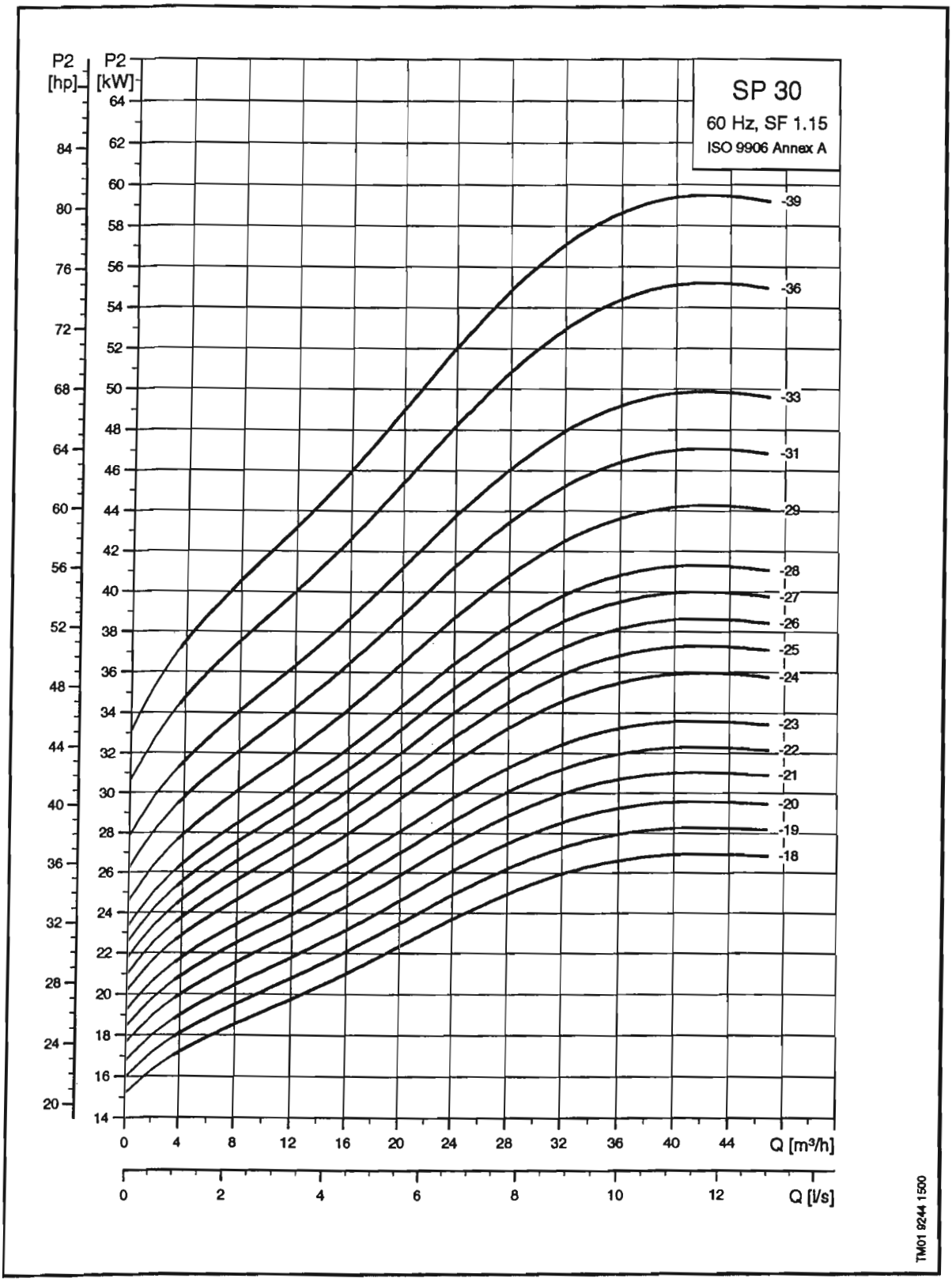
SP 30-24 to SP 30-39 are also available in N version with motors in N version. Dimensions as above.

Other types of connection are possible by means of connecting pieces, see page 86.

OEW-2


P2 [hp]
P2 [kW]
SP30
60Hz,SF1.15
ISO9906AnnexA
-17
-16
-15
-14
-13
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
Q[m³/h]
Q[l/s]
TM012286 1500

Power curves



GRUNDFOS

1 x 220 V, submersible motors

Electrical data													Dimensions	
Motor				Full-load current	Motor efficiency [%]			Power factor			$\frac{I_{st}}{I_n}$	Control box for 3-wire	Length	Weight
Type	Size	Power [kW]	Power [hp]	I_n [A]	$\eta_{50\%}$	$\eta_{75\%}$	$\eta_{100\%}$	$\cos\varphi_{50\%}$	$\cos\varphi_{75\%}$	$\cos\varphi_{100\%}$			[mm]	[kg]
MS 402	4"	0.25	0.33	4.40	39.0	49.0	54.0	0.48	0.51	0.64	3.0*	SA-SPM 4	256	6.8
MS 402	4"	0.37	0.5	5.90	43.0	52.5	56.0	0.46	0.54	0.62	3.6*	SA-SPM 4	256	6.8
MS 402	4"	0.55	0.75	8.00	42.5	51.0	57.0	0.47	0.56	0.63	3.7*	SA-SPM 4	291	8.2
MS 402	4"	0.75	1.0	9.60	47.0	55.5	60.0	0.50	0.60	0.70	3.8*	SA-SPM 4	306	8.9
MS 402	4"	1.1	1.5	11.5	53.5	62.0	67.0	0.60	0.73	0.82	4.0*	SA-SPM 4	346	10.5
MS 402	4"	1.1	1.5	13.1			88.0			0.63	4.4**		346	10.5

* Applies to 2- and 3-wire motors.
** Applies to 2-wire motors.

MS 402 2-wire motors incorporate motor protection and can therefore be connected directly to the mains.

3 x 220 V, submersible motors

Electrical data												Dimensions	
Motor				Full-load current	Motor efficiency [%]			Power factor			$\frac{I_{st}}{I_n}$	Length	Weight
Type	Size	Power [kW]	Power [hp]	I_n [A]	$\eta_{50\%}$	$\eta_{75\%}$	$\eta_{100\%}$	$\cos\varphi_{50\%}$	$\cos\varphi_{75\%}$	$\cos\varphi_{100\%}$		[mm]	[kg]
MS 402	4"	0.37	0.5	3.30	57.5	65.0	68.0	0.52	0.63	0.72	5.0	226	5.5
MS 402	4"	0.55	0.75	4.80	58.0	65.5	68.0	0.47	0.59	0.70	4.8	241	6.3
MS 402	4"	0.75	1.0	5.65	61.0	67.5	71.0	0.50	0.63	0.73	5.0	276	7.7
MS 4000R	4"	0.75	1.0	4.60	70.5	72.0	71.1	0.81	0.86	0.88	3.9	398	13.0
MS 402	4"	1.1	1.5	7.60	65.0	71.0	73.5	0.50	0.67	0.72	5.5	306	8.9
MS 4000R	4"	1.1	1.5	6.10	71.4	74.7	74.8	0.73	0.82	0.86	4.6	413	14.0
MS 402	4"	1.5	2.0	9.10	67.0	73.0	75.5	0.54	0.67	0.75	5.5	346	10.5
MS 4000R	4"	1.5	2.0	8.20	73.0	74.8	74.5	0.67	0.78	0.85	4.1	413	14.0
MS 4000 (R)	4"	2.2	3.0	11.4	73.9	76.6	77.2	0.58	0.71	0.80	4.7	453	16.0
MS 4000 (R)	4"	3.0	4.0	14.8	76.9	79.0	78.3	0.60	0.74	0.82	4.7	493	17.0
MS 4000 (R)	4"	4.0	5.5	19.0	77.6	79.7	79.2	0.68	0.79	0.85	5.4	573	21.0
MS 4000 (R)	4"	5.5	7.5	25.0	80.0	80.5	78.0	0.67	0.80	0.87	5.1	673	26.0
MS 6000 (R)	6"	5.5	7.5	26.4	77.5	80.0	80.5	0.63	0.73	0.80	4.3	541	35.5
MS 6000 (R)	6"	7.5	10	35.0	80.0	82.0	82.5	0.67	0.78	0.83	4.3	571	37.0
MS 6000 (R)	6"	9.2	12.5	43.5	78.0	81.0	80.5	0.68	0.78	0.83	4.4	601	42.5
MS 6000 (R)	6"	11	15	51.0	79.5	82.5	82.5	0.71	0.81	0.85	4.3	631	45.5
MS 6000 (R)	6"	13	17.5	59.0	81.0	83.5	83.0	0.69	0.84	0.84	4.5	661	48.5
MS 6000 (R)	6"	15	20	67.0	82.0	84.0	84.5	0.70	0.81	0.84	4.9	696	52.5
MS 6000 (R)	6"	18.5	25	84.0	82.0	84.5	84.5	0.68	0.79	0.83	5.0	751	58.0
MS 6000 (R)	6"	22	30	96.0	84.0	85.0	85.0	0.73	0.81	0.85	4.7	811	64.0
MS 6000 (R)	6"	26	35	116.0	83.5	85.0	85.0	0.73	0.82	0.86	4.6	871	69.5
MS 6000 (R)	6"	30	40	134.0	83.5	84.5	84.5	0.72	0.81	0.85	4.6	941	77.5

CU 3

The CU 3 control unit is an electronic motor starter for monitoring and protecting installations with rated voltages of 200 - 575 V, 50 - 60 Hz, and a maximum power consumption of 400 A.

