ESC ENGINEERING OF NEW YORK, P.C.
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REMEDIAL ACTION

June 3, 2004

Mr. Kevin Carpenter, P.E.
Senior Environmental Engineer
New York State Department of Environmental Conservation
Bureau of Eastern Remedial Action
Division of Environmental Remediation
625 Broadway, 11th Floor
Albany, NY 12233-7015

Re: Transmittal of Electronic PDF File
Groundwater Interim Remedial Measure Full-Scale Design Report, Revision No. 1
Former General Instrument Corporation Site, Hicksville, New York

Dear Mr. Carpenter:

ESC Engineering of New York, P.C., has enclosed a compact disc containing an Adobe Acrobat pdf file of the complete Groundwater Interim Remedial Measure Full-Scale Design Report, Revision No. 1, dated May 18, 2004, for the Former General Instrument Corporation (GIC) site in Hicksville, New York. Please feel free to contact us if you have any questions.

Sincerely yours,
ESC Engineering of New York, P.C.

James A. Sobieraj, P.E.
Senior Consultant

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Enclosure

ESC ENGINEERING OF NEW YORK, P.C.
9 Albany Street • Cazenovia, New York 13035 • (315) 655-3900 • Fax (315) 655-3907

May 18, 2004

Mr. Kevin Carpenter, P.E.
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau A, 11th Floor
625 Broadway
Albany, New York 12233-7015

Re: Groundwater Interim Remedial Measure Full-Scale Design Report, Revision No. 1
Former General Instrument Corporation Site, Hicksville, New York

Dear Mr. Carpenter:

On behalf of our client, ESC Engineering of New York, P.C., is providing this revised Groundwater Interim Remedial Measure Full-Scale Design Report to the New York State Department of Environmental Conservation (NYSDEC) to address offsite groundwater contamination associated with the former General Instrument Corporation (GIC) site located in Hicksville, New York. A full-scale groundwater circulation technology system is planned as an Interim Remedial Measure (IRM) for installation downgradient of the former GIC site on properties located at 508 Duffy Avenue and 100-136 Charlotte Avenue in Hicksville. Drilling began on April 19, 2004, and the full-scale system is anticipated to be in operation by mid-July 2004. This letter addresses comments included in the NYSDEC's conditional approval letter dated April 13, 2004.

Response to Comments

The NYSDEC's comments have been addressed in this revised IRM design report. For convenience, the NYSDEC's comments are provided below in italics, followed by ESC Engineering's responses in regular font.

Comment 1 – *"Page 4, Section 1.3.1, This section should reflect that there is a shallow aquifer, the upper glacial aquifer, above the Magothy."*

This section has been revised to reflect that the upper glacial aquifer is present above the Magothy in the vicinity of the IRM area.

Comment 2 – *"Page 8, Section 2.2, and Page 12, Section 3.2, While the remediation system is exempt from air permitting requirements, it must comply with the substantiative regulations. The* *assumptions, model inputs, and model results should be adjusted per March 30, 2004 e-mail correspondence between the Department and ESC."*

The model inputs have been modified to incorporate the following:

- The maximum vinyl chloride concentration detected during groundwater profile sampling of monitoring well W-30-285 has been changed to 430 micrograms per liter (µg/l) in Table 1. The estimated volatile organic compound (VOC) concentration anticipated in well UVB-3 has also been revised accordingly to 130 µg/l.
- The building height (h_b) listed in Table 2 and Appendix A has been changed to 12 feet, while the overall stack height (h_s) remains at 20 feet above the ground surface.
- The correction factor in Step 2 of the screening level ambient air quality impact assessment has been changed to 0.75 for $2.5>h_s/h_b>1.5$.

The model was rerun, and the results indicate a maximum ambient annual air quality impact of 0.049 micrograms per cubic meter (µg/m^3) and a short-term ambient air quality impact of 15.0 µg/m^3 in the vicinity of the IRM site. Because the annual and short-term guideline concentrations (AGC and SGC) listed in Appendix A of the Division of Air Quality Guidelines for the Assessment and Control of Toxic Compounds are 0.11 and 180,000 µg/m^3, respectively, operation of the IRM system will not exceed ambient air quality guideline values. The revised input and output for the model are included in Appendix A and Figure 4 has been revised accordingly.

Comments 3 and 4 – *"Page 18, Section 3.5, Third Bullet, While the Department approves the design of the system to meter a product to the UVB wells to reduce iron fouling, the Department cannot, at this time approve the proposed specific product (B-T20 Biocide). Since the piping system from the equipment building to the wells is unlikely to change based upon the product selection, the piping system is approved and the Department will continue its evaluation of the proposed product."…"Page 21, Section 3.5.3, Again, the acceptability of the proposed biocide is not approved at this time."*

Recent testing indicated only a slight presence of iron scaling in the air stripping trays after 9 months of operation of the pilot test well. Long-term iron scaling effects can be reduced through the use of an iron sequestering agent. While evidence of iron bacteria fouling has not yet been observed in the pilot test well, analytical data indicate that iron bacteria are present in low concentrations and could become an operational issue in the future. The underground transfer piping for a biocide and/or iron sequestering agent will be installed as designed but ESC Engineering will not implement the use of any product until approval is received from the Department. Initially, ESC Engineering will incorporate the use of an iron sequestering agent to reduce long-term iron scaling effects and may collect additional data from all three wells in the future to determine if a biocide is necessary. Language throughout the design report has been changed to reflect the fact that an iron sequestering agent will be used but a specific product is not referenced. ESC Engineering will continue to work with the NYSDEC and New York State Department of Health to find an approved product. Under separate cover, ESC Engineering will submit a material safety data sheet on a proposed iron sequestering agent to the NYSDEC. No sequestering agent or biocide will be used until ESC Engineering receives written approval from the NYSDEC.

<u>Comment 5</u> – *"Page 23, Section 3.5.4, The design and proposed operation of the VGAC units will result in significant loading of VOCs onto the carbon in the secondary units between saturation and change out of the primary units. The document does not describe the protocol for change out of the secondary units. Because the discharge must comply with New York State air quality regulations, change out of the carbon in the secondary units cannot be based upon reaching saturation. The protocol for managing the secondary carbon units must be described. This should also be addressed in the OM&M plan."*

The vapor treatment system design includes four 5,000-pound activated carbon vessels plumbed with two vessels in series parallel to two more vessels in series. ESC Engineering has modified the design to include flexible hose and fittings between the inlets and outlets of the vessels so that the configuration of the vessels can be rotated during carbon change-outs. After carbon in a primary vessel has reached saturation, it will be replaced with fresh carbon and the configuration will be adjusted such that the vessel with fresh carbon becomes the secondary unit. Section 3.5.4 has been revised to include this language and management of the carbon vessels will be described in the Operations and Maintenance (O&M) Plan to be submitted to the NYSDEC under separate cover.

<u>Comment 6</u> – *"Page 23, Section 3.5.5, This section indicates excavation of the utility trenches to three feet, while drawing Sheet 5 indicates the top of the HDPE pipe will be located 3 feet below grade. The document should specify a minimum depth for the top of the HDPE to be protective for truck traffic…."*

The minimum depth for all piping (to the top of the piping) will be 3 feet below grade and the report text has been modified accordingly.

"…Also, because the ground surface elevation is not likely to be consistent along the proposed route of the trench, the design should specify whether or not the HDPE must be installed at a specific pitch, flat, or simply at a minimum depth. The sensitivity to condensation accumulating in low spots in the pipe should be addressed. Cross-sectional drawings of the proposed trench route should be prepared to identify potential low spots in the piping. The Department's preference is to have these cross-sectional drawings prior to construction, but at a minimum, the must be provided as part of the as-built report. If necessary, access and drip legs should be considered to address any potential condensation concerns…"

The transfer piping design includes a demister at the outlet of each UVB well to trap small water droplets and drain them back into the UVB well vaults. Also, because the vapor will be under vacuum and at relatively constant temperature (because it is below grade), ESC Engineering does not expect considerable condensation within the transfer piping. Further, the air velocity in the transfer piping is sufficient to keep any water droplets that may form entrained in the vapor stream.

After the design report was provided to the NYSDEC, ESC Engineering contracted with a licensed surveyor to locate the proposed trench alignments. During this survey, spot elevation data were collected every 100 feet along the alignments. ESC Engineering will use this data and field observations to identify low spots in the piping alignment. As an additional precaution, drip legs and access ports will be installed at these locations to collect any condensate that may accumulate in the vapor transfer piping. Provisions will be included in the O&M plan to periodically open the access ports and bail the water from these collection points. A detail for these drainage collection points is included on Sheet 5.

"…This section indicates caution tape will be placed in the trench prior to backfill. Sheet 5 indicates metallic warning tape will be used. This should be clarified. The metallic warning tape is preferred.…"

Metallic tape will be placed in all trenches above buried piping to protect the piping during future excavations. The referenced text has been revised accordingly.

"…Construction quality control/construction quality assurance (CQA/CQC) specifications for the installation of the HDPE pipe must be provided. These should address, at a minimum, the welding of the pipe sections and leak testing."

A description of the construction QA/QC procedures to be used during the installation of the piping has been included in Section 3.5.5. All HDPE welds will be performed using the procedures described in Appendix D, while all PVC piping will be solvent welded with slip fittings or couplings. All vapor transfer piping will be leaked tested by isolating newly installed sections of piping and pressurizing the pipe to at least 50 pounds per square inch (psi). If the pipe loses more than 1 psi of pressure over 1 hour, the leak will be identified, repaired, and the pipe retested.

<u>Comment 7</u> – *"Page 24, Section 3.6, High water in the sump and high vacuum should also be considered as alarm conditions. High water would indicate injection pump failure or well clogging, and high vacuum could indicate a problem in the vacuum line such as clogging due to condensation buildup…"*

The design has been modified to include these alarm conditions.

"…Having each UVB system be able to experience an alarm without shutting the entire system down should be considered to increase reliability and overall runtime…"

ESC Engineering had considered this option and explored using this configuration. However, to accomplish this, check valves would be required on the discharge side of each blower to prevent uncontrolled migration of untreated vapors in the event of a shutdown. Our research indicated that 10-inch diameter check valves required a system pressure substantially higher than the design pressure to operate properly. The PLC will automatically notify ESC Engineering via fax of any alarm conditions, and the O&M vendor will be dispatched as quickly as possible to minimize downtime. In addition, the design includes a 10-inch butterfly valve on the discharge of each blower that can be manually closed to isolate each UVB well, thereby allowing independent operation of the three wells.

"...It should be specified if the PLC is field programmable and/or how changes to the PLC programming can be made."

Set points for the vacuum transmitters will be field programmable. If more complex changes are necessary, ESC Engineering will work with the PLC supplier or a subcontractor to edit the program. The program can then be reloaded onto the PLC through a direct connection using a laptop or through a remote connection.

Comment 8 – *"Page 26, Section 4.1, As indicated in my October 17, 2003 letter, the Department requests collection of groundwater samples from the lower screened intervals of the two new UVB wells. There has been no sampling from those intervals previously, and in the area of the proposed UVB-2, the vertical profiling showed increasing VOC concentrations with depth."*

Before the final piping is installed in the air stripper vault, ESC Engineering will insert a submersible pump into the downwell piping for the lower recharge zone. The pump will be set below the top of the water column within the piping but will be installed above the upper packer. A minimum of three well volumes (calculated from the lower packer to the well bottom), plus the volume of water in the downwell piping, will be purged before a sample is collected. Samples will be collected from UVB-2 and UVB-3 and will be analyzed for VOCs, including dichlorobenzenes, by EPA Method 8260.

Comment 9 – *"Page 29, Section 5.0, A draft OM&M plan should be submitted now and can be finalized after construction of the system. Any comment herein regarding OM&M are considered preliminary. Detailed OM&M comments will be made after receipt of the draft OM&M plan. The format and content of the OM&M plan should follow Department guidance. A section must be included in the OM&M plan describing if optimization of any of the system operational parameters may be needed, what data will be used to determine the need for optimization, and how any optimization will be implemented. The plan must describe how the formation of the recirculation cells will be verified in the long-term. The plan must also clearly describe how the off-gas treatment equipment will be monitored and managed to comply with air quality regulations."*

ESC Engineering will submit a draft O&M plan for the NYSDEC's review at least two weeks before system startup, which is scheduled to begin on July 12, 2004. The plan will be finalized after incorporating the NYSDEC's comments and submitted in conjunction with the completion report.

Comment 10 – *"Page 29, Section 5.2, Laboratory analysis of the performance monitoring samples should be performed more frequently than bi-monthly during the initial few months of operation. Once the system stabilizes the Department may be petitioned to reduce the frequency. For air samples, a correlation between field and laboratory analysis may allow for reduction in frequency of laboratory analysis or more cost effective analysis methods."*

Performance monitoring data from laboratory analyses for the pilot-scale system indicated that the VOCs concentrations in groundwater influent and effluent samples from UVB-1 stabilized within the first month of operation. ESC Engineering expects a similar trend for UVB-2 and UVB-3. However, to address the NYSDEC's concern, ESC Engineering proposes to increase the sampling frequency to monthly for the first 3 months, bimonthly for the rest of the first year of operation, and quarterly thereafter.

Comment 11 – "*Page 30, Section 5.2, Groundwater monitoring will be required from both up and down gradient of this system to evaluate system performance…The Department disagrees with the technical basis for not installing down gradient monitoring wells at this time, however, we will approve construction and startup of the system with the condition that design and construction of the monitoring network proceed in the near future. The downgradient wells should be installed prior to any anticipated positive effect caused by the system to enable determination of baseline downgradient conditions. The draft Groundwater Monitoring Plan for the site should be submitted with the draft OM&M plan."*

ESC Engineering will submit an interim groundwater monitoring plan (IGMP) to the NYSDEC in May 2004 that addresses monitoring the VOC plume migration while the remedial investigation/feasibility study (RI/FS) process is completed. After the full-scale IRM system is operational, ESC Engineering proposes a meeting with the NYSDEC to discuss plans for completing the RI/FS, including potential monitoring wells downgradient of the IRM. Additional monitoring wells that may be installed will be incorporated into the IGMP by written addenda to the plan. The IGMP will be superceded by a long-term monitoring plan when a final remedy is selected for the site.

Comment 12 – *"Page 31, Section 6.0, The performance monitoring reports should be submitted monthly for at least the first quarter after start-up. If conditions are stable, the Department can be petitioned to reduce the frequency. The first performance report should include results of any start-up testing."*

At the NYSDEC's request, performance monitoring reports will be submitted monthly for the first three months of operation of the full-scale system. The first report will be submitted 30 days after field activities have been completed and will include a summary of the start-up testing and preliminary analytical data.

Schedule

As previously noted, drilling at the site began on April 19, 2004. ESC Engineering anticipates completing the drilling activities by the end of May and full-scale startup activities by mid-July 2004. ESC Engineering will provide the NYSDEC with the IGMP and a quality assurance project plan in May 2004. A draft O&M plan will be submitted at least 2 weeks before startup activities are scheduled to begin.

If you have any questions or additional comments, please do not hesitate to contact us.

Sincerely yours,
ESC Engineering of New York, P.C.

John P. Black, P.E.
Senior Vice President

James A. Sobieraj, P.E.
Senior Consultant

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Enclosure

cc/encl: Mr. Donald Clark, Vishay General Semiconductor, LLC
Mr. Todd M. Hooker, Lowenstein Sandler, P.C.
Mr. James Sponable, NYS Department of Parks & Recreation

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GROUNDWATER INTERIM REMEDIAL MEASURE
OPERABLE UNIT NO. 2
FULL-SCALE DESIGN REPORT
GROUNDWATER CIRCULATION WELL SYSTEM

FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

REVISION NO. 1

PREPARED

BY

ESC ENGINEERING OF NEW YORK, P.C.

MARCH 26, 2004

REVISION NO. 1: MAY 18, 2004

Contents

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(continued)

Acronym List

AGC	Annual Guideline Concentration
bgs	below ground surface
BNL	Brookhaven National Labs
COC	constituent of concern
DCB	dichlorobenzene
DCE	dichloroethene
DPW	Department of Public Works
EPA	U.S. Environmental Protection Agency
GIC	General Instrument Corporation
gpm	gallons per minute
HDPE	high-density polyethylene
hp	horsepower
IRM	Interim Remedial Measure
lbs/day	pounds per day
lbs/hr	pounds per hour
LIPA	Long Island Power Authority
µg/l	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
O&M	operations and maintenance
PCE	tetrachloroethene
PEL	permissible exposure limit
PID	photoionization detector
PLC	programmable logic controller
ppb	parts per billion
psi	pounds per square inch
RI/FS	Remedial Investigation/Feasibility Study
scfm	standard cubic feet per minute
SGC	Short-Term Guideline Concentration
SVE	soil vapor extraction
TCE	trichloroethene
UVB	Unterdruck-Verdampfer-Brunnen
VFD	variable frequency drive
VGS	Vishay General Semiconductor
VOC	volatile organic compound
wci	water column inches

Professional Engineer Certification

I certify that I am an engineer licensed in the State of New York who has received a baccalaureate and post-graduate degree in engineering and have sufficient training and experience in remediation, groundwater hydrology, and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgements regarding engineering design. I further certify that this report, *Groundwater Interim Remedial Measure, Operable Unit No. 2, Full-Scale Design Report, Groundwater Circulation Well Technology*, dated March 26, 2004, and revised May 18, 2004, was prepared under my direction.

______________________________ ____________

James A. Sobieraj, P.E. Date
P.E. 077394

1.0 Introduction

Groundwater Circulation Well Technology has been selected for implementation as an offsite Interim Remedial Measure (IRM) associated with the former General Instrument Corporation (GIC) site (Site Number 1-30-020) located in Hicksville, New York. Remedial work at this site is being conducted by Vishay General Semiconductor (VGS), the corporate successor to GIC, in accordance with the Order on Consent (#W1-0236-88-07) signed by GIC on December 4, 1989, and the New York State Department of Environmental Conservation (NYSDEC) on January 16, 1990.

On behalf of VGS, ESC Engineering of New York, P.C., completed the first phase of the IRM, a pilot test of Unterdruck-Verdampfer-Brunnen (UVB) groundwater circulation well technology, to gather information on the stratigraphy and hydrogeology of the IRM location and to refine the design parameters for a full-scale system. A summary of the pilot test and a proposed conceptual design were provided to the NYSDEC in a report entitled *Groundwater Interim Remedial Measure, Operable Unit No. 2, Pilot Test Summary and Conceptual Full-Scale Design Report, Groundwater Circulation Well Technology*, dated September 19, 2003 (ESC Engineering 2003a). During this phase of the IRM, four monitoring wells and one UVB groundwater circulation well were installed. The UVB well was operated for one month during a pilot test to provide the necessary data for full-scale design and is currently in operation. Subsequent to the submission of the Pilot Test Report, VGS and ESC Engineering met with NYSDEC in Albany, New York and subsequently at the site with Neptune Regional Transmission System, NYS Department of Parks & Recreation, NYSDEC, and NYS Department of Transportation to coordinate the full-scale design and installation and to negotiate access agreements.

Groundwater at the former GIC site has been affected by volatile organic compounds (VOCs), including trichloroethene (TCE) and associated degradation products from both onsite and upgradient sources. Source control actions have been implemented at the site but residual concentrations and offsite sources unrelated to GIC are known to exist. Sampling results from several previous groundwater investigations indicate that affected groundwater exists downgradient of the former GIC site property boundary. This full-scale IRM consists of groundwater circulation wells to address the downgradient portion of the VOC plume emanating from the former GIC site and other upgradient sites. Groundwater circulation technology was selected following an evaluation of several potential remedial options. This technology was identified as the preferred strategy in part because of its success at other sites on Long Island in treating the full vertical and horizontal extent of VOC plumes. In addition, results of the pilot test indicate that circulation well technology will be effective at intercepting the VOC plume and removing VOC mass from the groundwater. This report provides the detailed design for a full-scale groundwater circulation well system to be installed at the site.

1.1 Site Description

The former GIC site is located at 600 West John Street northeast of the intersection of West John Street and Cantiague Rock Road in Hicksville, New York (Figure 1). The 11.5-acre site is located in a light industrial section of Hicksville and was developed in 1960 for General Transistor, who was subsequently acquired by the General Instrument Corporation. The site is surrounded by industrial and commercial properties.

1.2 Site History

GIC used the facility for the research, design, and manufacture of semiconductors, radar systems, and electronic equipment until operations ceased in 1994. Two one-story buildings and one two-story building were used for offices and research and manufacturing operations. 600 West John LLC currently owns the property and leases the buildings to industrial and commercial tenants.

Three potential areas of VOC releases were identified on the former GIC site: a former 2,000-gallon underground waste solvent tank (Area A), a former 1,000-gallon underground waste solvent tank (Area B), and a sump in an underground tunnel (Area C). The 2,000-gallon tank was immediately taken out of service. A preliminary investigation was conducted in two phases between 1981 and 1986 and included the installation of six monitoring wells. The investigation found that chlorinated VOCs had been released. A groundwater pump and treat system was installed during this time period, but was considered ineffective and operation was discontinued.

In 1986, GIC entered into a Consent Order with the NYSDEC and the former GIC site was listed as an inactive hazardous waste disposal site. Under the Consent Order, GIC agreed to identify and investigate releases of contaminants onsite and offsite. In January 1990, GIC and NYSDEC entered into a second Consent Order to conduct a Remedial Investigation/Feasibility Study (RI/FS). Two operable units (OU-1 and OU-2) were defined: affected onsite soil is referred to as OU-1 while affected groundwater is referred to as OU-2.

In 1994, a soil vapor extraction (SVE) system was installed as an IRM to address onsite soil. In March 1997, the NYSDEC issued a record of decision for OU-1 requiring SVE for treatment of onsite soils and as a result the system was upgraded. Closure testing conducted in the fall of 2001 indicated that Areas B and C were remediated, but that continued operation in Area A was still producing benefits. Additional testing was conducted in Areas B and C in December 2002 to confirm the results and operation in these areas was permanently discontinued with the approval of the NYSDEC. Modifications to the system were performed in the spring of 2003 and the system continues to operate in Area A.

After the preliminary investigations conducted between 1981 and 1986, five additional phases of groundwater investigation were conducted from 1990 through 2003. In April 2002, an ozone sparge system was proposed as an offsite groundwater IRM to be located along the southern boundary of the King Kullen property just north of the Long Island Railroad in the vicinity of monitoring wells W-18, W-19 and W-20. However, results from the Phase V RI, which was completed during the summer of 2002, warranted reevaluation of the proposed IRM. Four additional monitoring wells (W-26, W-27, W-28, and W-30) were installed on the southern boundary of the Ackerman property and on the eastern portion of the New York State Park Service (NYS Park Service) property. Total VOC concentrations in samples collected from these wells (screened from 252 to 285 feet below ground surface [bgs]) ranged from 468 micrograms per liter (µg/l) to 3,858 µg/l. These results indicated that the majority of the VOC mass is located between the King Kullen property and the southern boundary of the Ackerman property and at deeper depths than previously assumed. Based on these new data, an engineering reevaluation of potential remedial technologies was performed, which concluded that implementing groundwater circulation well technology along the southern boundary of the Ackerman property will allow collection and treatment of nine times greater mass of VOCs than the previous IRM proposal. The Phase V RI report (ESC Engineering and Stearns & Wheler 2003b) presents a detailed summary and interpretation of the investigative data.

In the summer of 2003, a pilot test of groundwater circulation technology was conducted to provide additional information for the design and operation of a full-scale UVB system. The results of the pilot test indicate that the technology will be successful at intercepting the VOC plume and removing substantive mass of VOCs from the aquifer. In addition, the pilot test provided information on the soil stratigraphy in the vicinity of the IRM, the yield of a UVB well, achievable groundwater extraction and injection rates, the efficiency of the air stripper, geochemistry and biochemistry data, and the maximum spacing between UVB wells to prevent breakthrough of VOCs (ESC Engineering 2003a).

1.3 Summary of Site Hydrogeology and Constituents of Concern

The former GIC site is underlain by 1,100 feet of unconsolidated material, and the groundwater table is located at approximately 70 feet bgs. Regional soils consist of gravelly sand (0 to 40 feet bgs), fine to medium sand (40 to 100 feet bgs), and silty fine sand (greater than 100 feet bgs).

1.3.1 Site Hydrogeology

The Magothy formation, which is overlain by the upper glacial aquifer, is the primary drinking water source for Long Island. Analysis of groundwater elevations recorded during historic sampling events indicates that the groundwater flow direction is toward the south, with a slight westward component at depths of 200 feet or less.

Based on boring logs for wells completed for the pilot test, soils in the immediate vicinity of the IRM location generally consist of sand with thin layers of clay, clayey sand, or silt. The majority of the clay and clayey sand layers were encountered at depths greater than 100 feet, are less than 1.5 feet in thickness, and appear to be localized. Clay lenses detected while installing monitoring wells W-35-380 and W-27-240 were not continuous throughout the entire pilot test area and did not have a significant impact on the overall circulation cell development.

1.3.2 Constituents of Concern

As described previously, there are numerous sources in the area. The primary constituents of concern (COCs) associated with the former GIC site are chlorinated solvents including TCE and associated degradation compounds. Other VOCs such as perchloroethene (PCE), xylenes, ethylbenzene, and dichlorobenzene (DCB) have also been detected.

As described in the Phase V RI report, the plume associated with the former GIC site extends from the source areas, under the King Kullen property located south of the former GIC property, to beyond the southern boundary of the Ackerman property (ESC Engineering and Stearns & Wheler 2003b). There are several converging plumes (only one of which is attributable to GIC) in the vicinity of the former GIC site. The plume that may be attributed to the former GIC site is depicted on figures 2 and 3. Data from previous investigations suggest that, near the southern Ackerman property line, the combined plume extends from approximately 160 to more than 380 feet bgs.

1.4 Purpose and Objectives of the IRM

The purpose and objectives of the IRM are to control the rate of migration of VOCs downgradient from the former GIC site and to remove VOC mass from groundwater. The IRM has been designed to treat the plume originating from the former GIC site, and will also address those portions of this plume that have commingled with plumes from other sources. As described in the Phase V RI Report, VOCs identified in groundwater samples from the easternmost well (W-26) and the westernmost well (W-28) along the southern boundary of the Ackerman property are likely attributable to sources other than the former GIC site (ESC Engineering and Stearns & Wheler 2003b). While some COCs from other plumes may be removed from the subsurface, the IRM will not capture the offsite plumes in the vicinity in their entirety.

As described in the *Conceptual Full-Scale Design Report*, UVB well systems consist of a single well with multiple screened intervals hydraulically separated by packers. A submersible pump extracts groundwater from one of the screened intervals, and pumps it to a below-grade air stripper located in a vault near the ground surface. The treated groundwater is then returned to the subsurface through the remaining screened intervals using either passive or active methods. Under ideal conditions, the simultaneous extraction and recharge causes a spherical zone of circulation to develop around the well casing. The shape of the zone of circulation can vary depending on the isotropic nature of the subsurface. The air stripper blower allows transfer of the VOCs from the well to either vapor treatment equipment located above grade or the atmosphere.

UVB well technology was selected for the IRM in part because of the documented success of this technology at the Brookhaven National Labs (BNL) site in Upton, New York, where subsurface conditions, target depths, and constituents are similar to those encountered at the IRM location. Seven UVB wells at the BNL site achieved 92.82 percent average removal efficiency during startup of the system.

UVB well technology was also selected because of the flexibility inherent in this type of system to adjust to unanticipated site conditions. The UVB well could be modified to change which zones are used for extraction and recharge. The configuration could also permit the introduction of an oxidant, such as ozone or potassium permanganate, into the subsurface through the discharge piping or top of the well casing.

2.0 Permitting and Site Access Requirements

The full-scale IRM system will consist of three UVB wells: two installed on the NYS Park Service property at 508 Duffy Avenue, and one installed on the Ackerman property at 100-136 Charlotte Avenue. Before the full-scale design could be finalized, permitting and site access agreements were a fundamental design consideration.

2.1 Site Access

The proposed locations of the three UVB wells are not on properties owned by VGS. While the Ackerman property is currently used for light commercial and industrial operations and no major land use changes are anticipated, Neptune RTS™ has submitted a proposal to the Long Island Power Authority (LIPA) to install an electrical converter station on the NYS Park Service property as shown on Sheet 3. Neptune RTS™ is one of several companies who have submitted proposals to LIPA, and award of the contract was anticipated in April 2004.

Because, the NYS Park Service property may be used in the near future for the proposed converter station, ESC Engineering negotiated two acceptable designs during a February 4, 2004, site meeting that met all site access requirements raised by the property owners, the existing and potential future tenants of the NYS Park Service property, and the NYSDEC. The major difference between the two designs is the location of circulation well UVB-2. Two locations, Options A and B (Sheets 3 and 4), were agreed upon by all stakeholders. Since this design report was first issued on March 26, 2004, UVB-2 has been installed in the Option A location. A decision regarding the converter station had not been reached by the anticipated date, and to stay on schedule for this project, drilling had to commence. Installing UVB-2 at the Option A location will accommodate the converter station if it is constructed. Using the Option A location will also increase the construction cost for this IRM as it requires approximately 750 additional feet of transfer piping compared to Option B.

ESC Engineering and their subcontractors will be allowed to enter the NYS Park Service property from 7 a.m. to 5 p.m. Monday through Saturday during construction, with the exception of the days when site access was allowed 24 hours per day during critical stages of the drilling for UVB-2. Once the full-scale system has been installed and startup has been completed, ESC

Engineering and their subcontractors will be allowed to access the wells and treatment equipment through several gates installed around the wells and equipment.

VGS negotiated an agreement with the owners of the Ackerman property allowing access to much of the parking lot on the south side of the building during construction. In addition, the owners of the Ackerman property agreed to allow VGS to install well UVB-3 in a fenced enclosure in the parking lot to control access to the well. VGS, ESC Engineering, and their subcontractors will have permission to access the well during routine and non-routine operations and maintenance and sampling site visits.

2.2 Permitting Requirements

ESC Engineering reviewed applicable federal, state, and local permitting requirements. ESC Engineering and their subcontractor will obtain the applicable drilling permits before work begins. Because the State of New York owns the property, no building permits are required by the Town of Oyster Bay for the treatment equipment building.

As a groundwater remediation system, the UVB system is exempt from air permitting requirements as a trivial activity under 6 NYCRR Part 201-3.3(c)(29). However, the NYSDEC has expressed concern regarding potential ambient air quality impacts due to vinyl chloride emissions from the UVB system. ESC Engineering completed an evaluation of potential air emissions from the proposed system and determined short-term and annual guideline concentrations (SGCs and AGCs) as listed in the New York State DAR-1 Guidelines for the Control of Toxic Ambient Air Contaminants will not be exceeded beyond the site boundaries. To verify this determination, ESC Engineering will monitor the vinyl chloride emissions during operation of the UVB system. Further detail regarding air emissions modeling and monitoring is included in Sections 3.2 and 5.2.

Well development and purge water generated during the installation of wells UVB-2 and UVB-3 will be temporarily containerized onsite. When a sufficient volume has been generated, the water will be treated using activated carbon and discharged to the ground surface of the adjacent Nassau County Department of Public Works (DPW) recharge basin to the southeast of the NYS Park Service property following the protocol used for the pilot test. ESC Engineering will coordinate the discharge of the treated water with the DPW and sample the water if required. No other permits are required to operate the full-scale IRM system at this time.

3.0 UVB System Design and Installation

After evaluating the types of groundwater circulation wells commercially available, a UVB well system was selected for the IRM. IEG Technologies Corporation of Mooresville, North Carolina, licenses use of UVB well systems in the United States and will assist ESC Engineering during the full-scale UVB well equipment installation and startup.

3.1 Current Plume Conditions and UVB Well Placement

As described in the Phase V RI report (ESC Engineering and Stearns & Wheler 2003b), field screening and groundwater sampling data indicate that VOCs are present along the southern Ackerman property boundary and the NYS Park Service property. Four soil borings (W-26, W-27, W-28, and W-30) were installed in the summer of 2002 to define the vertical and horizontal distribution of VOCs in this area. Three of the soil borings were installed to approximately 260 to 295 feet bgs, while a fourth was installed to 340 feet bgs. Field screening using a headspace analysis indicated that the vertical distribution of VOCs generally ranged from 160 feet bgs in soil boring W-26 to at least 340 feet bgs in soil boring W-30. The final depth of the plume could not be obtained because the maximum depth limit of the boring equipment had been reached.

Along the western edge of this transect at soil boring W-28, field screening samples contained relatively low concentrations of VOCs from 180 to 260 feet bgs, with most results less than 300 parts per billion (ppb) and cis-1,2-dichloroethene (DCE) as the primary compound detected. The two deepest samples from 250 feet bgs and 260 feet bgs contained VOCs at 831 ppb and 1,534 ppb. Moving eastward towards soil boring W-27, VOCs were detected from 210 to 290 feet bgs. The highest concentration was measured in the sample from 290 feet bgs, which contained 3,991 ppb total VOCs (predominately [68 percent] cis-1,2-DCE). The W-27 boring samples contained predominantly cis-1,2-DCE, although 1,200 ppb PCE was detected in the 250-foot interval sample. VOCs were detected in boring W-30, located further to the east on the Ackerman property, between 190 and 340 feet bgs. The highest concentration of VOCs was 3,670 ppb detected at 280 feet bgs, 70 percent of which was PCE. The concentration of VOCs in the easternmost boring, W-26, ranged from 280 ppb at 160 feet, to a maximum of 7,071 ppb at 255 feet. Concentrations below 255 feet steadily declined to 2,144 ppb at 285 feet.

The predominant compound in the W-26 boring was PCE, generally comprising greater than 95 percent of the VOC concentration.

To verify the field screening results, groundwater monitoring wells were installed in each of the soil borings. Each well was installed with 10 feet of screen across the interval with the highest VOC concentrations based on the field screening results. The groundwater sample from monitoring well W-28-262 contained 8 compounds at concentrations exceeding the New York State Ambient Water Quality Criteria (NYS criteria) for groundwater: acetone, 1,1-dichloroethane (estimated), 1,1-DCE, cis-1,2-DCE, PCE, 1,1,1-trichloroethane, TCE, and vinyl chloride. Like the field screening samples, groundwater concentrations were less than 200 μg/l, except for cis-1,2-DCE, which represented 58 percent of the total VOCs concentration detected. The groundwater sample from monitoring well W-27-285 contained 6 compounds above the NYS criteria: 1,1-DCE (estimated), cis-1,2-DCE, PCE, TCE, vinyl chloride, and xylenes (estimated). The groundwater sample contained predominately cis-1,2-DCE and TCE. The groundwater sample from monitoring well W-30-285 contained five compounds above the NYS criteria: acetone, cis-1,2-DCE, PCE, TCE, and vinyl chloride. PCE represented 63 percent of the VOCs detected in this sample. In contrast, the results for the groundwater sample from the easternmost monitoring well, W-26-270, contained only two compounds that exceeded the NYS criteria: PCE at a concentration of 3,800 μg/l and TCE at an estimated concentration of 58 μg/l.

The results of the field screening and groundwater sampling completed in the summer of 2002 indicate that there are commingled plumes both horizontally and vertically in the area of the proposed IRM. Figures 2 and 3 depict the current plume interpretation for the former GIC site. As can be seen on these figures, the portion of the commingled plumes that may be attributable to the former GIC site extends (horizontally) from the vicinity of W-28-262 to W-30-285.

To address the portion of the commingled plumes that may be attributable to the former GIC site, two additional UVB wells with stacked cells are proposed for the full-scale IRM. The proposed IRM wells will be located downgradient of the former GIC site on the NYS Park Service and Ackerman properties as shown on Figures 2 and 3. The locations available for placement of the additional wells are limited by a proposed electrical converter station on the western portion of the NYS Park Service property and use of the parking lot on the Ackerman property. As can be seen on Figures 2 and 3, there were two proposed locations for well UVB-2

(Option A or Option B). Because a decision by LIPA regarding the proposed converter station had not been reached by the anticipated date (April 22, 2004), and because the schedule for this IRM could not be delayed, UVB-2 was installed in the Option A location during late April and early May 2004.

As described in Section 3.5 of the *Conceptual Full-Scale Design Report*, the circulation cell of a single-cell UVB well is roughly trapezoidal in shape. IEG Technologies used a numerical computer model developed by Dr. Jürgen Stamm (REVERZ 1.0a) that utilizes the work of Herrling et al. (1991) to calculate critical dimensions of a groundwater circulation system. The model calculates the distance, D, between two UVB wells spaced along the plane perpendicular to the natural groundwater flow direction at which all groundwater is captured between the top of the recharge screen and the bottom of the extraction screen. In addition, the model calculates the upgradient stagnation point, S, of the circulation cell and the ratio of groundwater flow into the circulation cell to the extraction rate of the UVB well. For the lower and upper circulation cells, the maximum value for D ranged from 350 to 353 feet, the stagnation point ranged from 179 to 183 feet, and the groundwater flow to extraction rate ratio ranged from 0.34 to 0.38. Using the more conservative values from the lower circulation cell, the capture zones for the three proposed wells for the full-scale system are illustrated in Figures 2 and 3. To provide overlap of the capture zones and work within the access limitations of the site, the proposed wells will be spaced a maximum of 330 feet on center along planes perpendicular to the groundwater flow direction. The final locations of the wells may be altered slightly in the field at the discretion of ESC Engineering oversight personnel to avoid underground utilities or unanticipated obstacles.

3.2 Evaluation of Air Emissions

The proposed full-scale UVB system is exempt from air permitting requirements as a trivial activity under 6 NYCRR Part 201-3.3(c)(29). However, the NYSDEC indicated that although a permit is not required, emission rates for vinyl chloride will be compared with the maximum SGCs and AGCs listed in the New York State DAR-1 Guidelines for the Control of Toxic Ambient Air Contaminants (Guidelines) to ensure operation of the UVB system will not negatively impact ambient air quality in the vicinity of the site. ESC Engineering previously completed an evaluation of potential ambient air quality impacts due to the interim operation of

UVB-1 while the full-scale system was being designed. The results of this evaluation indicated that the AGCs and SGCs would not be exceeded beyond the site boundaries. In addition, the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) would not be exceeded at any location onsite (ESC Engineering 2004).