The CU 3 monitors the following parameters:

System insulation resistance to earth before start.
Motor temperature.
Motor current consumption and current unbalance.
Voltage supply.
Phase sequence.

The CU 3 protects against:

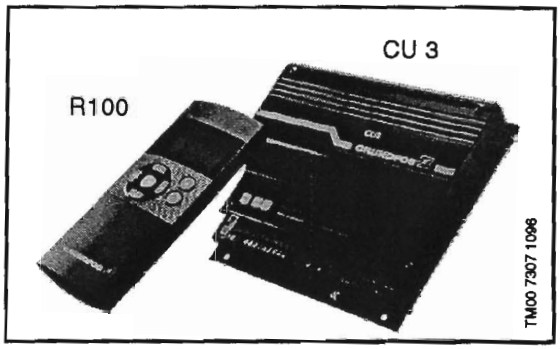
Dry running.
Incipient motor defect.
Too high motor temperature.
Motor burnout.

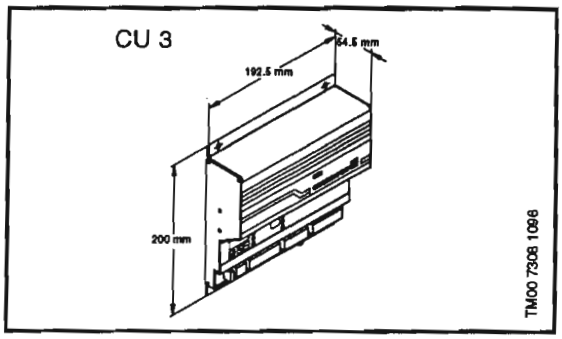
As standard, the CU 3 incorporates:

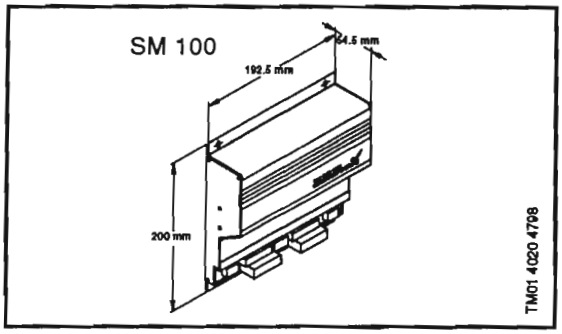
- Time relay for star-delta starting and autotransformer starting.
- Relay output for external fault indication.

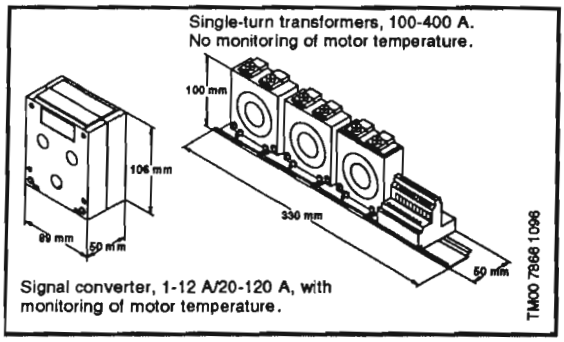
In addition CU 3 can be expanded to offer the following functions:

- **Remote control R100:** Wireless infra-red remote control by means of the R100. This function enables the user to change factory settings and to monitor the installation by calling up actual operating data, e.g. current consumption, supply voltage and operating hours.
- **External sensors SM 100:** Reception of data from external sensors by means of an SM 100 sensor module and control according to the data received, e.g. flow rate, pressure, water level and conductivity.
- **Communication module:** Monitoring and communication via a data BUS (GENIbus), a modem or radio, e.g. PC-based control/monitoring.









Technical data

Enclosure class:	IP 20.
Ambient temp.:	–20°C to +60°C.
Relative humidity:	99%.
Voltage variation:	–25/+15% of nominal voltage.
Frequency:	45 Hz to 65 Hz.
Max. back-up fuse:	10 A.
Relay output:	Max. 415 V, 3 A, AC 1.
Approvals:	The CU 3 complies with: VDE, DEMKO, EN, UL and CSA.
Marking:	CE.

R100 Menus

0. General

1. Operation

1.1 Warning and stop indication
1.2 Indication of automatically reset fault indications
Possibility of start and stop.

2. Status

Indication of:

2.1 Motor temperature
2.2 Current and voltage values
2.3 Average supply voltage
2.4 Average input current of the three phases
2.5 Actual current unbalance
2.6 Actual insulation resistance to earth
2.7 Phase sequence and frequency
2.8 Actual power input and total power consumption
2.9 Accumulated number of operating hours
2.10 Value measured by an external sensor
2.11 Energy consumption per m^3 pumped liquid
2.12 Actual flow
2.13 Accumulated flow.

The R100 offers a number of setting possibilities:

3. Limits

Indication and setting of:

3.1 Motor temperature
3.2 Current stop limits
3.3 Current warning limits
3.4 Voltage variations
3.5 Insulation resistance
3.6 Current unbalance
3.7 Stop for external sensor.
3.8 Warning limits for external sensor

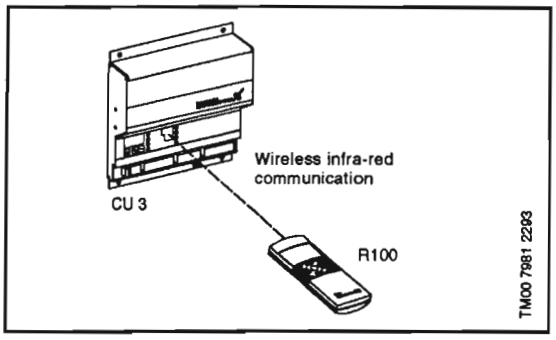
4. Installation

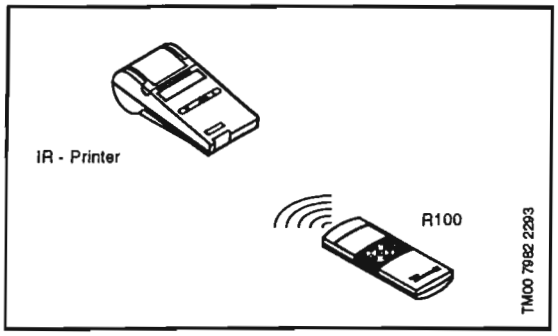
Setting possibilities:

4.1 Automatic or manual resetting of fault indications
4.2 Release time for fault indications
4.3 Star connection time for star-delta or auto-transformer starting
4.4 Starting delay when first started, e.g. after supply failure
4.5 Minimum start cycle time
4.6 On/off of groundwater lowering function
4.7 Run/stop times for groundwater lowering
4.8 Electronic numbering of CU 3 units
4.9 On/off of power and temperature measuring function
4.10 External sensor type
On/off of external analog sensor with or without zero offset
Maximum value of external analog sensor
4.11 Groundwater lowering by means of level sensors
Filling and emptying function
4.12 On/off of external digital sensor.

Status report

All settings and measured values can be transferred to a portable printer via wireless infra-red communication and be printed in a status report.





MTP 75 motor protection

Long motor life

The MTP 75 protects against too high motor temperature. This is the most simple and the cheapest way of ensuring long motor life. The customer is certain that operating conditions are observed and is given indication of the time when a service check should be made.

Too high motor temperature may be caused by:

- Overload
- Frequent starting/stopping (hunting)
- Operation against closed valve/frozen discharge pipe
- Insufficient flow of liquid past the motor
- Pumping of too hot water
- Deposits on the motor
- Overvoltage
- Undervoltage
- Current unbalance
- Dry running (Note that the pump is not protected if the water table is below the pump inlet. For example this may occur if several boreholes are located close to each other).

Application and installation

The MTP 75 can be used only for motors with built-in temperature transmitter and should be installed for instance in a control cabinet. The MTP 75 may be installed in any type of control cabinet containing a thermal relay with differential release and contactor. The thermal relay is necessary to protect against blocking or phase failure, since this will cause the temperature to rise much faster than the MTP 75 is able to register.

The MTP 75 is supplied with base for mounting on DIN rail.

Operation

The temperature transmitter will send a high-frequency signal indicating the motor temperature through the motor supply cable. The MTP 75 will stop the motor via the contactor if the temperature rises above 75°C. The temperature limit is factory-set and cannot be changed.

Display:

No light: Motor stopped. No supply voltage or electrical fault at temperature measuring.

Green light: Motor in operation and motor temperature OK, i.e. below 75°C.

Red light: Motor stopped and motor temperature too high, i.e. above 75°C.

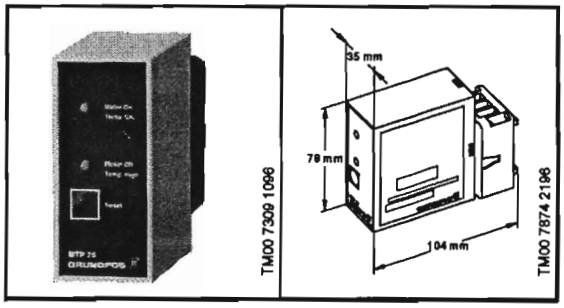
The MTP 75 is reset manually by pressing the reset button on the front cover or by switching off the voltage supply to the MTP 75.

No unnecessary downtime

Since the MTP 75 measures only the temperature and no other parameters causing a temperature rise, the motor and thus the pump will stop only when the motor temperature is too high.

Reliability

The MTP 75 is reliable due to its simple construction and because it requires no extra cables in the borehole.



Technical data of MTP 75

Supply voltage:	2 variants: 1 x 200-240 V ±10%, 50/60 Hz. 3 x 380-415 V ±10%, 50/60 Hz. A transformer is required for voltages over 415 V.
Control voltage:	Contact load: Maximum 415 V/3 A. Minimum 12 V/20 mA.
Enclosure class:	IP 20.
Operating conditions:	Min. temperature: –20°C. Max. temperature: +60°C. Relative humidity: 99%.
Storage:	Min. temperature: –20°C. Max. temperature: +60°C Relative humidity: 99%.
Approvals:	Complying with the regulations of VDE and DEMKO.

Product numbers

MTP 75 without plug-in base, capacitor and signal transformer:

Voltage range [V]	Product number
1 x 200-240	00 62 51 78
3 x 380-415	00 62 51 79

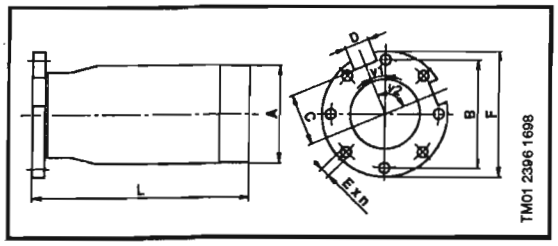
MTP 75 complete with plug-in base, capacitor and signal transformer:

Voltage range [V]	Product number
1 x 200-240	00 62 58 04
3 x 380-415	00 62 58 05

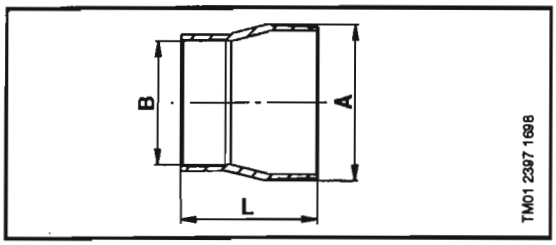
Connecting pieces

The tables below show the range of connecting pieces for connection of thread to flange and thread to thread.

Thread - Flange



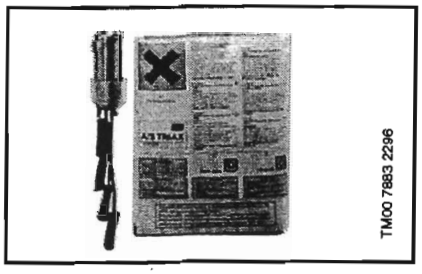
Thread - Thread



Type	Pump outlet	Connecting piece	Thread - Flange										Product number	
			A	Dimensions [mm]						v_1	v_2	n	DIN W.-Nr. 1.4301	DIN W.-Nr. 1.4401
				B	C	D	E	F	L					
SP 17	Rp 2.5	R 2½ → JIS 2	R 2½	100	50.5	30	ø11	125	200	30	120	6	00 12 51 22	00 12 56 18
		R 2½ → JIS 2.5	R 2½	115	57	30	ø11	140	200	22.5	90	8	00 12 51 23	00 12 56 19
		R 2½ → DIN 50 PN 16	R 2½	125	62.5	22	ø18	165	95	45	180	4		ID 81 42
		R 2½ → DIN 50 PN 40	R 2½	125	62.5	22	ø18	165	97	45	180	4		ID 81 43
		R 2½ → DIN 65 PN 16	R 2½	145	72.5	22	ø18	185	100	45	180	4		ID 81 44
		R 2½ → DIN 65 PN 40	R 2½	145	72.5	25	ø18	185	110	22.5	180	8		ID 81 45
		R 2½ → DIN 80 PN 16	R 2½	160	80	25	ø18	200	95	22.5	180	8		ID 81 46
		R 2½ → DIN 80 PN 40	R 2½	160	80	25	ø18	200	99	22.5	180	8		ID 81 47
SP 30	Rp 3	R 3 → JIS 3	R 3	136	66	35	ø15	165	200	22.5	90	8	00 13 51 21	00 13 56 17
		R 3 → DIN 65 PN 16	R 3	145	72.5	22	ø18	185	105	45	180	4		ID 81 52
		R 3 → DIN 65 PN 40	R 3	145	72.5	25	ø18	185	109	22.5	180	8		ID 81 53
		R 3 → DIN 80 PN 16	R 3	160	80	25	ø18	200	110	22.5	180	8		ID 81 54
		R 3 → DIN 80 PN 40	R 3	160	80	25	ø18	200	120	22.5	180	8		ID 81 55
		R 3 → DIN 100 PN 16	R 3	180	90	25	ø18	220	107	22.5	180	8		ID 81 56
		R 3 → DIN 100 PN 40	R 3	190	95	25	ø22	220	109	22.5	180	8		ID 81 57
SP 46 SP 60	Rp 3 Rp 4	R 4 → JIS 4	R 4	155	72	35	ø15	180	200	22.5	90	8	00 15 51 24	00 15 56 22
		R 3 → DIN 65 PN 16	R 3	145	72.5	22	ø18	185	105	45	180	4		ID 81 52
		R 3 → DIN 65 PN 40	R 3	145	72.5	25	ø18	185	109	22.5	180	4		ID 81 53
		R 3 → DIN 80 PN 16	R 3	160	80	25	ø18	200	110	22.5	180	8		ID 81 54
		R 3 → DIN 80 PN 40	R 3	160	80	25	ø18	200	120	22.5	180	8		ID 81 55
		R 3 → DIN 100 PN 16	R 3	180	90	25	ø18	220	107	22.5	180	8		ID 81 56
		R 3 → DIN 100 PN 40	R 3	190	95	25	ø22	220	109	22.5	180	8		ID 81 57
		R 4 → DIN 100 PN 16	R 4	180	90	25	ø18	220	120	22.5	180	8		ID 81 58
		R 4 → DIN 100 PN 40	R 4	190	95	25	ø22	235	130	22.5	180	8		ID 81 59
SP 77 SP 95	Rp 5	R 5 → JIS 4	R 5	155	75	35	ø15	180	313	22.5	90	8	00 19 50 42	00 19 55 45
		R 5 → JIS 5	R 5	190	97	45	ø19	225	315	22.5	90	8	00 19 50 43	00 19 55 46
		R 5 → DIN 100 PN 16	R 5	180	95	45	ø18	225	315	22.5	90	8	00 19 89 26	00 19 89 76
		R 5 → DIN 100 PN 40	R 5	190	102.5	45	ø22	240	314	22.5	90	8	00 19 89 27	00 19 89 77
		R 5 → DIN 125 PN 16	R 5	210	110	45	ø18	250	317	22.5	90	8	00 19 89 14	00 19 89 64
		R 5 → DIN 125 PN 40	R 5	220	120	45	ø26	270	317	22.5	90	8	00 19 89 15	00 19 89 65
		R 5 → DIN 150 PN 16	R 5	240	127.5	45	ø22	285	317	22.5	90	8	00 19 89 04	00 19 89 54
		R 5 → DIN 150 PN 40	R 5	250	135	45	ø26	300	323	22.5	90	8	00 19 89 05	00 19 89 55
SP 125 SP 160 SP 215	Rp 6	R 6 → JIS 5	R 6	190	97	45	ø19	225	316	22.5	90	8	00 20 51 28	00 20 56 28
		R 6 → JIS 6	R 6	224	111	45	ø19	252	317	22.5	90	8	00 20 51 29	00 20 56 29
		R 6 → DIN 125 PN 16	R 6	210	110	45	ø18	250	317	22.5	90	8	00 19 89 28	00 19 89 78
		R 6 → DIN 125 PN 40	R 6	220	120	45	ø26	270	321	22.5	90	8	00 19 89 29	00 19 89 79
		R 6 → DIN 150 PN 16	R 6	240	127.5	45	ø22	285	317	22.5	90	8	00 19 89 16	00 19 89 66
		R 6 → DIN 150 PN 40	R 6	250	135	45	ø26	300	323	22.5	90	8	00 19 89 17	00 19 89 67
		R 6 → DIN 200 PN 16	R 6	295	155	45	ø22	340	317	15	90	12	00 19 89 06	00 19 89 56
		R 6 → DIN 200 PN 40	R 6	320	172.5	45	ø30	375	327	15	90	12	00 19 89 07	00 19 89 57