To evaluate the potential ambient air quality impacts posed by the full-scale system, ESC Engineering followed the same process previously used as described in Appendix B of the Guidelines. This process involves an initial conservative screening analysis using calculations to estimate emissions of ambient air contaminants. The screening level analysis indicated site-specific modeling was required to refine the air quality impact analysis. The Guidelines strongly suggest using the Air Guide-1 computer program developed by the NYSDEC to complete this modeling.

The AGC for vinyl chloride is 0.11 micrograms per cubic meter ($\mu g/m^3$), while the SGC is 180,000 $\mu g/m^3$. The maximum vinyl chloride concentration ever detected in the vapor effluent from UVB-1 has been 3,300 $\mu g/m^3$, which is two orders of magnitude below the SGC. To calculate the anticipated vinyl chloride air emission rates for UVB-2 and UVB-3, ESC Engineering used profiling and groundwater data collected in August 2002 from monitoring wells W-28-262 (located near the proposed location of UVB-2) and W-26-270 and W-30-285 (located near UVB-3) to estimate the potential vinyl chloride concentrations in groundwater. By averaging the maximum vinyl chloride concentration detected during profiling and the concentrations in groundwater samples collected after the wells were installed, the anticipated vinyl chloride concentrations in groundwater were estimated to be 215 µg/l at UVB-2 and 139 µg/l at UVB-3. As these anticipated concentrations of vinyl chloride are in the same range as the concentration of vinyl chloride previously observed at UVB-1 (120 to 240 µg/l) and previous vapor samples indicated vinyl chloride concentrations in the system exhaust ranged from 89 to 3,300 $\mu g/m^3$, the concentrations of vinyl chloride in the vapor effluent of the full-scale system are not expected to exceed the SGC. Also, as the effluent vapor concentration should decrease over time, ESC Engineering never expects the SGC to be exceeded.

3.2.1 Screening Level Analysis

Following the procedures for the Standard Point Source Method outlined in Appendix B of the Guidelines, ESC Engineering completed an ambient air quality impact screening analysis of the proposed full-scale system to determine if the AGC and SGC for vinyl chloride could be exceeded. Calculations used to complete the screening level analysis can be found in Appendix A.

VGS does not own any of the properties to be used for the proposed IRM system, and the proposed full-scale IRM design includes UVB wells on the Ackerman and NYS Park Service properties. Therefore, for the purposes of this air quality impact analysis, the IRM site boundaries have been defined as the properties on which the systems are bounded by the surrounding public roads and routes of access: the railroad tracks to the north, Charlotte Avenue to the east, the Wantaugh Parkway to the west, and Duffy Avenue to the south (Figure 1). For either proposed location of UVB-2, vapors from all three wells will be conveyed to a central location for treatment and discharge as shown on Sheets 3 and 4 (provided under separate cover).

To estimate the vinyl chloride emission rates from each UVB well, ESC Engineering utilized both recent groundwater sampling data and vapor sampling data collected during the pilot test and interim operation of UVB-1 (Table 1). For UVB-1, the anticipated vinyl chloride emission rate was estimated based on the groundwater influent sample from UVB-1 collected on December 17, 2003. The vinyl chloride emission rates from UVB-2 and UVB-3 were estimated from August 2002 profiling and groundwater sampling data for monitoring wells W-28-262 and W-26-270 and W-30-285, respectively, as previously described. To be conservative, ESC Engineering assumed an operational efficiency of 100 percent and a vinyl chloride stripping efficiency of 98 percent, the maximum stripping efficiency for vinyl chloride measured to date. Assuming a groundwater extraction rate of 60 gallons per minutes (gpm) and no appreciable removal of vinyl chloride by the activated carbon, the concentration in the vapor stream would be approximately 1,400 $\mu g/m^3$ at 3,000 standard cubic feet per minute (scfm) for the full-scale system. This is equivalent to an annual emission rate of 141 pounds per year (0.0161 pounds per hour [lbs/hr]).

Using the screening equations in Appendix B of the Guidelines, the maximum and potential annual ambient air quality impacts due to vinyl chloride emissions during full-scale operation of the UVB system were estimated to be 0.75 $\mu g/m^3$, which exceeds the AGC of 0.11 $\mu g/m^3$. The maximum short-term impact was calculated to be 48.8 $\mu g/m^3$, which is significantly less than the SGC of 180,000 $\mu g/m^3$.

3.2.2 Air Emissions Modeling

ESC Engineering followed the protocol in Appendix B of the Guidelines to perform a "more precise and less conservative analysis" of the potential vinyl chloride impacts using the Air Guide-1 software program. The program consists of a comprehensive screening analysis of emissions using "enhanced" Appendix B procedures from the Guidelines. A refined analysis of the emissions is then performed using the input and output data and NYSDEC's version of the U.S. Environmental Protection Agency's (EPA's) ISCLT2 model (version 93109). The model input and output data used for this analysis are included in Table 2 and Appendix A.

ESC Engineering also made the following assumptions:

- Meteorological conditions in Hicksville are similar to JFK Airport.
- The site has an urban classification.
- The building housing the system equipment is 60 feet in length, 12 feet wide, and the highest point of the roof (i.e., the building height) is 12 feet above grade.

Figure 4 illustrates vinyl chloride isoconcentration contours generated by the ISCLT2 model that represent the potential ambient air quality impacts of operating the full-scale UVB system. As shown on Figure 4, the AGC of 0.11 $\mu g/m^3$ will not be exceeded within the IRM site boundaries or offsite. In addition, the model calculated a maximum potential ambient air quality impact of 0.049 $\mu g/m^3$, which is five orders of magnitude below the OSHA PEL for site workers of 2,560 $\mu g/m^3$ for vinyl chloride.

3.2.3 Air Emissions Controls

While the results of the modeling indicate that the AGC and SGC for vinyl chloride will not be exceeded beyond the site boundaries, the Guidelines further state that contaminants, such as vinyl chloride, that are classified HIGH toxicity and therefore have an "A" Environmental Rating, should be controlled to the extent practicable. However, the Guidelines also allow for the NYSDEC to consider a "no control" option if the emission rate is less than 0.1 lb/hr. As shown above, the predicted vinyl chloride emission rate from UVB-1 is 0.0161 lb/hr, which is approximately 6 times less than threshold of 0.1 lb/hr to consider no control.

ESC Engineering researched Best Available Control Technologies to remove vinyl chloride from the vapor stream, and installed 960 pounds of an oxidizing media called HS-600 during the interim operation of UVB-1 as an experimental measure. After vapor sample results showed the HS-600 to be minimally effective, ESC Engineering consulted the manufacturer of the media to determine if the vinyl chloride destruction capacity could be increased or extended. While no published data are available, the manufacturer stated that at one site, 66 percent destruction efficiency of 1 part per million by volume vinyl chloride (2,560 $\mu g/m^3$) was achieved when the contact time through the HS-600 was approximately 4.7 seconds. To achieve 90 percent destruction efficiency, the manufacturer estimated a minimum contact time of 20 seconds; however, no data were available to substantiate this estimate.

In the configuration used during the interim operation of UVB-1, the contact time through the HS-600 was only 1.7 seconds. To increase the contact time higher than 4.7 seconds for the full-scale system and using a standard-size carbon unit with a cross-sectional area of 48 square feet, the minimum bed thickness of the HS-600 would be 4.9 feet. This is equivalent to approximately 14,100 pounds of HS-600. To further increase the contact time to 20 seconds, two or three much larger vessels would be required. For example, approximately 60,000 pounds of HS-600 spread across three vessels with a cross-sectional area of 48 feet or two vessels with a cross-sectional area of 80 feet, would create bed depths of 20.8 and 12.5 feet, respectively. The added back pressure caused by these large vessels would require larger, higher horsepower blowers or adding booster blowers, significantly increasing power consumption. In addition, tens of thousands of pounds of HS-600 would require disposal in a landfill or an incinerator. Therefore, ESC Engineering does not believe treatment of the low vinyl chloride emissions using HS-600 will provide a net benefit to the environment, and petitions the NYSDEC to consider the no control option for the full-scale UVB system. ESC Engineering will incorporate carbon to remove other VOCs from the vapor effluent as described in Section 3.5.

3.3 Site Preparation and Equipment Building

The existing electrical service panel will be relocated inside the equipment building. Underground electrical conduits will be installed from each of the UVB wells back to the service panel. ESC Engineering met with engineers from Neptune RTS™ to coordinate the location of the underground electrical conduit so that the conduits will not be damaged during installation of the converter station and that they may be accessible in the future if needed.

The area will first be cleared and grubbed as necessary for trenching of the electrical conduits and installation of the UVB wells. Care will be taken to minimize the number of large trees to be removed and silt fencing may be installed as necessary to prevent erosion during construction.

Pavement on the Ackerman property was saw cut for the trench and mixing pit. While excavating the pit, the site was deemed not suitable for a subsurface pit and aboveground tanks are being used for the drilling fluid. A portion of the fence between the Ackerman property and the recharge basin may be temporarily removed during construction activities but will be replaced at the completion of the site work activities.

For Option A, temporary access was cleared through the trees on the western portion of the NYS Park Service property. A new locking gate will be installed in the fence to allow long-term access to well UVB-2. If the converter station is built, well UVB-2 will be accessed using the proposed perimeter access road to be constructed by Neptune RTS™.

The treatment equipment will be installed in a wood-framed building constructed on the eastern edge of the NYS Park Service property. The ground surface within the footprint of the building will be graded to provide a level surface and a concrete slab foundation will be installed. The building will be 12 feet wide by 60 feet long oriented in a north-south direction as shown on Sheets 3 and 4. The walls of the building will be 10 feet high, with a final roof height of 12 feet at the center of the peak. Overhead doors will be installed on either end of the building to move equipment in and out of the building as necessary, and 8 hatches will be installed in the roof of the building to facilitate carbon change-outs.

3.4 UVB Well Construction

Construction of the additional UVB wells will be similar in design to UVB-1. Each well will be installed to 380 feet bgs in two phases using a trailer-mounted Failing Jet A rotary drill rig. The initial phase will use mud rotary techniques to install a 20-inch ID welded steel surface casing to approximately 70 feet bgs. This surface casing will be used to maintain hydrostatic pressure in the borehole above the water table during the second phase of drilling. After the surface casing is installed below the water table and grouted in place, the drill rig will be converted to reverse rotary for the remainder of the borehole. Because the lithology of the surrounding area has been sufficiently documented, no additional soil sampling is planned during well construction.

After the well casing is installed, the area around the well casing will be excavated to approximately 8 feet bgs to allow for installation of the below-grade well vault. The outer steel well casing and the steel well riser will also be cut to approximately 8 feet bgs, and the well vault, a section of 48-inch-diameter double-walled high density polyethylene (HDPE) pipe, will be fitted over the well casing. Before installation, the bottom of the well vault will be sealed with an HDPE plate and an HDPE riser slightly larger than the outside diameter of the well casing will be installed in the center of the plate. This riser will fit over the steel well casing when the vault was installed, and the annulus between the well casing and the HDPE riser will filled with an expandable latex-based sealant or grout to provide an impermeable seal between the well vault and the well casing.

Each UVB well will be constructed of 10-inch ID Schedule 40, butt welded, low-carbon steel riser equipped with three sections of 10-inch ID continuous-wrap 304 stainless steel screen. The screened intervals of wells UVB-2 and UVB-3 will be from 210 to 240 feet bgs, 285 to 315 feet bgs, and 360 to 380 feet bgs, similar to the existing UVB well. To minimize potential impacts from thin clay lenses observed at approximately 230 feet bgs in the soil borings for W-27-240 and W-35-380 installed during the pilot test, the upper screened interval will be a 30-foot section that straddles the clay lenses. The 20-foot lower screened interval will be from 360 to 380 feet bgs to avoid similar thin clay lenses observed at 321 and 341 feet bgs. The middle screened interval will be installed at 285 to 315 feet bgs for even placement between the upper and lower screened intervals.

The sand filter pack and screen size openings will be the same as used for UVB-1. The sand filter pack and screen size openings for each screen of the existing UVB well were determined by performing a grain size analysis of soil collected from the proposed screen intervals of the soil boring for monitoring well W-35-380. Assuming a maximum design extraction rate of 80 gpm to account for the maximum rated capacity of the air stripper and possible reductions in efficiency of the well over time, the slot size selected is 0.040 inches for the portion of the screen where sand is present. For portions of the screen where silt or clay material is present, the maximum design flow rate decreased to 20 gpm and the corresponding slot size is reduced to 0.010 or 0.020 inches.

Two packers will be installed inside each UVB well to isolate the upper, middle, and lower screened intervals. The packers will be equipped with custom cores to allow for installation of the effluent and influent piping, pump cables, inflation line, and transducer cables similar to the existing system as shown on Sheet 5. The packers will be set below the upper and middle screened intervals.

Vibrating-wire pressure transducers will also be installed in each screened interval to measure fluctuations in total head when the system is in operation. The pressure transducers will be non-venting and will have the ability to be connected to a datalogger.

Soil cuttings from the UVB wells will be placed in lined roll-off boxes temporarily staged onsite and will be disposed offsite in accordance with all federal, state, and local regulations. Each UVB well will be developed after a minimum of 24 hours using an air lift line and a custom-built surge block. With the approval of the DPW, water generated during this process will be contained in 20,000-gallon storage tanks, treated using activated carbon, and recharged to the ground surface following the protocol used during the pilot test.

3.5 UVB System Equipment

The equipment selected for the additional UVB wells will be similar in design to the existing system. However, some modifications will be made based on the results of the groundwater sampling, information gained during the pilot test, and interim operation of the system. The following modifications from UVB-1 will be incorporated into the full-scale system:

- use of a larger blowers to increase the air flow rate and stripping efficiency while minimizing back pressure limitations on off-gas treatment
- installation of two stripping trays in each UVB well to increase the water retention time and overall VOC removal efficiency
- provisions for incorporating the use of a biocide and/or iron sequestering agent to control biological growth and oxidation

Each UVB well system will include a well vault with a locking lid, a below grade air stripper with dual trays, a submersible extraction pump, a sump pump, a blower, and electrical controls. Vapors from the three wells will be combined for treatment through activated carbon. A biocide and/or an iron sequestering agent delivery system will be installed in the equipment building to transfer the liquid to each UVB well if needed. Preliminary cut sheets for some of the equipment can be found in Appendix B. Cut sheets for installed equipment will be provided in the completion report.

The existing treatment building was constructed as a temporary unit for the pilot test and will be replaced with a larger structure to house the blowers, the vapor treatment units, the biocide/iron sequestering agent drums and metering pumps, and the electrical controls for the full-scale system. ESC Engineering evaluated options for temporary structures (e.g., trailer, sea container, shed, etc.) for the full-scale design based on building permit requirements, adequate space for the necessary equipment, ease of construction, and cost. A simple pre-fabricated wood-frame structure (described in Section 3.3) was selected to house the equipment. This new structure will be placed to the north of the existing equipment building adjacent to the Ackerman property fence as shown on Sheets 3 and 4.

3.5.1 Groundwater Extraction Pumps and Packers

Based on observed well yields from other UVB wells on Long Island and average groundwater velocity calculations provided by Stearns & Wheler, a design flow rate of 60 gpm was estimated to provide a minimum of two passes through the circulation cell before ultimate discharge downgradient of the circulation cell. Therefore, a 4-inch diameter, 3 horsepower (hp) submersible pump (Grundfos model 60S30-5) was selected for UVB-1. The pump was equipped with a TECO-Westinghouse Fluxmaster 100 variable frequency drive (VFD) to allow adjustment of the extraction rate to match the recharge rate of the well.

However, extraction and recharge tests conducted during the pilot test indicated that the formation may be able to accommodate higher flow rates. With the addition of a second stripping tray and larger blowers, it may be possible to achieve the desired 90 percent VOC removal efficiency at a higher flow rate. The maximum extraction rate of well UVB-1 is limited by the size of the downwell pump. Therefore, ESC Engineering has selected a slightly larger 4-inch diameter pump for wells UVB-2 and UVB-3 (Grundfos model 75S30-5 or approved substitute). While the initial extraction rate of the wells will be 60 gpm, ESC Engineering will evaluate the effects of increasing the extraction rate of each well as the influent VOC concentration decreases.

After each well vault is set in place, a drilling rig will be set up over the well. The vibrating-wire transducers, inflatable packers, and the submersible pump will be slowly lowered into the well casing, while 20-foot sections of 20-inch-diameter HDPE pipe will be threaded together to form the extraction and discharge piping. An Ebara 50DW61.5 pump with a 2-hp motor or similar sump pump capable of pumping up to 40 gpm at 50 feet of head and equipped with a VFD will then be placed in the bottom of the well vault to pump water to the lower screened interval of the UVB well. A schematic of the piping, packers, and pumps can be found on Sheet 5.

3.5.2 Air Strippers and Blowers

Each UVB well will be equipped with a below-grade air stripper and a dedicated blower. All three blowers will be located in the equipment building on the NYS Park Service property near UVB-1.

The air strippers are manufactured in Germany, are specific to this technology, and are available in two sizes (30 or 80 gpm). The larger air stripper will be used based on the flow rates observed during the pilot test. To maximize the VOC removal efficiency, dual-tray air strippers will be installed in the well vaults. Each removable tray will contain baffles and sit above the bottom of the vault as shown on Sheet 5.

Sampling completed during the pilot test and interim operation of the UVB system indicated a maximum total VOC removal efficiency of 89 percent. While some compounds were removed at greater than 98 percent efficiency, the concentrations of cis-1,2-DCE and 1,2-DCB were only reduced by 87 and 74 percent (due to low Henry's constants), respectively, even with the addition of a second stripping tray. The existing blower for UVB-1 generates approximately 650 scfm. To maximize the overall stripping efficiency, ESC Engineering will replace the existing blower with a larger unit capable of producing 1,000 scfm of air at a higher system pressure and vacuum. Calculations were performed to determine the minimum vacuum requirements of the blower based on data collected during the pilot test and estimated back pressure from the vapor treatment units. A summary of the calculations can be found in Appendix C.

Because the layout of the equipment varies with each UVB well, ESC Engineering evaluated the necessary vacuum for each well. Pressure losses due to friction along the piping from the wellheads to the proposed blower locations, as well as back pressure due to the vapor treatment units, were calculated for each UVB well as shown in Appendix C. The following conditions were assumed:

- All vapor transfer piping for wells UVB-1 and UVB-3 will be 8 inches in diameter.
- Vapor transfer piping for well UVB-2 will be 10 inches in diameter for Option A.
- Vapor flow from all three UVB wells will be combined after the blowers before it enters the vapor treatment units.
- The exhaust stack will be 10-inch diameter and will be 10 feet taller than the minimum height of the equipment building.
- Vapor transfer pipe will be Schedule 40 PVC. PVC duct will be used for the exhaust stack and to connect the carbon vessels to the blowers.

Based on the calculations, the required vacuum at the blower inlet ranges from 20.1 to 24.7 water column inches (wci), and the required pressure at the blower outlet is approximately 15.5 wci. A centrifugal blower capable of producing a minimum of 1,000 cfm of air at 25 wci vacuum and 16 wci pressure will be specified for each new UVB well. The existing 5-hp blower used for UVB-1 will also be replaced with a similar unit. Blower curves typical for the specified type of unit are included in Appendix B.

3.5.3 Iron Sequestration and Biological Growth Inhibitors

Results of sampling completed during the pilot test indicate that the presence of iron and bacteria may cause iron scaling or biofouling during operation of the full-scale system. More recent results for samples collected in May 2004 indicated that slight iron oxidation is occurring, while iron bacteria are present in low concentrations and are relatively non-aggressive. Based on these results, long-term iron scaling problems may be controlled through the use of an iron sequestering agent. While biofouling has not been evident during interim operation of the UVB well, the potential exists for this to be encountered during long-term operation as biofouling is a common problem in groundwater supply wells in Nassau County. Therefore, treatment to prevent these problems is included in the full-scale design.

ESC Engineering will work with suppliers of products available to reduce iron scaling and biofouling to determine the best products for this application that will be approved by the NYSDEC and the New York State Department of Health. Initially, ESC Engineering will incorporate the use of an iron sequestering agent only to prevent long-term iron scaling. Additional testing may be performed over time on all three UVB wells to determine the need for a biocide to reduce iron bacteria fouling.

The approved iron sequestering agent will be automatically metered into each UVB well in accordance with the manufacturer's recommendations based on flow rates and analytical data. The application rate may be adjusted during long-term operation of the UVB wells based on the rate of scaling encountered. Transfer piping for the biocide/iron sequestering agent will be 0.75-inch HDPE water service tubing.

3.5.4 Vapor Treatment Equipment

Based on the maximum observed total VOC concentration detected in the monitoring wells installed during the Phase V RI, the anticipated VOC mass loading onto the air stripper for the pilot test was approximately 0.114 lbs/hr or 2.7 pounds per day (lbs/day; ESC Engineering 2003a). During the pilot test and interim operation of the UVB well, VOC mass loading rates onto the air stripper from well UVB-1 were less than anticipated, ranging from 0.046 to 0.083 lbs/hr (1.1 to 2.0 lbs/day). During the pilot test and interim operation of the system, the carbon required replacement after approximately 600 hours of operation. As previously described, while the HS-600 media may have been effective at removing some of the vinyl chloride from the system exhaust, it was not effective at long-term reduction of vinyl chloride concentrations and the results of modeling indicate the ambient air quality impacts due to vinyl chloride emissions are confined to the subject site. Therefore, HS-600 will not be used in the full-scale system.

Vapors from all three UVB wells will be combined for treatment through four activated carbon units plumbed with two units in series parallel to two more units in series. Because the chemistry of the groundwater near wells UVB-2 and UVB-3 may be slightly different than that of UVB-1, ESC Engineering reviewed historical data from monitoring wells W-28-262, W-26-270, and W-30-285 to estimate the VOC mass loading rate onto the carbon from each of the new UVB wells. In addition, data collected from the pilot test and interim operation of UVB-1 were used to estimate the VOC mass loading from UVB-1. It was assumed that two stripping trays will be used in each UVB well and that the additional of a larger blower will increase the maximum VOC stripping efficiency to 90 percent.

Based on the interim operational data, it is estimated that a maximum of approximately 2.0 lbs/day would be loaded onto the carbon from UVB-1 (refer to Table TC-6 in Appendix C for calculations). Based on historical groundwater profiling and sampling data, the anticipated VOC mass loading rates from UVB-2 and UVB-3 are 0.90 and 2.2 lbs/day, respectively. To maximize the time between carbon change-outs while minimizing back pressure across the carbon units, two

5,000-pound carbon units will be installed in parallel to treat vapors from the UVB wells. One additional 5,000-pound carbon unit will be installed in series with each primary unit as a polishing step and to prevent VOC emissions while scheduling carbon change-outs. In this configuration, the anticipated time between carbon change-outs is 98 days.

Each vapor treatment unit will be equipped with sampling ports on the inlet and outlet piping. To reduce line losses and back pressure on the blowers from the carbon units, the vapor treatment units will be connected using 10-inch diameter flexible hose as shown on Sheet 5. When monitoring data indicate the primary unit is saturated, a carbon change-out will be scheduled within 2 weeks. The secondary units will contain 5,000 pounds of carbon, which will be sufficient to treat the vapors during this short period. After the carbon in the primary unit has been replaced, the flexible hose will be configured such that the secondary unit is rotated into the primary position.

After the air passes through the carbon units, treated vapors will be combined and discharged through a 10-inch diameter PVC exhaust stack installed after the outlets of the secondary vapor treatment units. The exhaust stack will be a minimum of 10 feet high above the roof of the building, will be secured to the building roof, and will be equipped with a rain cap.

3.5.5 Transfer Piping and Electrical Conduits

All trenches for the electrical conduits and subsurface piping will be excavated to a minimum depth such that the top of the piping is a minimum of 3 feet bgs to account for vehicular traffic and freezing conditions. The electrical conduits and piping will be installed and the trenches will be backfilled with soil free of rocks and debris to prevent damage to the piping. Junction boxes will be installed in the electrical conduits approximately every 500 feet or at changes in direction of the conduits so that the electrical wires may be accessed in the future if necessary and to prevent damage to the electrical wires during installation. Condensate collection points will be installed at the point of lowest elevation of the vapor transfer piping as shown on Sheet 5. Provisions will be included in the operations and maintenance (O&M) plan to periodically inspect these points and remove any water from the collection piping. In addition, metallic warning tape will be placed in all trenches above buried piping to prevent damage to the pipe during future work at the site.

All HDPE piping will be butt-welded in accordance with the procedures in Appendix D, while all PVC piping will be solvent welded. The vapor transfer piping will be pressure tested by isolating sections of newly installed pipe and pressurizing the pipe to 50 pounds per square inch (psi). If the pipe loses more than 1 psi of pressure over 1 hour, the leak will be identified and repaired and the pipe will be retested. This will be repeated until the welds pass this pressure test.

3.6 System Telemetry

Existing well UVB-1 is equipped with an electrical control panel with logic that shuts down the system in the event of an alarm condition. This system cannot be monitored remotely and is not equipped with a datalogger. The full-scale system will be equipped with a central programmable logic controller (PLC) connected to a computer and a phone line and modem will be installed so that data can be monitored and collected remotely. In addition, the PLC will be programmed such that ESC Engineering and their O&M subcontractor will be notified if the system shuts down for any reason.

The full-scale system telemetry will incorporate the following alarm conditions for each well that will shut down the entire system:

- low water in the UVB well vault sump
- high water in the UVB well vault sump
- low vacuum on the inlet side of the blower
- high vacuum on the inlet side of the blower
- power failure

The system will be programmed such that an alarm condition will shut down the entire system. A process and instrumentation diagram depicting the logic and controls associated with the full-scale system is included on Sheet 7. In the event the system program requires modifications, ESC Engineering will work with the PLC supplier or a subcontractor to edit the program. The program can then be reloaded onto the system using a direct connection with a laptop or through a remote connection.

The system will be wired such that the following information can be remotely monitored and downloaded if desired:

- equipment in operation
- extraction rate for each well
- recharge rate for each well
- total volume extracted for each well
- total volume recharged for each well

- alarm conditions activated, if applicable, for each well
- time of shutdown, if applicable, for each well
- pressure in each screened interval of the UVB well
- inlet vacuum for each blower
- air velocity on the discharge side of each blower

In addition, ESC Engineering will work with the equipment supplier and electrician to ensure the proper wiring is installed between all switches and transmitters and the PLC. Due to the long distances between wells UVB-2 and UVB-3 and the PLC, the electrical signals from the flow transmitters may become distorted, thereby providing inaccurate flow measurements. Special cables or signal boosters will be installed as necessary to prevent this distortion.

4.0 System Startup and Optimization

System startup activities will include collection of baseline groundwater samples, adjustment of extraction and recharge rates to achieve optimal flow rates, and collection of water and vapor samples. Planned startup activities and the schedule for sampling are described in more detail in the following sections.

4.1 Baseline Groundwater Sampling

Groundwater samples will be collected from nearby monitoring wells, and the middle screens (extraction zone) and lower recharge screens of wells UVB-2 and UVB-3l before full startup begins. Baseline water level measurements will be collected from wells UVB-2 and UVB-3 before the pumps are installed, as well as from monitoring wells W-35-240, W-35-315, W-35-380, W-27-240, W-27-285, W-30-285, and W-26-270. This work will be completed as part of the proposed sampling program outlined in the Interim Groundwater Monitoring Plan (IGMP) to be submitted to the NYSDEC in May 2004.

Samples collected from the monitoring and UVB wells will be analyzed for VOCs including dichlorobenzenes by EPA Method 8260. The samples collected from the new UVB wells will also be analyzed for total iron by EPA Method 6010, dissolved iron by EPA Method 6010, total hardness by EPA Method 130.1, alkalinity by EPA Method 310.1, pH by EPA Method 9040, total bacteria count, and presence of iron bacteria. Consistent with previous sampling events, the samples will be sent to STL-Connecticut in Shelton, Connecticut, and STL-Newburgh in Newburgh, New York for analysis within a standard turnaround time of two weeks.

4.2 Determination of Optimum Injection and Extraction Rates

Similar to the pilot test, startup activities will include pumping tests on wells UVB-2 and UVB-3 to optimize the extraction and recharge rates into the aquifer.

The packers will be set at the desired depths above the lower and middle screened intervals and fully inflated. The recharge piping to the lower screened interval will be valved closed. The down-well submersible pump will be turned on while the blower is still off, and the extraction rate will be monitored using a flow meter installed on the extraction piping inside the well vault. Responses in the pressure transducers installed in each screened interval will also be monitored using non-vented vibrating wire transducers manufactured by Geokon of Lebanon, New Hampshire, or an approved substitute. Water generated during this test will be pumped to the temporary storage tanks for later treatment and discharge to the ground surface as described in Section 3.4.

After it has been confirmed that wells UVB-2 and UVB-3 will yield a minimum of 60 gpm, the pumping tests will continue with recharge into the upper screened interval only. The blower will be turned on and treated water will be recharged into the subsurface passively through the top of the well casing. Pressure in each screened interval of the well will be monitored. When the down-well pump is first turned on, the pressure in the extraction interval will decrease while the pressure in the upper interval will increase. Once the circulation cell has developed, these pressures will stabilize indicating that the extraction rate is equal to the recharge rate. The extraction rate will then be increased and the pressures will again be allowed to stabilize. During the pilot test, this initial time to reach equilibrium was on the order of minutes. This process will continue by adjusting the extraction rate of the pump until either the maximum extraction rate of the pump or the maximum recharge rate of the aquifer if reached. Based on the pilot test results, ESC Engineering expects the extraction rate of the pump, which is restricted by the capacity of the air stripper, to be the limiting parameter.

The valve on the discharge piping to the lower screened interval will then be opened for recharge into the lower screen. A submersible sump pump located in the bottom of the well vault will pump all extracted water from the vault to the lower screened interval. The recharge test will proceed in a similar manner as the recharge test on the upper screened interval.

After the maximum achievable flow rates into the upper and lower screened intervals are determined, the system will be turned on with recharge into both intervals. The system will be balanced by adjusting the extraction rate while maintaining similar recharge rates into the upper and lower screened intervals. Once each new well has been balanced and the maximum extraction and recharge rates have been determined, the full-scale system will be started with all three wells in operation.

4.3 VOC Removal Efficiency

After the optimum extraction and recharge rates for each well have been determined, one set of influent and effluent water samples will be collected from each air stripper after a minimum of 24 hours of operation. The samples will be analyzed for VOCs including dichlorobenzenes using EPA Method 8260 by STL-Connecticut within a standard turnaround time of 2 weeks. The results will be used to calculate the VOC removal efficiency for each well.

As described in Section 3.5.4, activated carbon will be used to remove VOCs from the air stripper exhaust. Vapor samples collected during the pilot test and interim operation of well UVB-1 were used to estimate carbon consumption rates and verify VOC emission rates from the vapor treatment units. The results of the vapor sampling indicated that the carbon has been effectively removing the majority of the VOCs in the vapor stream. Therefore, carbon will be used to remove VOCs from the vapor effluent.

After all three UVB wells have been balanced and started and the system has been in operation for a minimum of 24 hours, one set of vapor samples will be collected for laboratory analysis using evacuated Summa canisters to verify effective treatment. Samples will be collected from the combined carbon influent and midstream between each set of carbon vessels. The Summa canisters will be equipped with regulators set to a flow rate of 100 milliliters per minute and the samples will be collected over a minimum of 35 minutes. The samples will be analyzed for VOCs by Method TO-15 by STL-Knoxville of Knoxville, Tennessee, within a standard 2-week turnaround timeframe.

5.0 System Operation and Maintenance

Operation and maintenance of the full-scale UVB system is critical to the success of this groundwater IRM. A detailed O&M plan for the site will be developed after this proposed design is approved, LIPA has awarded the electrical service contract, and the equipment vendors and installation subcontractors have been selected. This O&M plan will include, at a minimum, manufacturer's cut sheets, a schedule for recommended routine maintenance activities, a system operation checklist, and an electrical control wiring diagram. The O&M plan will be submitted as a draft document to the NYSDEC at least two weeks before system startup. Based on the NYSDEC's comments, the plan will be finalized and submitted in conjunction with the completion report.

5.1 Routine Operation and Maintenance

ESC Engineering will contract with an O&M firm to conduct biweekly routine site visits of the UVB system. During the site visits, subcontractor personnel will inspect the equipment and perform routine maintenance as necessary. In addition, subcontractor personnel will complete a checklist and collect system performance data. The data collected will include but are not limited to injection and extraction flow rates at each well, cumulative gallons of water treated, air flow rates, vault vacuum, blower vacuum, and carbon inlet, midstream, and outlet pressure and VOC concentrations using a photoionization detector (PID). Over time, the frequency of the site visits may be reduced.

5.2 Performance Monitoring

ESC Engineering will monitor the performance of the full-scale system through biweekly collection of data and periodic system sampling. In addition, ESC Engineering may elect to collect performance monitoring data on a weekly basis through remote monitoring of the system. Groundwater influent and treated effluent samples will be collected from each UVB well monthly for the first three months of operation, bimonthly for the first year of operation, and quarterly thereafter. The water samples will be analyzed for VOCs, including dichlorobenzenes, using EPA Method 8260B. In addition, field vapor samples will be collected of the carbon influent, carbon midstream, and media effluent biweekly using clean Tedlar bags and a PID.

During the first three months of operation, bimonthly for the remainder of the first year of operation, and quarterly thereafter, a vapor sample will be collected for laboratory analysis from the carbon effluent. The vapor samples will be analyzed for VOCs, including dichlorobenzenes, using method TO-15.

As will be outlined in the Interim Groundwater Monitoring Plan for the site, groundwater samples will be collected on a semi-annual basis from monitoring wells W-30-285, W-26-270, W-27-240, W27-285, W-35-240, W-35-315, and W-35-380 to monitor the performance of the IRM system in the immediate vicinity of the UVB wells. No additional groundwater monitoring wells will be installed at this time. While downgradient monitoring data will be useful for monitoring the effectiveness of the groundwater circulation well technology, the timeframe for the circulation cells to fully develop is on the order of years. Therefore, downgradient monitoring wells installed and sampled in the near future will not provide practical data to evaluate the effects of the IRM system on downgradient groundwater concentrations. Additional groundwater monitoring wells will be incorporated into a long-term groundwater monitoring program for the site when the RI/FS process is complete.

6.0 Schedule and Reporting

A revised schedule for implementation of the full-scale system is presented in Figure 5. At the request of the NYSDEC, ESC Engineering moved forward with the drilling schedule and began installation of UVB-2 on April 19, 2004. Upon the NYSDEC's approval of the design report, execution of site access agreements, and final determination of whether the proposed converter station will be built on the NYS Park Service property, ESC Engineering will finalize contracts with equipment vendors and construction subcontractors. Equipment orders will be placed in early May and full-scale construction will begin in June 2004. Startup is anticipated in July 2004.

ESC Engineering will prepare brief performance monitoring reports monthly for the first three months of operation and bimonthly thereafter. After one year of operation, this frequency will be reduced to quarterly. The reports will include a log of system operation, system performance and analytical data collected during the reporting period, a summary of waste generated, and an estimate of the total mass of VOCs removed from the groundwater during operation. In addition, any problems encountered during the reporting period and modifications to the operation of the system will be noted. With the approval of the NYSDEC, semi-annually groundwater monitoring reports will be prepared in accordance with the site-wide Interim Groundwater Sampling Plan to be submitted to the NYSDEC in May 2004.

7.0 References

ESC Engineering of New York, P.C. 2004. Letter from James A. Sobieraj, P.E., and Christine D. Albertin to Mr. Kevin Carpenter of the NYSDEC regarding Operable Unit 2 Groundwater IRM Bimonthly Progress Report, Former General Instrument Corporation Site, Hicksville, New York. February 11.

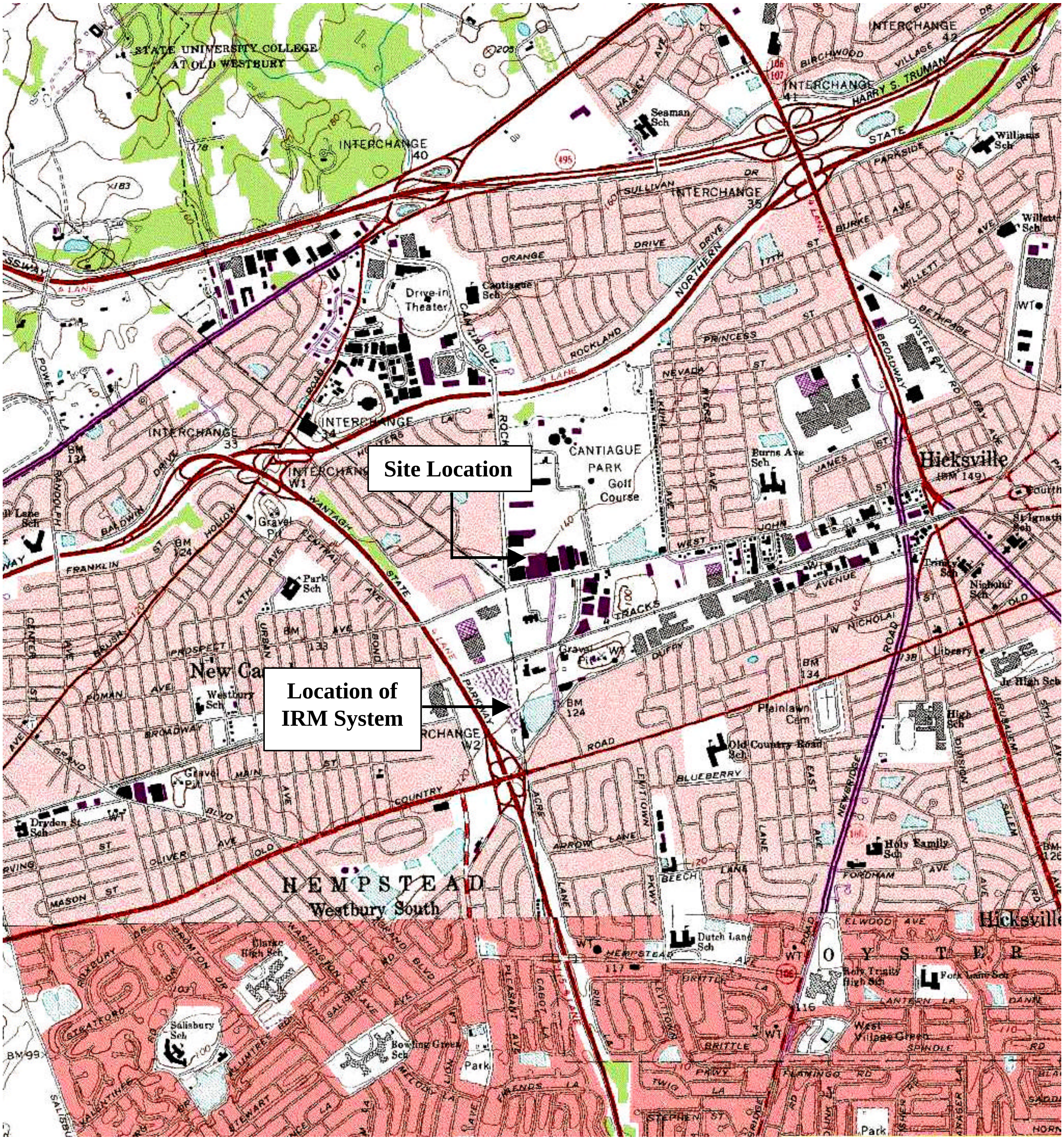
ESC Engineering of New York, P.C. 2003a. Groundwater Interim Remedial Measure, Operable Unit No. 2, Pilot Test Summary and Conceptual Full-Scale Design Report, Groundwater Circulation Well Technology, Former General Instrument Corporation Site, Hicksville, New York. September 19.