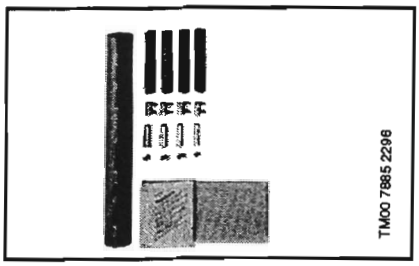
Type	Pump outlet	Connecting piece	Thread - Thread		Product number	
			A	Dimensions		
				Length [mm]	DIN W.-Nr. 1.4301	DIN W.-Nr. 1.4401
SP 77 SP 95	Rp 5	R 5 → Rp 4	R 5	121	19.00 63	19.05 85
		R 5 → Rp 6	R 5	150	19.00 69	19.05 91
	NPT 5	NPT 5 → NPT 4	NPT 5	121	19.00 64	19.05 86
		NPT 5 → NPT 6	NPT 5	150	19.00 70	19.05 92
SP 125 SP 160 SP 215	Rp 6	R 6 → Rp 5	R 5	150	20.01 30	20.06 40
	NPT 6	NPT 6 → NPT 5	NPT 6	150	20.01 35	20.06 45

Cable termination kit with plug



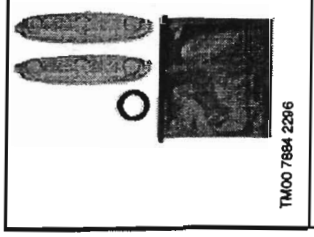
Description	Version	Prod. no.
For watertight joining of motor cable and submersible drop cable in an acrylic tube filled with resin. Used for both single and multi-core cables during installation of submersible pumps. 24 hours of hardening is required.	**MS 402 and MS 4000 up to 7.5 kW:**	
	For cables up to 4 x 2.5 mm²	79 99 01
	For cables up to 4 x 6 mm²	79 99 02

Cable termination kit type KM



Description	Version			Prod. no.
	Motor cable	**[mm²]**	**Number of leads**	
For watertight shrink-joining of motor cable and submersible drop cable. Enables the joining of: - cables of equal size. - cables of different sizes. - a cable lead and a single-lead. The joint is ready for use after a few minutes and requires no long hardening time as do resin joints. The joint cannot be separated.	Flat cable	1.5 - 6.0 1.5 - 4.0	3 4	00 11 62 51
	Flat cable	6 - 10 10 - 16	4 3	00 11 62 52
	Flat cable	16 - 25	3 4	00 11 62 55
	3 single leads	1.5 - 6.0	3	00 11 62 53
	3 single leads	10 - 25	3	00 11 62 54
	4 single leads	1.5 - 4.0	4	00 11 62 57
	4 single leads	6 - 16	4	00 11 62 58

Cable termination kit



Description	Version			Prod. no.
For watertight joining of motor cable and submersible drop cable.	**Type**	**Diameter of joint**	**For outer cable diameter [mm]**	
For 4" motors and cables up to 4 x 6 mm²	M 0	ø40	app. 6-15	00 ID 89 03
For 6" motors and cables up to 4 x 10 mm²	M 1	ø46	app. 9-23	00 ID 89 04
For 6" motors and cables up to 4 x 16 mm²	M 2	ø52	app. 17-31	00 ID 89 05
For 8" and 10" motors and cables up to 4 x 35 mm²	M 3	ø77	app. 26-44	00 ID 89 06
For 8" and 10" motors and cables up to 4 x 70 mm²	M 4	ø97	app. 29-55	91 07 07 00

Groundwater Pump Headloss Calculations

1. Estimate headloss in overburden extraction system.

   Use OEW-2 since this well will be the furthest from the air stripper.
   Assumed static head = 70 feet (30 feet to groundwater + 40 feet to entrance of air stripper) at proposed OEW-2. Dynamic head estimated based upon 130 gallons per minute across 580 feet on 4 inch diameter steel pipe. The headloss is 1.02 feet per 100 feet of pipe. In addition there is assumed to be 10-90 degree elbows in the piping system. Each elbow is equivalent to 13 feet of pipe; therefore, the elbows are equivalent to 130 feet of pipe. The total piping is 710 feet and the dynamic headloss is equal to 7.2 feet. A safety factor of 1.5 is applied to the dynamic headloss to account for miscellaneous headloss across fittings. The total headloss is equal to 70 feet + 1.5 x 7.2 feet = 81 feet.

   Based upon the desired flow rate and head, a Grundfos SP30-3 submersible pump is selected based upon the attached pump curves.

2. Estimate headloss in bedrock extraction system.

   Assumed static head = 55 feet (25 feet to groundwater + 30 feet to entrance of air stripper) at proposed BEW-2. Dynamic head estimated based upon 70 gallons per minute across 400 feet on 4 inch diameter steel pipe. The headloss is 1.02 feet per 100 feet of pipe. In addition there is assumed to be 10-90 degree elbows in the piping system. Each elbow is equivalent to 13 feet of pipe; therefore, the elbows are equivalent to 130 feet of pipe. The total piping is 530 feet and the dynamic headloss is equal to 5.4 feet. A safety factor of 1.5 is applied to the dynamic headloss to account for miscellaneous headloss across fittings. The total headloss is equal to 55 feet + 1.5 x 5.4 feet = 63 feet.

   Based upon the desired flow rate and head, a Grundfos SP14A-3 submersible pump is selected based upon the attached pump curve.

Appendix I

Air-Stripper Capacity Evaluation

Evaluate Air Stripper Capacity

1. Estimate average concentration of tetrachloroethene (PCE) in extracted groundwater.

   Assumptions:

   An evaluation of January 2002 groundwater sampling data indicate PCE concentrations in the areas of the proposed extraction wells as follows:

OP-11: 298 µg/l	OP-9: 72.1 µg/l
OP-16: 2,080 µg/l	North Well:37.2 µg/l

   The expected pumping rates in the 4 proposed extraction wells in the following areas based upon the groundwater model are as follows:

OP-11: 130 gpm	OP-9: 130 gpm
OP-16: 70 gpm	North Well:170 gpm

$$PCEave = \frac{130(298)+130(72.1)+70(2080)+170(37.2)}{130+130+70+170}$$

$PCE_{ave} = 400$ µg/l

2. Determine if existing air stripper has capacity to treat PCE at the proposed loading rates.

   Assumptions:

   Groundwater flow rate is 500 gpm
   Average PCE concentration in groundwater is 400 µg/l
   Effluent standard is 5 µg/l

   The air stripper is a 6-foot diameter packed tower with 20 feet Lanpac™ 3.5-inch polypropylene random packing. The discharge stack is 18-inches in diameter and the blower is capable of supplying 5,500 standard cubic feet per minute (scfm) at 6-inches of water column back pressure.

   a) Determine Henry's constant, H*, for PCE

      Henry's constant is equal to 0.0184 atm-m^3/mol (Superfund Chemical Data Matrix).

$$H^* = \frac{Hx1000}{RT}$$

Where:

H* = Henry's constant (unitless)
R = Universal Gas Constant; 0.082 atm/(K)(g mol/l)
T = Temperature in Kelvin; (273 + C)

At an operating temperature of 55° F (12° C), then H* is 0.787.

b) Determine air-water ratio, Q_a/Q_w

At a peak flow rate of 400 gpm x 1.25 (peak factor), the air-water ratio is as follows:

$$\frac{Q_a}{Q_w} = \frac{5500cfmx7.48\frac{gal}{ft^3}}{500} = 82$$

c) Estimate Stripping Factor, S.

$$S = H^* \frac{Q_a}{Q_w} = 0.787x82 = 65$$

d) Estimate Surface Loading Rate, SLR.

$$SLR = \frac{Q}{A_{strip}}$$

Where:

Q = hydraulic loading rate; 500 gpm
A_{sp} = cross-sectional area of stripping column; $\pi(6)^2/4$ ft^2

Inputting the values, SLR is estimated to be 17.7 gpm/ft^2

e) Estimate height of transfer units, HTU.

$$HTU = \frac{L}{K_L a}$$

Where:

L = SLR in length/time; 2.4 ft/min or 0.04 ft/sec
K_L = rate constant; 5.55 x 10^{-4} ft/s
a = specific surface area; 22.4 ft^2/ft^3

Therefore, the HTU is equal to 3.2 ft.

f) Calculate the number of transfer units, NTU, given the packing height, Z.

$$NTU = \frac{Z}{HTU} = \frac{20}{3.2} = 6.25$$

g) Estimate the PCE concentration in the liquid effluent from the air stripper.

$$NTU = \left(\frac{S}{S-1}\right)\ln\left[\left(\frac{C_{in}}{C_{out}}\right)\left(\frac{S-1}{S}\right)+\frac{1}{S}\right]$$

Solving the above equation for C_{out} gives an effluent PCE concentration of less than 1 µg/l. At an influent PCE concentration of 1,000 µg/l, the effluent concentration is 2.1 µg/l which is below the standard. Therefore, the stripper can treat 500 gpm of groundwater with a PCE concentration of 1,000 µg/l to below the regulatory standard of 5 µg/l.

h) Estimate effluent concentration if hydraulic loading rate is 700 gpm at 400 µg/l.

Following the same procedures as above:

S = 59
SLR = 24.8 gpm/ft^2
L = 3.3 ft/min or 0.055 ft/sec
HTU = 4.58 ft
NTU = 4.36
C_{out} = 5.4 µg/l which is above the allowable limit.

i) Estimate effluent concentration if hydraulic loading rate is 600 gpm at 400 µg/l.

Following the same procedures as above:

S = 68.6
SLR = 21.2 gpm/ft^2
L = 2.8 ft/min or 0.047 ft/sec
HTU = 3.9 ft
NTU = 5.1
C_{out} = 2.6 µg/l which is below the allowable limit

Appendix J

State Pollutant Discharge Elimination System Permit

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

State Pollutant Discharge Elimination System (SPDES)
DISCHARGE PERMIT

Special Conditions (Part 1)

First3.99

Industrial Code:	**2812**	SPDES Number:	**NY- 0072079**
Discharge Class (CL):	**01**	DEC Number:	**8-2422-00015/00023**
Toxic Class (TX):	**T**	Effective Date (EDP):	**8/1/00**
Major Drainage Basin:	**04**	Expiration Date (ExPD):	**8/1/05**
Sub Drainage Basin:	**02**	Modification Dates:	**10/1/01**
Water Index Number:	**Groundwater**	Attachment(s):	General Conditions (Part II) Date: 11/90
Compact Area:			

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et.seq.)(hereinafter referred to as "the Act").

PERMITTEE NAME AND ADDRESS

Name: **Jones Chemicals, Inc.** Attention: **William S. Wadsworth, Branch Manager**

Street: **100 Sunny Sol Boulevard**

City: **Caledonia** State: **NY** Zip Code: **14423**

is authorized to discharge from the facility described below:

FACILITY NAME AND ADDRESS

Name: **Jones Chemicals, Inc. - Caledonia Facility**

Location (C,T,V): **Caledonia (C)** County: **Livingston**

Facility Address: **100 Sunny Sol Boulevard**

City: **Caledonia** State: **NY** Zip Code: **14423**

NYTM -E: NYTM - N:

From Outfall No.: **001** at Latitude: **42 ° 58 ′ 20 ″** & Longitude: **77 ° 50 ′ 50 ″**

into receiving waters known as: **Groundwater** Class: **GA**

and: (list other Outfalls, Receiving Waters & Water Classifications)

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in Special Conditions (Part I) and General Conditions (Part II) of this permit.

DISCHARGE MONITORING REPORT (DMR) MAILING ADDRESS

Mailing Name: **Jones Chemicals, Inc.**

Street: **100 Sunny Sol Boulevard**

City: **Caledonia** State: **NY** Zip Code: **14423**

Responsible Official or Agent: **Timothy J. Gaffney, Executive Vice President** Phone: **716-538-2314**

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal not less than 180 days prior to the expiration date shown above.

DISTRIBUTION:

Bureau of Water Permits

Permit Administrator:	
Address:	
Signature:	Date: 8/28/01

PERMIT LIMITS, LEVELS AND MONITORING DEFINITIONS

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OUTFALL	WASTEWATER TYPE	RECEIVING WATER	EFFECTIVE	EXPIRING
	This cell describes the type of wastewater authorized for discharge. Examples include process wastewater, storm water, non-contact cooling water.	This cell lists classified waters of the state to which the listed outfall discharges.	The date this page starts in effect.	The date this page is no longer in effect

PARAMETER	MINIMUM	MAXIMUM	UNITS	SAMPLE FREQ.	SAMPLE TYPE
	The minimum level that must be maintained at all times.	The maximum level that may not be exceeded at any time.			

PARAMETER	COMPLIANCE LIMIT	ACTION LEVEL	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE
	Daily Max. and Daily Avg. are defined below. All determinations of compliance with substance specific discharge limits are made by comparing monitoring results to the compliance level.	Type I or Type II Action Levels are monitoring requirements, as defined below, that trigger additional monitoring and permit review when exceeded.	This can include units of flow, pH, Temperature, mass or concentration. Examples include SU, °F, µg/l, lbs/d, etc.	Examples include Daily, 3/week, weekly, 2/month, monthly, quarterly, 2/yr and yearly.	Examples include grab, 24 hour composite and 3 grab samples collected over a 6 hour period.

DAILY DISCHARGE.: The discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for the purposes of sampling. For pollutants expressed in units of mass, the 'daily discharge' is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the 'daily discharge' is calculated as the average measurement of the pollutant over the day.

DAILY MAX.: The highest allowable daily discharge.

DAILY AVG.: The highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

ACTION LEVELS: Routine Action Level monitoring results, if not provided for on the Discharge Monitoring Report (DMR) form, shall be appended to the DMR for the period during which the sampling was conducted. If the additional monitoring requirement is triggered as noted below, the permittee shall undertake a short-term, high-intensity monitoring program for the parameter(s). Samples identical to those required for routine monitoring purposes shall be taken on each of at least three consecutive operating and discharging days and analyzed. Results shall be expressed in terms of both concentration and mass, and shall be submitted no later than the end of the third month following the month when the additional monitoring requirement was triggered. Results may be appended to the DMR or transmitted under separate cover to the same address. If levels higher than the Action Levels are confirmed, the permit may be reopened by the Department for consideration of revised Action Levels or effluent limits. The permittee is not authorized to discharge any of the listed parameters at levels which may cause or contribute to a violation of water quality standards.

TYPE I : The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results in excess of the stated Action Level.

TYPE II: The additional monitoring requirement is triggered upon receipt by the permittee of any monitoring results that show the stated action level exceeded for four of six consecutive samples, or for two of six consecutive samples by 20 % or more, or for any one sample by 50 % or more.