ESC Engineering of New York, P.C. and Stearns & Wheler, LLC. 2003b. Offsite Groundwater Investigation, Phase V, Summer 2002. Vishay General Semiconductor, Inc., Hicksville, New York. Revision No. 1, February 7.

Herrling, B., J. Stamm, E.J. Alesi, and P. Brinnel. 1992. Vacuum Vaporizer Wells (UVB) for In Situ Remediation of Volatile and Strippable Contaminants in the Unsaturated and Saturated Zone. Proceedings of the Symposium on Soil Venting, April 29 – May 1, 1991, Houston, Texas.

NYSDEC. 1991. DAR-1 Guidelines for the Control of Toxic Ambient Air Contaminants.

Plastics Pipe Institute. 1998. Polyethylene Joining Procedures. Published by The Society of the Plastics Industry, Inc.



Reference
7.5 Minute Series Topographic Quadrangle
Hicksville, New York
Photorevised 1979 Scale 1:25,000 Metric

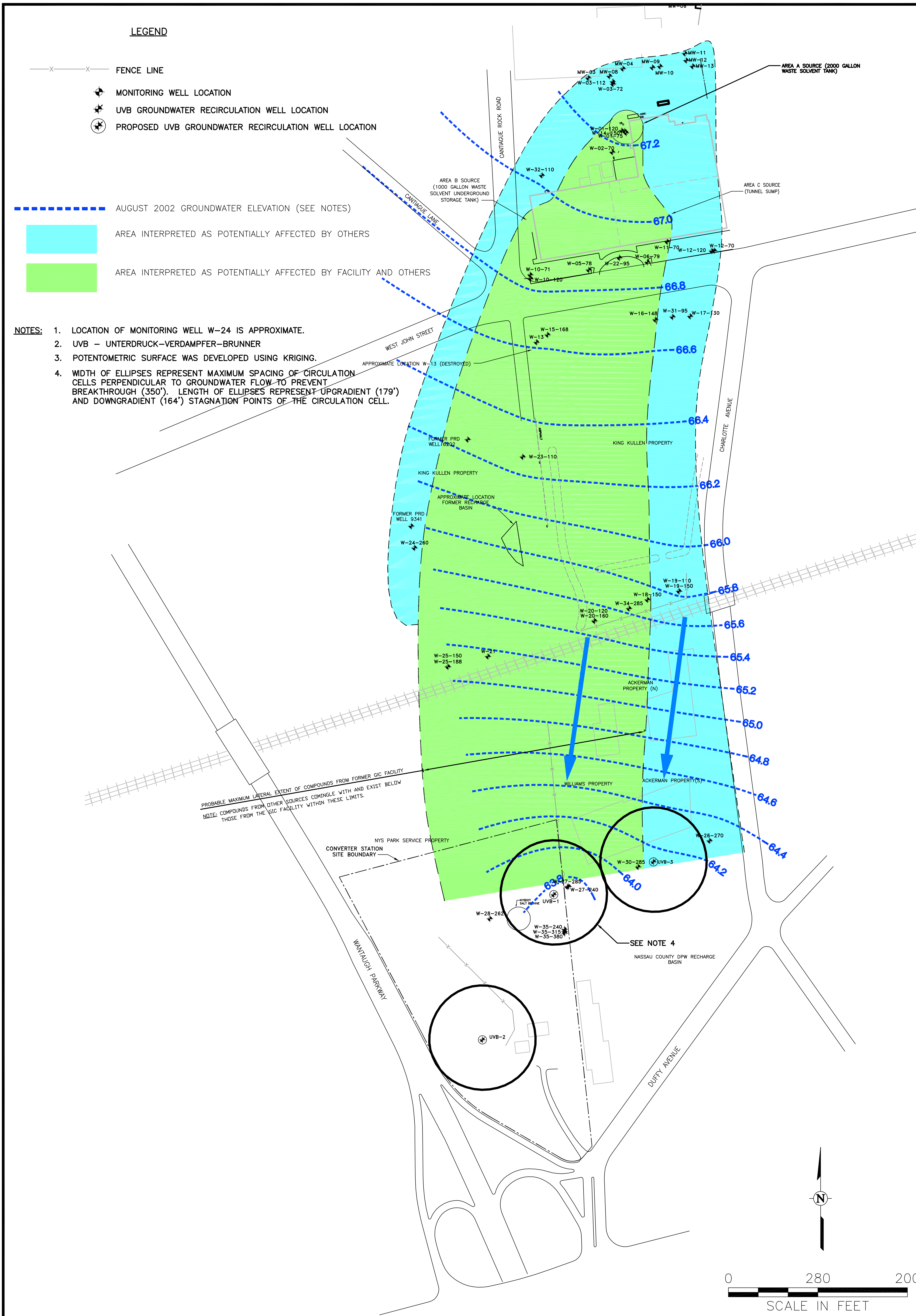
N

Quadrangle Location

Scale in Meters
0 500 1000
0 1000 2000
Scale in Feet

ESC ENGINEERING OF NEW YORK, P.C.
9 ALBANY STREET
CAZENOVIA, NEW YORK 13035
315-655-3900

Figure 1
Site Location
Former General Instrument Corporation Site
Hicksville, New York



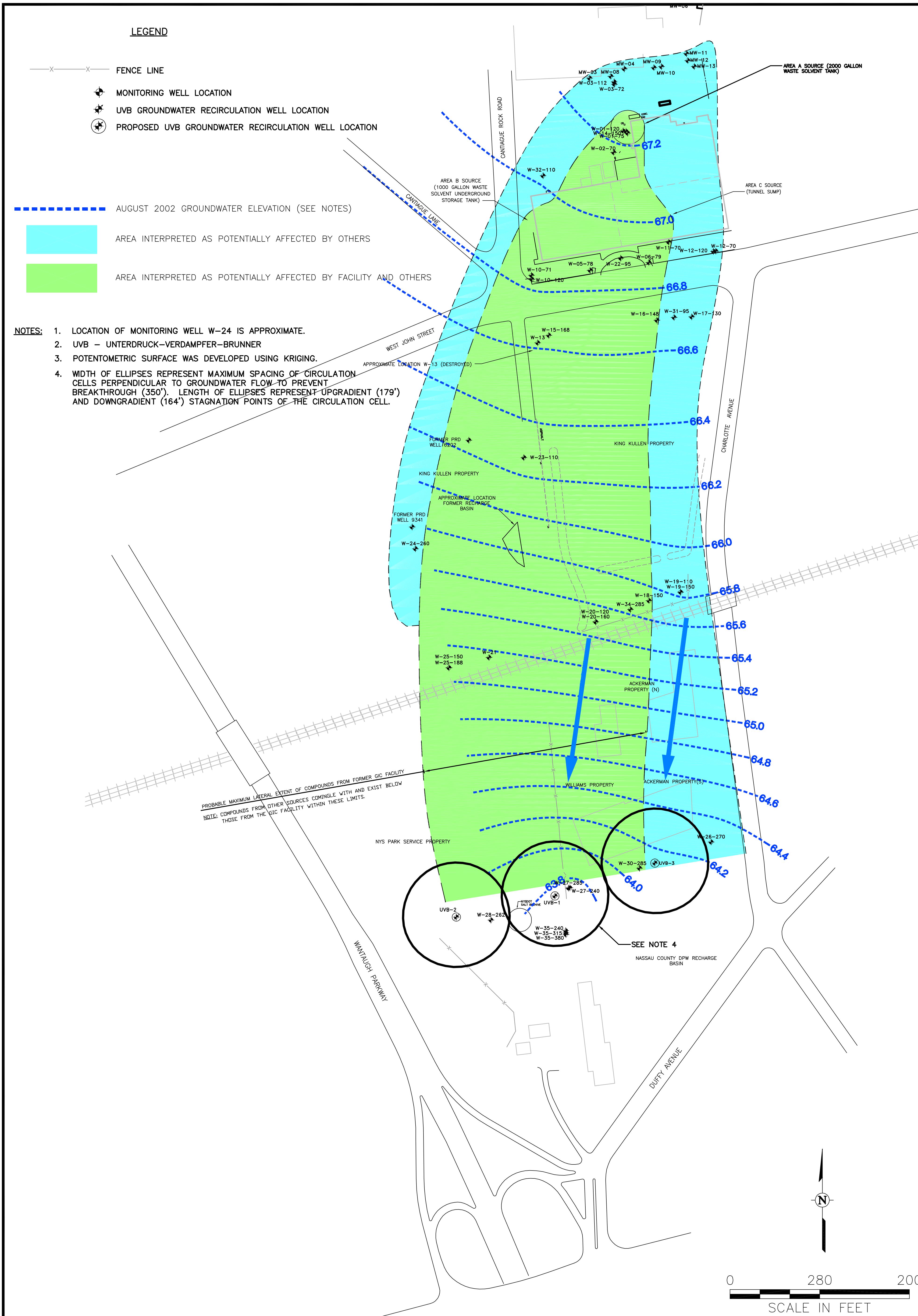
ESC ENGINEERING OF NEW YORK, P.C.

Figure 2

EXISTING AND PROPOSED UVB AND MONITORING WELL LOCATIONS OPERABLE UNIT NO. 2 (OPTION A)

FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK
PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

Drawn By: EGC
Checked:
Approved:
DWG Name: 14892756



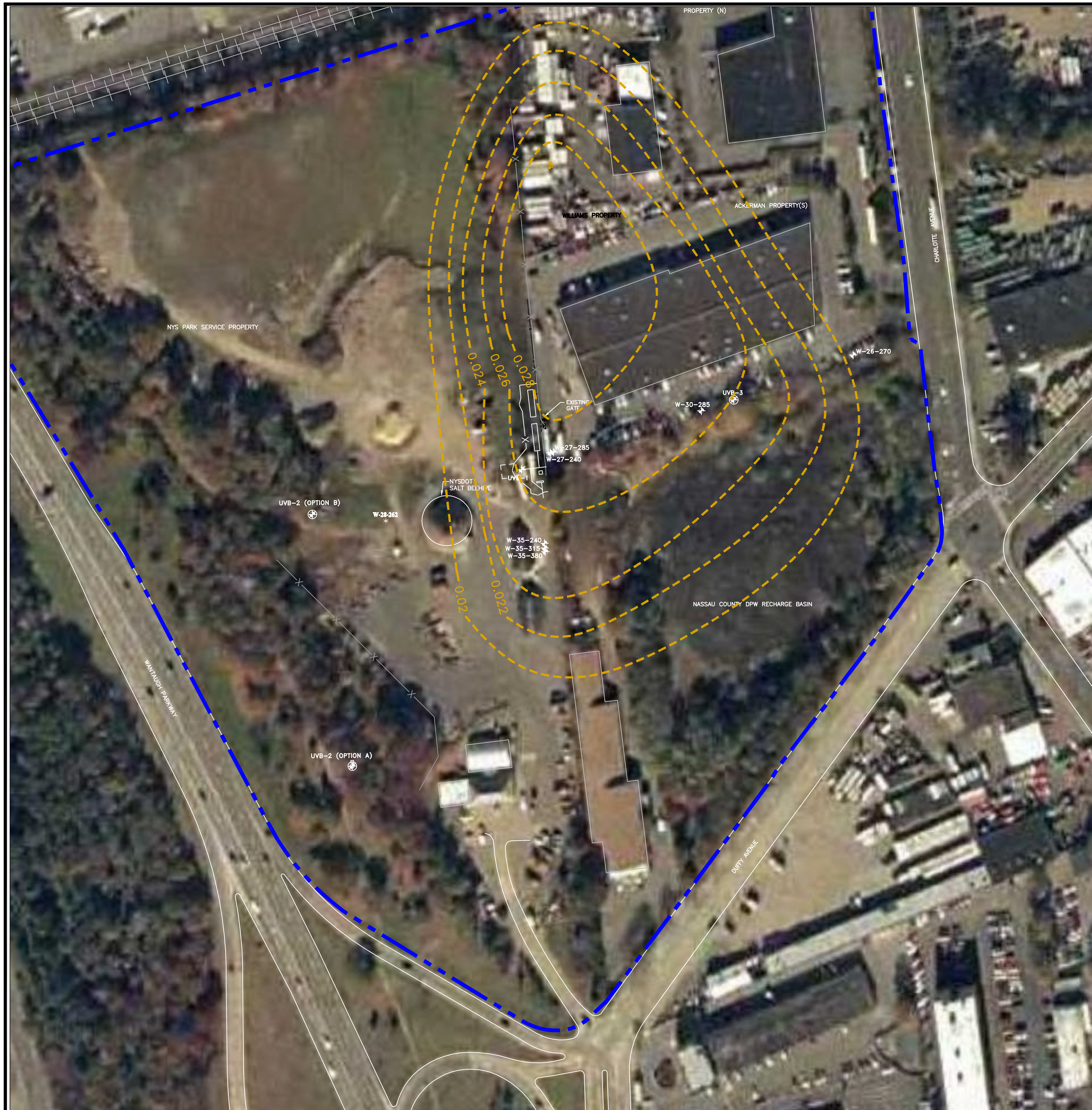
ESC ENGINEERING OF NEW YORK, P.C.

Figure 3

EXISTING AND PROPOSED UVB AND MONITORING WELL LOCATIONS OPERABLE UNIT NO. 2 (OPTION B)

FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK
PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

Drawn By:	EGC
Checked:	
Approved:	
DWG Name:	14892757



LEGEND

- PROPERTY LINE
- FENCE LINE
- MONITORING WELL LOCATION
- UVB GROUNDWATER RECIRCULATION WELL LOCATION
- PROPOSED UVB GROUNDWATER RECIRCULATION WELL LOCATION
- MONITORING WELL (TO BE ABANDONED)
- VINYL CHLORIDE ISCONCENTRATION CONTOUR ($\mu G/M^3$)

N

0 160 320

SCALE IN FEET

Drawn By: EGC

Checked:

Approved:

DWG Name: 14892759

FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR

LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

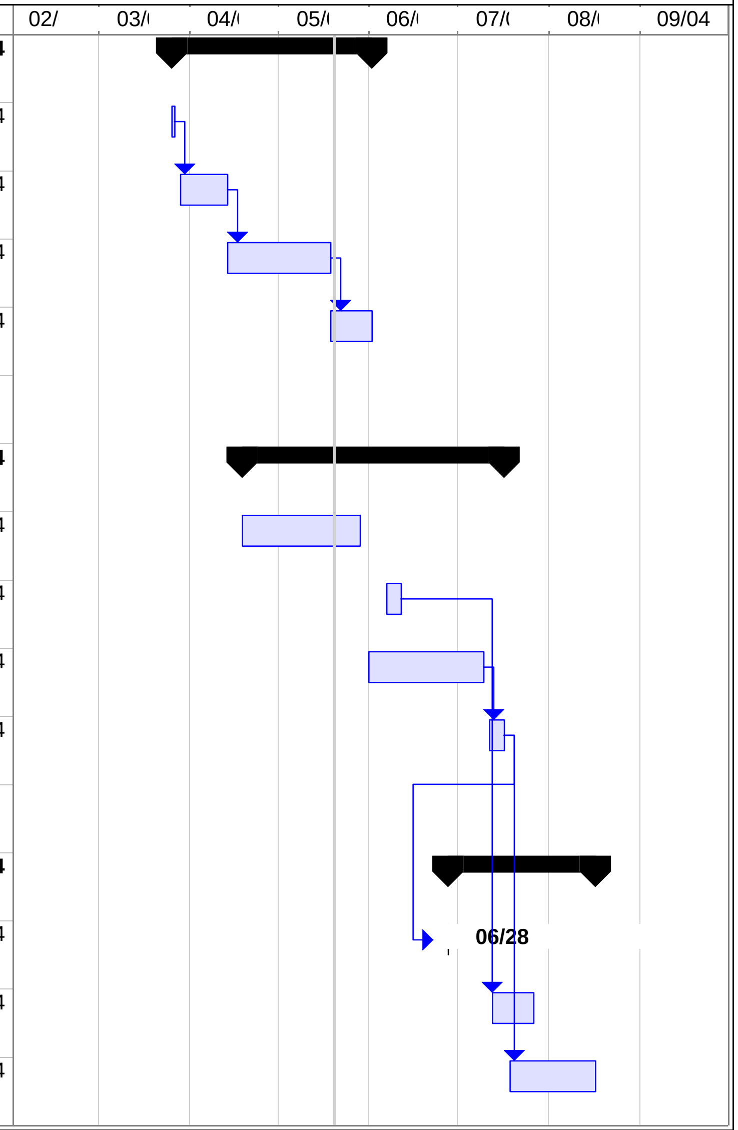
Figure 4

POTENIAL AMBIENT AIR QUALITY IMPACTS DUE TO VINYL CHLORIDE EMISSIONS

ESC ENGINEERING OF NEW YORK, P.C.

Figure 5
Full-Scale IRM Schedule - Former General Instrument Corporation Site
Hicksville, New York

ID	Task Name	Duration	Start	Finish
1	**IRM Full-Scale Design**	**47 days**	**Fri 03/26/04**	**Tue 06/01/04**
2	Submit Full-Scale IRM Detailed Design Report	1 day	Fri 03/26/04	Fri 03/26/04
3	NYSDEC Review and Comment	12 days	Mon 03/29/04	Tue 04/13/04
4	Respond to NYSDEC Comments and Submit Revision	25 days	Wed 04/14/04	Tue 05/18/04
5	NYSDEC Approval of Final Design	9 days	Wed 05/19/04	Tue 06/01/04
6				
7	**IRM Full-Scale Installation**	**63 days**	**Mon 04/19/04**	**Fri 07/16/04**
8	UVB Well Drilling for Full-Scale System	30 days	Mon 04/19/04	Fri 05/28/04
9	Baseline Groundwater Sampling	5 days	Mon 06/07/04	Fri 06/11/04
10	Full-Scale Equipment Installation	28 days	Tue 06/01/04	Fri 07/09/04
11	Full-Scale Startup	5 days	Mon 07/12/04	Fri 07/16/04
12				
13	**Reporting**	**35 days**	**Mon 06/28/04**	**Mon 08/16/04**
14	Draft O&M Plan	0 days	Mon 06/28/04	Mon 06/28/04
15	Semiannual Groundwater Monitoring Report	10 days	Tue 07/13/04	Mon 07/26/04
16	Construction Completion Report and Final O&M Plan	21 days	Mon 07/19/04	Mon 08/16/04



Project: Full-Scale IRM
Date: May 18, 2004

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

q:/$client/lowenstein/hicksville/irm/full-scale/design report/may 18, 2004051804 IRM Schedule.mpp

Table 1

Summary of Historical Groundwater Sampling Results Near IRM System
Former General Instrument Corporation Site
Hicksville, New York

Nearby UVB Well:	UVB-1				UVB-2		UVB-3				
Sample ID:	**UVB-1**	**UVB1-IN**	**Influent**	**UVB1-IN**	**W-28-262**		**W-26-270**		**W-30-285**		**W-30 Dup**
Groundwater or Profile Sample?	**Groundwater**	**Groundwater**	**Groundwater**	**Groundwater**	**Profile**	**Groundwater**	**Profile**	**Groundwater**	**Profile**	**Groundwater**	**Groundwater**
Date Sampled:	**5/15/03**	**8/14/03**	**10/29/03**	**12/17/03**	**Aug-02**	**Aug-02**	**Aug-02**	**Aug-02**	**Aug-02**	**Aug-02**	**Aug-02**
Screened Interval (feet bgs):	**285-315**				**150-260**	**252-262**	**160 to 285**	**260-270**	**210 to 340**	**275-285**	
Volatile Organic Compounds (µg/l)											
Acetone	50 U	160 JB	100 U	100 U	NA	81	NA	ND U	NA	63	ND U
Carbon disulfide	25 U	100 U	50 U	50 U	NA	ND U	NA	ND U	NA	ND U	ND U
Carbon tetrachloride	25 U	100 U	50 U	50 U	NA	ND U	NA	ND U	NA	ND U	ND U
Chloroform	25 U	100 U	50 U	50 U	NA	ND U	NA	ND U	NA	ND U	ND U
1,2-Dichlorobenzene	NA	190	140	200	15 to 21	ND U	10 to 96	ND U	200 to 340	ND U	ND U
1,1-Dichloroethane	25 U	100 U	50 U	50 U	NA	15 J	NA	ND U	NA	ND U	ND U
1,1-Dichloroethene	30	23 J	14 J	24 J	NA	25	NA	ND U	NA	ND U	ND U
cis-1,2-Dichloroethene	890	1,800	1,000	1,900	16 to 890	730	11 to 45	ND U	44 to 730	200	200
trans-1,2-Dichloroethene	16 J	100 U	50 U	50 U	NA	ND U	NA	ND U	NA	ND U	ND U
Methyl ethyl ketone	50 UJ	140 J	100 U	100 U	NA	ND U	NA	ND U	NA	ND U	ND U
Methylene chloride	25 UB	56 JB	9 JB	6 J	NA	4 JB	NA	22 JB	NA	5 JB	3 JB
Tetrachloroethene	260	270	210	350	22 to 69	43	280 to 7,000	3800	46 to 2,600	730	930
1,1,1-Trichloroethane	25 U	100 U	50 U	50 U	NA	43	NA	ND U	NA	ND U	ND U
Trichloroethene	900	400	220	380	20 to 180	160	12 to 410	58 J	130 to 740	120	150
Vinyl chloride	240	210	120	190	150 to 280	150	19	ND U	11 to 430	47	57
Xylenes (total)	25 U	32 J	50 U	50 U	NA	ND U	NA	ND U	NA	ND U	ND U
Total VOCs (b)	**2,336**	**3,065**	**1,704**	**3,050**	**20 to 1,534**	**1,247**	**280 to 7,071**	**3,858**	**334 to 3,670**	**1,160**	**1,337**
Total Vinyl Chloride	**240**	**210**	**120**	**190**	**150 to 280**	**150**	**19**	**ND**	**11 to 430**	**47**	**57**

a/ U = Not detected above method detection limit; J = estimated value; B = detected in method blank

b/ Only compounds identified above method detection limits are included in this table. Total VOCs do not include methylene chloride, a suspected laboratory contaminant.

Table 2

Emissions Screening, AG-1, and ISCLT2 Air Modeling Input Data
Former General Instrument Corporation Site
Hicksville, New York

Parameter	Operation of Full-Scale System
Building Height (feet)	12
Height Above Structure (feet)	8
Stack Height (feet)	20
Internal Diameter (inches)	10
Exit Temperature (degrees Farenheit)	75
Exit Velocity (feet/second)	92
Exit Flowrate (scfm)	3,000
Shortest Distance from Building to Property Line (feet) (a)	635
Building Width (feet)	12
Building Length (feet)	60
Direction Building is Facing (degrees)	0
UTME (b)	622396
UTMN (b)	513078
Vinyl Chloride Emission Rate (lbs/hour)	0.0161
Vinyl Chloride Emission Rate (lbs/year)	141

a/ Distance from equipment exhaust to Charlotte Avenue to the east
b/ UTM = Universal Transverse Mercator coordinates (in meters)

Appendix A – Vinyl Chloride Emissions Modeling Results

Table A-1

Ambient Air Quality Impacts Due to Vinyl Chloride Groundwater IRM - Operable Unit Two
Former General Instrument Corporation Site
Hicksville, New York

Prepared by:	CDA	**Date:**	03/30/2004
Checked by:	JS	**Date:**	05/11/2004

Objective:
Determine maximum allowable vinyl chloride emission rate based on design stack height and flow rate data for wells UVB-1, UVB-2, and UVB-3 of the UVB system at the Former GIC site in Hicksville, New York.

Given:

Building Height (h_b; feet) =	12
Stack Height (h_s; feet) =	20
h_s/h_b =	1.67
Stack Radius (inches) =	5
Stack Radius (R; feet) =	0.417
Stack Flow (cfm) =	3,000
Exit Velocity (V; ft/sec) =	91.7
Temperature (F) =	75
Temperature (Rankine) =	535

	UVB-1	UVB-2	UVB-3	
Groundwater concentration (Cvc) =	190	215	139	μg/l
Groundwater flow rate (Qw) =	60	60	60	gpm
Air Stripper Loading Rate = Cvc x Qw =	43,149	48,827	31,567	μg/min
Air Stripping Efficiency =	98	98	98	percent
Air Emission Rate =	42,286	47,850	30,936	μg/min
Total Air Emission Rate =	122,000			μg/min
Vinyl Chloride Concentration in Vapor =	1,400			μg/m^3 (Calculated)
Annual Hours of Operation =	8,760			hours/year
Estimated Vinyl Chloride Emission Rate =	141			lbs/year

Notes: Vinyl chloride concentration at UVB-1 estimated from most recent sampling event.
Vinyl chloride concentration at UVB-2 estimated from average of August 2002 profiling and groundwater data for W-28-262.
Vinyl chloride concentration at UVB-3 estimated from average of August 2002 groundwater and profiling data for W-26-270 and W-30-285.

Calculations for Annual Vinyl Chloride Impacts:
Calculations are based on equations and procedures provided in Appendix B (Ambient Air Quality Impact Screening Analysis) to the New York State Department of Environmental Conservation's DAR-1 Guidelines for the Control of Toxic Ambient Air Contaminants.

Step 1: Evaluate building cavity impacts using basic cavity impact method.

From Section II.A.1.:	Horizontal extent of cavity ($3h_b$; feet) =	36	
	Distance to nearest property line (D_{pl}; feet) =	635	(estimated)

Because D_{pl} is greater than $3h_b$, building cavity impacts, if they occur, are confined to onsite receptors and do not need to be calculated.

Table A-1

Ambient Air Quality Impacts Due to Vinyl Chloride Groundwater IRM - Operable Unit Two
Former General Instrument Corporation Site
Hicksville, New York

Step 2: Evaluate point source impacts using standard point source method.

From Section III.A.1: Stack is capped; therefore, there is no plume rise and effective stack height, h_e (feet) = h_s (feet).
This parameter is insignificant for adjusting effective stack height given input and Air Guide formula.

From Section III.A.2.: Calculate maximum actual annual impact during interim operation, C_a, using the following equation:

$$C_a\ (ug/m^3) = \frac{(6.0)(Q_a)(0.75)}{h_e^{2.25}}$$ (0.75 factor is for 2.5> h_s/h_b >1.5 from Section III.A.4.a)

where: Q_a = emission rate (lb/year)

Qa = 141 lb/yr = 0.0161 lb/hr

C_a = 0.75 ug/m^3

From Section III.A.3.: Calculate maximum potential annual impact during interim operation, C_p, using the following equation:

$$C_p\ (ug/m^3) = \frac{(52{,}500)(Q_a)(0.75)}{h_e^{2.25}}$$ (0.75 factor is for 2.5> h_s/h_b >1.5 from Section III.A.4.a)

where: Q = emission rate (lb/hr) = 0.0161 lb/hr

C_p = 0.75 ug/m^3

From Section III.A.5: Calculate maximum actual short-term impact during interim operation, CST, using the following equation:

C_{ST} (ug/m^3) = $(C_p)(65)$

C_{ST} = 48.8 ug/m^3

Comparison with OSHA PEL:

From NIOSH Pocket Guide to Chemical Hazards (June 1997), the OHSA PEL for vinyl chloride is as follows:

PEL = 1 ppm = 2,560 μg/m^3

Ceiling PEL = 5 ppm = 12,800 μg/m^3 (15 minute time-weighted exposure)

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
616000	518000	1.290E-05	622000	515000	0.000264302	628000	512000	3.86E-05
617000	518000	1.51E-05	623000	515000	0.000364312	616000	511000	2.54E-05
618000	518000	1.86E-05	624000	515000	0.000210309	617000	511000	3.20E-05
619000	518000	2.37E-05	625000	515000	0.0001262	618000	511000	4.29E-05
620000	518000	2.97E-05	626000	515000	8.43E-05	619000	511000	6.14E-05
621000	518000	4.70E-05	627000	515000	5.97E-05	620000	511000	9.27E-05
622000	518000	7.14E-05	628000	515000	4.49E-05	621000	511000	0.000120088
623000	518000	8.16E-05	616000	514000	2.36E-05	622000	511000	0.000139747
624000	518000	7.78E-05	617000	514000	2.98E-05	623000	511000	0.000171081
625000	518000	6.62E-05	618000	514000	3.92E-05	624000	511000	0.000127921
626000	518000	5.26E-05	619000	514000	5.43E-05	625000	511000	8.37E-05
627000	518000	4.12E-05	620000	514000	7.96E-05	626000	511000	5.76E-05
628000	518000	3.41E-05	621000	514000	0.000162806	627000	511000	4.16E-05
616000	517000	1.43E-05	622000	514000	0.000510702	628000	511000	3.25E-05
617000	517000	1.73E-05	623000	514000	0.000915335	619000	515000	3.98E-05
618000	517000	2.11E-05	624000	514000	0.000312424	619500	515000	4.85E-05
619000	517000	2.74E-05	625000	514000	0.000153409	620000	515000	5.99E-05
620000	517000	3.71E-05	626000	514000	9.20E-05	620500	515000	7.47E-05
621000	517000	5.53E-05	627000	514000	6.22E-05	621000	515000	0.000103803
622000	517000	9.93E-05	628000	514000	4.54E-05	621500	515000	0.000140206
623000	517000	0.000117123	616000	513000	2.73E-05	622000	515000	0.000264302
624000	517000	0.000107182	617000	513000	3.56E-05	622500	515000	0.000382228
625000	517000	8.15E-05	618000	513000	4.92E-05	623000	515000	0.000364312
626000	517000	5.99E-05	619000	513000	7.43E-05	623500	515000	0.000289625
627000	517000	4.70E-05	620000	513000	0.00013065	624000	515000	0.000210309
628000	517000	3.84E-05	621000	513000	0.00031934	624500	515000	0.000157029
616000	516000	1.54E-05	622000	513000	0.002545449	625000	515000	0.0001262
617000	516000	1.93E-05	623000	513000	0.001753346	619000	514500	4.27E-05
618000	516000	2.48E-05	624000	513000	0.000334612	619500	514500	5.36E-05
619000	516000	3.25E-05	625000	513000	0.00014857	620000	514500	6.91E-05
620000	516000	4.65E-05	626000	513000	8.71E-05	620500	514500	9.15E-05
621000	516000	6.92E-05	627000	513000	5.86E-05	621000	514500	0.000124119
622000	516000	0.000151169	628000	513000	4.29E-05	621500	514500	0.000193731
623000	516000	0.000187887	616000	512000	2.70E-05	622000	514500	0.000372039
624000	516000	0.000149336	617000	512000	3.49E-05	622500	514500	0.000640702
625000	516000	9.89E-05	618000	512000	4.75E-05	623000	514500	0.000569059
626000	516000	7.11E-05	619000	512000	6.94E-05	623500	514500	0.000374577
627000	516000	5.41E-05	620000	512000	0.000114627	624000	514500	0.000250867
628000	516000	4.22E-05	621000	512000	0.000240458	624500	514500	0.000186653
616000	515000	1.91E-05	622000	512000	0.000380573	625000	514500	0.000141917
617000	515000	2.27E-05	623000	512000	0.000474259	619000	514000	5.43E-05
618000	515000	2.80E-05	624000	512000	0.00020867	619500	514000	6.54E-05
619000	515000	3.98E-05	625000	512000	0.000107328	620000	514000	7.96E-05
620000	515000	5.99E-05	626000	512000	7.13E-05	620500	514000	0.000107883
621000	515000	0.000103803	627000	512000	5.10E-05	621000	514000	0.000162806
621500	514000	0.000262065	624500	512500	0.000178933	622000	514250	0.000440268
622000	514000	0.000510702	625000	512500	0.000131228	622250	514250	0.000726284

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622500	514000	0.001357699	619000	512000	6.94E-05	622500	514250	0.000895186
623000	514000	0.000915335	619500	512000	8.71E-05	622750	514250	0.000853047
623500	514000	0.000489522	620000	512000	0.000114627	623000	514250	0.000717459
624000	514000	0.000312424	620500	512000	0.000161727	623250	514250	0.000552615
624500	514000	0.000211753	621000	512000	0.000240458	623500	514250	0.000417765
625000	514000	0.000153409	621500	512000	0.000343553	623750	514250	0.000338551
619000	513500	6.58E-05	622000	512000	0.000380573	624000	514250	0.000282216
619500	513500	8.31E-05	622500	512000	0.000499429	621000	514000	0.000162806
620000	513500	0.000109062	623000	512000	0.000474259	621250	514000	0.000204572
620500	513500	0.000151046	623500	512000	0.000308572	621500	514000	0.000262065
621000	513500	0.000224379	624000	512000	0.00020867	621750	514000	0.00037278
621500	513500	0.000385274	624500	512000	0.000146197	622000	514000	0.000510702
622000	513500	0.001048885	625000	512000	0.000107328	622250	514000	0.001033078
622500	513500	0.005095745	619000	511500	6.48E-05	622500	514000	0.001357699
623000	513500	0.001527863	619500	511500	8.17E-05	622750	514000	0.001237094
623500	513500	0.000646147	620000	511500	0.000105367	623000	514000	0.000915335
624000	513500	0.000353704	620500	511500	0.000139082	623250	514000	0.000640927
624500	513500	0.000224958	621000	511500	0.000176712	623500	514000	0.000489522
625000	513500	0.000157362	621500	511500	0.000192874	623750	514000	0.00038865
619000	513000	7.43E-05	622000	511500	0.000215611	624000	514000	0.000312424
619500	513000	9.60E-05	622500	511500	0.000252312	621000	513750	0.000180594
620000	513000	0.00013065	623000	511500	0.000272637	621250	513750	0.000238473
620500	513000	0.000191937	623500	511500	0.000217977	621500	513750	0.000324516
621000	513000	0.00031934	624000	511500	0.000161326	621750	513750	0.000457452
621500	513000	0.000672375	624500	511500	0.00012411	622000	513750	0.000737891
622000	513000	0.002545449	625000	511500	9.66E-05	622250	513750	0.001580855
622500	513000	0.018832034	621000	514500	0.000124119	622500	513750	0.002345444
623000	513000	0.001753346	621250	514500	0.000155732	622750	513750	0.001851126
623500	513000	0.000631411	621500	514500	0.000193731	623000	513750	0.001143165
624000	513000	0.000334612	621750	514500	0.000236377	623250	513750	0.000787876
624500	513000	0.000211915	622000	514500	0.000372039	623500	513750	0.000576872
625000	513000	0.00014857	622250	514500	0.000540888	623750	513750	0.000433931
619000	512500	7.34E-05	622500	514500	0.000640702	624000	513750	0.000336184
619500	512500	9.42E-05	622750	514500	0.00062456	621000	513500	0.000224379
620000	512500	0.000126501	623000	514500	0.000569059	621250	513500	0.000281109
620500	512500	0.000180933	623250	514500	0.000466534	621500	513500	0.000385275
621000	512500	0.000282803	623500	514500	0.000374577	621750	513500	0.000608804
621500	512500	0.000548603	623750	514500	0.0002979	622000	513500	0.001048885
622000	512500	0.00106142	624000	514500	0.000250867	622250	513500	0.002498087
622500	512500	0.001554653	621000	514250	0.000142558	622500	513500	0.005095745
623000	512500	0.000906787	621250	514250	0.000172827	622750	513500	0.002751808
623500	512500	0.000439286	621500	514250	0.000227929	623000	513500	0.001527863
624000	512500	0.000259331	621750	514250	0.000295663	623250	513500	0.000957386
623500	513500	0.000646147	622125	513750	0.000932873	622875	513375	0.002402217
623750	513500	0.000466966	622250	513750	0.001580855	623000	513375	0.001742725
624000	513500	0.000353704	622375	513750	0.002228771	623125	513375	0.001307825
621000	513250	0.000283595	622500	513750	0.002345444	623250	513375	0.001020888