FINAL PERMIT LIMITS, LEVELS AND MONITORING

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OUTFALL No.	WASTEWATER TYPE	RECEIVING WATER	EFFECTIVE	EXPIRING
001	Treated Non-Contact Cooling Water, Treated Process Wastewater, Boiler Blowdown, Water Softener Brine, Cooling Tower Purge Water, and Stormwater Runoff.	Groundwater	10/1/01	ExPD

PARAMETER	MINIMUM	MAXIMUM	UNITS	SAMPLE FREQUENCY	SAMPLE TYPE	FOOTNOTES (FN)
pH	6.5	8.5	SU	Weekly	Grab	

PARAMETER	COMPLIANCE LIMIT		MONITORING ACTION LEVEL		UNITS	SAMPLE FREQUENCY	SAMPLE TYPE	FN
	Daily Avg.	Daily Max.	TYPE I	TYPE II				
Flow	Monitor	700,000			GPD	Continuous	Meter	
Chloride	Monitor	500			mg/l	Monthly	Grab	
Sulfate (SO_4)	Monitor	Monitor			mg/l	Monthly	Grab	1
Solids. Total Dissolved	Monitor	2500			mg/l	Monthly	Grab	
Iron. Total	Monitor	0.60			mg/l	Monthly	Grab	
Benzene	Monitor	1.0			µg/l	2/Month	Grab	2,3
Bromodichloromethane	Monitor	5.0			µg/l	2/Month	Grab	2,3
Bromoform	Monitor	50			µg/l	2/Month	Grab	2,3
Carbon Tetrachloride	Monitor	5.0			µg/l	2/Month	Grab	2,3
Chloroform	Monitor	7.0			µg/l	2/Month	Grab	2,3
Dibromochloromethane	Monitor	50			µg/l	2/Month	Grab	2,3
1,1-Dichloroethane	Monitor	5.0			µg/l	2/Month	Grab	2,3
1,2-cis-Dichloroethylene	Monitor	5.0			µg/l	2/Month	Grab	2,3
1,2-trans-Dichloroethylene	Monitor	5.0			µg/l	2/Month	Grab	2,3
Ethylbenzene	Monitor	5.0			µg/l	2/Month	Grab	2,3
Methylene Chloride	Monitor	5.0			µg/l	2/Month	Grab	2,3
Tetrachloroethylene	Monitor	5.0			µg/l	2/Month	Grab	2,3
Toluene	Monitor	5.0			µg/l	2/Month	Grab	2,3
1,1,1-Trichloroethane	Monitor	5.0			µg/l	2/Month	Grab	2,3
1,1,2-Trichloroethane	Monitor	1.0			µg/l	2/Month	Grab	2,3
Trichloroethylene	Monitor	5.0			µg/l	2/Month	Grab	2,3
1,2-Xylene	Monitor	5.0			µg/l	2/Month	Grab	2,3
Sum of 1,3-Xylene and 1,4-Xylene	Monitor	10			µg/l	2/Month	Grab	2,3
Total Aggregate Concentration	Monitor	100			µg/l	2/Month	Calculated	2,3

Footnotes:

1. The intake (on-site production well) must be monitored for sulfate on the same day outfall 001 is monitored. Intake monitoring results must be summarized on or as an attachment to the corresponding DMR.

2. The arithmetic sum of the concentrations of these parameters shall not exceed a total concentration of 100 µg/l.

3. The measurement frequency for these parameters shall be **monthly** following a period of **24** consecutive **2/month** sampling events showing no exceedances of stated discharge limitations. If the discharge limitation of any parameter exceeds the stated limit, the measurement frequency for all these parameters shall again be **2/month**, until a period of **eight** consecutive sampling events shows no exceedances of the stated discharge limits, at which point **monthly** monitoring may resume.

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SPECIAL CONDITIONS - BEST MANAGEMENT PRACTICES (SMALL FACILITIES)

1. The permittee shall develop a Best Management Practices (BMP) plan to prevent, or minimize the potential for, release of significant amounts of toxic or hazardous pollutants to the waters of the State through plant site runoff; spillage and leaks; sludge or waste disposal; and storm water discharges including, but not limited to, drainage from raw material storage. Completed BMP plans shall be submitted by **EDPM + 1 Year** to the Regional Water Engineer at the address shown on the Recording, Reporting and Additional Monitoring Requirements page. The BMP plan shall be implemented within 6 months of submission.

2. Subsequent modifications to or renewal of this permit does not reset or revise the deadline set forth in (1) above, unless a new deadline is set explicitly by such permit modification or renewal.

3. The BMP plan shall be documented in narrative form and shall include any necessary plot plans, drawings or maps. Other documents already prepared for the facility such as a Safety Manual or a Spill Prevention, Control and Countermeasure (SPCC) plan may be used as part of the plan and may be incorporated by reference. USEPA guidance for development of storm water elements of the BMP is available in the September 1992 manual "Storm Water Management for Industrial Activities," USEPA Office of Water Publication EPA 832-R-92-006 (available from NTIS, (703)487-4650, order number PB 92235969). A copy of the BMP plan shall be maintained at the facility and shall be available to authorized Department representatives upon request. The BMP plan shall include the following BMP's:

a. BMP Committee
b. Reporting of BMP Incidents
c. Risk Identification & Assessment
d. Employee Training
e. Inspections and Records
f. Preventive Maintenance
g. Good Housekeeping
h. Materials Compatibility
i. Security
j. Spill prevention & response
k. Erosion & sediment control
l. Management of runoff

Note that for some facilities, especially those with few employees, some of the above BMP's may not be applicable. It is acceptable in these cases to indicate "Not Applicable" for the portion(s) of the BMP plan that do not apply to your facility, along with an explanation.

4. The BMP plan shall be reviewed annually and shall be modified whenever: (a) changes at the facility materially increase the potential for significant releases of toxic or hazardous pollutants, (b) actual releases indicate the plan is inadequate or (c) a letter from the Regional Water Engineer highlights inadequacies in the plan.

5. **Facilities with Petroleum and/or Chemical Bulk Storage (PBS and CBS) Areas:**
Compliance must be maintained with all applicable regulations including those involving releases, registration, handling and storage (6NYCRR 595-599) and (6NYCRR 612-614). Stormwater discharges from handling and storage areas should be eliminated where practical.

a. Spill Cleanup - All spilled or leaked substances must be removed from secondary containment systems as quickly as practical and in all cases within 24 hours. The containment system must be thoroughly cleaned to remove any residual contamination which could cause contamination of stormwater and the resulting discharge of pollutants to waters of the State. Following spill cleanup the affected area must be completely flushed with clean water three times and the water removed after each flushing for proper disposal in an on-site or off-site wastewater treatment plant permitted to discharge such wastewater. Alternatively, the permittee may test the first batch of stormwater following the spill cleanup to determine discharge acceptability. If the water contains no pollutants it may be discharged. Otherwise it must be disposed of as noted above. See *Discharge Monitoring* below for the list of parameters to be sampled for.

b. Discharge Operation - Stormwater must be removed before it compromises the required containment system capacity. All discharges must be done under the direct supervision of plant environmental, health and safety personnel. Bulk storage secondary containment drainage systems must be locked in a closed position except when the operator is in the process of

draining accumulated stormwater. Transfer area secondary containment drainage systems must be locked in a closed position during all transfers and must not be reopened unless the transfer area is clean of contaminants. Stormwater discharges from secondary containment systems should be avoided during periods of precipitation. A logbook shall be maintained on-site noting the date, time and personnel supervising each discharge.

c. Discharge Monitoring of Bulk Storage Secondary Containment Systems - *This paragraph only applies to those bulk storage containment system outlets which are not identified in the SPDES permit as an outfall with explicit effluent limitations.* A representative sample shall be collected of each discharge[1] from each outlet. The sample must be analyzed for flow, pH, the substance(s) stored within the containment area and any other pollutants the permittee knows or has reason to believe are present[2]. Flow may be calculated by measuring the depth of water within the containment area times the wetted area converted to gallons or by other suitable methods.

d. Discharge Monitoring of Transfer Area Secondary Containment Systems - *This paragraph only applies to those transfer area containment system outlets which are separate from bulk storage containment system outlets and are not identified in the SPDES permit as an outfall with explicit effluent limitations.* The first discharge[1] following any spill or leak must be sampled for flow, pH, the substance(s) transferred in that area and any other pollutants believed to be present. Flow may be calculated as noted in the previous paragraph.

e. Discharge Reporting - Any samples or measurements required above must be submitted to the Department by appending them to the corresponding discharge monitoring report (DMR). Failure to perform the required discharge monitoring and reporting shall constitute a violation of the terms of the SPDES permit.

f. Prohibited Discharges - The following discharges are prohibited unless specifically authorized elsewhere in this SPDES permit: spills or leaks, tank bottoms, maintenance wastewaters, wash waters where detergents or other chemicals have been used, tank hydrotest and ballast waters, contained fire fighting runoff, fire training water contaminated by contact with pollutants or containing foam or fire retardant additives, and, unnecessary discharges of water or wastewater into secondary containment systems. An example of a necessary discharge could be the addition of steam to prevent bulk storage containment area sump pumps from freezing during cold weather. In all cases, any discharges which contain a visible sheen, foam, or odor, or may cause or contribute to a violation of water quality are prohibited.