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
621250	513250	0.000383372	622625	513750	0.002197182	621750	513250	0.000869671
621500	513250	0.000552486	622750	513750	0.001851126	621875	513250	0.001134232
621750	513250	0.000869671	622875	513750	0.001466425	622000	513250	0.001545945
622000	513250	0.001545945	623000	513750	0.001143165	622125	513250	0.002579781
622250	513250	0.004843583	623125	513750	0.000925531	622250	513250	0.004843583
622500	513250	0.015052435	623250	513750	0.000787876	622375	513250	0.016718969
622750	513250	0.004320424	621750	513625	0.000527739	622500	513250	0.015052435
623000	513250	0.001899596	621875	513625	0.000659837	622625	513250	0.007272399
623250	513250	0.001056709	622000	513625	0.000890643	622750	513250	0.004320424
623500	513250	0.000677041	622125	513625	0.001172616	622875	513250	0.002756716
623750	513250	0.000474672	622250	513625	0.002002988	623000	513250	0.001899596
624000	513250	0.000353813	622375	513625	0.00315097	623125	513250	0.001385688
621000	513000	0.00031934	622500	513625	0.003327186	623250	513250	0.001056709
621250	513000	0.00044455	622625	513625	0.002988297	621750	513125	0.001085546
621500	513000	0.000672375	622750	513625	0.002276418	621875	513125	0.001522679
621750	513000	0.001161686	622875	513625	0.001680077	622000	513125	0.002295899
622000	513000	0.002545449	623000	513625	0.00129534	622125	513125	0.003794005
622250	513000	0.008987607	623125	513625	0.001063463	622250	513125	0.00669808
622500	513000	0.018832034	623250	513625	0.000877367	622375	513125	0.024317978
622750	513000	0.004109004	621750	513500	0.000608804	622500	513125	0.022752168
623000	513000	0.001753346	621875	513500	0.000785438	622625	513125	0.009435494
623250	513000	0.000977895	622000	513500	0.001048885	622750	513125	0.004790602
623500	513000	0.00063141	622125	513500	0.001535969	622875	513125	0.002869266
623750	513000	0.000446022	622250	513500	0.002498087	623000	513125	0.001914967
624000	513000	0.000334612	622375	513500	0.004823181	623125	513125	0.001375146
621000	512750	0.000310394	622500	513500	0.005095745	623250	513125	0.001040211
621250	512750	0.00042365	622625	513500	0.004040021	621750	513000	0.001161686
621500	512750	0.000616102	622750	513500	0.002751808	621875	513000	0.001652265
621750	512750	0.001016948	622875	513500	0.001966951	622000	513000	0.002545449
622000	512750	0.001954127	623000	513500	0.001527863	622125	513000	0.004382528
622250	512750	0.002897287	623125	513500	0.001199299	622250	513000	0.008987607
622500	512750	0.004224014	623250	513500	0.000957386	622375	513000	0.022655845
622750	512750	0.002400464	621750	513375	0.000676272	622500	513000	0.018832034
623000	512750	0.001253181	621875	513375	0.000923682	622625	513000	0.007453476
623250	512750	0.000753265	622000	513375	0.001305926	622750	513000	0.004109004
623500	512750	0.000529834	622125	513375	0.001953825	622875	513000	0.002564783
623750	512750	0.000392022	622250	513375	0.003256085	623000	513000	0.001753346
624000	512750	0.000302532	622375	513375	0.008294352	623125	513000	0.001278811
621750	513750	0.000457452	622500	513375	0.008677064	623250	513000	0.000977895
621875	513750	0.000584739	622625	513375	0.005406795	621750	512875	0.001100557
622000	513750	0.000737891	622750	513375	0.003393468	621875	512875	0.00151497
622000	512875	0.002293244	622624	513374	0.005441941	622190	513126	0.005064126
622125	512875	0.00377029	622686	513374	0.004103593	622252	513126	0.0067174
622250	512875	0.005776423	622748	513374	0.003420293	622314	513126	0.010202096
622375	512875	0.007620738	622810	513374	0.002875323	622376	513126	0.024945151
622500	512875	0.008637365	622872	513374	0.002425116	622438	513126	0.038066022
622625	512875	0.005254526	622128	513312	0.002262513	622500	513126	0.022636917

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622750	512875	0.003132213	622190	513312	0.002974545	622562	513126	0.014379856
622875	512875	0.00199531	622252	513312	0.004091602	622624	513126	0.009488882
623000	512875	0.001462639	622314	513312	0.006286704	622686	513126	0.006609868
623125	512875	0.001116504	622376	513312	0.011650596	622748	513126	0.004836129
623250	512875	0.000878851	622438	513312	0.013275937	622810	513126	0.003685161
622128	513498	0.001556076	622500	513312	0.011728984	622872	513126	0.00290146
622190	513498	0.001848192	622562	513312	0.008521905	622128	513064	0.004504323
622252	513498	0.002542116	622624	513312	0.006020832	622190	513064	0.006240553
622314	513498	0.003715747	622686	513312	0.004826277	622252	513064	0.008834857
622376	513498	0.00487813	622748	513312	0.003909238	622314	513064	0.013155622
622438	513498	0.005280739	622810	513312	0.003184733	622376	513064	0.005473493
622500	513498	0.005134591	622872	513312	0.002621435	622438	513064	0.0463828
622562	513498	0.004777486	622128	513250	0.002614191	622500	513064	0.024798229
622624	513498	0.004071637	622190	513250	0.00346293	622562	513064	0.014249061
622686	513498	0.003381035	622252	513250	0.004909423	622624	513064	0.009175789
622748	513498	0.002776965	622314	513250	0.007307283	622686	513064	0.006348862
622810	513498	0.00226725	622376	513250	0.016903486	622748	513064	0.004640679
622872	513498	0.001985906	622438	513250	0.020040084	622810	513064	0.003540137
622128	513436	0.001772128	622500	513250	0.015052435	622872	513064	0.002792448
622190	513436	0.002189528	622562	513250	0.009614168	622314	513374	0.005412525
622252	513436	0.002728217	622624	513250	0.007303366	622345	513374	0.006905679
622314	513436	0.004488642	622686	513250	0.005611351	622376	513374	0.008381921
622376	513436	0.006283496	622748	513250	0.004354741	622407	513374	0.009337593
622438	513436	0.006882299	622810	513250	0.003437641	622438	513374	0.0093289
622500	513436	0.006590437	622872	513250	0.002783731	622469	513374	0.009111333
622562	513436	0.005839996	622128	513188	0.002865416	622500	513374	0.008718562
622624	513436	0.004736607	622190	513188	0.003990804	622531	513374	0.008033909
622686	513436	0.003774185	622252	513188	0.00575888	622562	513374	0.007104208
622748	513436	0.002979188	622314	513188	0.009294218	622593	513374	0.006234977
622810	513436	0.002554619	622376	513188	0.025143204	622624	513374	0.005441941
622872	513436	0.002206278	622438	513188	0.032518812	622655	513374	0.004731534
622128	513374	0.00198262	622500	513188	0.017016526	622686	513374	0.004103593
622190	513374	0.00258251	622562	513188	0.012086859	622314	513343	0.005886228
622252	513374	0.003291641	622624	513188	0.008626702	622345	513343	0.007855618
622314	513374	0.005412525	622686	513188	0.006263605	622376	513343	0.009828255
622376	513374	0.008381921	622748	513188	0.004703813	622407	513343	0.011099687
622438	513374	0.0093289	622810	513188	0.003641036	622438	513343	0.011054147
622500	513374	0.008718562	622872	513188	0.002894931	622469	513343	0.010719595
622562	513374	0.007104208	622128	513126	0.003829748	622500	513343	0.010151554
622531	513343	0.008998744	622314	513219	0.008375295	622407	513341	0.011229667
622562	513343	0.007809462	622345	513219	0.011842413	622422	513341	0.011245429
622593	513343	0.006727181	622376	513219	0.020611227	622437	513341	0.011187255
622624	513343	0.00576547	622407	513219	0.026357321	622452	513341	0.011059108
622655	513343	0.004925396	622438	513219	0.025260324	622467	513341	0.010866792
622686	513343	0.004432755	622469	513219	0.021430919	622482	513341	0.010617509
622314	513312	0.006286704	622500	513219	0.016492683	622497	513341	0.010319361
622345	513312	0.008939963	622531	513219	0.012621146	622317	513326	0.006340343

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
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UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622376	513312	0.011650596	622562	513219	0.010732573	622332	513326	0.007452408
622407	513312	0.013391873	622593	513219	0.009280448	622347	513326	0.00858679
622438	513312	0.013275937	622624	513219	0.007994818	622362	513326	0.009725405
622469	513312	0.012752562	622655	513219	0.006892138	622377	513326	0.010848279
622500	513312	0.011728984	622686	513219	0.005961584	622392	513326	0.011934647
622531	513312	0.010047731	622314	513188	0.009294218	622407	513326	0.012279127
622562	513312	0.008521905	622345	513188	0.012420931	622422	513326	0.012287893
622593	513312	0.007178447	622376	513188	0.025143204	622437	513326	0.01220893
622624	513312	0.006020832	622407	513188	0.034979641	622452	513326	0.012047372
622655	513312	0.005358452	622438	513188	0.032518812	622467	513326	0.011810779
622686	513312	0.004826277	622469	513188	0.023797646	622482	513326	0.011508483
622314	513281	0.006462352	622500	513188	0.017016526	622497	513326	0.011150849
622345	513281	0.010115514	622531	513188	0.014200078	622317	513311	0.006548263
622376	513281	0.013963818	622562	513188	0.012086859	622332	513311	0.007833915
622407	513281	0.016433667	622593	513188	0.010211546	622347	513311	0.009154122
622438	513281	0.016181735	622624	513188	0.008626702	622362	513311	0.010486007
622469	513281	0.015345589	622655	513188	0.00731774	622377	513311	0.011803725
622500	513281	0.013362403	622686	513188	0.006263605	622392	513311	0.013080034
622531	513281	0.011118797	622314	513157	0.009688973	622407	513311	0.013476854
622562	513281	0.00916802	622345	513157	0.014230987	622422	513311	0.013474993
622593	513281	0.007517632	622376	513157	0.029866045	622437	513311	0.013368471
622624	513281	0.006603443	622407	513157	0.049336165	622452	513311	0.013164038
622655	513281	0.005877901	622438	513157	0.039227679	622467	513311	0.012871634
622686	513281	0.005224937	622469	513157	0.023839446	622482	513311	0.012503433
622314	513250	0.007307283	622500	513157	0.019304413	622497	513311	0.011950144
622345	513250	0.011227101	622531	513157	0.016174281	622317	513296	0.006710264
622376	513250	0.016903486	622562	513157	0.013370172	622332	513296	0.00820345
622407	513250	0.020563092	622593	513157	0.01103076	622347	513296	0.00974929
622438	513250	0.020040084	622624	513157	0.009158241	622362	513296	0.011318671
622469	513250	0.018554602	622655	513157	0.007677014	622377	513296	0.012877789
622500	513250	0.015052435	622686	513157	0.006502386	622392	513296	0.014390371
622531	513250	0.012070019	622317	513341	0.006105825	622407	513296	0.014850364
622562	513250	0.009614168	622332	513341	0.007072269	622422	513296	0.014832636
622593	513250	0.008317432	622347	513341	0.008052707	622437	513296	0.014689329
622624	513250	0.007303366	622362	513341	0.009032763	622452	513296	0.014429461
622655	513250	0.006399186	622377	513341	0.009996837	622467	513296	0.014066286
622686	513250	0.005611351	622392	513341	0.010928892	622482	513296	0.013615861
622497	513296	0.012753611	622392	513236	0.022029936	622487	513280	0.014444963
622317	513281	0.006798539	622407	513236	0.022925505	622494	513280	0.013886333
622332	513281	0.008540344	622422	513236	0.022719855	622410	513273	0.017380174
622347	513281	0.010361707	622437	513236	0.022238085	622417	513273	0.017358352
622362	513281	0.012225461	622452	513236	0.021516161	622424	513273	0.017299242
622377	513281	0.014086863	622467	513236	0.020144882	622431	513273	0.017203806
622392	513281	0.015896866	622482	513236	0.018052394	622438	513273	0.017073434
622407	513281	0.016433667	622497	513236	0.016127236	622445	513273	0.01690965
622422	513281	0.016392533	622410	513294	0.015055015	622452	513273	0.016714696
622437	513281	0.016199714	622417	513294	0.015049563	622459	513273	0.016490895

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UTME	UTMN	Vinyl Chloride Impact (mg/m³)	UTME	UTMN	Vinyl Chloride Impact (mg/m³)	UTME	UTMN	Vinyl Chloride Impact (mg/m³)
622452	513281	0.015867597	622424	513294	0.015015575	622466	513273	0.016240742
622467	513281	0.0154141	622431	513294	0.014953678	622473	513273	0.015966849
622482	513281	0.01478101	622438	513294	0.014864772	622480	513273	0.015522392
622497	513281	0.013593557	622445	513294	0.014749987	622487	513273	0.014907074
622317	513266	0.006880498	622452	513294	0.014610666	622494	513273	0.0143052
622332	513266	0.008812816	622459	513294	0.014448315	622410	513266	0.018268203
622347	513266	0.010971972	622466	513294	0.014264587	622417	513266	0.018238513
622362	513266	0.013203505	622473	513294	0.014061224	622424	513266	0.018167913
622377	513266	0.015447779	622480	513294	0.01384005	622431	513266	0.018057551
622392	513266	0.017637251	622487	513294	0.013549721	622438	513266	0.017909039
622407	513266	0.018268237	622494	513294	0.01306786	622445	513266	0.01772443
622422	513266	0.018192202	622410	513287	0.015778106	622452	513266	0.017506113
622437	513266	0.017932519	622417	513287	0.015768189	622459	513266	0.017256584
622452	513266	0.017506113	622424	513287	0.015727097	622466	513266	0.016978722
622467	513266	0.016936902	622431	513287	0.015655562	622473	513266	0.016675666
622482	513266	0.015849864	622438	513287	0.015554608	622480	513266	0.016041499
622497	513266	0.014455047	622445	513287	0.015425544	622487	513266	0.015376419
622317	513251	0.007402779	622452	513287	0.015269917	622494	513266	0.014727749
622332	513251	0.008972054	622459	513287	0.015089461	622410	513259	0.019221999
622347	513251	0.011547376	622466	513287	0.014886067	622417	513259	0.019182794
622362	513251	0.014243322	622473	513287	0.014661724	622424	513259	0.01909864
622377	513251	0.016979141	622480	513287	0.014418497	622431	513259	0.018970896
622392	513251	0.019659909	622487	513287	0.013992023	622438	513259	0.018801464
622407	513251	0.020407941	622494	513287	0.013473321	622445	513259	0.018592753
622422	513251	0.020280123	622410	513280	0.01655167	622452	513259	0.018347563
622437	513251	0.019928008	622417	513280	0.016536418	622459	513259	0.018068984
622452	513251	0.019375829	622424	513280	0.016487073	622466	513259	0.017760338
622467	513251	0.018657714	622431	513280	0.016404392	622473	513259	0.017307669
622482	513251	0.016952552	622438	513280	0.01628964	622480	513259	0.016569587
622497	513251	0.015313207	622445	513280	0.016144343	622487	513259	0.015850388
622317	513236	0.007944751	622452	513280	0.015970273	622494	513259	0.015151241
622332	513236	0.008946097	622459	513280	0.015769441	622410	513252	0.02024811
622347	513236	0.01203606	622466	513280	0.015544003	622417	513252	0.020197386
622362	513236	0.015324509	622473	513280	0.01529625	622424	513252	0.020097187
622377	513236	0.018701298	622480	513280	0.015014508	622431	513252	0.019949118
622438	513252	0.01975547	622478	513268	0.016080683	622457	513256	0.018519104
622445	513252	0.01951908	622481	513268	0.01579833	622460	513256	0.018387932
622452	513252	0.019243224	622484	513268	0.015518652	622463	513256	0.018251184
622459	513252	0.018931523	622448	513265	0.017753989	622466	513256	0.018109135
622466	513252	0.01858782	622451	513265	0.017656835	622469	513256	0.017962083
622473	513252	0.017903872	622454	513265	0.017553844	622472	513256	0.017672768
622480	513252	0.017103242	622457	513265	0.017445236	622475	513256	0.017341713
622487	513252	0.016325669	622460	513265	0.017331142	622478	513256	0.017014246
622494	513252	0.015572125	622463	513265	0.017211862	622481	513256	0.016690413
622410	513245	0.021354068	622466	513265	0.017087679	622484	513256	0.016370324
622417	513245	0.02128936	622469	513265	0.01695882	622448	513253	0.019271363
622424	513245	0.021170082	622472	513265	0.016825544	622451	513253	0.019152803

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UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622431	513245	0.020998174	622475	513265	0.016606554	622454	513253	0.019027632
622438	513245	0.020776374	622478	513265	0.016311554	622457	513253	0.018896135
622445	513245	0.020508062	622481	513265	0.01601938	622460	513253	0.018758602
622452	513245	0.02019711	622484	513265	0.015730137	622463	513253	0.018615346
622459	513245	0.01984776	622448	513262	0.018117961	622466	513253	0.018466666
622466	513245	0.019403856	622451	513262	0.018015895	622469	513253	0.018279849
622473	513245	0.018507782	622454	513262	0.017907806	622472	513253	0.017932937
622480	513245	0.017638555	622457	513262	0.017793927	622475	513253	0.017589847
622487	513245	0.016797531	622460	513262	0.017674508	622478	513253	0.017250696
622494	513245	0.015985709	622463	513262	0.0175498	622481	513253	0.016915588
622448	513271	0.017054737	622466	513262	0.017419998	622484	513253	0.016584633
622451	513271	0.016966514	622469	513262	0.017285317	622448	513250	0.019677447
622454	513271	0.016872812	622472	513262	0.017146109	622451	513250	0.019552734
622457	513271	0.016773827	622475	513262	0.016849726	622454	513250	0.019421201
622460	513271	0.016669767	622478	513262	0.016544262	622457	513250	0.019283164
622463	513271	0.016560843	622481	513262	0.016241897	622460	513250	0.019138925
622466	513271	0.016447265	622484	513262	0.015942739	622463	513250	0.018988812
622469	513271	0.016329249	622448	513259	0.018491965	622466	513250	0.018833147
622472	513271	0.016207011	622451	513259	0.018384708	622469	513250	0.018554602
622475	513271	0.016080774	622454	513259	0.018271234	622472	513250	0.018194806
622478	513271	0.01585185	622457	513259	0.018151796	622475	513250	0.017839203
622481	513271	0.015578955	622460	513259	0.018026656	622478	513250	0.017487917
622484	513271	0.015308481	622463	513259	0.017896079	622481	513250	0.017141052
622448	513268	0.01739974	622466	513259	0.017760338	622484	513250	0.016798705
622451	513268	0.017307209	622469	513259	0.017619701	622451	513266	0.017539263
622454	513268	0.017208921	622472	513259	0.017414559	622452	513266	0.017506113
622457	513268	0.017105185	622475	513259	0.01709494	622453	513266	0.017472325
622460	513268	0.016996225	622478	513259	0.016778594	622454	513266	0.017437913
622463	513268	0.016882256	622481	513259	0.016465657	622455	513266	0.01740288
622466	513268	0.016763501	622484	513259	0.016156225	622456	513266	0.017367208
622469	513268	0.016640201	622448	513256	0.018876318	622457	513266	0.017330924
622472	513268	0.016512575	622451	513256	0.018763572	622458	513266	0.017294047
622475	513268	0.016365614	622454	513256	0.018644411	622459	513266	0.017256584
622460	513266	0.017218547	622453	513262	0.017944485	622459	513259	0.018068984
622461	513266	0.017179944	622454	513262	0.017907806	622460	513259	0.018026656
622462	513266	0.017140782	622455	513262	0.01787048	622461	513259	0.01798372
622463	513266	0.017101068	622456	513262	0.017832512	622462	513259	0.017940192
622451	513265	0.017656835	622457	513262	0.017793927	622463	513259	0.017896079
622452	513265	0.017623141	622458	513262	0.017754724	622447	513267	0.017546795
622453	513265	0.017588807	622459	513262	0.017714914	622448	513267	0.017516764
622454	513265	0.017553844	622460	513262	0.017674508	622449	513267	0.017486069
622455	513265	0.017518252	622461	513262	0.017633515	622450	513267	0.017454723
622456	513265	0.017482048	622462	513262	0.017591944	622451	513267	0.017422736
622457	513265	0.017445236	622463	513262	0.0175498	622452	513267	0.01739011
622458	513265	0.01740781	622451	513261	0.018137731	622453	513267	0.017356852
622459	513265	0.017369766	622452	513261	0.018101784	622454	513267	0.017322941
622460	513265	0.017331142	622453	513261	0.018065158	622455	513267	0.017288419

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UTME	UTMN	Vinyl Chloride Impact (mg/m³)	UTME	UTMN	Vinyl Chloride Impact (mg/m³)	UTME	UTMN	Vinyl Chloride Impact (mg/m³)
622461	513265	0.017291941	622454	513261	0.018027881	622456	513267	0.017253287
622462	513265	0.017252181	622455	513261	0.017989952	622457	513267	0.017217569
622463	513265	0.017211862	622456	513261	0.017951384	622458	513267	0.017181257
622451	513264	0.017775459	622457	513261	0.017912185	622459	513267	0.017144371
622452	513264	0.017741213	622458	513261	0.017872362	622447	513266	0.017665379
622453	513264	0.017706325	622459	513261	0.017831929	622448	513266	0.017634844
622454	513264	0.017670795	622460	513261	0.017790891	622449	513266	0.017603636
622455	513264	0.017634636	622461	513261	0.017749263	622450	513266	0.017571779
622456	513264	0.017597852	622462	513261	0.017707048	622451	513266	0.017539263
622457	513264	0.017560465	622463	513261	0.017664261	622452	513266	0.017506113
622458	513264	0.017522464	622451	513260	0.018260669	622453	513266	0.017472325
622459	513264	0.017483875	622452	513260	0.018224124	622454	513266	0.017437913
622460	513264	0.017444696	622453	513260	0.018186905	622455	513266	0.01740288
622461	513264	0.017404901	622454	513260	0.01814902	622456	513266	0.017367208
622462	513264	0.017364524	622455	513260	0.018110482	622457	513266	0.017330924
622463	513264	0.017323593	622456	513260	0.018071296	622458	513266	0.017294047
622451	513263	0.017895138	622457	513260	0.018031471	622459	513266	0.017256584
622452	513263	0.017860338	622458	513260	0.017991021	622447	513265	0.017785041
622453	513263	0.017824883	622459	513260	0.01794995	622448	513265	0.017753989
622454	513263	0.017788781	622460	513260	0.017908273	622449	513265	0.017722268
622455	513263	0.01775204	622461	513260	0.017865995	622450	513265	0.017689882
622456	513263	0.017714674	622462	513260	0.01782313	622451	513265	0.017656835
622457	513263	0.017676691	622463	513260	0.017779687	622452	513265	0.017623141
622458	513263	0.017638097	622451	513259	0.018384708	622453	513265	0.017588807
622459	513263	0.017598903	622452	513259	0.018347563	622454	513265	0.017553844
622460	513263	0.017559111	622453	513259	0.018309733	622455	513265	0.017518252
622461	513263	0.017518742	622454	513259	0.018271234	622456	513265	0.017482048
622462	513263	0.017477803	622455	513259	0.018232072	622457	513265	0.017445236
622463	513263	0.01743627	622456	513259	0.018192254	622458	513265	0.01740781
622451	513262	0.018015895	622457	513259	0.018151796	622459	513265	0.017369766
622452	513262	0.017980522	622458	513259	0.018110704	622447	513264	0.01790579
622448	513264	0.017874219	622454	513261	0.018027881	621853	513463	0.00078851
622449	513264	0.017841969	622455	513261	0.017989952	621953	513463	0.000988936
622450	513264	0.017809043	622456	513261	0.017951384	622053	513463	0.001305033
622451	513264	0.017775459	622457	513261	0.017912185	622153	513463	0.001816076
622452	513264	0.017741213	622458	513261	0.017872362	622253	513463	0.002686548
622453	513264	0.017706325	622459	513261	0.017831929	622353	513463	0.005069841
622454	513264	0.017670795	622447	513260	0.018399917	622453	513463	0.006084506
622455	513264	0.017634636	622448	513260	0.018366162	622553	513463	0.005488259
622456	513264	0.017597852	622449	513260	0.018331695	622653	513463	0.004033522
622457	513264	0.017560465	622450	513260	0.018296527	622753	513463	0.002847767
622458	513264	0.017522464	622451	513260	0.018260669	622853	513463	0.00220021
622459	513264	0.017483875	622452	513260	0.018224124	622953	513463	0.001765552
622447	513263	0.018027641	622453	513260	0.018186905	623053	513463	0.001428377
622448	513263	0.017995542	622454	513260	0.01814902	621853	513363	0.000881934
622449	513263	0.017962752	622455	513260	0.018110482	621953	513363	0.001162267
622450	513263	0.017929278	622456	513260	0.018071296	622053	513363	0.001563884

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622451	513263	0.017895138
622452	513263	0.017860338
622453	513263	0.017824883
622454	513263	0.017788781
622455	513263	0.01775204
622456	513263	0.017714674
622457	513263	0.017676691
622458	513263	0.017638097
622459	513263	0.017598903
622447	513262	0.018150602
622448	513262	0.018117961
622449	513262	0.018084625
622450	513262	0.018050598
622451	513262	0.018015895
622452	513262	0.017980522
622453	513262	0.017944485
622454	513262	0.017907806
622455	513262	0.01787048
622456	513262	0.017832512
622457	513262	0.017793927
622458	513262	0.017754724
622459	513262	0.017714914
622447	513261	0.018274693
622448	513261	0.018241497
622449	513261	0.018207599
622450	513261	0.018173011
622451	513261	0.018137731
622452	513261	0.018101784
622453	513261	0.018065158
622453	513163	0.030529345
622553	513163	0.013864866
622653	513163	0.00770228
622753	513163	0.004686645
622853	513163	0.00311955
622953	513163	0.002223199
623053	513163	0.001667433
621853	513063	0.001540313
621953	513063	0.002139982
622053	513063	0.00317558
622153	513063	0.00512151
622253	513063	0.008899542
622353	513063	0.015769323
622453	513063	0.042876255
622553	513063	0.015259054
622653	513063	0.00765072
622753	513063	0.004528611
622853	513063	0.002991075

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622457	513260	0.018031471
622458	513260	0.017991021
622459	513260	0.01794995
621853	513663	0.00060715
621953	513663	0.000760226
622053	513663	0.000940651
622153	513663	0.001138046
622253	513663	0.001886088
622353	513663	0.002655485
622453	513663	0.002996792
622553	513663	0.002890746
622653	513663	0.002601426
622753	513663	0.002124663
622853	513663	0.001701076
622953	513663	0.001348166
623053	513663	0.001135718
621853	513563	0.000685069
621953	513563	0.000854811
622053	513563	0.00111822
622153	513563	0.001431659
622253	513563	0.002287232
622353	513563	0.003575028
622453	513563	0.004134068
622553	513563	0.003893087
622653	513563	0.003236812
622753	513563	0.002492281
622853	513563	0.001884129
622953	513563	0.001532569
623053	513563	0.001283522

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622153	513363	0.002256056
622253	513363	0.003436567
622353	513363	0.007652792
622453	513363	0.009798164
622553	513363	0.007638502
622653	513363	0.004852862
622753	513363	0.003456468
622853	513363	0.002595886
622953	513363	0.001982422
623053	513363	0.00154821
621853	513263	0.001041613
621953	513263	0.001293067
622053	513263	0.001871001
622153	513263	0.002833919
622253	513263	0.004784318
622353	513263	0.012011089
622453	513263	0.017824883
622553	513263	0.010070345
622653	513263	0.006232515
622753	513263	0.004188549
622853	513263	0.002923994
622953	513263	0.002151413
623053	513263	0.001643618
621853	513163	0.001330751
621953	513163	0.001779531
622053	513163	0.002481092
622153	513163	0.003581153
622253	513163	0.006120588
622353	513163	0.015377832

Table A-2

ISCLT2 Model Output
Former General Instrument Corporation Site
Hicksville, New York

UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)	UTME	UTMN	Vinyl Chloride Impact (mg/m^3)
622953	513063	0.002129083						
623053	513063	0.001598677						
621853	512963	0.001525955						
621953	512963	0.002096601						
622053	512963	0.003050118						
622153	512963	0.004868087						
622253	512963	0.00876477						
622353	512963	0.013777909						
622453	512963	0.019455364						
622553	512963	0.010646116						
622653	512963	0.005685812						
622753	512963	0.003686672						
622853	512963	0.002588471						
622953	512963	0.001908841						
623053	512963	0.001465825						

** AIR GUIDE 1 - ANALYSIS **

********** INPUT DATA **********

Facility Name & Address: FORMER GIC SITE 508 DUFFY AVENUE HICKSVILLE

SIC Code: 0 Application: CO UTME: 622396. UTMN: 513078. BL FACING DIRECTION: 0.0 %CONTROL: 0.0000

LOC	FAC	E.P.	CAS #	SOURCE TYPE	HA, or h(AREA) FEET	hs FEET	D IN.	T F	V FPS	Q ACFM	EMISSIONS #/HOUR	EMISSIONS #/YEAR	DPL, or D(AREA) FT	BW, or S(AREA) FT	BL FT
		1	00075-01-4	POINT	8.	20.	10.	75.	92.00	3000.00	0.01610	141.	635.	12.	60.

CONTAMINANT TOXICITY PROFILE FOR AIR GUIDE 1 ANALYSIS

CONTAMINANT NAME	CAS NUMBER	SGC ug/m3	HOW SGC ASSIGNED	AGC ug/m3	HOW AGC ASSIGNED	DAR TOXICITY	COMMENTS
VINYL CHLORIDE	00075-01-4	180000.00000	NYSDEC	0.020000000	NYSDEC	HIGH	A,H

COMMENTS :

(A) ACGIH Human Carcinogen.

(H) HAP identified by 1990 CAAA.

EMISSION POINT AND CONTAMINANT IMPACT SUMMARY OF AIR GUIDE 1 ANALYSIS

							SHORT-TERM IMPACT	CAVITY IMPACT	POINT or AREA SOURCE IMPACT	
LOC	FAC	E.P.	CAS NUMBER	EMISSIONS #/HOUR	EMISSIONS #/YEAR	ANNUAL EMISSIONS #/HOUR	MAXIMUM (Cav,Pt,Area) ug/m3	ACTUAL ANNUAL ug/m3	POTENTIAL ANNUAL ug/m3	ACTUAL ANNUAL ug/m3
		1	00075-01-4	0.016100	141.0000	0.016096	15.011198	0.000000	0.254699	0.254925
SUMMARY TOTALS				0.016100	141.0000	0.016096	15.011198	0.000000	0.254699	0.254925

EMISSION POINT AND CONTAMINANT ASSESSMENT OF AIR GUIDE 1 ANALYSIS

						SHORT-TERM IMPACT	CAVITY IMPACT	POINT or AREA SOURCE IMPACT	
LOC	FAC	E.P.	CAS NUMBER	AGC ug/m3	SGC ug/m3	MAXIMUM (Cav,Pt,Area) % OF SGC	ACTUAL ANNUAL % OF AGC	POTENTIAL ANNUAL % OF AGC	ACTUAL ANNUAL % OF AGC
		1	00075-01-4	0.020000000	180000.0000	0.0083	0.0000	1273.4927	1274.6227
SUMMARY TOTALS						0.0083	0.0000	1273.4927	1274.6227

CONTAMINANT IMPACT SUMMARY OF AIR GUIDE 1 ANALYSIS

CAS NUMBER	EMISSIONS #/HOUR	EMISSIONS #/YEAR	ANNUAL EMISSIONS #/HOUR	SUMMATION OF SHORT-TERM IMPACTS, MAXIMUM (Cav,Pt,Area) ug/m3	SUMMATION OF CAVITY IMPACTS ACTUAL ANNUAL ug/m3	SUMMATION OF POINT or AREA SOURCE IMPACTS POTENTIAL ANNUAL ug/m3	SUMMATION OF POINT or AREA SOURCE IMPACTS ACTUAL ANNUAL ug/m3
00075-01-4	0.016100	141.0000	0.016096	15.011198	0.000000	0.254699	0.254925
SUMMARY TOTALS	0.016100	141.0000	0.016096	15.011198	0.000000	0.254699	0.254925

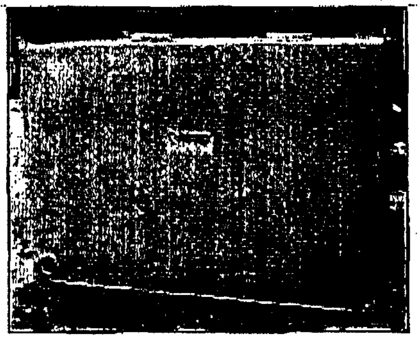
CONTAMINANT ASSESSMENT SUMMARY OF AIR GUIDE 1 ANALYSIS

CAS NUMBER	AGC ug/m3	SGC ug/m3	SUMMATION OF SHORT-TERM IMPACTS, MAXIMUM (Cav,Pt,Area) % OF SGC	SUMMATION OF CAVITY IMPACTS ACTUAL ANNUAL % OF AGC	SUMMATION OF POINT or AREA SOURCE IMPACTS POTENTIAL ANNUAL % OF AGC	SUMMATION OF POINT or AREA SOURCE IMPACTS ACTUAL ANNUAL % OF AGC
00075-01-4	0.020000000	180000.0000	0.0083	0.0000	1273.4927	1274.6227
SUMMARY TOTALS			0.0083	0.0000	1273.4927	1274.6227

Appendix B - Equipment Cut-Sheets

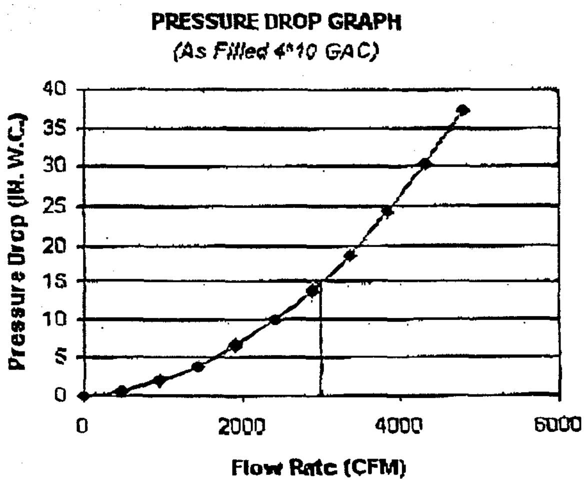
Catalog

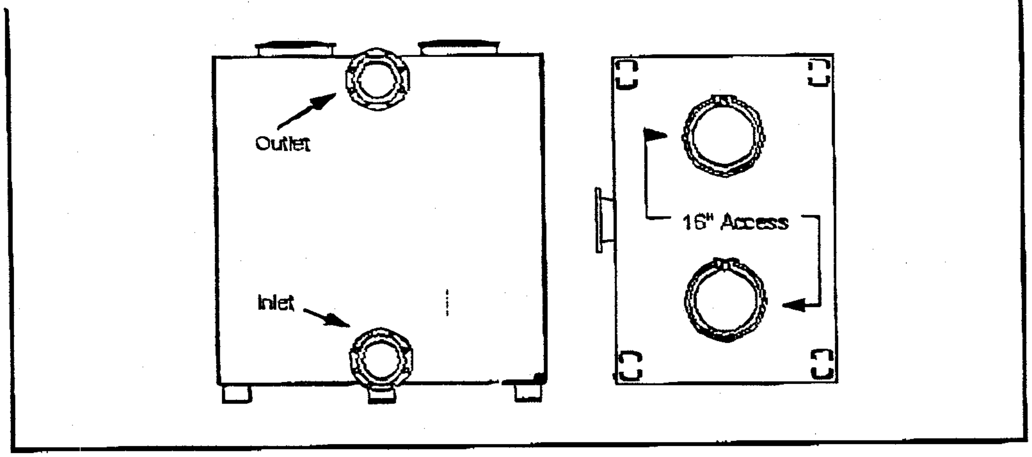
VF SERIES FILTERS
MODEL VF-5000



The VF-5000 filter is a media filter vessel designed to treat vapor streams where pressure drop is a strong concern. While the typical design application is a activated carbon adsorbtion unit, the filter can easily accommodate many medias. The sturdy construction makes these filter vessels ideal for long term treatment units. Some applications include:

- Soil Vapor Extraction Treatment
- Air Stripper Off Gas Treatment
- Odor Removal System
- Storage Tank Purge Vapor Treatment
- Pilot Study
- Industrial Process Treatment





VF-10000 SPECIFICATIONS			
Overall Height	6'8"	Vessel/Internal Piping Materials	CS/ CS (False Floor)
Footprint	6' x 8'	Internal Coating	Polyamide Epoxy Resin
Inlet / Outlet (150# FLNG)	10"	External Coating	Epoxy Mastic (Light Grey)
Drain / Vent (FNPT)	3/4"	Maximum Pressure / Temp	2 PSIG / 250° F
GAC Fill (lbs)	5000	Cross Sectional Bed Area	48 FT^2
Shipping / Operational Weight (lbs)	7,100/8,200	Bed Depth/Volume	3.7 FT / 179 FT^3

Tetrasolv Filtration, Inc. • 1200 East 26th Street • Anderson, Indiana 46016 • USA
Toll Free: 800-441-4034 Telephone: 765-643-3941 • Fax: 765-643-3949
www.tetrasolv.com - info@tetrasolv.com

DWU/DWXU

Stainless Steel Submersible Sewage Pump

Built for the Pro . . .

Ebara Dominator series sewage pumps are designed for reliable pumping of waste water with suspended solids up to 2" in diameter.

Stainless Steel construction is ideal for residential, commercial, and industrial applications. Dual seals are a standard feature, enhancing the rugged, high service factor motor design.

New manufacturing techniques make the Dominator *superior* in dependability and efficiency. Quality components are stronger, dimensionally consistent, and they weigh much less than conventional cast iron parts.

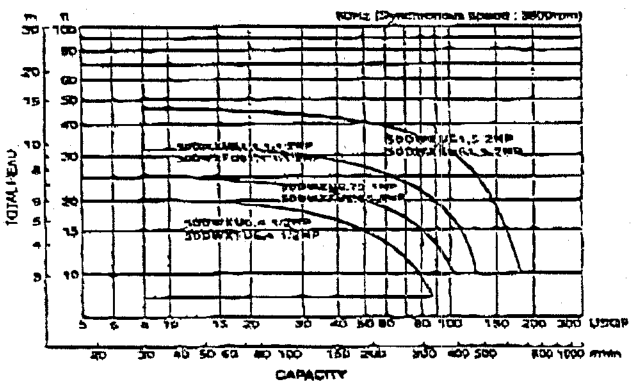
When duty requirements demand material conformance for corrosion and erosion resistance, Ebara Stainless Steel is the choice!

Ebara *guarantees* the product to be tough and reliable.

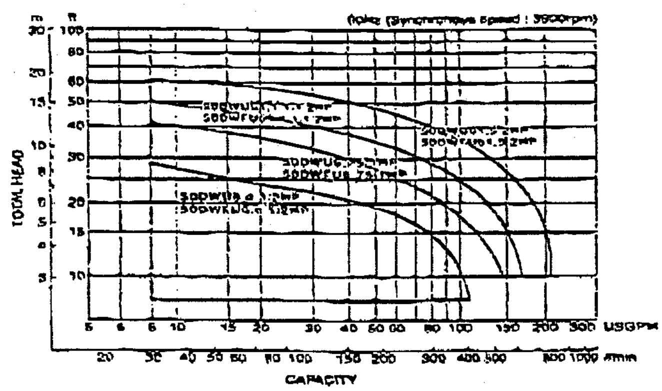
Features

- 304 stainless steel
- 2 inch solids handling
- Horsepower/kw & service factors
  - ½ horsepower/0.375 kw 1.87 SF
  - 1 horsepower/0.75 kw 1.4 SF
  - 1½ horsepower/1.1 kw 1.1 SF
  - 2 horsepower/1.5 kw 1.3 SF
- Single & three phase models – 60Hz
- Motor Type is 2 pole, dry submerged, rated continuous duty
- 25 foot power cord SOW-A/SO
- Class F motor insulation
- Max fluid temperature 104°F (40°C) continuous operation, fully submerged; 140°F (60°C) intermittent operation
- Automatic & manual operation
- Auto float switch is mechanical/non-mercury
- Discharge is NPT thread or 150 lb ANSI flange
- Double mechanical seal with viton elastomers
- Shielded ball bearings 50,000 hour
- Single channel & liquid vortex impellers
- Single phase models have thermal overloads
- Flows to 185 GPM
- Heads to 65 feet

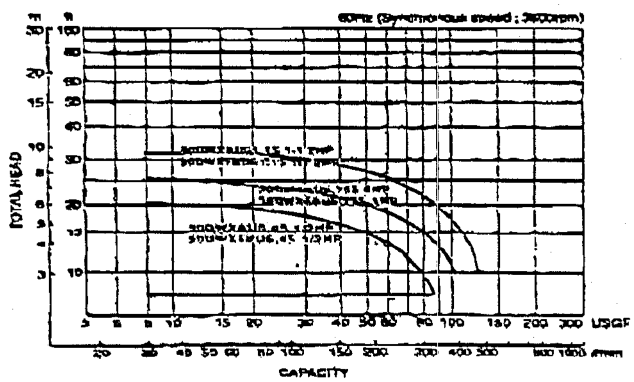
■ DWXU SELECTION CHART
- VORTEX IMPELLER
- SINGLE PHASE & THREE PHASE
- MANUAL OPERATION
- THREADED OR FLANGED DISCHARGE



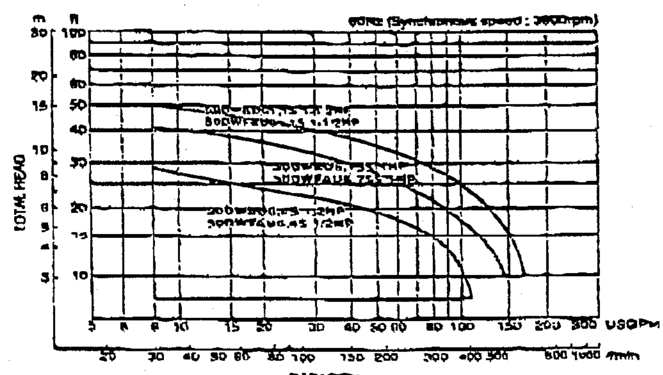
■ DWU SELECTION CHART
- SINGLE CHANNEL IMPELLER
- SINGLE PHASE & THREE PHASE
- MANUAL OPERATION
- THREADED OR FLANGED DISCHARGE



■ DWXAU SELECTION CHART
- VORTEX IMPELLER
- SINGLE PHASE
- AUTOMATIC OPERATION
- THREADED OR FLANGED DISCHARGE



■ DWAU SELECTION CHART
- SINGLE CHANNEL IMPELLER
- SINGLE PHASE
- AUTOMATIC OPERATION
- THREADED OR FLANGED DISCHARGE



EBARA

1651 Cedar Line Drive • Rock Hill, SC 29730 • Phone: (803) 327-5005 • FAX: (803) 327-5097

EBARA INTERNATIONAL CORP.

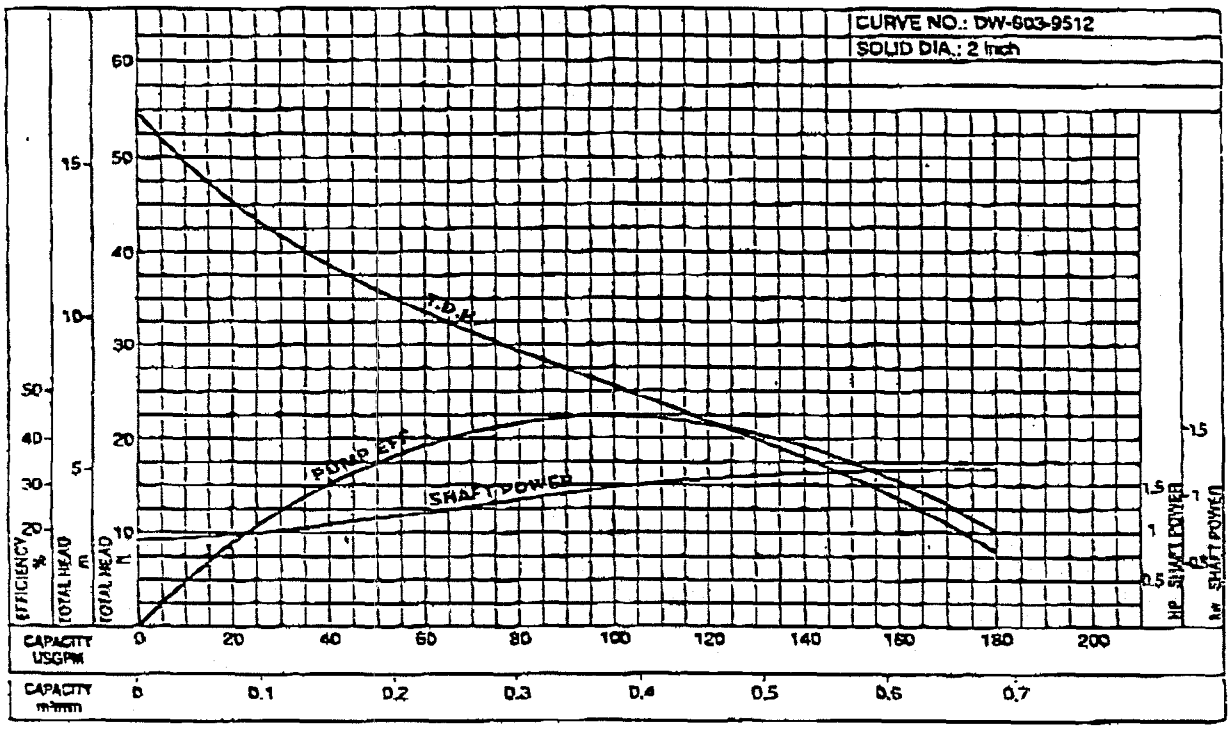
ETC-1004

EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS DWU DWXU

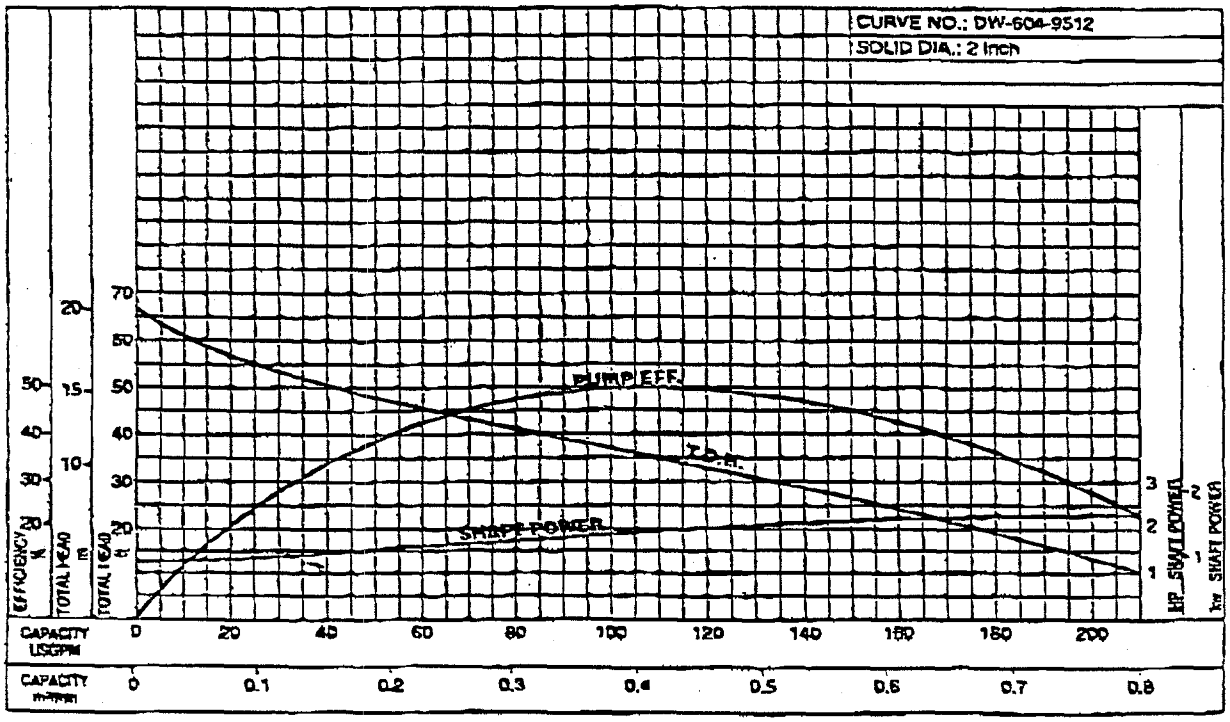
PERFORMANCE CURVES

DW-302

50DW61.1 (1-1/2HP) SYNCHRONOUS SPEED : 3600 R.P.M. 2 Inch Discharge



50DW61.5 (2HP) SYNCHRONOUS SPEED : 3600 R.P.M. 2 Inch Discharge



EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS DWXU

SPECIFICATIONS AND SELECTION CHART DW-101

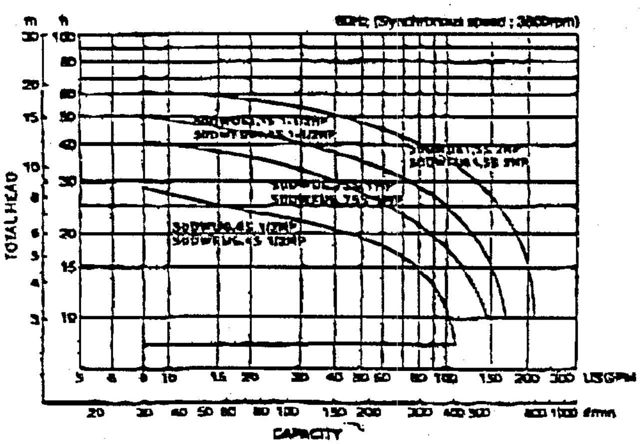
MODEL DWU, DWFU (MANUAL OPERATION PUMPS)

■ SPECIFICATIONS

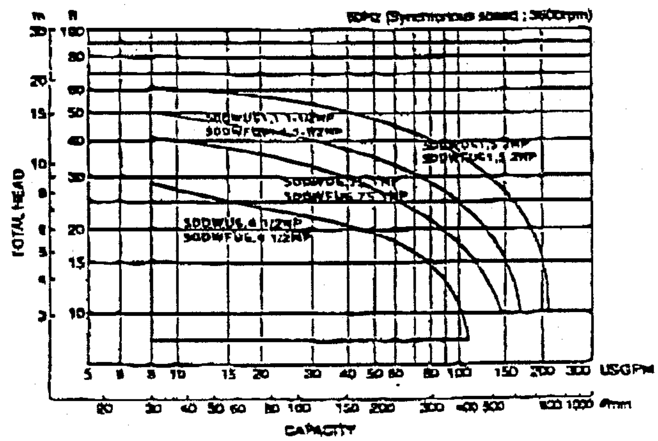
	STANDARD	OPTIONAL
Size	2 inch	
Range of HP	½ to 2HP	
Range of Performance	Capacity 8 to 210GPM Head 8 to 65ft.	
Limitation		
Maximum Water Temperature	104°F (140°C)	
Speed	3600 rpm	
Materials		
Casing	304 Stainless Steel	
Impeller	304 Stainless Steel	
Shaft	304 Stainless Steel	
Motor Frame	304 Stainless Steel	
Fastener	304 Stainless Steel	
Mechanical Seal	Double Mechanical Seal	
Materials..............Upper Side	Carbon/Ceramic	
Materials..............Lower Side	Silicon Carbide/Silicon Carbide	
Impeller Type	Single Channel	
Bearing	Prelubricated Ball Bearing	
Motor	Air-filled Motor, Insulation Class F	
Single Phase	115V (½, 1HP), 208/230V	
Three Phase	208/230, 460V	
Motor Protection	Built-in Overload Protection	
Accessories	Submersible Cable 20ft.	QDC System

■ SELECTION CHART

• SINGLE PHASE



• THREE PHASE

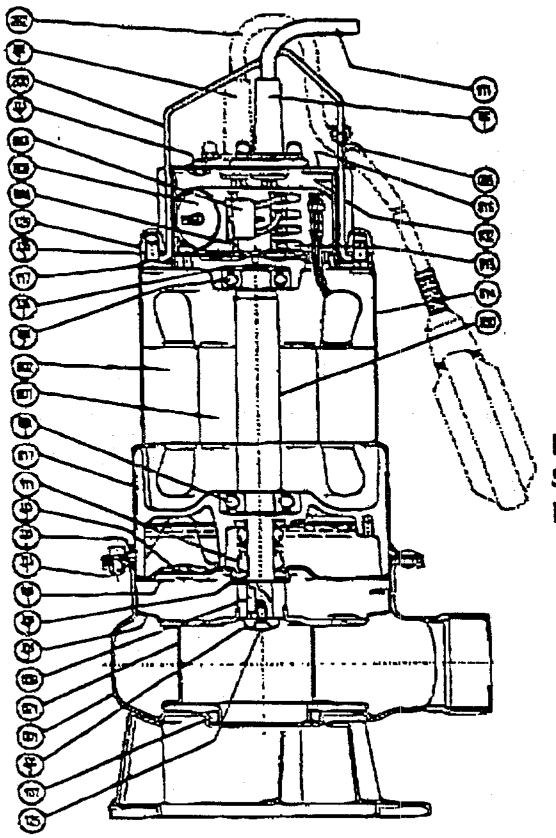


EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS DWU DWXU

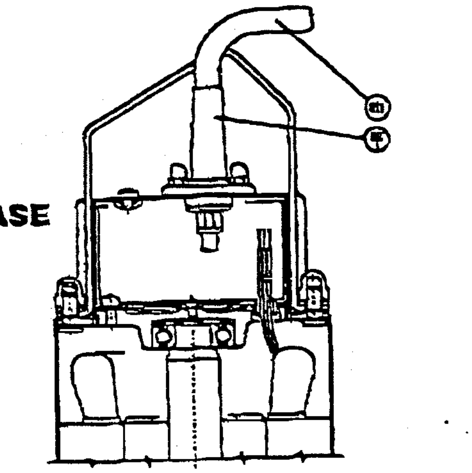
SECTIONAL VIEW

DW-501

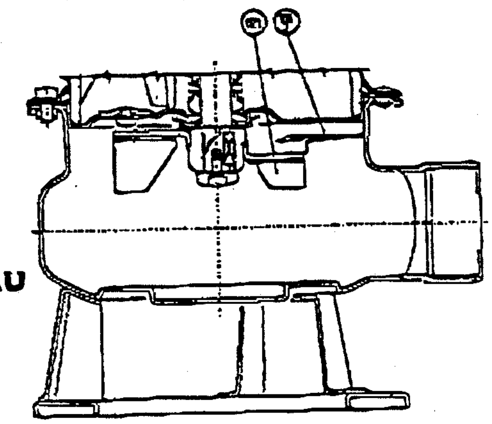
MODEL DWU, DWXU MANUAL TYPE
MODEL DWAU, DWXAU AUTOMATIC TYPE



DWU•DWAU SINGLE PHASE MOTOR



THREE PHASE MOTOR



DWXU•DWXAU

Remarks: ※Recommended spare parts.
Part No. 095. 262, 862-2 are installed only for automatic operation models.
Part No. 107 is installed only for model DW/DWA/DWF/DWFA single channel impeller.
Part No. 809 is installed only for single phase models.
Part No. 915 is installed only for three phase models.

Part No.	Part Name	Material	ASTM, AISI Code	No. for 1 Unit
001	Casing	304 S.S.	AISI 304	1
016-1	Casing Cover	304 S.S.	AISI 304	1
016-2	Disk	304 S.S.	AISI 304	1
016-3	Seal Support	304 S.S.	AISI 304	1
021	Impeller	304 S.S.	AISI 304	1
039	Key	304 S.S.	AISI 304	1
095	Float Switch Stay	—		1
107	Casing Ring	Viton		1
※111	Mechanical Seal	—		1 Set
※115-1	"O" Ring	Viton		1
※115-2	"O" Ring	Viton		1
※115-3	"O" Ring	Viton		3
※117	Gasket	Viton		1
125	Impeller Bolt	304 S.S.	AISI 304	1
129	Nut	304 S.S.	AISI 304	4
135-1	Washer	304 S.S.	AISI 304	1
135-2	Washer	304 S.S.	AISI 304	1
135-3	Washer	304 S.S.	AISI 304	4

Part No.	Part Name	Material	ASTM, AISI Code	No. for 1 Unit
200	Lifting Hanger	304 S.S.	AISI 304	1
262	Float Switch	—		1
801	Rotor	—		1
802	Stator	—		1
809	Capacitor	—		1
811	Submersible Cable	—		1
814	Motor Frame	304 S.S.	AISI 304	1
816	Bracket	304 S.S.	AISI 304	1
817	Bracket	304 S.S.	AISI 304	1
830	Shaft	304 S.S.	AISI 304	1
844	Motor Protector Bracket	Plastic		1
848	Motor Protector	—		1
※849-1	Ball Bearing	—		1
※849-2	Ball Bearing	—		1
862-1	Cable Connector	Rubber (NBR)		1
862-2	Cable Connector	Rubber (NBR)		
915	External Terminal	—		1
932	Capacitor Holder	Nylon		1

EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS

DWU
DWXU

MOTOR SPECIFICATION

DW-M001

MODEL DWU, DWAU, DWFU, DWFAU

Output		Phase	Rating			Locked Rotor Current	Insulation Class	Overload Protection	Cable					Performance Data at Rating Point		[illegible]	[illegible]
HP	kW		Voltage V	Current A	Speed RPM	A			Type	No. of Cord	[illegible]	[illegible]	Length	Efficiency %	Power Factor %	[illegible]	[illegible]
½	0.4	Single	115	8.3	3350	33.7	F	Built-In Auto Cut	SOW-A	3	1.25	#16	25	63.3	98.0	0.67	EI
			208/230	4.4/4.4	3350/3350	9.2/10.7								88.0/82.3	99.5/95.4	2.44	EI
1	0.75		115	11.1	3375	46.8					2.0	#14		74.6	99.0	0.50	EI
			208/230	6.1/6.1	3375/3375	24.7/28.5					1.25	#16		74.4/72.9	98.9/94.3	1.54	EI
1½	1.1		208/230	6.5/6.5	3380/3380	33.3/38.9								78.3/77.8	98.1/96.3	1.11	EI
2	1.5		208/230			50.0/56.0					2.0	#14		80.6/79.5	99.0/98.0	0.62	EI
½	0.4	Three	208/230	3.0/3.0	3425/3425	20.8/23.0		Built-In Thermal Switch		4	1.25	#16		72.9/78.5	72.0/62.0	4.15	EI
			460	1.28	3450	9.9								76.8	70.0	20.0	EI
1	0.75		208/230	3.75/3.75	3475/3475	27.9/32.3								80.7/80.4	81.9/73.9	2.82	EI
			460	1.9	3475	18.7								81.0	76.7	12.9	EI
1½	1.1		208/230	4.75/4.75	3500/3500	42.5/47.0								81.8/81.7	82.9/75.8	1.94	EI
			460	2.34	3475	24.4								82.6	75.4	7.36	EI
2	1.5		208/230	7.0/7.0	3475/3475	62.1/68.7								82.5/81.8	83.5/75.1	1.30	EI
			460	3.2	3475	32.5								82.0	81.3	5.52	EI

EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS DWU DWXU

ELECTRICAL DATA

DW-M008

Hz	Poles	Phase	Output (HP)	Voltage (V)	Applicable Model	
60	2	3	½ to 2	208/230	DWU	DWFU

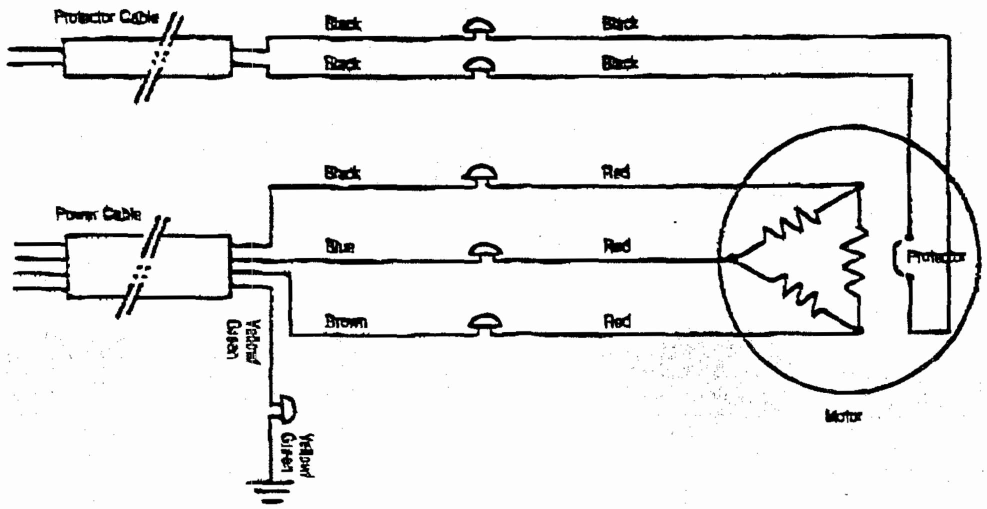
Name-Plate Rating	Item No.					
	Output (HP)	½	1	1½	2	
	Phase	3	3	3	3	
	Poles	2	2	2	2	
	Volts	208/230	208/230	208/230	208/230	
	Amperes	3.00/3.00	3.75/3.75	4.76/4.76	7.00/7.00	
	Speed	3425/3425	3475/3475	3500/3500	3475/3475	
	Insulation Class	F	F	F	F	
Capacity of Capacitor µ F	Start	—	—	—	—	
	Run	—	—	—	—	
No Load Test	Amperes	1.33/1.64	1.57/1.87	2.18/2.68	2.76/3.78	
	Watts	101/122	128/146	140/165	188/238	
Resistance at 20°C OHMS	Coil	4.15	2.82	1.942	1.301	
100% Load	Current Amp.	1.84/1.99	3.17/3.14	4.52/4.50	5.98/6.06	
	Efficiency %	78.8/76.5	80.7/80.4	81.8/81.7	82.5/81.8	
	Power Factor %	72.0/62.0	81.9/75.9	82.6/75.9	83.5/75.1	
	Speed RPM	3520/3530	3490/3510	3480	3495/3510	
Locked Rotor Torque %		592	500	440	415	
Start Current Amp.		20.8/23.0	27.9/32.3	42.6/47.0	62.1/68.7	
Vibration Micron						
Noise Phon (50 cm)						
Number Starts Per Hour		20	20	20	20	
Design Standard		NEMA (EQUIVALENT)				
Voltage Tolerance %		±5				
Frequency Tolerance %		±5				
(Ref. data Mft's Symbols)		E1	E1	E1	E1	

EBARA SUBMERSIBLE STAINLESS STEEL SEWAGE PUMPS DWU DWXU

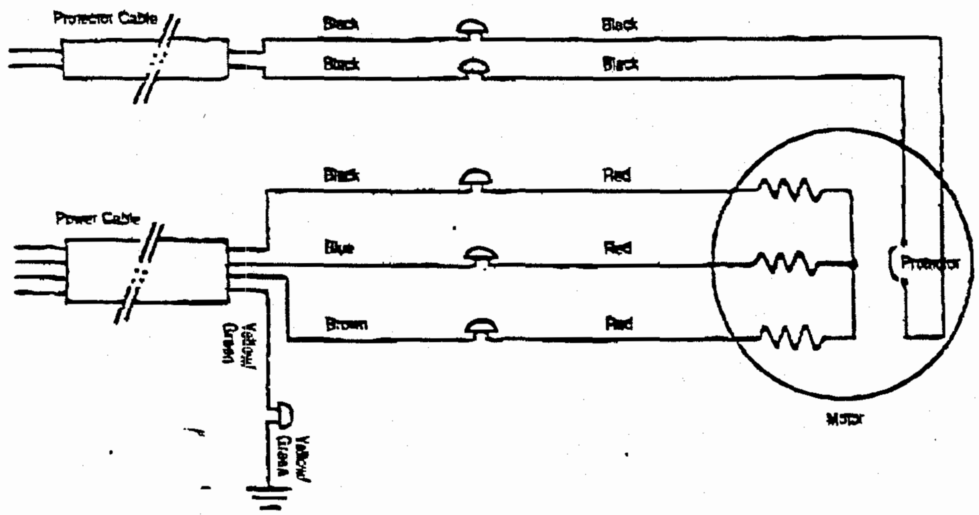
MOTOR WIRING DIAGRAM DW-M004

■ MANUAL OPERATION TYPE (Three Phase)

208/230V



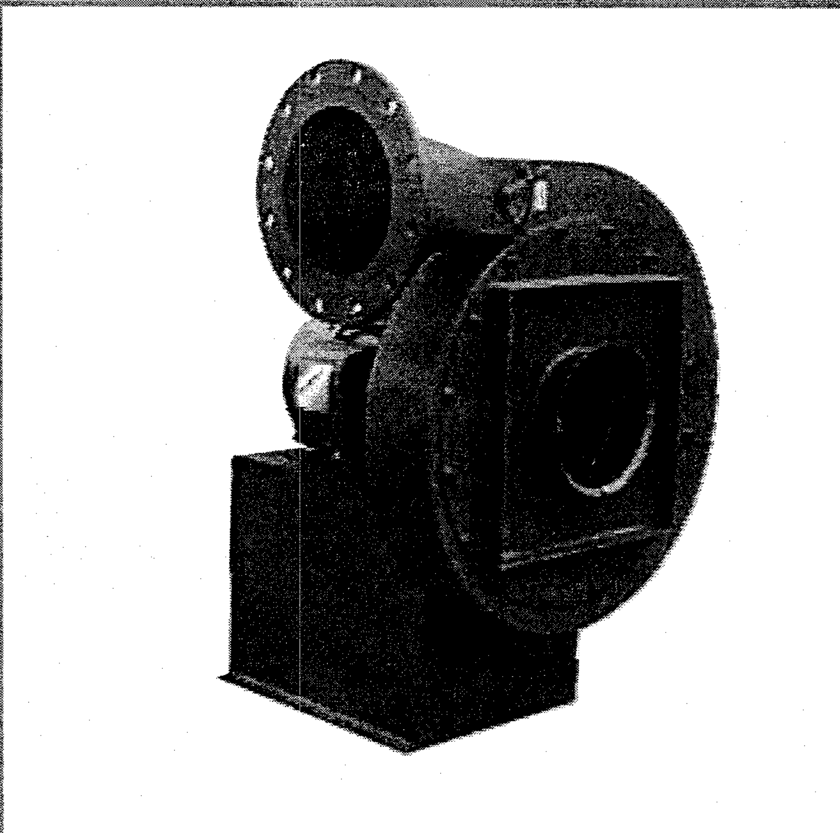
460V



Twin City Fan & Blower

BULLETIN 1250
April 2001

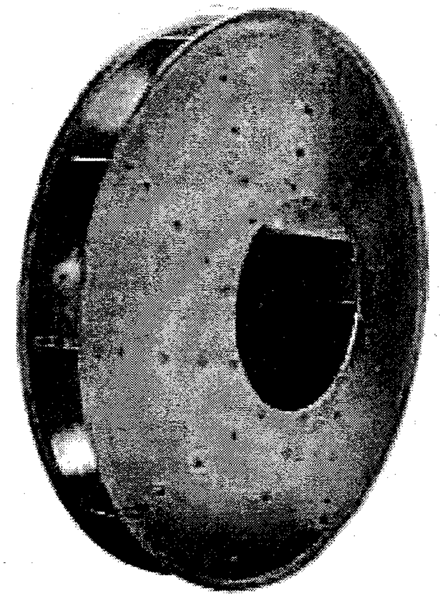
TURBO PRESSURE BLOWERS
TYPE TBNA and TBNS



TBN Turbo Pressure Blowers

Introduction

The TBN series of fans are low volume, high-pressure blowers designed for stable operation throughout their operating range. Multiple outlet sizes and wheel diameters allow the most efficient selections across a wide range of operating points. These units incorporate a high efficiency wheel design at an economical price.



TBNA Aluminum Wheel

Typical Applications

- Pneumatic conveying
- Exhausting
- Combustion air
- Air knives
- Chemical processes
- Thermal oxidation
- Aeration
- Seal air

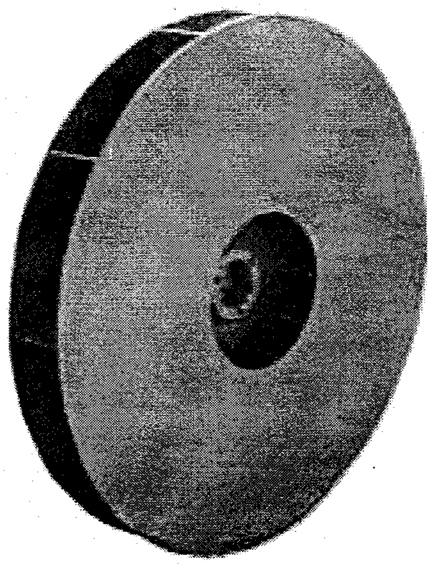
Capabilities

- Static pressures to 57" w.g.
- Airflow capabilities to 5400 CFM
- High temperature applications to 600°F

Wheel Construction

TBNA

The TBNA offers a radial air handling wheel of riveted aluminum construction. A standard split taper-lock bushing allows for easy wheel removal from shaft. This wheel is available in both narrow "N" and wide "W" widths for optimum performance and high efficiency. The TBNA is designed to handle clean air applications with temperatures up to 200°F. The TBNA wheel is a non-reversible design.



TBNS Steel Wheel

TBNS

The TBNS is an all welded radial design steel wheel that is available in a variety of special materials. The TBNS wheel is furnished with a split taper-lock bushing for easy removal and maintenance. This wheel is available in both narrow "N" and wide "W" widths to meet specific performance requirements. The TBNS is designed to handle fumes, light particulates, and temperatures up to 600°F. The TBNS design is less efficient than the TBNA and requires a BHP correction. See the table in the Engineering Data section for correction factors. The TBNS wheel is a reversible design.

Housing Construction

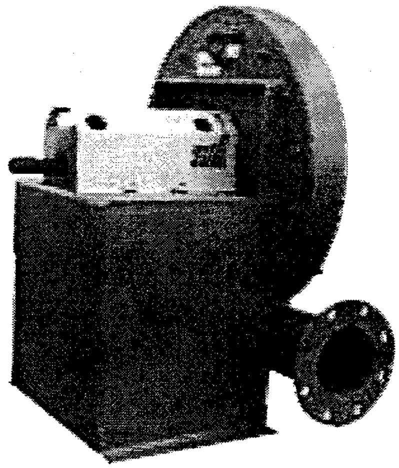
All TBN fans come standard with heavy gauge, continuously welded steel housings and pedestals for rugged, heavy duty, long term service. All housings are reversible and rotatable. TBN fans come standard with an inlet venturi with screen and a round punched flanged outlet connection.

Arrangements

Arrangement 1 (Belt Driven)

The fan wheel on an Arrangement 1 is overhung on the shaft, i.e., mounted at the end of the shaft. The motor can be mounted in any of the four AMCA standard motor positions, W, X, Y or Z. The two fan bearings are mounted on the bearing pedestal, out of the airstream.

Maximum Temperatures:
200°F Aluminum Wheel - TBNA
300°F Steel Wheel - TBNS
600°F High Temperature Construction - TBNS



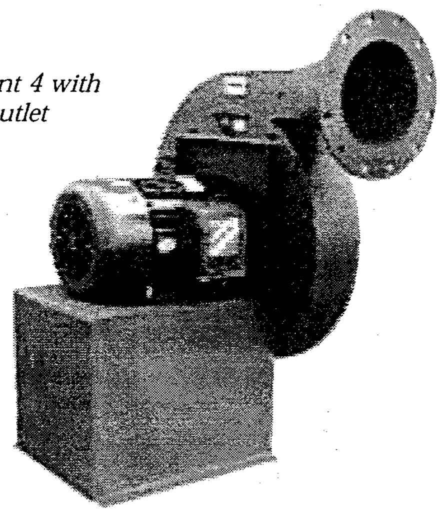
Arrangement 1 with Optional Shaft & Bearing Guard

Arrangement 4 (Direct Drive)

The fan wheel on an Arrangement 4 is mounted directly on the motor shaft with the motor mounted on a pedestal. An Arrangement 4 offers a compact, low maintenance design, as there are no fan bearings, fan shaft or drive parts to maintain.

Maximum Temperature: 180°F.

Arrangement 4 with Punched Outlet Flange

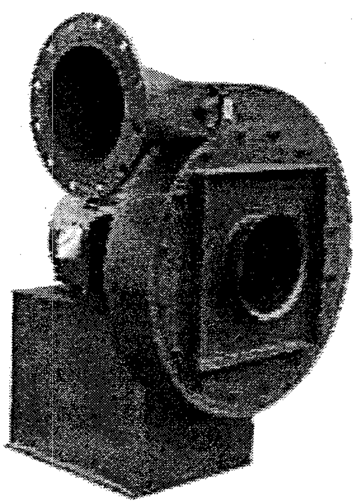


Arrangement 8 (Direct Drive)

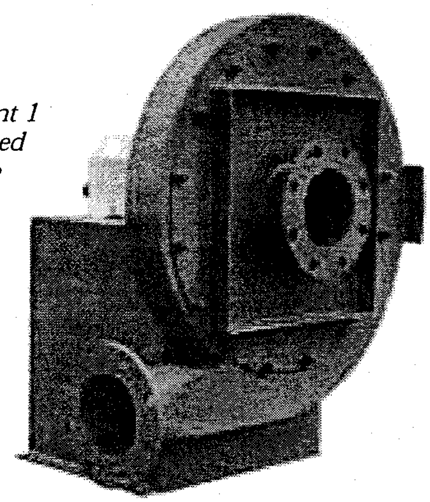
An Arrangement 8 is a modified version of an Arrangement 1 used for direct drive. The bearing pedestal is extended to accommodate the motor. A flexible coupling connects the fan and motor shaft.

Maximum Temperatures:
200°F Aluminum Wheel - TBNA
300°F Steel Wheel - TBNS
600°F High Temperature Construction - TBNS

Arrangement 4 with Inlet Venturi & Screen



Arrangement 1 with Punched Inlet Flange



Inlet and Outlet Connections/Accessories

Inlet Connections

The following inlet connections are available at no additional charge:

Inlet Venturi with Screen

Recommended for all non-ducted inlet installations to obtain catalog performance. Unless otherwise specified, an inlet venturi with screen will be furnished.

Flanged Inlet

For bolted pipe or duct connections. Flanged inlet is punched to ANSI 125/150 hole pattern.

Inlet Pipe Assembly

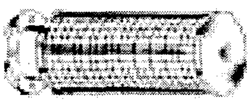
For slip-on pipe or duct connections.

Inlet Accessories

The following optional inlet side accessories are available:

Inlet Filter

Cleanable wire mesh filter with mounting assembly. Filter suitable for atmospheric air only and cannot be used in a ducted inlet application. Fan must be specified with flanged inlet.

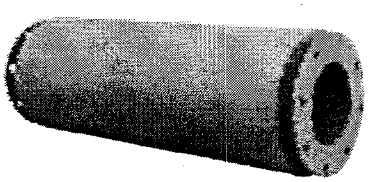


Inlet Filter With Hood

Inlet filter described above with a hood to protect against the elements.

Inlet Silencer

Welded steel construction with acoustical absorption material to reduce noise emanating from fan inlet. Flanged connection is suggested for mounting to the inlet of the fan. The opposite end of the silencer can be furnished with an inlet venturi, inlet flange, or inlet pipe assembly. Unless otherwise specified, the silencer will be furnished with flanges (punched) at both ends.



Outlet Connections

Flanged Outlet

Outlet flange punched to ANSI 125/150 hole pattern for bolted connection is standard.

Plain Pipe Outlet

An optional plain pipe outlet is available for slip type connections. Refer to the dimensional drawings.