(1) Discharge includes stormwater discharges and snow and ice removal. If applicable, a representative sample of snow and/or ice should be collected and allowed to melt prior to sample preservation and analysis.

(2) If the stored substance is a petroleum product (i.e. fuel oil, gasoline, kerosene, etc.) then the discharge should be sampled for oil & grease, benzene, ethylbenzene, naphthalene, toluene and total xylenes. If the substance(s) are listed in Tables 6-8 of application form NY-2C sampling is required. If the substance(s) are listed in NY-2C Tables 9-10 sampling for appropriate indicator parameters may be required, e.g., substituting BOD5 for methanol, substituting toxicity testing for demeton. Form NY-2C is available on the NYSDEC web site. Contact the facility inspector for further instructions on the appropriate indicator parameters to select. In all cases flow and pH monitoring is required.

WATER TREATMENT CHEMICAL (WTC) REQUIREMENTS (9/99)

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New or increased use of a WTC requires prior DEC review and authorization. At a minimum, the permittee must notify the DEC in writing of its intent to change WTC use by submitting a completed WTCFX Form for each WTC. The DEC will review that submittal and determine if a SPDES permit modification is necessary or whether WTC review and authorization may proceed outside of the formal permit administrative process. **The majority of WTC authorizations do not require formal SPDES permit modification.** WTCs which are used in closed systems and cannot be discharged or those which are discharged to municipal STP do not require DEC review. **WTC use and discharge questions or requests for forms** should be directed to the DEC staff person who developed your SPDES permit. If you are not sure who that is, contact the DEC staff person who last inspected your facility.

Examples of WTCs include, biocides, coagulants, conditioners, corrosion inhibitors, defoamers, flocculants, scale inhibitors, sequestrants, and settling aids. DEC staff may also direct you to use the WTCFX Form for review and authorization of substances other than WTCs, e.g. process chemicals.

The permittee must demonstrate that the use and discharge of any WTCs containing **phosphorus**, tributary to the Great Lakes Basin or other ponded waters, is necessary and that no acceptable alternatives exist. Please note that in some cases your permit may require modification to regulate phosphorus.

Generic WTC Usage Requirements

1. WTC usage shall not exceed the usage rate reported by the permittee or authorized below, whichever is less.

2. The discharge shall not cause or contribute to a violation of water quality or an exceedance of AWQC.

3. **The permittee must maintain a logbook** of all WTC use, noting for each WTC the date, time, exact location, and amount of each dosage, and, the name of the individual applying or measuring the chemical. The logbook must also document that adequate process controls are in place to ensure that excessive levels of WTCs are not used and subsequently discharged through outfalls. The permittee shall retain the logbook data for a period of at least 3 years. This period may be extended by request of the DEC.

4. **The permittee shall provide an annual report,** attached to the December DMR, containing the following information for each outfall: the current list of WTCs authorized for use and discharge by the DEC, for each WTC the amount in pounds used during the year, identification of authorized WTCs the permittee no longer uses, and any other pertinent information.

List of WTCs Authorized for Use and Discharge*

Affected Outfall(s)	Dosage (lbs/day) Avg	Max	* WTC Manufacturer and Product Name	WTC Function
001	0.014	0.014	DuBois Conden-Saf 2500	Boiler Corrosion Inhibitor
001	0.016	0.016	DuBois Confidence 10-C	Boiler Corrosion/Scale Inhibitor
001	0.016	0.016	DuBois Elim-Iron	Metal Oxide Descalant
001	234 mg/l max		DuBois GCO-30	Cooling Tower Biocide
001	0.029	5.3	DuBois GWT-16	Boiler Oxygen Scavenger

* - Authorized WTCs must either be listed above or identified in a letter sent to the permittee by the DEC subsequent to issuance of this permit page. In cases where a WTC is listed above and in a letter from the DEC, the more recent document will control.

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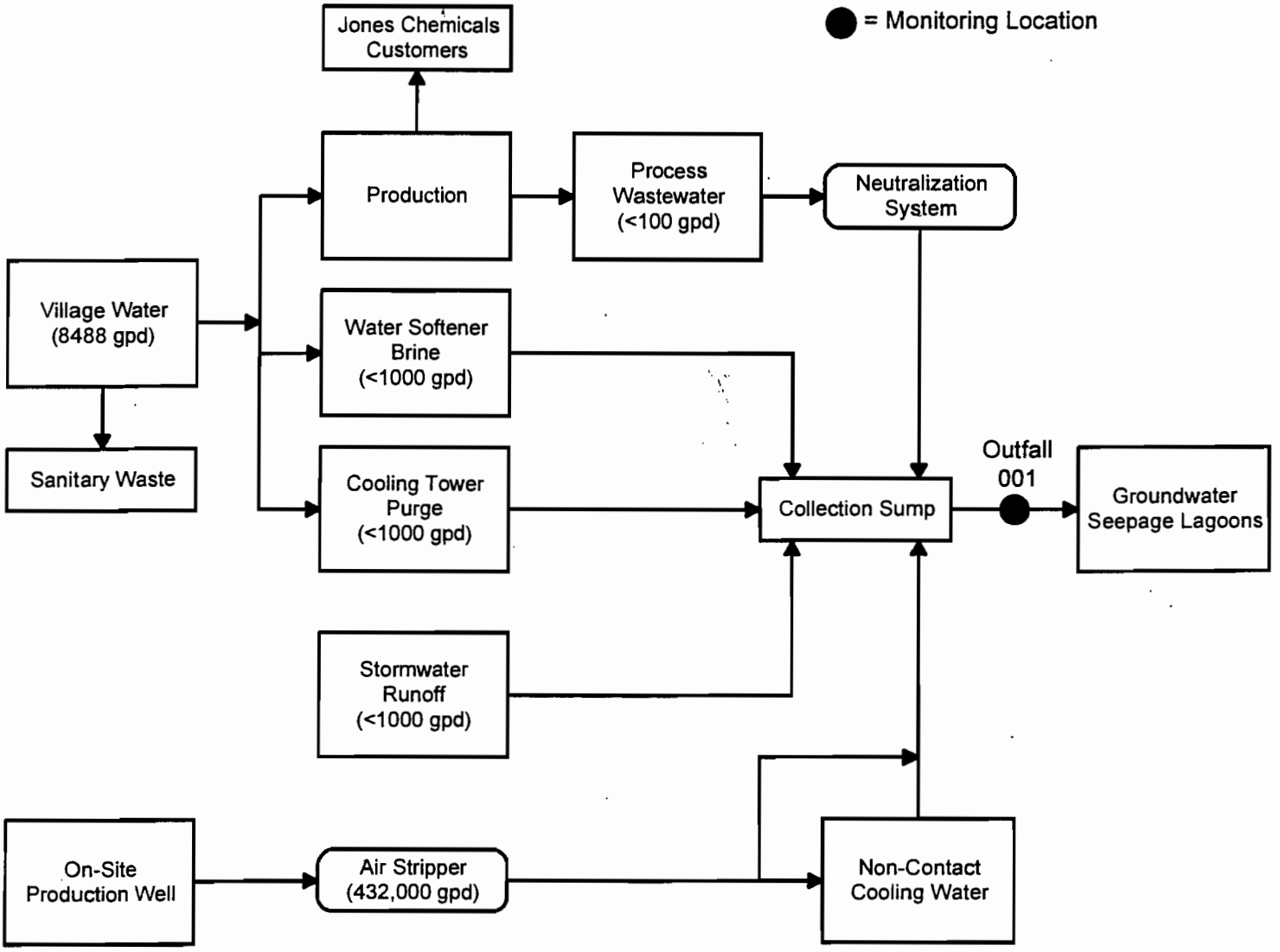
MONITORING LOCATIONS

The permittee shall take samples and measurements, to comply with the monitoring requirements specified in this permit, at the location(s) specified below:



RECORDING, REPORTING AND ADDITIONAL MONITORING REQUIREMENTS

a) The permittee shall also refer to the General Conditions (Part II) of this permit for additional information concerning monitoring and reporting requirements and conditions.

b) The monitoring information required by this permit shall be summarized, signed and retained for a period of three years from the date of the sampling for subsequent inspection by the Department or its designated agent. **Also, monitoring information required by this permit shall be summarized and reported by submitting;**

[X] (if box is checked) completed and signed Discharge Monitoring Report (DMR) forms for each 1 month reporting period to the locations specified below. Blank forms are available at the Department's Albany office listed below. The first reporting period begins on the effective date of this permit and the reports will be due no later than the 28th day of the month following the end of each reporting period.