Outlet Accessories

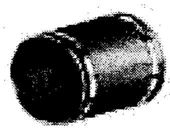
The following optional outlet side accessories are available:

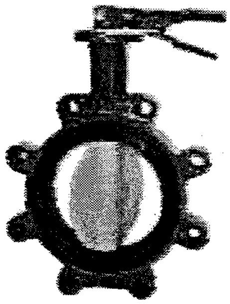
Flexible Connector for Flanged Outlet

Companion flange with rubber sleeve and clamps offers flexible connection between the fan and outlet ductwork. Flexible rubber sleeve is good to 200°F operation.

Flexible Connector for Plain Pipe Outlet

Rubber sleeve with clamps for fans ordered with optional plain pipe outlet.



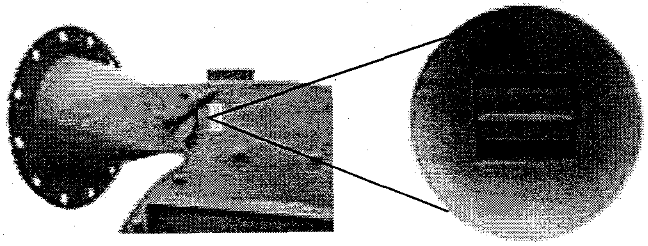


Outlet Blast Gate

A wafer-type butterfly valve for mounting to outlet flange allows controlling flow to full shutoff. Available for automatic control. Maximum temperature 250°F.

Built-in Outlet Damper

A low cost single blade damper installed near the discharge of the fan housing for volume control where moderate leakage can be allowed. Available for manual control only.



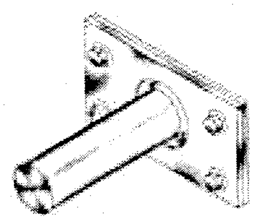
Outlet Silencer

Reduces noise emanating from fan outlet. Construction similar to inlet silencer.

Accessories

Shaft Closure Plate
Aluminum plate to reduce air leakage from the fan housing.

Shaft Seal
Standard shaft seal is a ceramic felt material sandwiched between the housing and an aluminum retaining plate. Seal is good to 600°F. Shaft seal does not make fan gas tight.



Drain
Standard ¾" NPT half coupling located at the lowest point of the housing. Available with or without plug.

Inspection Port
Heavy duty bolted panel provides access for wheel inspection.

Shaft & Bearing Guards
OSHA style to enclose the shaft and bearings. Painted safety yellow.

Belt Guards
OSHA style to enclose the V-belt drive. Painted safety yellow.

Coupling Guards
OSHA style to enclose the coupling. Painted safety yellow.

Unitary Base
Steel structural base for mounting fan and motor on common structure.

Isolation Base
Unitary base with 1" deflection isolators. Not recommended for Arr. 8.

Inertia Base
Steel structural base complete with 1" deflection isolators and rebar. Concrete by others. Available for all arrangements.

Vibration Rails
Available for Arrangement 4 with RIS isolators.

Motors
Twin City Fan & Blower provides and recommends 3600 RPM motors with cast housings and cast feet or with a full length fabricated steel base for trouble-free operation.

Optional Construction

High Temperature Construction
Available for Model TBNS only.

301 to 500°F — Package includes shaft seal, shaft cooler with guard, high temperature grease, and TCF blue enamel paint.

501 to 600°F — Package includes shaft seal, shaft cooler with guard, high temperature grease, and high temperature aluminum paint.

Special Materials — Stainless steel and other special alloys are available in the type TBNS radial design.

Spark Resistant Construction
Available for Model TBNA only. Fan applications may involve the handling of fumes or vapors. Such applications require careful consideration by the system designer to insure the safe handling of such gases. Twin City Fan & Blower offers the following classifications of spark resistant construction per AMCA Standard 99-0401-86. It is the specifier's or the user's responsibility to specify the type of spark resistant construction with full recognition of the potential hazards and the degree of protection required.

Construction

Type A — All parts of the fan in contact with the airstream must be made of nonferrous material — usually aluminum and limited to 200°F.

Type B — The fan shall have a nonferrous wheel and nonferrous rub ring about the opening through which the shaft passes — usually aluminum wheel and rub ring and limited to 200°F.

Type C — Not available.

Engineering Data

Steel Wheel (TBNS) Horsepower Correction Factors

(Increase BHP from curves when using steel wheel)

SIZE	BHP CORRECTION FACTOR
14N to 18N	1.03
14W to 18W	1.09
19N to 22N	1.14
19W to 22W	1.12
23N to 26N	1.10
23W to 26W	1.10

Pressure Conversions

MULTIPLY	BY	TO OBTAIN
PSI	27.7123	IN. W.G.
PSI	16	OSI
OSI	1.732	IN. W.G.
OSI	0.0625	PSI
IN. W.G.	0.57737	OSI
IN. W.G.	0.03609	PSI

PSI = Pounds per square inch
OSI = Ounces per square inch
In. W.G. = Inches water gauge

Wheel Weights and WR^2 (moment of inertia in $lb\text{-}ft^2$)

SIZE	WHEEL			
	TBNA (ALUMINUM)		TBNS (STEEL)	
	WT. (LB)	WR^2 (LB-FT²)	WT. (LB)	WR^2 (LB-FT²)
14N	10.5	3.3	13.1	1.9
14W	10.5	4.0	12.8	2.0
15N	10.6	3.4	14.6	2.5
15W	10.6	4.1	14.6	2.7
16N	10.7	3.5	16.2	3.2
16W	10.7	4.2	16.5	3.4
17N	10.8	3.7	18.0	4.0
17W	10.9	4.5	18.5	4.3
18N	11.0	3.9	19.8	5.0
18W	11.1	4.7	20.5	5.4
19N	14.7	8.1	21.7	6.1
19W	14.9	9.7	22.0	6.4
20N	14.8	8.4	23.7	7.4
20W	15.2	10.1	24.1	7.8
21N	15.0	8.8	25.8	8.9
21W	15.5	10.6	26.4	9.5
22N	15.2	9.3	28.0	10.7
22W	15.8	11.2	28.8	11.3
23N	19.8	16.8	43.2	19.3
23W	21.1	21.6	43.9	20.3
24N	20.1	17.5	46.8	22.7
24W	21.5	22.5	47.8	24.1
25N	20.3	18.2	50.6	26.6
25W	21.9	23.4	51.9	28.2
26N	20.5	19.0	54.5	31.0
26W	22.3	24.4	56.1	32.9

Material Specifications

SIZE	HOUSING			MOTOR BASE	SHAFT DIA.	BEARING CODE	MAX. RPM	
	SIDES	SCROLL	FRAME		ARR. 1 & 8	ARR. 1 & 8	TBNA	TBNS ①
14 to 18	10 GA.	10 GA.	0.25" x 2"	0.25"	1³/₁₆	XHDB	4000	4000
19 to 22	10 GA.	10 GA.	0.25" x 2"	0.25"	1⁷/₁₆	RB	3900	3900
23 to 26	10 GA.	10 GA.	0.25" x 2"	0.25"	1⁷/₁₆	RB	3800	3600

① Derating of speed is not required for stainless steel or high temperature construction.

Due to speed and load ratings, bearing substitution is not permitted.
XHDB = Extra heavy duty ball bearings such as Link Belt P-U319
RB = Roller bearings such as Link Belt PB22423

Bare Fan Weights (Lbs.)

SIZE	ARRANGEMENT 1		ARRANGEMENT 4		ARRANGEMENT 8	
	TBNA	TBNS	TBNA	TBNS	TBNA	TBNS
14N to 18N	202	212	185	195	282	292
14W to 18W	218	230	201	213	298	310
19N to 22N	278	292	252	266	395	409
19W to 22W	335	351	309	325	452	468
23N to 26N	392	432	366	406	524	564
23W to 26W	445	473	419	447	577	605

Inlet Suction Pressure Correction

If the inlet pressure is suction or negative, the static pressure required must be corrected by the inlet density ratio.

Example: Operating conditions: 70°F at sea level. System resistance at the inlet of the fan is 40".

The correction factor from the table at right is 0.902, or it can be calculated as follows:

$$(407.5 - 40") \div 407.5 = 0.902$$

Equivalent static pressure to be used for selection from the standard performance curves:

$$40" \div 0.902 = 44.36"$$

Actual air density at the inlet of the fan:

$$0.075\ lb/ft^3 \times 0.902 = 0.0676\ lb/ft^3$$

Inlet Suction Pressure Correction Factors

INLET SUCTION PRESSURE (IN. W.G.)	CORRECTION FACTOR	INLET SUCTION PRESSURE (IN. W.G.)	CORRECTION FACTOR
5	0.988	35	0.914
10	0.975	40	0.902
15	0.963	45	0.890
20	0.951	50	0.877
25	0.939	55	0.865
30	0.926	60	0.853

Correction Factor = (407.5 – Inlet Suction Pressure) ÷ 407.5

Performance Data

Selection

The performance curves shown are for type TBNA and are based on standard air density: 70°F at sea level (0.075 lb/ft^3). A brake horsepower correction factor must be applied for type TBNS (see page 6).

Selection Steps

1. Locate the CFM required on the horizontal axis.
2. Follow a vertical line up to the fan curve closest to the required SP. This will determine the fan size. The dotted lines represent system characteristic curves.
3. Interpolate BHP.

Selection Example:

Size = 22N4	RPM = 3500
Density = 0.075 lb/ft^3	Outlet Velocity = 5727 FPM
CFM = 500	BHP (TBNA) = 4.85
SP = 33.8"	BHP (TBNS) = 4.85 x 1.14 = 5.53

Model Nomenclature

TBNA 20 N 4

MODEL
TBNA – Aluminum wheel
TBNS – Steel wheel (apply BHP correction factors from page 6)

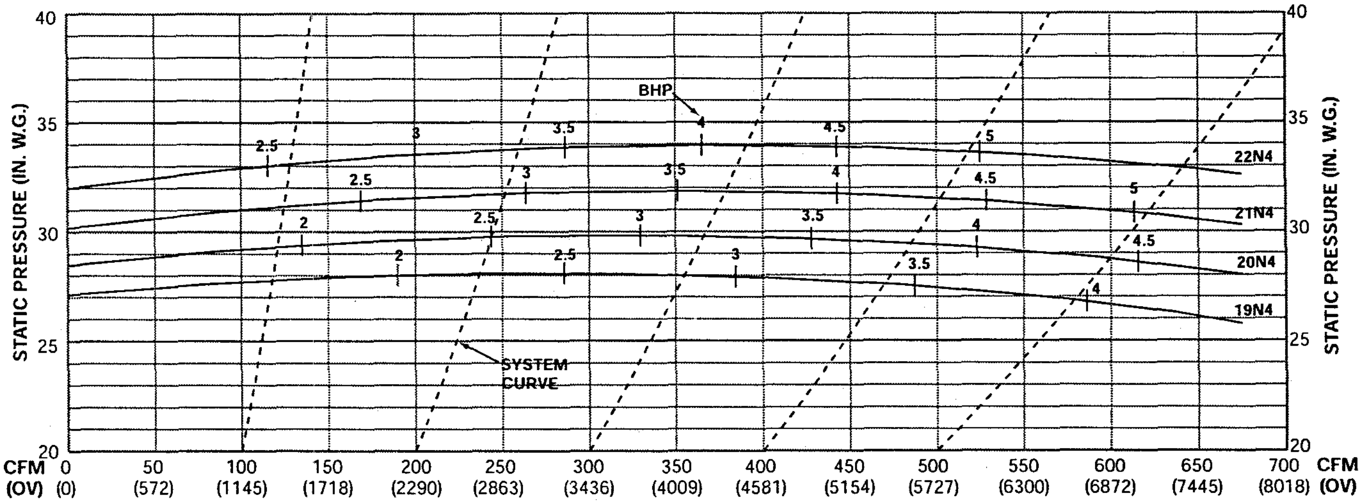
WHEEL DIAMETER (IN.)
14 17 20 23 26
15 18 21 24
16 19 22 25

WHEEL WIDTH
N – Narrow
W – Wide

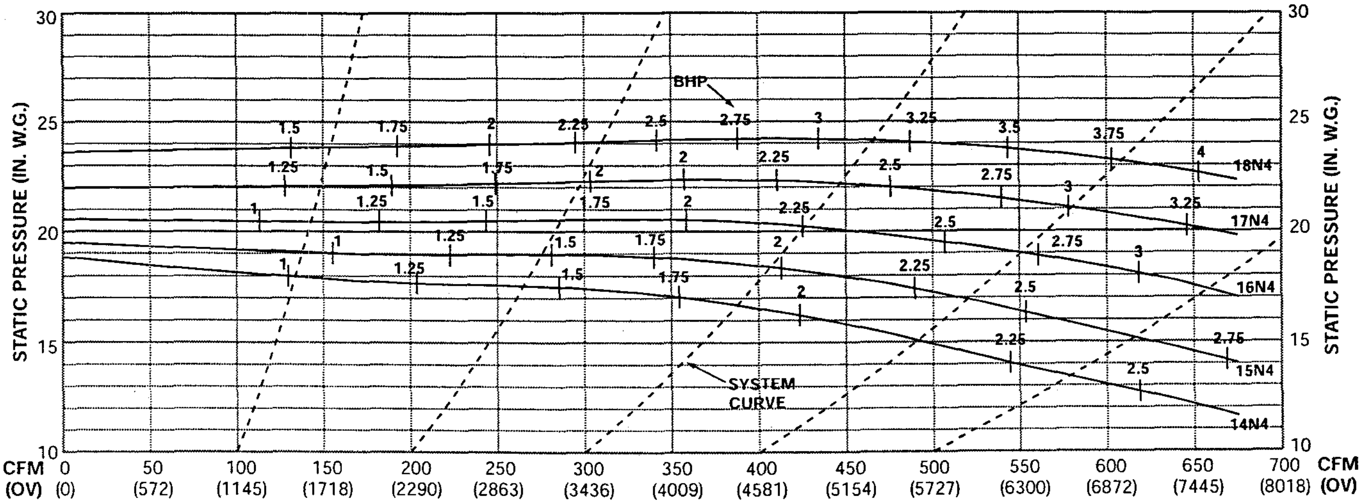
OUTLET SIZE (IN.)
4 6 8
10 12

4 In. Outlet — Outlet Area: 0.09 ft^2

19N4, 20N4, 21N4, 22N4 — 3500 RPM

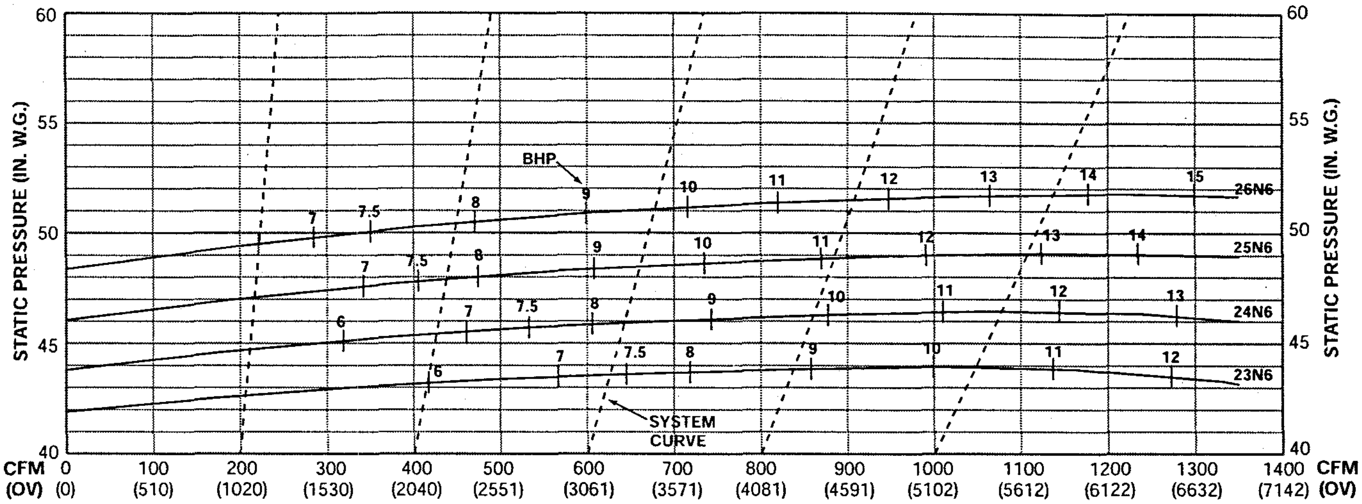


14N4, 15N4, 16N4, 17N4, 18N4 — 3500 RPM

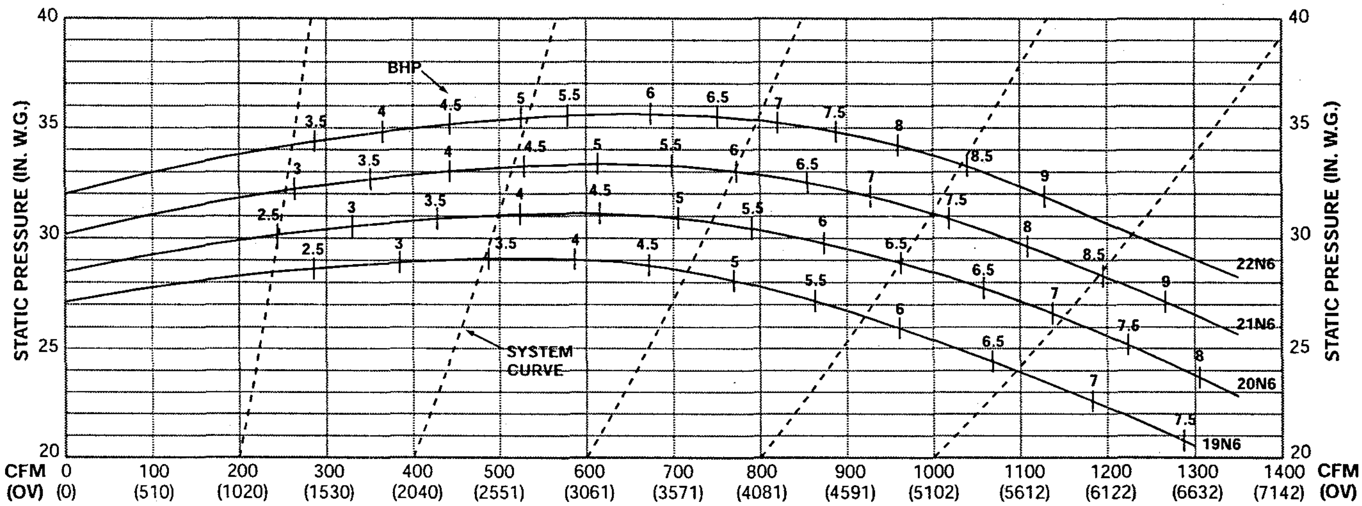


Performance shown is with a ducted outlet, and a ducted inlet or inlet with venturi.

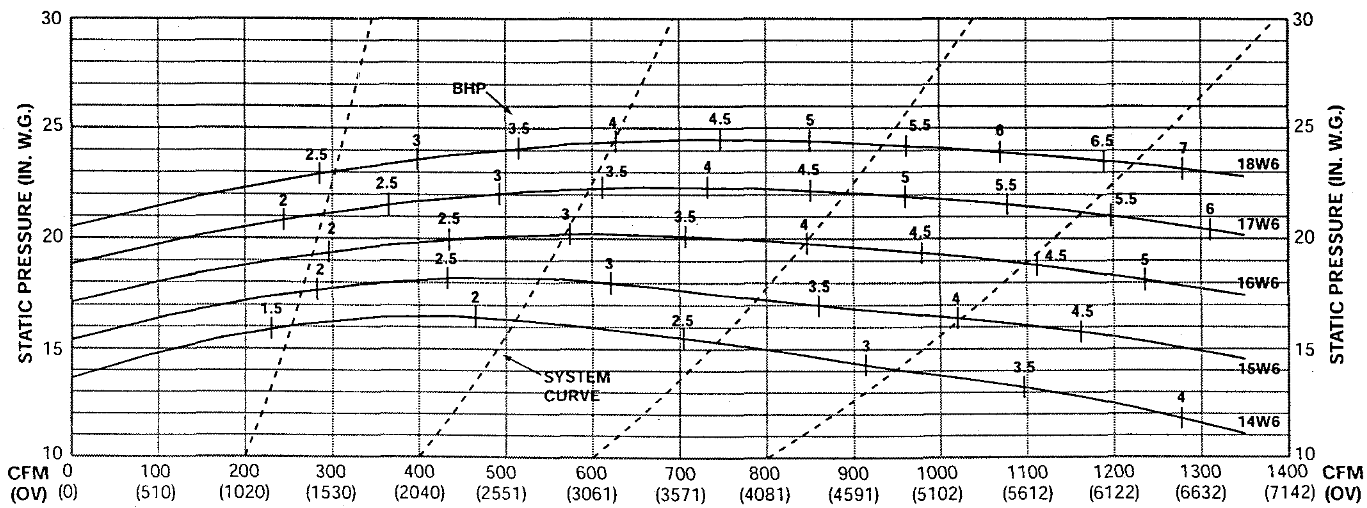
23N6, 24N6, 25N6, 26N6 — 3500 RPM



19N6, 20N6, 21N6, 22N6 — 3500 RPM



14W6, 15W6, 16W6, 17W6, 18W6 — 3500 RPM



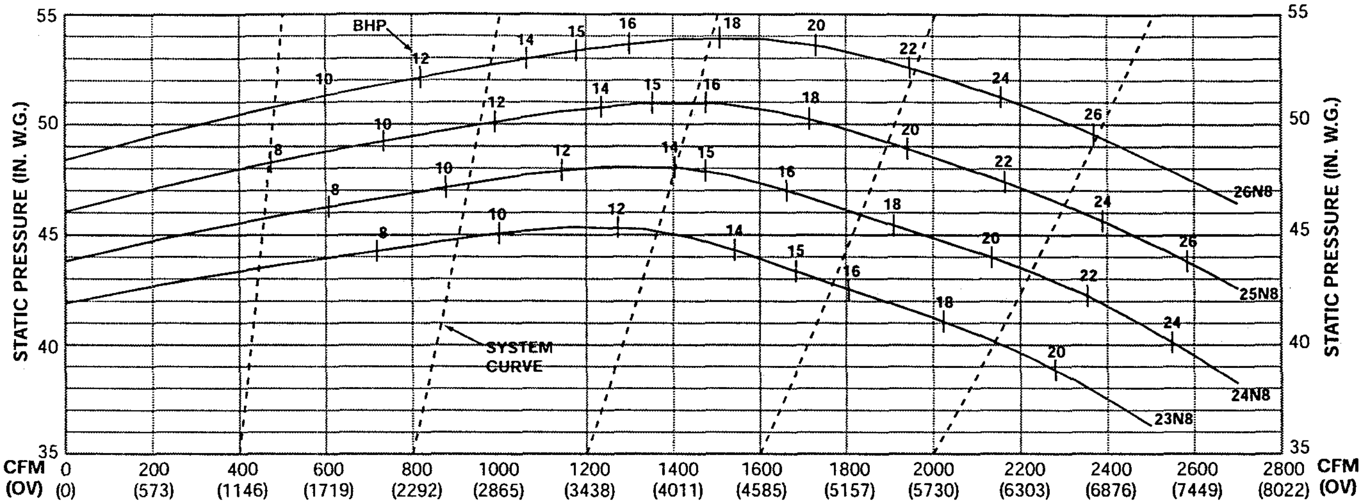
Performance shown is with a ducted outlet, and a ducted inlet or inlet with venturi.

8 In. Outlet

Outlet Area: 0.35 ft²

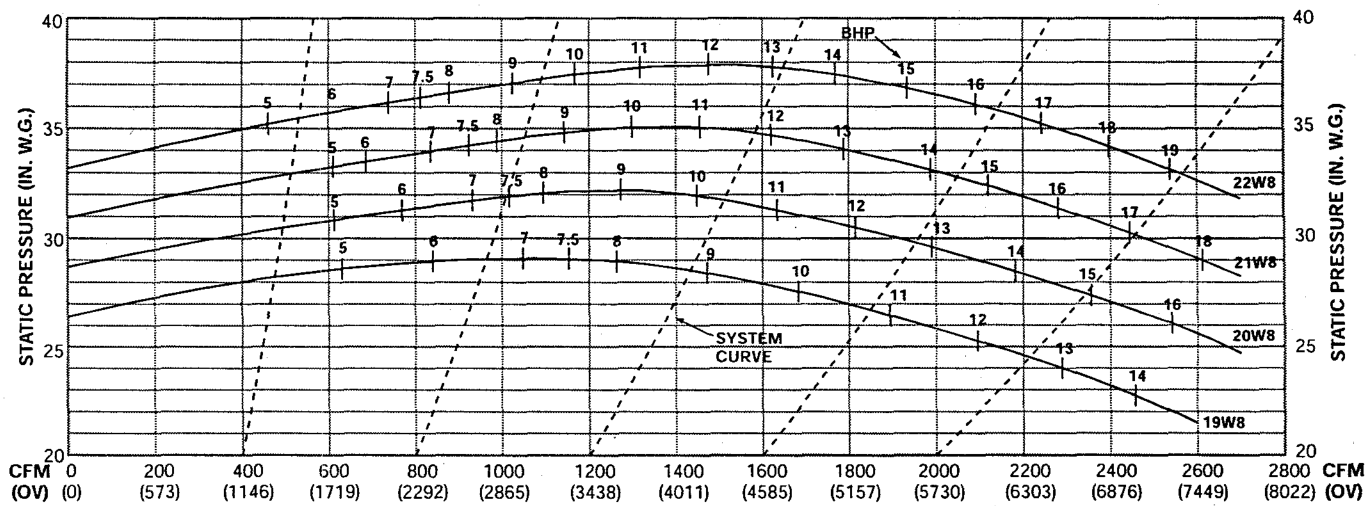
23N8, 24N8, 25N8, 26N8

3500 RPM



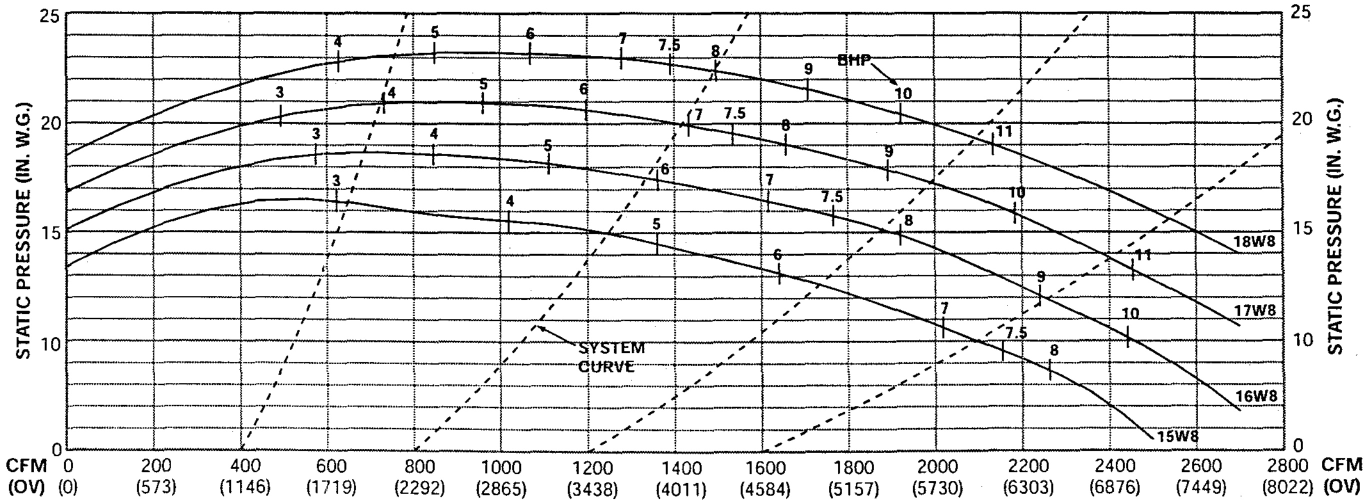
19W8, 20W8, 21W8, 22W8

3500 RPM



15W8, 16W8, 17W8, 18W8

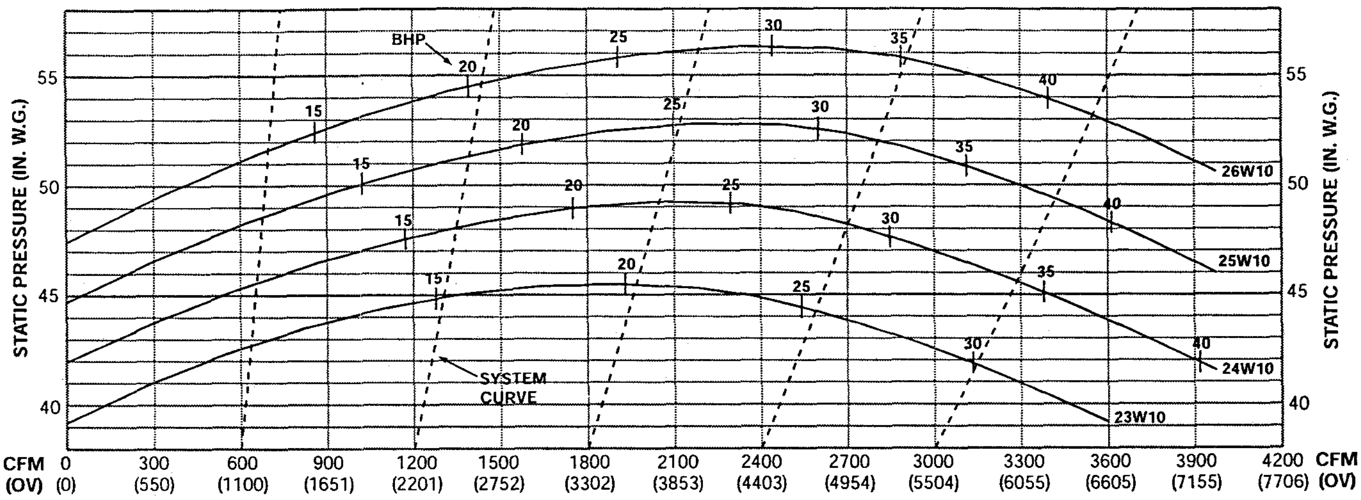
3500 RPM



Performance shown is with a ducted outlet, and a ducted inlet or inlet with venturi.

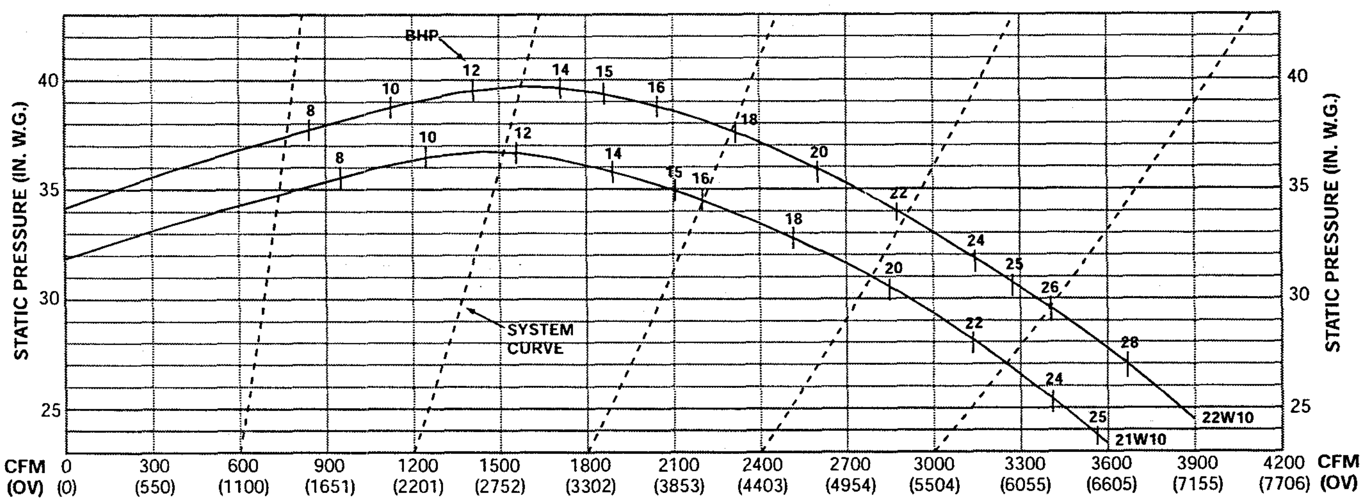
23W10, 24W10, 25W10, 26W10

3550 RPM



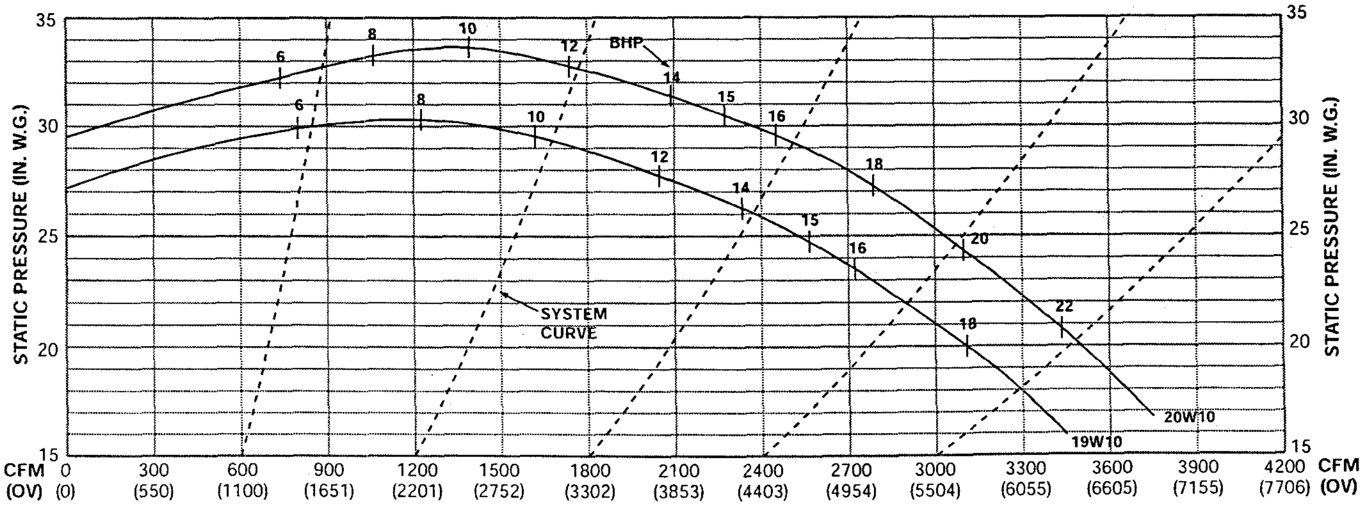
21W10, 22W10

3550 RPM



19W10, 20W10

3550 RPM



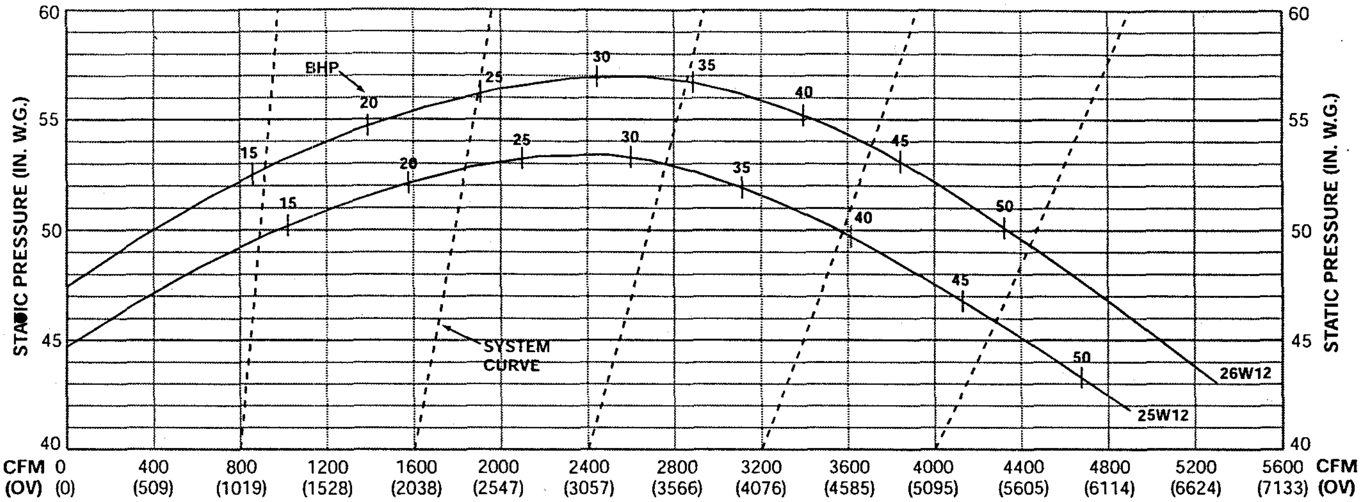
Performance shown is with a ducted outlet, and a ducted inlet or inlet with venturi.

12 In. Outlet

Outlet Area: 0.79 ft^2

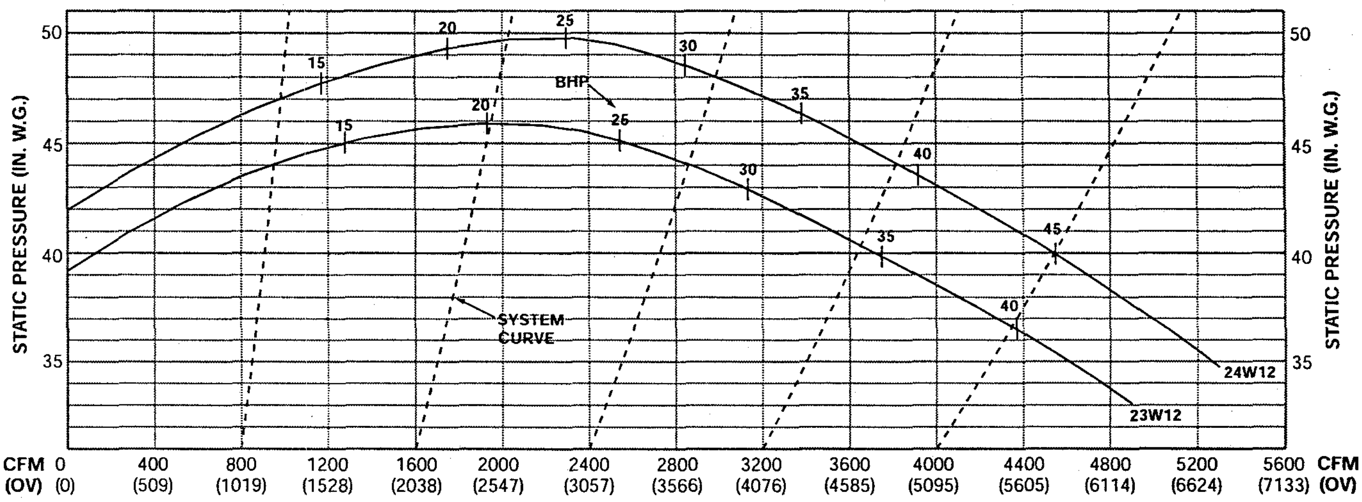
25W12, 26W12

3550 RPM

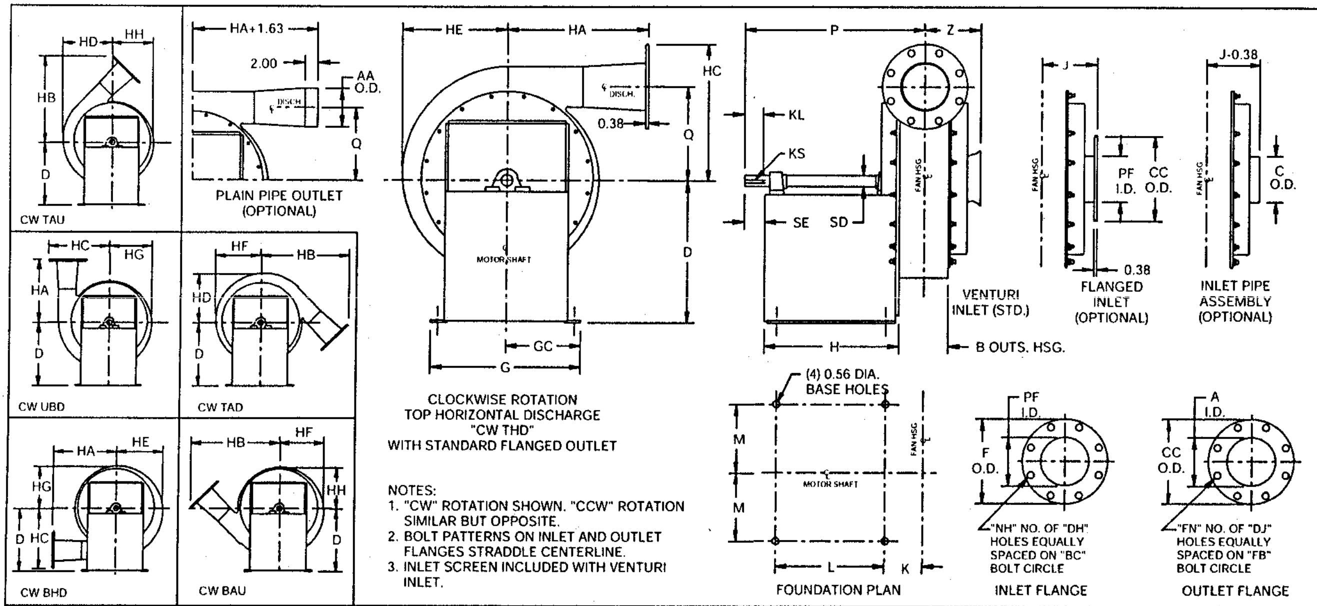


23W12, 24W12

3550 RPM



Performance shown is with a ducted outlet, and a ducted inlet or inlet with venturi.



TYPE "TBNA" AND "TBNS" ARR. 1 SWSI ROTATABLE | DRAWN 12/20/99

TWIN CITY FAN & BLOWER
MINNEAPOLIS, MINNESOTA 55442

REVISED 2/14/01
DWG. No. BC1617/B

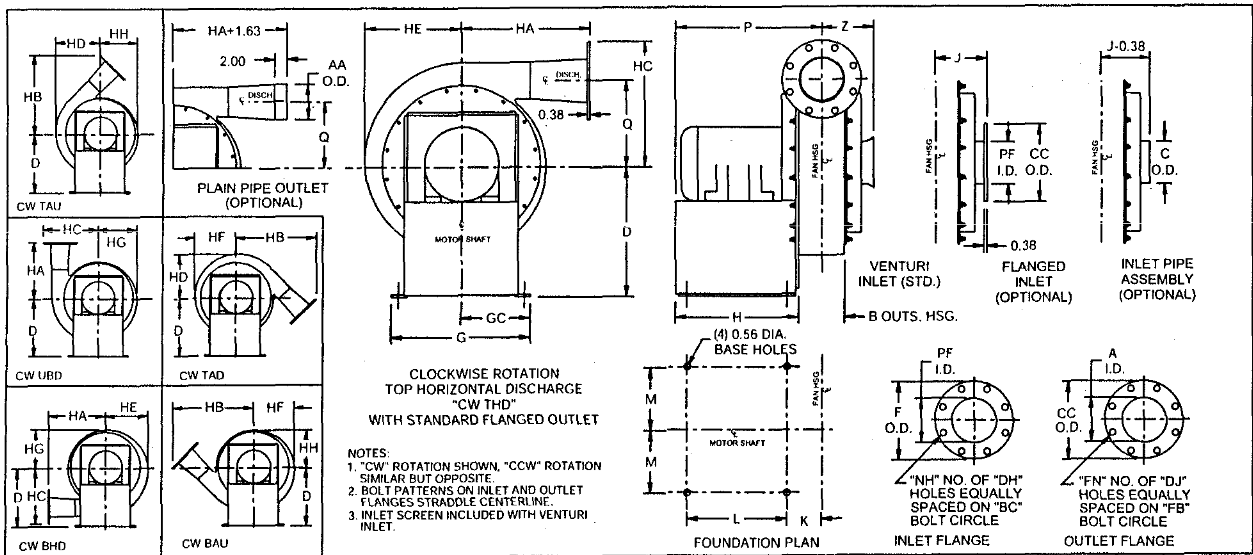
JOB:
LOC.:
S.O. NO.:
CERT. BY:

SIZE	DISCH	ROT	UNIT#		
CFM	SP	RPM	BHP	OV	TS

ACCESSORIES REQ'D

SIZE	A	AA	B	BC	C	CC	D	DH	DJ	F	FB	FN	G	GC	H	HA	HB	HC	HD	HE	HF	HG	HH	J	K	KL	KS	L	M	NH	P	PF	Q	SD	SE	Z
14N4, 15N4 16N4, 17N4, 18N4	4.00	4.50	3.88	9.50	6.63	9.00	17.75	0.88	0.75	11.00	7.50	8	19.50	9.75	11.63	18.25	24.44	16.31	14.00	13.63	13.19	12.75	12.31	5.63	3.38	2.38	.25x.13	8.63	8.88	8	16.19	6.00	11.75	1.19	2.63	4.56
14W6, 15W6 16W6, 17W6, 18W6	6.00	6.63	6.25	11.75	8.63	11.00	17.75	0.88	0.88	13.50	9.50	8	19.50	9.75	11.63	18.25	25.13	17.31	14.00	13.63	13.19	12.75	12.31	6.75	4.50	2.38	.25x.13	8.63	8.88	8	17.38	8.00	11.75	1.19	2.63	6.38
15W8, 16W8 17W8, 18W8	8.00	8.63	6.25	11.75	8.63	13.50	17.75	0.88	0.88	13.50	11.75	8	19.50	9.75	11.63	18.25	26.00	18.56	14.00	13.63	13.19	12.75	12.31	6.75	4.50	2.38	.25x.13	8.63	8.88	8	17.38	8.00	11.75	1.19	2.63	6.38
19N4, 20N4 21N4, 22N4	4.00	4.50	3.88	9.50	6.63	9.00	23.00	0.88	0.75	11.00	7.50	8	23.50	11.75	17.13	17.75	26.25	19.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	3.25	.38x.19	14.13	10.88	8	23.06	6.00	14.88	1.44	4.00	4.56
19N6, 20N6 21N6, 22N6	6.00	6.63	3.88	9.50	6.63	11.00	23.00	0.88	0.88	11.00	9.50	8	23.50	11.75	17.13	17.75	26.94	20.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	3.25	.38x.19	14.13	10.88	8	23.06	6.00	14.88	1.44	4.00	4.56
19W8, 20W8 21W8, 22W8	8.00	8.63	6.25	11.75	8.63	13.50	23.00	0.88	0.88	13.50	11.75	8	23.50	11.75	17.13	17.75	27.88	21.63	17.00	16.50	16.00	15.50	15.00	6.75	4.50	3.25	.38x.19	14.13	10.88	8	24.13	8.00	14.88	1.44	3.88	6.38
19W10, 20W10 21W10, 22W10	10.00	10.75	6.25	14.25	8.63	16.00	23.00	1.00	1.00	16.00	14.25	12	23.50	11.75	17.13	21.75	31.56	22.88	17.00	16.50	16.00	15.50	15.00	6.75	4.50	3.25	.38x.19	14.13	10.88	12	24.13	10.00	14.88	1.44	3.88	6.38
23N6, 24N6 25N6, 26N6	6.00	6.63	5.00	11.75	8.63	11.00	24.00	0.88	0.88	13.50	9.50	8	23.50	11.75	17.13	19.00	29.81	23.13	20.00	19.50	18.88	18.25	17.69	7.00	3.88	3.88	.38x.19	14.13	10.88	8	24.13	8.00	17.63	1.44	4.50	5.25
23N8, 24N8 25N8, 26N8	8.00	8.63	5.00	11.75	8.63	13.50	24.00	0.88	0.88	13.50	11.75	8	23.50	11.75	17.13	19.00	30.69	24.38	20.00	19.50	18.88	18.25	17.69	7.00	3.88	3.88	.38x.19	14.13	10.88	8	24.13	8.00	17.63	1.44	4.50	5.25
23W10, 24W10 25W10, 26W10	10.00	10.75	7.25	14.25	10.75	16.00	24.00	1.00	1.00	16.00	14.25	12	23.50	11.75	17.13	23.00	34.38	25.63	20.00	19.50	18.88	18.25	17.69	7.25	5.00	3.88	.38x.19	14.13	10.88	12	25.25	10.00	17.63	1.44	4.50	6.88
23W12, 24W12 25W12, 26W12	12.00	12.75	7.25	17.00	10.75	19.00	24.00	1.00	1.00	19.00	17.00	12	23.50	11.75	17.13	23.00	35.44	27.13	20.00	19.50	18.88	18.25	17.69	7.25	5.00	3.88	.38x.19	14.13	10.88	12	25.25	12.00	17.63	1.44	4.50	6.88

DIMENSIONS ARE NOT TO BE USED FOR CONSTRUCTION. CERTIFIED DRAWINGS AVAILABLE UPON REQUEST.



TYPE "TBNA" AND "TBNS" ARR. 4 SWSI ROTATABLE

DRAWN 11/2/99

TWIN CITY FAN & BLOWER
MINNEAPOLIS, MINNESOTA 55442

REVISED 2/14/01

DWG. No. BC16176B

JOB

LOC

S.O. NO.

CERT BY:

SIZE	DISCH	ROT	UNIT #		
CFM	SP	RPM	BHP	OV	TS

ACCESSORIES REQ'D

SIZE	MOTOR FR	A	AA	B	BC	C	CC	D	DH	DJ	F	FB	FN	G	GC
14N4, 45N 15N4, 17N4, 18N4	143T & 145T 182T & 184T	4.00	4.50	3.88	9.50	6.63	9.00	17.75 19.00	0.88	0.75	11.00	7.50	8	19.50	9.75
14W6, 15W6 16W6, 17W6, 18W6	143T & 145T 182T & 184T	6.00	6.63	6.25	11.75	8.63	11.00	17.75 19.00	0.88	0.88	13.50	9.50	8	19.50	9.75
15W8, 16W8 17W8, 18W8	182T & 184T 213T & 215T	8.00	8.63	6.25	11.75	8.63	13.50	19.00 19.75	0.88	0.88	13.50	11.75	8	19.50	9.75
19N4, 20N4 21N4, 22N4	145T 182T & 184T	4.00	4.50	3.88	9.50	6.63	9.00	23.00 24.00	0.88	0.75	11.00	7.50	8	23.50	11.75
19N6, 20N6 21N6, 22N6	182T & 184T 213T & 215T	6.00	6.63	3.88	9.50	6.63	11.00	24.00 24.75	0.88	0.88	11.00	9.50	8	23.50	11.75
19W8, 20W8 21W8, 22W8	182T & 184T 213T & 215T 254T & 256T	8.00	8.63	6.25	11.75	8.63	13.50	24.00 24.75 26.00	0.88	0.88	13.50	11.75	8	23.50	11.75
19W10, 20W10 21W10, 22W10	213T & 215T 254T & 256T 284TS	10.00	10.75	6.25	14.25	8.63	16.00	24.75 26.00 26.75	1.00	1.00	16.00	14.25	12	23.50	11.75
23N6, 24N6 25N6, 26N6	184T 213T & 215T 254T & 256T	6.00	6.63	5.00	11.75	8.63	11.00	24.00 24.75 26.00	0.88	0.88	13.50	9.50	8	23.50	11.75
23N8, 24N8 25N8, 26N8	213T & 215T 254T & 256T	8.00	8.63	5.00	11.75	8.63	13.50	24.75 26.00	0.88	0.88	13.50	11.75	8	23.50	11.75
23W10, 24W10 25W10, 26W10	254T & 256T 284TS 286TS 324TS & 326TS	10.00	10.75	7.25	14.25	10.75	16.00	26.00 26.75 28.25 29.25	1.00	1.00	16.00	14.25	12	23.50	11.75
23W12, 24W12 25W12, 26W12	286TS 324TS & 326TS	12.00	12.75	7.25	17.00	10.75	19.00	28.25 29.25	1.00	1.00	19.00	17.00	12	23.50	11.75

SIZE	H	HA	HB	HC	HD	HE	HF	HG	HH	J	K	L	M	NH	P	PG	Q	Z
14N4, 45N 15N4, 17N4, 18N4	11.50 17.00	18.25	24.44	16.31	14.00	13.63	13.19	12.75	12.31	5.63	3.38	8.63 14.13	8.88	8	13.56 19.06	6.00	11.75	4.56
14W6, 15W6 16W6, 17W6, 18W6	11.50 17.00	18.25	25.13	17.31	14.00	13.63	13.19	12.75	12.31	6.75	4.50	8.63 14.13	8.88	8	14.75 20.25	8.00	11.75	6.38
15W8, 16W8 17W8, 18W8	17.00 17.00	18.25	26.00	18.56	14.00	13.63	13.19	12.75	12.31	675	4.50	14.13 14.13	8.88	8	20.25 20.25	8.00	11.75	6.38
19N4, 20N4 21N4, 22N4	17.00 17.00	17.75	26.25	19.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	14.13 14.13	10.88	8	19.06 19.06	6.00	14.88	4.56
19N6, 20N6 21N6, 22N6	17.00 17.00	17.75	26.94	20.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	14.13 14.13	10.88	8	19.06 19.06	6.00	14.88	4.56
19W8, 20W8 21W8, 22W8	17.00 17.00 22.38	17.75	27.88	21.63	17.00	16.50	16.00	15.50	15.00	6.75	4.50	14.13 14.13 19.50	10.88	8	20.25 20.25 25.63	8.00	14.88	6.38
19W10, 20W10 21W10, 22W10	17.00 22.38 22.38	21.75	31.56	22.88	17.00	16.50	16.00	15.50	15.00	6.75	4.50	14.13 19.50 19.50	10.88	12	20.25 25.63 25.63	10.00	14.88	6.38
23N6, 24N6 25N6, 26N6	17.00 17.00 22.38	19.00	29.81	23.13	20.00	19.50	18.88	18.25	17.69	7.00	3.88	14.13 14.13 19.50	10.88	8	19.63 19.63 25.00	8.00	17.63	5.25
23N8, 24N8 25N8, 26N8	17.00 22.38	19.00	30.69	24.38	20.00	19.50	18.88	18.25	17.69	7.00	3.88	14.13 19.50	10.88	8	19.63 25.00	8.00	17.63	5.25
23W10, 24W10 25W10, 26W10	22.38 22.38 26.38 26.38	23.00	34.38	25.63	20.00	19.50	18.88	18.25	17.69	7.25	5.0	19.50 19.50 23.50 23.50	10.88	12	26.13 26.13 30.13 30.13	10.00	17.63	6.88
23W12, 24W12 25W12, 26W12	26.38 26.38	23.00	35.44	27.13	20.00	19.50	18.88	18.25	17.69	7.25	5.00	23.50 23.50	10.88	12	30.13 30.13	12.00	17.63	6.88

DIMENSIONS ARE NOT TO BE USED FOR CONSTRUCTION. CERTIFIED DRAWINGS AVAILABLE UPON REQUEST.

TYPE "TBNA" AND "TBNS" ARR. 8 SWSI ROTATABLE

DRAWN 12/17/99

REVISED 2/14/01

DWG. No. BC16341B

TWIN CITY FAN & BLOWER
MINNEAPOLIS, MINNESOTA 55442

JOB:

LOC:

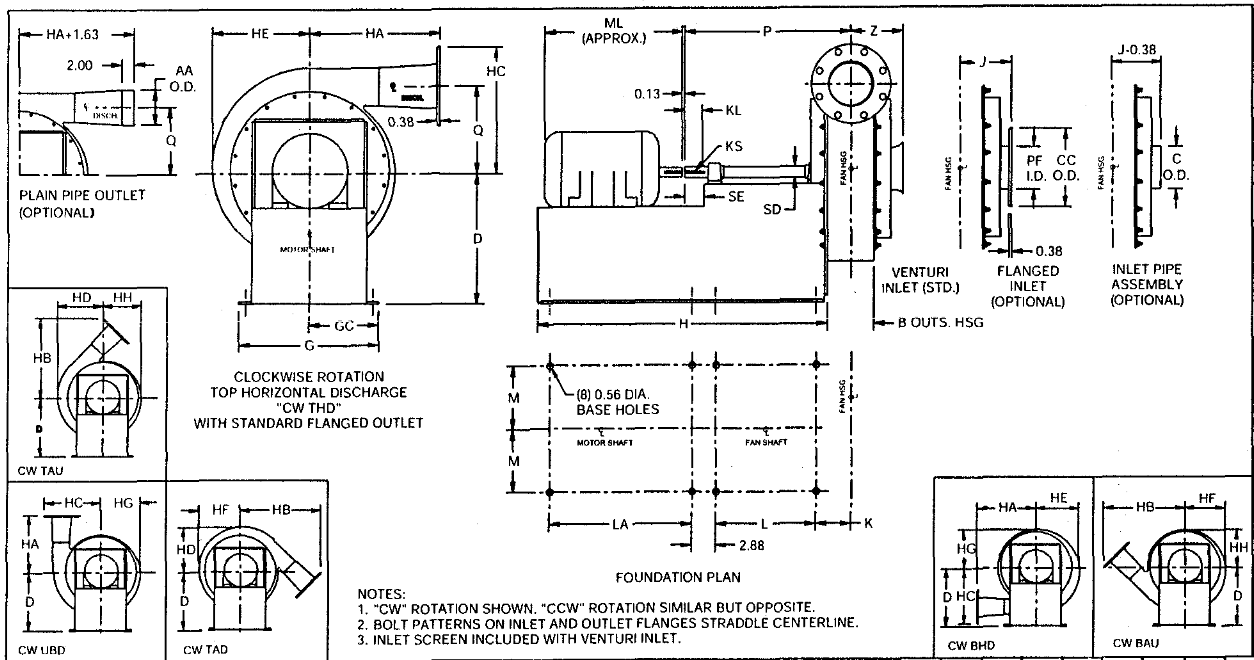
S.O. NO.:

CERT. BY:

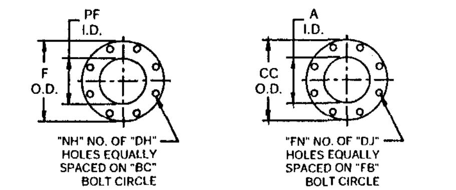
SIZE	DISCH	ROT	UNIT #
CFM	SP	RPM	BHP

OV | TS

ACCESSORIES REQ'D



NOTES:
1. "CW" ROTATION SHOWN. "CCW" ROTATION SIMILAR BUT OPPOSITE.
2. BOLT PATTERNS ON INLET AND OUTLET FLANGES STRADDLE CENTERLINE.
3. INLET SCREEN INCLUDED WITH VENTURI INLET.



INLET FLANGE

OUTLET FLANGE

SIZE	MOTOR FR.	A	AA	B	BC	C	CC	D	DH	DJ	F	FB	FN	G	GC	H	HA	HB	HC	HD	HE	HF	HG	HH	J	K	KL	KS	L	LA	M	ML	NH	P	PF	Q	SD	SE	Z
14N4, 15N4 16N4, 17N4, 18N4	143T & 145T 182T & 184T	4.00	4.50	3.88	9.50	6.63	9.00	17.75	0.88	0.75	11.00	7.50	8	19.50	9.75	28.63 32.50	18.25	24.44	16.31	14.00	13.63	13.19	12.75	12.31	5.63	3.38	2.38	.25x.13	8.63	14.13 18.00	8.88	14.38 18.13	8	16.19	6.00	11.75	1.19	2.63	4.56
14W6, 15W6 16W6, 17W6, 18W6	143T & 145T 182T & 184T	6.00	6.63	6.25	11.75	8.63	11.00	17.75	0.88	0.88	13.50	9.50	8	19.50	9.75	28.63 32.50	18.25	25.13	17.31	14.00	13.63	13.19	12.75	12.31	6.75	4.50	2.38	.25x.13	8.63	14.13 18.00	8.88	14.38 18.13	8	17.38	8.00	11.75	1.19	2.63	6.38
15W8, 16W8 17W8, 18W8	182T & 184T 213T & 215T	8.00	8.63	6.25	11.75	8.63	13.50	17.75	0.88	0.88	13.50	11.75	8	19.50	9.75	32.50 33.50	18.25	26.00	18.56	14.00	13.63	13.19	12.75	12.31	6.75	4.50	2.38	.25x.13	8.63	18.00 19.00	8.88	18.13 20.13	8	17.38	8.00	11.75	1.19	2.63	6.38
19N4, 20N4 21N4, 22N4	143T & 145T 182T & 184T	4.00	4.50	3.88	9.50	6.63	9.00	23.00	0.88	0.75	11.00	7.50	8	23.50	11.75	35.50 39.38	17.75	26.25	19.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	3.25	.38x.19	14.13	15.50 19.38	10.88	14.38 18.13	8	23.06	6.00	14.88	1.44	4.00	4.56
19N6, 20N6 21N6, 22N6	182T & 184T 213T & 215T	6.00	6.63	3.88	9.50	6.63	11.00	23.00	0.88	0.88	11.00	9.50	8	23.50	11.75	39.38 40.38	17.75	26.94	20.38	17.00	16.50	16.00	15.50	15.00	6.13	3.38	3.25	.38x.19	14.13	19.38 20.38	10.88	18.13 20.13	8	23.06	6.00	14.88	1.44	4.00	4.56
19W8, 20W8 21W8, 22W8	182T & 184T 213T & 215T 254T & 256T	8.00	8.63	6.25	11.75	8.63	13.50	23.00	0.88	0.88	13.50	11.75	8	23.50	11.75	39.38 40.38 45.38	17.75	27.88	21.63	17.00	16.50	16.00	15.50	15.00	6.75	4.50	3.25	.38x.19	14.13	19.38 20.38 25.38	10.88	18.13 20.13 25.75	8	24.13	8.00	14.88	1.44	3.88	6.38
19W10, 20W10 21W10, 22W10	213T & 215T 254T & 256T 284TS & 286TS	10.00	10.75	6.25	14.25	8.63	16.00	23.00	1.00	1.00	16.00	14.25	12	23.50	11.75	40.38 45.38 46.50	21.75	31.56	22.88	17.00	16.50	16.00	15.50	15.00	6.75	4.50	3.25	.38x.19	14.13	20.38 25.38 26.50	10.88	20.13 25.75 27.50	12	24.13	10.00	14.88	1.44	3.88	6.38
23N6, 24N6 25N6, 26N6	182T & 184T 213T & 215T 254T & 256T	6.00	6.63	5.00	11.75	8.63	11.00	24.00	0.88	0.88	13.50	9.50	8	23.50	11.75	40.00 41.00 46.00	19.00	29.81	23.13	20.00	19.50	18.88	18.25	17.69	7.00	3.88	3.88	.38x.19	14.13	20.00 21.00 26.00	10.88	18.13 20.13 25.75	8	24.13	8.00	17.63	1.44	4.50	5.25
23N8, 24N8 25N8, 26N8	213T & 215T 254T & 256T	8.00	8.63	5.00	11.75	8.63	13.50	24.00	0.88	0.88	13.50	11.75	8	23.50	11.75	41.00 46.00	19.00	30.69	24.38	20.00	19.50	18.88	18.25	17.69	7.00	3.88	3.88	.38x.19	14.13	21.00 26.00	10.88	20.13 25.75	8	24.13	8.00	17.63	1.44	4.50	5.25
23W10, 24W10 25W10, 26W10	254T & 256T 284TS & 286TS 324TS & 326TS	10.00	10.75	7.25	14.25	10.75	16.00	24.00	1.00	1.00	16.00	14.25	12	23.50	11.75	46.00 47.13 50.38	23.00	34.38	25.63	20.00	19.50	18.88	18.25	17.69	7.25	5.00	3.88	.38x.19	14.13	26.00 27.13 30.38	10.88	25.75 27.50 30.50	12	25.25	10.00	17.63	1.44	4.50	6.88
23W12, 24W12 25W12, 26W12	284TS & 286TS 324TS & 326TS	12.00	12.75	7.25	17.00	10.75	19.00	24.00	1.00	1.00	19.00	17.00	12	23.50	11.75	47.13 50.38	23.00	35.44	27.13	20.00	19.50	18.88	18.25	17.69	7.25	5.00	3.88	.38x.19	14.13	27.13 30.38	10.88	27.50 30.50	12	25.25	12.00	17.63	1.44	4.50	6.88

DIMENSIONS ARE NOT TO BE USED FOR CONSTRUCTION. CERTIFIED DRAWINGS AVAILABLE UPON REQUEST.

Typical Specifications

Fans shall be Type TBNA or TBNS Turbo Pressure Blowers as manufactured by Twin City Fan & Blower, Minneapolis, Minnesota.

PERFORMANCE – Fans shall be tested and rated in accordance with industry accepted test codes and shall be guaranteed by the manufacturer to deliver rated published performance levels.

HOUSING – Fan housings shall be constructed of continuously welded heavy gauge steel and shall be rotatable and reversible. A choice of inlet connections at no additional charge shall include an inlet venturi with screen, an inlet pipe assembly and a punched flange to ANSI 125/150. The outlet connection shall be flanged and punched to ANSI 125/150 with the option of a plain pipe assembly.

WHEEL – Type TBNA wheels shall be constructed of aluminum alloy with riveted construction. Type TBNS wheels shall be constructed of continuously welded heavy gauge steel or from a variety of special materials. Wheels shall be available in narrow and wide widths to meet specific performance requirements. Wheels shall be statically and dynamically balanced. The complete fan assembly shall be test balanced at the operating speed prior to shipment.

SHAFT (ARR. 1 & 8 ONLY) – Shafts shall be AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts shall be sized for the first critical speed of at least 1.43 times the maximum speed.

BEARINGS (ARR 1, 8 ONLY) – Bearings shall be heavy duty, grease lubricated, anti-friction ball or roller, self-aligning, pillow block type and selected for a minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum fan RPM.

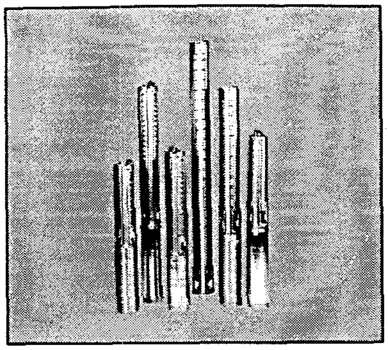
FINISH AND COATING – The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust-preventative primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum-based rust protectant. Aluminum components shall be unpainted.

ACCESSORIES – When specified, accessories such as inlet filters, inlet filters with hoods, inlet and outlet silencers, flexible connectors for flanged outlet and plain pipe outlets, outlet blast gates, built-in outlet dampers, shaft closure plates, shaft seals, drains, inspection ports, shaft and bearing guards, belt guards, couplings, coupling guards, unitary bases, isolation bases, inertia bases, and vibration rails shall be provided by Twin City Fan & Blower to maintain one source responsibility.

FACTORY RUN TEST – All fans prior to shipment shall be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced to in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.

GUARANTEE – Manufacturer shall guarantee the workmanship and materials for its Turbo Pressure Blowers for at least one (1) year from startup or eighteen (18) months from shipment, whichever occurs first.

Position	Count	Description	Single Price
	1	75S30-5	Price on request



Note! Product picture may differ from actual product

Product No.: 07110005
Multi-stage submersible pump for raw water supply, groundwater lowering and pressure boosting. The pump is suitable for pumping clean, thin, non-agressive liquids without solid particles or fibres.

The pump is made entirely of Stainless steel DIN W.-Nr. 1.4301 DIN W.-Nr. and suitable for horizontal as well as vertical installation.
The pump is fitted with a built-in non-return valve.

Liquid:
Maximum liquid temperature: 104 °F

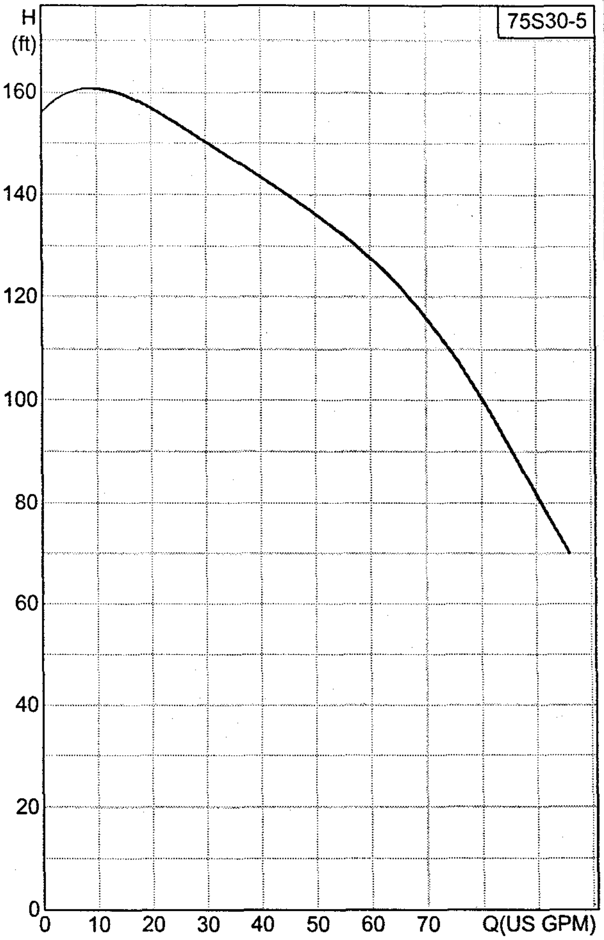
Technical:
Speed for pump data: 3450 rpm

Materials:
Material, pump: Stainless steel
1.4301 DIN W.-Nr.
304 AISI
Material, impeller: Stainless steel
1.4301 DIN W.-Nr.
304 AISI

Installation:
Size, pump outlet: 2" NPT
Motor diameter: 4 inch

Electrical data:
Power (P2) required by pump: 3.782 HP
Mains frequency: 60 Hz
Starting method: DOL

Description	Value
Product Number	07110005
Product name	75S30-5
EAN number	5700390257408
Applic. motor	GRUNDFOS
Impeller	Stainless steel
Impeller	1.4301 DIN W.-Nr.
Impeller	304 AISI
Liquid max temp	104 °F
Max flow	95 US GPM
Min flow	10 US GPM
Model	A
Motor diameter	4 inch
n	3450 rpm
P2	3.782 HP
Pump	Stainless steel
Pump	1.4301 DIN W.-Nr.
Pump	304 AISI
Pump outlet	2" NPT
Sales region	Namreg
Stages	5
Start. method	DOL
Valve	Y



+GF+ SIGNET 515/3-8510-XX Rotor-X Paddlewheel Flow Sensor

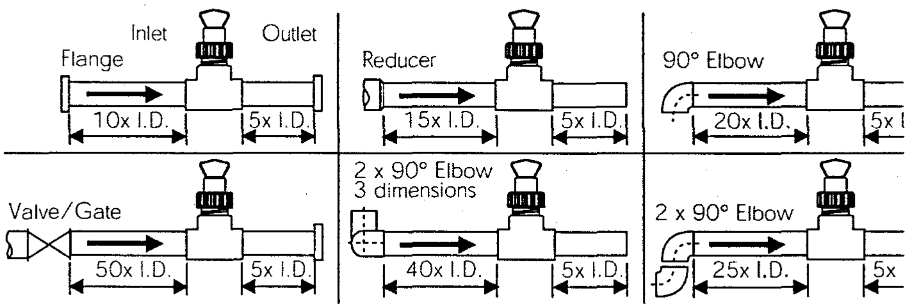
ENGL

P51590-1
15/97

SAFETY INSTRUCTIONS
1. Do not remove from pressurized lines.
2. Do not exceed maximum temperature/pressure specifications.
3. Do not install/service without following installation instructions (see sensor manual).
4. Wear safety goggles and faceshield during installation/service.
5. Do not alter product construction.
6. Failure to follow safety instructions could result in severe personal injury!

1. Location of Fitting

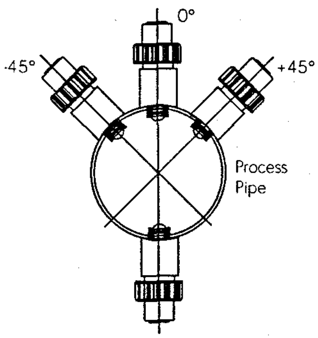
Recommended sensor upstream/downstream mounting requirements



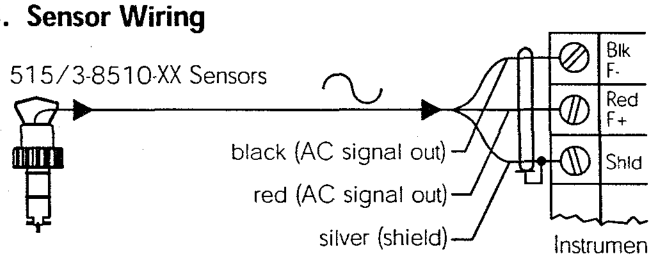
2. Sensor Mounting Position

- Horizontal pipe runs: Mount sensor in the upright (0°) position for best overall performance. Mount at a maximum of 45° when air bubbles are present. Do not mount on the bottom of the pipe when sediments are present.

- Vertical pipe runs: Sensor must be mounted in lines with UPWARD flow only.



3. Sensor Wiring



Technical Notes
- Use 2-conductor shielded cable for cable extensions up to 60 m (200 ft).
- Cable shield must be maintained through cable splice.
- Refer to your instrument manual for specific wiring details.

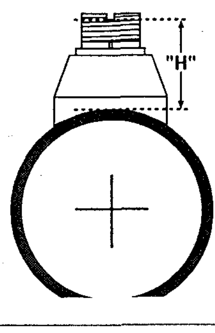
4. +GF+ SIGNET Fittings

Type	Description
Plastic tees	• 0.5 to 4 in. versions • PVC or CPVC • Mounts via glue-on fittings
PVC glue-on saddles (O-ring not required)	• 2 to 4 in., cut 1-7/16 in. hole in pipe • 6 to 8 in., cut 2-1/4 in. hole in pipe • Align wedge arrows with saddle arrows during assembly. • Pipes over 8 in., use iron saddle
Iron strap-on saddles	• 2 to 4 in., cut 1-7/16 in. hole in pipe • Over 4 in., cut 2-1/4 in. hole in pipe • Special order over 12 in.
Carbon steel weld-on weldolets	• 2 to 4 in., cut 1-7/16 in. hole in pipe • Over 4 in., cut 2-1/4 in. hole in pipe • Remove insert before welding • Installed by certified welder only • Special order over 12 in.
Carbon steel threaded tees	• 0.5 to 2 in. versions • Mounts on threaded pipe ends

Type	Description
	Metric plastic saddle • For pipes DN 65 to 200 mm • Requires a 30 mm diam. hole in the pipe • Wedge and saddle arrows must match
	Metric wafer fitting • For pipes DN 65 to 200 mm • Follow the recommended installation guidelines
	Metric union fitting • For pipes from DN 15 to 50 mm • PP or PVDF • Follow the recommended installation guidelines

5. H-Dimensions

The plastic sensor insert in the Weldolet fitting MUST be removed during the welding process. When reinstalled, it is important that the insert be threaded to the proper height ("H" dimension).



Weldolet part number	"H" dimension inches	mm	Weldolet part number	"H" dime[nsion] inches	[mm]
CS4W020	2.38	60.45	CS4W240	4.16	1[illegible]
CS4W025	2.33	59.18	CS4W360	4.10	1[illegible]
CS4W030	2.32	58.92			
CS4W040	2.30	58.42	CR4W020	2.38	6[illegible]
CS4W050	3.09	78.48	CR4W025	2.33	5[illegible]
CS4W060	2.96	75.18	CR4W030	2.32	5[illegible]
CS4W080	2.73	69.34	CR4W040	2.30	5[illegible]
CS4W100	5.48	139.19	CR4W050	3.09	7[illegible]
CS4W120	5.25	133.35	CR4W060	2.96	7[illegible]
CS4W140	5.10	129.54	CS4W080	2.73	6[illegible]
CS4W160	4.85	123.19	CR4W100	5.48	1[illegible]
CS4W180	4.60	116.84	CR4W120	5.25	1[illegible]
[illegible]	[illegible]	[illegible]			

6. Standard Sensor Installation

1. Lubricate the sensor O-rings with a silicone lubricant (e.g. GE silicone compound #G632 or equivalent). Do not use any petroleum based lubricant that will attack the O-rings.