[ ] (if box is checked) an annual report to the Regional Water Engineer at the address specified below. The annual report is due by February 1 and must summarize information for January to December of the previous year in a format acceptable to the Department.

[ ] (if box is checked) a monthly "Wastewater Facility Operation Report..." (form 92-15-7) to the:
[ ] Regional Water Engineer and/or [ ] County Health Department or Environmental Control Agency specified below

Send the original (top sheet) of each DMR page to:

Department of Environmental Conservation
Division of Water
Bureau of Watershed Compliance Programs
50 Wolf Road
Albany, New York 12233-3506

Phone: (518) 457-8954

Send the first copy (second sheet) of each DMR page to:

Department of Environmental Conservation
Regional Water Engineer, Region 8
6274 E. Avon-Lima Road
Avon, New York 14414

Phone: 716-226-2466

Send an additional copy of each DMR page to:

c) Noncompliance with the provisions of this permit shall be reported to the Department as prescribed in the attached General Conditions (Part II)

d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

e) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculations and recording of the data on the Discharge Monitoring Reports.

f) Calculation for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

g) Unless otherwise specified, all information recorded on the Discharge Monitoring Report shall be based upon measurements and sampling carried out during the most recently completed reporting period.

h) Any laboratory test or sample analysis required by this permit for which the State Commissioner of Health issues certificates of approval pursuant to section five hundred two of the Public Health Law shall be conducted by a laboratory which has been issued a certificate of approval. Inquiries regarding laboratory certification should be sent to the Environmental Laboratory Accreditation Program, New York State Health Department Center for Laboratories and Research, Division of Environmental Sciences , The Nelson A. Rockefeller Empire State Plaza, Albany, New York 12201.

Appendix K

In Situ Chemical Oxidation Design Calculations

In-Situ Chemical Oxidation

1. Determine mass of tetrachloroethene (PCE) in overburden.

Assume: source area is 15 feet (ft) in diameter
70% groundwater in overburden source area has PCE concentration of 0.298 mg/l; 25% has PCE concentration of 1.2 mg/l; and 5% has PCE concentration of 2.08 mg/l
organic content of overburden soil is 0.6%
groundwater table is at 15 ft below ground surface (bgs)
bedrock is at 40 ft bgs
bulk density of overburden is 110 lbs/ft^3
porosity of overburden is 0.35

a) Mass of PCE at the source in overburden groundwater

C_{gw} = 0.7(0.298 mg/l) x 0.25(1.2 mg/l) x 0.05(2.08 mg/l)
= 0.613 mg/l
M_{gw} = 0.613 mg/l x [0.35π(15)^2(40ft-15ft)/4] x 28.61 l/ft^3
= 27 g or 0.06 lbs

b) Mass of PCE at the source adsorbed to overburden soil

Estimate concentration, *X*, adsorbed to soil

$$X = K_d x C_{gw}$$

Where:
K_d = K_{oc} x f_{oc}
K_{oc} = octanol water partitioning coefficient; 155 l/kg
f_{oc} = fractional organic content of soil; 0.006
C_{gw} = average groundwater concentration at the source

The estimated concentration of PCE adsorbed to the soil is 0.57 mg/kg.

Estimate mass, M_s, of PCE sorbed to the soil.

$$M_s = X \times V_s \times \rho \times 10^{-6} \text{ kg/mg}$$

Where:
X = PCE concentration of sorbed to soil
V_s= volume of soil at source; 4,416 ft^3
ρ = soil bulk density; 110 lbs/ft^3

The estimated mass of PCE sorbed to soil beneath the groundwater table at the source is 0.28 lbs.

c) Estimate total mass of PCE in overburden with safety factor of 100.

The total mass of PCE is estimated to be 0.06 lbs in groundwater plus 0.28 lbs in soil for a total mass of 0.34 lbs. Using a safety factor of 100, the total mass is estimated to be 3.4 lbs.

2. Determine mass of tetrachloroethene (PCE) in bedrock.

Assume: source area is 15 feet (ft) in diameter
100% groundwater in bedrock source area has PCE concentration of 2.08 mg/l
organic content of bedrock is 0.1%
bedrock is at 40 ft bgs
source extends to depth of 55 ft bgs
bulk density of bedrock is 125 lbs/ft^3
porosity of overburden is 0.15

a) Mass of PCE at the source in bedrock groundwater

C_{gw} = 2.08 mg/l

M_{gw} = 2.08 mg/l x [0.15π(15)^2(15ft)/4] x 28.6 l/ft^3
= 23.6 g or 0.05 lbs

b) Mass of PCE at the source adsorbed to bedrock

Estimate concentration, X, adsorbed to bedrock

$$X = K_d x C_{gw}$$

Where:
K_d = K_{oc} x f_{oc}
K_{oc} = octanol water partitioning coefficient; 155 l/kg
f_{oc} = fractional organic content of bedrock; 0.001
C_{gw} = average groundwater concentration at the source

The estimated concentration of PCE adsorbed to the bedrock is 0.32 mg/kg.

Estimate mass, M_s, of PCE sorbed to the bedrock.

$$M_s = X \times V_s \times \rho \times 10^{-6} \text{ kg/mg}$$

Where:

X = PCE concentration of sorbed to bedrock
V_s = volume of soil at source; 2,649 ft^3
ρ = soil bulk density; 125 lbs/ft^3

The estimated mass of PCE sorbed to bedrock at the source is 0.106 lbs.

c) Estimate total mass of PCE in bedrock with safety factor of 100.

The total mass of PCE is estimated to be 0.05 lbs in groundwater plus 0.106 lbs in bedrock for a total mass of 0.156 lbs. Using a safety factor of 100, the total mass is estimated to be 1.56 lbs.

3. Estimate volume of $KMnO_4$ to be added to oxidize PCE

Assume: source area is 15 feet (ft) in diameter
5 injection wells in overburden and 1 injection well in bedrock zone
based on stoichiometric ratio 1.4 gram of $KMnO_4$ is required for every gram of PCE
chemical oxygen demand (COD) is 10 times greater than PCE demand
safety factor of 5
bedrock is at 40 ft bgs
source extends to depth of 55 ft bgs
Volume of overburden is $0.35\pi(15)^2(40ft-15ft)/4=1545\ ft^3$
Volume of overburden is $0.15\pi(15)^2(55ft-40ft)/4=397\ ft^3$
30% of volume is required to ensure contact of $KMnO_4$ with PCE

a) Overburden

3.4 lbs PCE=1,540 g; therefore, 1,540 g PCE x 1.4 g $KMnO_4$/g PCE = 2,156 g $KMnO_4$
COD depletion = 10 x 2,156 g $KMnO_4$ = 21,560 g $KMnO_4$
Design Amount = 21,560 g $KMnO_4$ x 5 =108,000 g $KMnO_4$
% Solution = 108 x 10^6 mg/463.5 ft^3(28.6l/ft^3) = 8,144 mg/l = 0.81%

b) Bedrock

1.56 lbs PCE=708 g; therefore, 708 g PCE x 1.4 g $KMnO_4$/g PCE = 990 g $KMnO_4$
COD depletion = 10 x 990 g $KMnO_4$ = 9,900 g $KMnO_4$
Design Amount = 9,900 g $KMnO_4$ x 5 =49,500 g $KMnO_4$
% Solution = 49.5 x 10^6 mg/119 ft^3(28.6l/ft^3) = 14,540 mg/l = 1.5%

4. Determine application rate

   a) Overburden

      Given the high transmissivity (233 gpm/ft) of this zone, the 3,475 gallons of $KMnO_4$ solution can be gravity fed into this zone over one single day.

   b) Bedrock

      Given a transmissivity of approximately 45 gpm/ft of this zone, the 890 gallons of $KMnO_4$ can be gravity fed into the bedrock zone over a single day.