2. Using an alternating/twisting motion, lower the sensor into the fitting, making sure the installation arrows on the black cap are pointing in the direction of flow, **see Figure A.**

3. Engage one thread of the sensor cap then turn the sensor until the alignment tab is seated in the fitting notch. **Hand tighten the sensor cap. DO NOT** use any tools on the sensor cap or the cap threads and/or fitting flange threads will be damaged, **see Figure B.**

Figure A

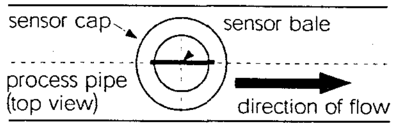
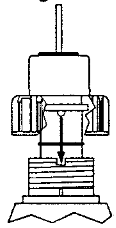


Figure B



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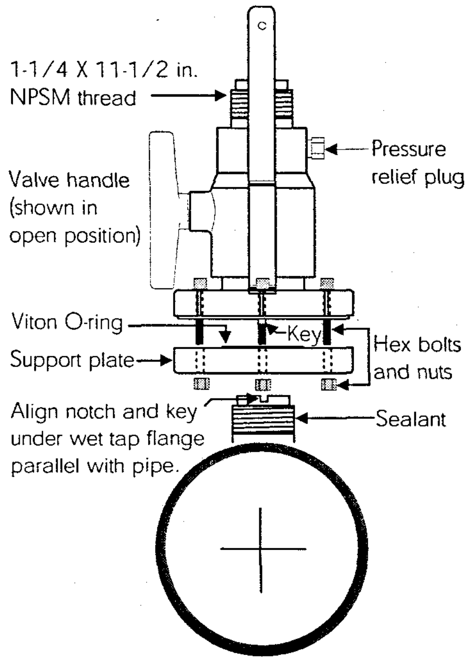
7. Wet-Tap Installation

The +GF+ SIGNET 319 Wet-Tap Assembly attaches directly onto any +GF+ Signet fitting to enable sensor removal without system shutdown. It consists of a flange and support plate which thread onto the pipe fitting insert, and a PVC ball valve through which an extended length 515 sensor is inserted into the pipe.



Procedure

1. Remove six hex nuts and bolts from the Wet-Tap flange. Separate the support plate from the main assembly. Be sure that the Viton O-ring is properly seated in the support plate groove.

2. Apply sealant to the pipe fitting insert threads to prevent leaks.

3. Screw support plate onto pipe fitting insert. It must be threaded completely down until the notches at the top of the pipe fitting insert are exposed.

4. Mount the main Wet-Tap Assembly on the support plate. Make certain the alignment keys on the flange mate with the notches on the pipe fitting insert.

5. Replace the six hex nuts and bolts to secure the Wet-Tap Assembly in place. Adjust the support plate position as necessary to align screws.

6. Check the pressure relief plug on Wet-Tap Assembly. It must closed be finger tight to prevent leaks.

7. Close ball valve by turning the orange handle to the fully closed position (parallel with pipe).

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8. Wet-Tap Sensor Installation

⚠ The 319 Wet-Tap Assembly allows installation into pressurized pipes without system shutdown. **+GF+ Signet recommends reducing flow system pressure to 25 psi or less during sensor installation in a pressurized pipe.**

Non-Pressurized Installation

Open the orange ball valve handle to the full open position. Follow the steps 1-3 outlined in section 6. Attach the cable clamps and safety cables to the cable brackets. Verify the relief valve is closed before system operation, **see Figure C.**

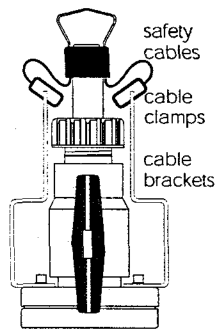


Figure C

Pressurized Installation

1. Lubricate the sensor O-rings with a silicone lubricant (e.g. GE silicone compound #G632 or equivalent)/ Do not use any petroleum based lubricant that will attack the O-rings.

2. Being careful not to bump the sensor rotor against the closed ball valve orifice, gently insert the extended 515 sensor into the 319 Assembly until the first two O-rings seat inside the bore, **see Figure D.**

3. Attach the cable clamps on each of the sensor's safety cables to the 319 assembly cable brackets (Hand tighten only), **see Figure D.**

4. Pull the flow sensor upward to remove slack in the safety cables, **see Figure E**

5. Reduce system pressure to 25 psi or less.

6. **Wearing safety face protection**, slowly open the ball valve to the full open position (perpendicular to pipe).

7. Using an alternating/twisting motion, push the extended sensor into the 319 assembly, making sure the sensor's installation decal is pointing in the direction of flow and the alignment tab seats into the fitting notch, **see Figure F.**. Align the tab under the red sensor cap in the notches on the fitting insert. Hand tighten the red sensor cap, **see Figure G.** DO NOT use any tools on the red sensor cap or the cap threads and/or fitting flange threads will be damaged.

Figure D

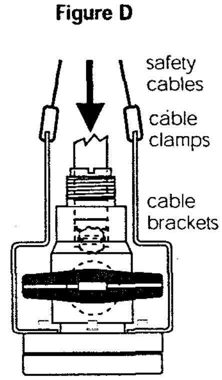
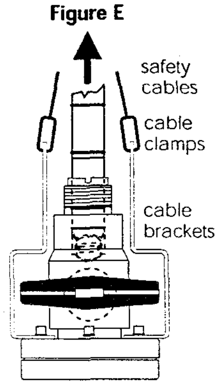


Figure E



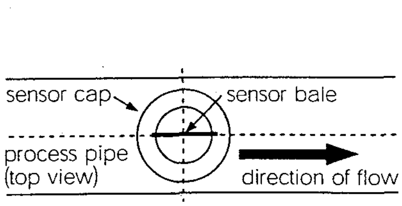


Figure F

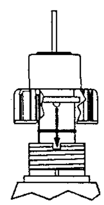


Figure G

⚠ **CAUTION:** Maximum 319 Wet-Tap operating pressure: 7 bar (100 psi) @ 20 °C (68 °F)
Maximum 515 sensor installation/removal pressure: 1.7 bar (25 psi) @ 22 °C (72 °F)

9. K-Factors

The **K-Factor** is the number of pulses the sensor will generate for each engineering unit of fluid which passes. They are listed in U.S. gallons and in liters. For example, in a 1 inch PVC pipe, the paddlewheel generates 176.670 pulses per gallon of fluid passing the rotor. K-factors are listed for pipes up to 12 inch. For pipes over 12 inch, consult your +GF+ Signet distributor.

PIPE SIZE	+GF+ SIGNET FITTING TYPE	K-FACTOR U.S. GAL	K-FACTOR LITERS
SCH 80 PVC TEES FOR SCH 80 PVC PIPE			
1/2 IN.	PV8T005	480.190	126.867
3/4 IN.	PV8T007	257.720	68.090
1 IN.	PV8T010	174.670	46.148
1 1/4 IN.	PV8T012	83.390	22.032
1 1/2 IN.	PV8T015	58.580	15.477
2 IN.	PV8T020	32.480	8.581
2 1/2 IN.	PV8T025	21.833	5.768
3 IN.	PV8T030	13.541	3.578
4 IN.	PV8T040	7.626	2.015
SCH 80 CPVC TEES FOR SCH 80 CPVC PIPE			
1/2 IN.	CPV8T005	480.190	126.867
3/4 IN.	CPV8T007	257.720	68.090
1 IN.	CPV8T010	174.670	46.148
1 1/4 IN.	CPV8T012	83.390	22.032
1 1/2 IN.	CPV8T015	58.580	15.477
SCH 80 PVC SADDLES FOR SCH 80 PVC PIPE			
2 IN.	PV8S020	32.480	8.581
2 1/2 IN.	PV8S025	21.833	5.768
3 IN.	PV8S030	13.541	3.578
4 IN.	PV8S040	7.626	2.015
6 IN.	PV8S060	4.162	1.100
8 IN.	PV8S080	2.370	0.626
SCH 80 PVC SADDLE ON SCH 40 PVC PIPE			
2 IN.	PV8S020	27.350	7.226
2 1/2 IN.	PV8S025	18.874	4.987
3 IN.	PV8S030	12.638	3.339
4 IN.	PV8S040	6.728	1.778
6 IN.	PV8S060	3.730	0.985
8 IN.	PV8S080	2.153	0.569
CARBON STEEL TEES ON SCH 40 PIPE			
1/2 IN.	CS4T005	370.202	97.808
3/4 IN.	CS4T007	212.063	56.027
1 IN.	CS4T010	141.138	37.289
1 1/4 IN.	CS4T012	60.655	16.025
1 1/2 IN.	CS4T015	45.350	11.982
2 IN.	CS4T020	26.767	7.072
STAINLESS STEEL TEES ON SCH 40 PIPE			
1/2 IN.	CR4T005	358.960	94.838
3/4 IN.	CR4T007	202.610	53.530
1 IN.	CR4T010	127.140	33.590
1 1/4 IN.	CR4T012	61.910	16.357
1 1/2 IN.	CR4T015	40.410	10.676
2 IN.	CR4T020	22.300	5.892

PIPE SIZE	+GF+ SIGNET FITTING TYPE	K-FACTOR U.S. GAL	K-FACTOR LITERS
GALVANIZED IRON TEES ON SCH 40 PIPE			
1 IN.	IR4T010	104.538	27.619
1 1/4 IN.	IR4T012	62.979	16.639
1 1/2 IN.	IR4T015	46.688	12.335
2 IN.	IR4T020	29.459	7.783
BRONZE TEES ON SCH 40 PIPE			
1 IN.	BR4T010	104.538	27.619
1 1/4 IN.	BR4T012	62.979	16.639
1 1/2 IN.	BR4T015	46.688	12.335
2 IN.	BR4T020	29.459	7.783
COPPER TEE FITTINGS ON COPPER PIPE PIPE			
1/2 IN.SK K	CUKT005	443.206	117.095
1/2 IN. SK L		414.413	109.488
3/4 IN.SK K	CUKT007	212.156	56.052
3/4 IN. SK L		191.086	50.485
1 IN.SK K	CUKT010	127.176	33.600
1 IN. SK L		119.840	31.662
1 1/4 IN.SK K	CUKT012	88.218	23.307
1 1/4 IN. SK L		85.451	22.576
1 1/2 IN.SK K	CUKT015	56.962	15.049
1 1/2 IN. SK L		55.160	14.573
2 IN.SK K	CUKT020	29.370	7.759
2 IN. SK L		28.605	7.558
STAINLESS STEEL WELDOLETS ON SCH 40 PIPE			
2 1/2 IN.	CR4W025	18.800	4.967
3 IN.	CR4W030	12.170	3.215
4 IN.	CR4W040	6.960	1.839
5 IN.	CR4W050	5.260	1.390
6 IN.	CR4W060	3.690	0.975
8 IN.	CR4W080	2.130	0.563
10 IN.	CR4W100	1.350	0.357
12 IN.	CR4W120	0.960	0.254
CARBON STEEL WELDOLETS ON SCH 40 PIPE			
2 1/2 IN.	CS4W025	18.800	4.967
3 IN.	CS4W030	12.170	3.215
4 IN.	CS4W040	6.960	1.839
5 IN.	CS4W050	5.260	1.390
6 IN.	CS4W060	3.690	0.975
8 IN.	CS4W080	2.130	0.563
10 IN.	CS4W100	1.350	0.357
12 IN.	CS4W120	0.960	0.251

PIPE SIZE	+GF+ SIGNET FITTING TYPE	K-FACTOR U.S. GAL	K-FACTOR LITERS
COPPER/BRONZE BRAZOLETS ON SCH 40 PIPE			
2 1/2 IN.	BR4B025	18.800	4.967
3 IN.	BR4B030	12.170	3.215
4 IN.	BR4B040	6.960	1.839
5 IN.	BR4B050	5.260	1.390
6 IN.	BR4B060	3.690	0.975
8 IN.	BR4B080	2.130	0.563
10 IN.	BR4B100	1.350	0.357
12 IN.	BR4B120	0.960	0.254
SCH 80 IRON SADDLES ON SCH 80 PIPE			
2 IN.	IR8S020	32.360	8.550
2 1/2 IN.	IR8S025	22.220	5.871
3 IN.	IR8S030	13.420	3.546
4 IN.	IR8S040	7.660	2.024
5 IN.	IR8S050	5.860	1.548
6 IN.	IR8S060	4.090	1.081
8 IN.	IR8S080	2.330	0.616
10 IN.	IR8S100	1.530	0.404
12 IN.	IR8S120	1.060	0.280
SCH 80 IRON SADDLE ON SCH 40 PIPE			
2 IN.	IR8S020	26.820	7.086
2 1/2 IN.	IR8S025	18.800	4.967
3 IN.	IR8S030	11.990	3.168
4 IN.	IR8S040	6.850	1.810
5 IN.	IR8S050	5.330	1.408
6 IN.	IR8S060	3.760	0.993
8 IN.	IR8S080	2.130	0.563
10 IN.	IR8S100	1.350	0.357
12 IN.	IR8S120	0.960	0.254

Conversion Formulas

1 U.S. gallon = 0.003785 cubic meters
0.000003069 Acre feet
8.3454 pounds of water

K-Factors DIN Pipes

PIPE SIZE	+GF+ SIGNET FITTING TYPE	K-FACTOR U.S. GAL	K-FACTOR LITERS	CODE
POLYPROPYLENE FITTINGS (DIN/ISO AND BS AND ANSI)				
DN 15	PPMT005	481.553	127.227	198.150.522
DN 20	PPMT007	277.089	73.207	198.150.523
DN 25	PPMT010	141.181	37.300	198.150.524
DN 32	PPMT012	83.540	22.071	198.150.525
DN 40	PPMT015	51.265	13.544	198.150.526
DN 50	PPMT020	29.596	7.819	198.150.527
DN 65	PPMT025	20.658	5.458	198.150.560
DN 80	PPMT030	13.330	3.522	198.150.561
DN 100	PPMT040	8.708	2.301	198.150.562
DN 125	PPMT050	5.067	1.339	198.150.563
DN 150	PPMT060	3.689	0.975	198.150.564
DN 200	PPMT080	2.040	0.539	198.150.565
PVDF FITTINGS (DIN/ISO AND BS AND ANSI)				
DN 15	SFMT005	420.868	111.194	198.150.529
DN 20	SFMT007	228.149	60.277	198.150.530
DN 25	SFMT010	136.697	36.116	198.150.531
DN 32	SFMT012	79.294	20.950	198.150.532
DN 40	SFMT015	43.490	11.490	198.150.533
DN 50	SFMT020	25.908	6.845	198.150.534
DN 65	SFMT025	18.067	4.773	198.150.571
DN 80	SFMT030	12.357	3.265	198.150.572
DN 100	SFMT040	8.060	2.129	198.150.573
DN 125	SFMT050	4.431	1.171	198.150.574
DN 150	SFMT060	3.227	0.853	198.150.575
DN 200	SFMT080	2.036	0.538	198.150.576

PIPE SIZE	+GF+ SIGNET FITTING TYPE	K-FACTOR U.S. GAL	K-FACTOR LITERS	CODE
PVC FITTINGS (DIN/ISO) - EUROPE ONLY				
DN 15	PVMT005	486.183	128.450	198.150.4
DN 20	PVMT007	242.846	64.160	198.150.4
DN 25	PVMT010	148.637	39.270	198.150.4
DN 32	PVMT012	85.125	22.490	198.150.4
DN 40	PVMT015	51.855	13.700	198.150.4
DN 50	PVMT020	29.750	7.860	198.150.4
DN 65	PVMT025	17.487	4.620	198.150.5
DN 80	PVMT030	12.491	3.300	198.150.5
DN 100	PVMT040	8.138	2.150	198.150.5
DN 150	PVMT060	4.088	1.080	198.150.5
DN 200	PVMT080	2.044	0.540	198.150.5

10. Order Information

Standard 515 Rotor-X Paddlewheel Flow Sensors — All O-rings are Viton®

Order No.	Sensor Body	Rotor Pin	Rotor	Pipe Size	Code
P51530-P0	Polypro.	Titanium	PVDF (black)	0.5 to 4.0 in.	198 801 620
P51530-P1	Polypro.	Titanium	PVDF (black)	5.0 to 8.0 in.	198 801 621
P51530-P2	Polypro.	Titanium	PVDF (black)	10 to 36 in.	198 801 622
P51530-V0	PVDF (natural)	Hastelloy C	PVDF (natural)	0.5 to 4.0 in.	198 801 623
P51530-V1	PVDF (natural)	Hastelloy C	PVDF (natural)	5.0 to 8.0 in.	198 801 624
P51530-V2	PVDF (natural)	Hastelloy C	PVDF (natural)	10 to 36 in.	198 801 625
P51530-T0	PVDF (natural)	PVDF (natural)	PVDF (natural)	0.5 to 4.0 in.	198 801 663
P51530-T1	PVDF (natural)	PVDF (natural)	PVDF (natural)	5.0 to 8.0 in.	198 801 664
P51530-T2	PVDF (natural)	PVDF (natural)	PVDF (natural)	10 to 36 in.	198 801 669

319 Wet-Tap Assembly Including Extended 515 Sensor — Rotor pin material is Titanium

Order No.	Valve	Sensor Body	Rotor	Pipe Size	Code
MK319/515-P3	PVC	Polypro.	PVDF (black)	0.5 to 4.0 in.	198 840 119
MK319/515-P4	PVC	Polypro.	PVDF (black)	5.0 to 8.0 in.	198 840 120
MK319/515-P5	PVC	Polypro.	PVDF (black)	10 to 36 in.	198 840 121

319 Wet-Tap Without 515 Sensor

Order No.	Material	Description
P31940	PVC	319 Wet-Tap

Extended 515 Sensors for 319 Wet-Tap

Order No.	Sensor Body	Rotor Pin	Rotor	Pipe Size	Code
P51530-P3	Polypro.	Titanium	PVDF (black)	0.5 to 4.0 in.	198 840 310
P51530-P4	Polypro.	Titanium	PVDF (black)	5.0 to 8.0 in.	198 840 311
P51530-P5	Polypro.	Titanium	PVDF (black)	10 to 36 in.	198 840 312

515 Accessories

Order No. Rotors	Material	Code
M1538-2	PVDF (std.)	198 801 181
M1538-4	Tefzel	198 820 018
P51546	Tefzel with sleeve	198 820 017
P51550-3	PVDF (natural) + Rotor Pin	198 820 043

Order No. Rotor Pin	Material	Code
M1546-1	Titanium	198 801 182
M1546-2	Hastelloy C	198 801 183
M1546-3	Tantalum	198 820 014
M1546-4	Stainless steel	198 820 015
P51545	Ceramic	198 820 016
P51550-3	PVDF (natural) + Rotor	198 820 043

Order No. O-Rings	Material	Code
1220-0021	Viton® (std.)	198 801 186
1224-0021	EPR	198 820 006
1228-0021	Kalrez	198 820 007

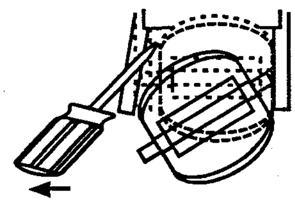
Order No.	Description	Code
P31542	Sensor cap, PP	198 801 630
P31536	Plug, PP	198 840 201
P31536-2	Plug, PVDF (nat.) with std. cap	198 840 202

+GF+ SIGNET 3-8510-XX Integral Sensor Accessories

Order No.	Description	Code
3-8011	Integral sensor mounting kit with 1/2 in. NPT ports	198 864 500
3-8011-D	Integral sensor mounting kit with PG 13.5 ports	198 864 501

Order No.	Description	Pipe Size	Code
3-8510-P0	Integral sensor, Polypro.	0.5 to 4 inch	198 864 504
3-8510-P1	Integral sensor, Polypro.	5 to 8 inch	198 864 505
3-8510-V0	Integral sensor, PVDF (natural)	0.5 to 4 inch	198 864 506

11. Rotor Replacement Procedure



1. To remove the rotor, insert a small screwdriver between the rotor and the ear of the sensor.
2. Twist the screwdriver blade to flex the ear outward enough to remove one end of the rotor and pin. **DO NOT** flex the ear any more than necessary! If it breaks, the sensor cannot be repaired.
3. Install the new rotor by inserting one ear into the hole, then flex the opposite ear back enough to slip rotor into place.

12. Specifications

General Data

Flow Rate Range:	0.3 to 6 m/s (1 to 20 ft/s)
Linearity:	±1% of maximum range
Repeatability:	±0.5% of maximum range
Pipe Size Range:	15 to 900 mm (0.5 to 36 in.)
Cable Length:	7.6 m (25 ft) can splice up to 60 m (200 ft) without amplification
Cable type:	2-conductor twisted pair with shield

Materials

Sensor Assembly: Various thermoplastics available. Refer to section 10 for details.

Electrical

Source Impedance: 8 kΩ

Quality Standards

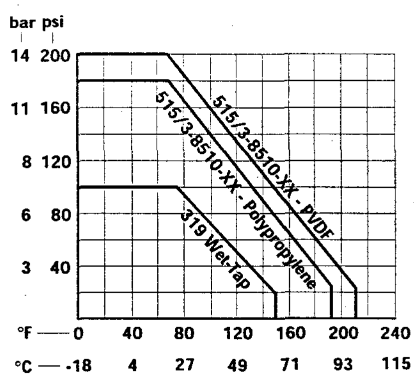
- FM, CE
- Manufactured under ISO 9001

Fluid Conditions

515/3-8510-XX Sensor Pressure/Temperature Ratings:

Polypropylene Body:
- 12.5 bar (180 psi) max. @ 20 °C (68 °F)
- 1.7 bar (25 psi) max. @ 90 °C (194 °F)

PVDF Body:
- 14 bar (200 psi) max @ 20 °C (68 °F)
- 1.7 bar (25 psi) max @ 100 °C (212 °F)



319 Wet-Tap Assembly Pressure/Temperature Ratings:
- 7 bar (100 psi) max. @ 25 °C (77 °F)
- 1.4 bar (20 psi) max. @ 66 °C (150 °F)

+GF+ SIGNET

Sales Offices:

USA George Fischer, Inc., 2882 Dow Avenue, Tustin, CA 92780/USA, Tel. (714) 731-8800, Fax (714) 731-6201

Switzerland Georg Fischer Rohrleitungssysteme AG, P.O. Box 671, CH-8201 Schaffhausen/Switzerland, Tel. 052/631 1111, Fax 052/631 2830

Singapore George Fischer Pte. Ltd., 15 Kaki Bukit Road 2, KB Warehouse Complex, Singapore 1441, Tel. 65/747 0611, Fax 65/747 0577

Japan Kubota George Fischer, 2-47 Shikitsuhigashi, 1-Chome, Naniwa-Ku, Osaka, 556-91 Japan, Tel. 816/648 2545, Fax 816/648 2565

China Georg Fischer Ltd., Rm 1503, Business Residence Bldg. of Asia Plaza, 2-3 Bldg. No. 5th Qu Anzhenxili, Chaoyang Qu, Beijing 100029, P.R. China, Tel. 86/10 6443 0577, Fax 86/10 6443 0578

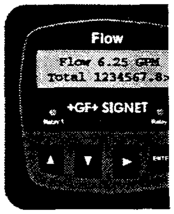
Australia George Fischer Pty. Ltd., Suite 3, 41 Stamford Road, Oakleigh, Victoria 3166, Australia, Tel. 61/3 9568 0966, Fax 61/3 9568 0988

Signet Scientific Company, 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A., Tel. (626) 571-2770, Fax (626) 573-2057

+GF+ SIGNET 8550-2 Flow Transmitter Instructions

ENGL

3-8550.090-2 (A-9/99) English



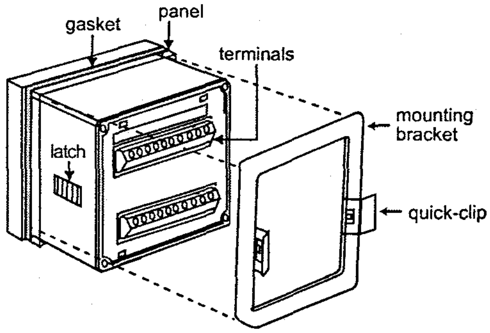
CAUTION!

- Remove power to unit before wiring input and output connections.
- Follow instructions carefully to avoid personal injury.

Contents

1. Installation

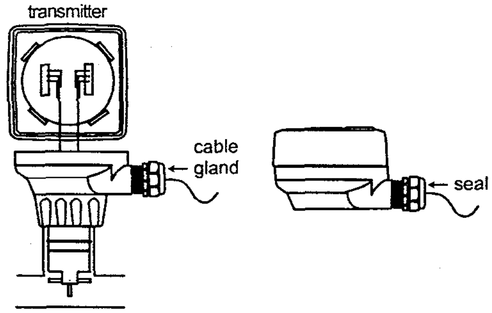
The transmitter is available in three versions: a panel mount version, an integral (pipe mount) version, and a universal assembly installation near the sensor.



1.1 Panel Installation

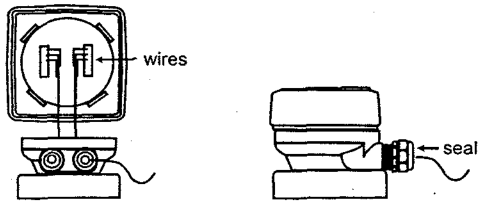
The Panel Mounting kits are supplied with the hardware to install instrumentation into panels and maintain a NEMA 4X seal.

1. Punch out panel and de-burr edges. Recommended clearance on all sides between instruments is 1 inch.
2. Place gasket on instrument, and install in panel.
3. Slide mounting bracket over back of instrument until quick-clips snap into latches on side of instrument.
4. Connect wires to terminals.
5. To remove, secure instrument temporarily with tape from front or grip from rear of instrument. DO NOT RELEASE. Press quick-clips outward and remove.



1.2 Integral Assembly (3-8051)

1. Punch out conduit ports if necessary.
2. Connect sensor to integral adapter. Push and twist-lock integral adapter to conduit base and secure with locking ring and screw.
3. Mount unit in pipe. Route cable through cable gland and connect to transmitter.
4. Close unit and secure. Seal cable entry.



1.3 Universal Assembly (3-8050)

1. Install transmitter base
2. Connect wires to transmitter.
3. Close unit and secure with push and twist lock. Seal cable entry.

2. Specifications

General

Compatibility: +GF+ SIGNET Flow Sensors (w/freq out)
Accuracy: ±0.5 Hz
Enclosure:

- Rating: NEMA 4X/IP65 front
- Case: PBT
- Window: Polyurethane coated polycarbonate
- Keypad: Sealed 4-key silicone rubber
- Weight: Approx. 325g (12 oz.)

Display:

- Alphanumeric 2 x 16 LCD
- Update rate: 1 second
- Contrast: User selected, 5 levels

Environmental

Operating temperature: -10 to 70°C (14 to 158°F)
Storage temperature: -15 to 80°C (5 to 176°F)
Relative humidity: 0 to 95%, non-condensing

Standards and Approvals

- CSA, CE, UL listed
- Manufactured under ISO 9001

Electrical

Sensor Input:

- Range: 0.5 to 1500 Hz
- Sensor power: 2-wire: 1.5 mA @ 5 VDC ± 1%
  3 or 4 wire: 20 mA @ 5 VDC ± 1%
- Optically isolated from current loop
- Short circuit protected

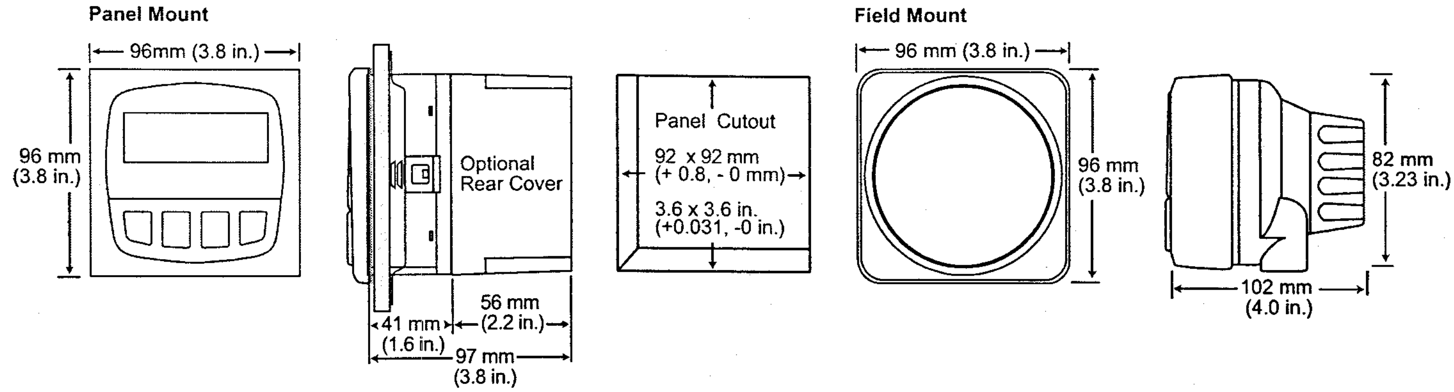
Current output:

- 4 to 20 mA, isolated, fully adjustable and reversible
- Power: 12 to 24 VDC ±10%, regulated
- Max loop impedance: 50 Ω max. @ 12 V, 325 Ω max. @ 1
  600 Ω max. @ 24V
- Update rate: 100 ms
- Accuracy: ±0.03 mA

Relay outputs (2 sets):

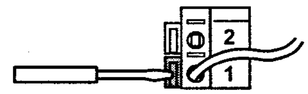
- Mechanical SPDT contacts: Hi, Lo, Pulse Programmable
- Maximum voltage rating: 5 A @ 30 VDC, 5 A @ 250 VAC resistive load
- Hysteresis: User adjustable

Dimensions



3. Electrical Connections

⚠ Caution: Failure to fully open terminal jaws before removing wire may permanently damage instrument.



Wiring Procedure
1. Remove 0.5 - 0.625 in. (13-16 mm) of insulation from wire end.
2. Press the orange terminal lever downward with a small screwdriver to open terminal jaws.
3. Insert exposed (non-insulated) wire end in terminal hole until it bottoms out.
4. Release orange terminal lever to secure wire in place. Gently pull on each wire to ensure a good connection.

Wiring Removal Procedure
1. Press the orange terminal lever downward with a small screwdriver to open terminal jaws.
2. When fully open, remove wire from terminal.

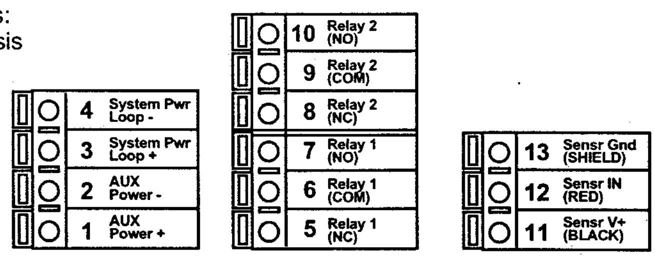
Terminals	Description
1. AUX Power +	12-24 VDC
2. AUX Power -	

System Power/Loop	
3. System Power/Loop +	12-24 VDC ±5%, system power and current loop connections.
4. System Power/Loop -	Max. loop impedence: 50 Ω max @12 V, 600 Ω max. @ 24 V.

<u>Relays</u>
5. Relay 1 NC contact
6. Relay 1 COM contact
7. Relay 1 NO contact
8. Relay 2 NC contact
9. Relay 2 COM contact
10. Relay 2 NO contact

Relay 1 / 2 contact sets programmable as:
- High/Low alarm with adjustable hysteresis
- Proportional pulse output
- Disable (Off) selection

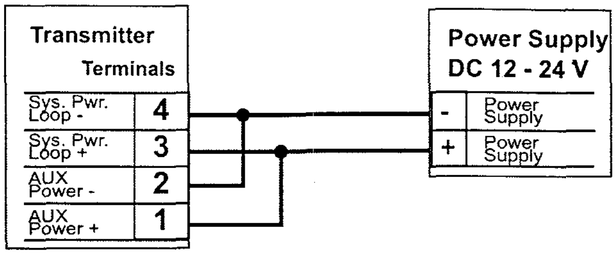
<u>Sensor Input</u>
11. Black (Sensr V+)
12. Red (Sensr IN)
13. Silver (Sensr GND)



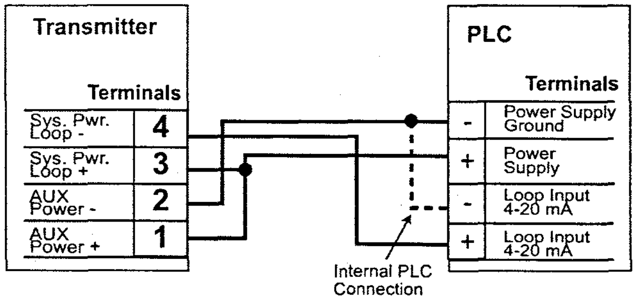
Wiring Tips:
- Do not route sensor cable in conduit containing AC power wiring - electrical noise may interfere with sensor signal.
- Routing sensor cabling in grounded metal conduit may prevent moisture damage, electrical noise, and mechanical damage.
- Seal cable entry points to prevent moisture damage.
- When placing two wire ends into a single terminal, solder or crimp ends together.

3.1 System Power/Loop Connections

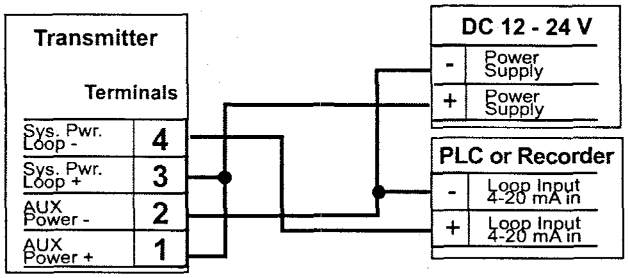
Stand-alone application, no current loop used



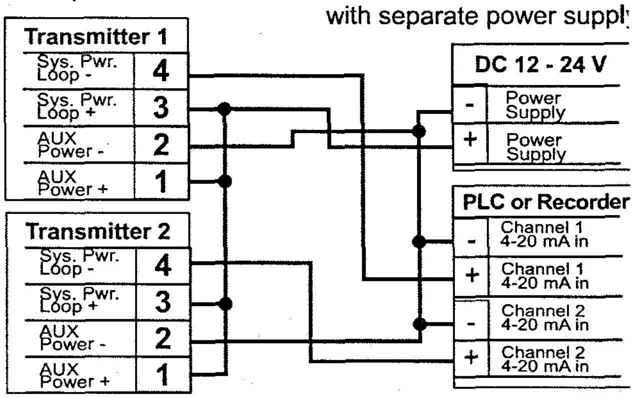
Connection to a PLC with built-in power supply



Connection to a PLC/Recorder, separate supply

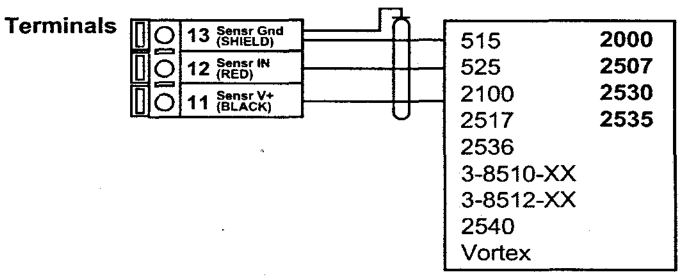


Example: Two transmitters connected to PLC/Recorder with separate power supply



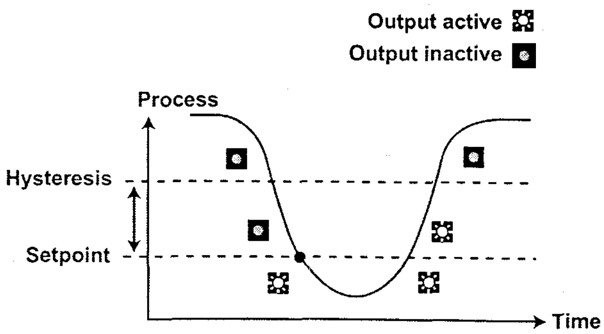
3.2 Sensor Input Connections

Wiring Tip:
Do not route sensor cable in any conduit containing AC power wiring - electrical noise may interfere with the signal.



3.3 Open Collector Functions

- **Low:** Output triggers when process variable is less than setpoint.
- **High:** Output triggers when process variable is higher than setpoint.
  Example: In Low Alarm Mode Operation, the output becomes active when the process drops below the setpoint, and becomes inactive when the process rises above the setpoint plus hysteresis. The opposite is true for High Alarm Mode.
- **Off:** Disables output pulse.
- **Pulse:** Outputs a pulse whenever a specified amount of volume has been totalized.
- **Frequency:** Outputs a pulse whenever the divided numbe pulses are input.



4. Menu Functions

VIEW Menu: is displayed during standard operation.

- Press UP or DOWN buttons to view process parameters.
- Press UP and DOWN buttons at the same time, to exit any other display and return to VIEW menu.
- Display will return to VIEW menu in 10 minutes unless a key is pressed.

CALIBRATE Menu: contains display setup and output parameters. A security code feature prevents unauthorized tampering. To access CALIBRATE menu:

- Press ENTER button for 2 seconds to display: `CALIBRATE: ---- Enter Key Code`
- Press UP, UP, UP, DOWN buttons in sequence to display: `CALIBRATE: XXXX Enter Key Code`

OPTIONS Menu: contains setup and display features for minor display or output adjustments. To access OPTIONS menu:

- Press ENTER button for 5 seconds to display: `OPTIONS: ---- Enter Key Code`
- Press UP, UP, UP, DOWN buttons in sequence to display: `OPTIONS: XXXX Enter Key Code`

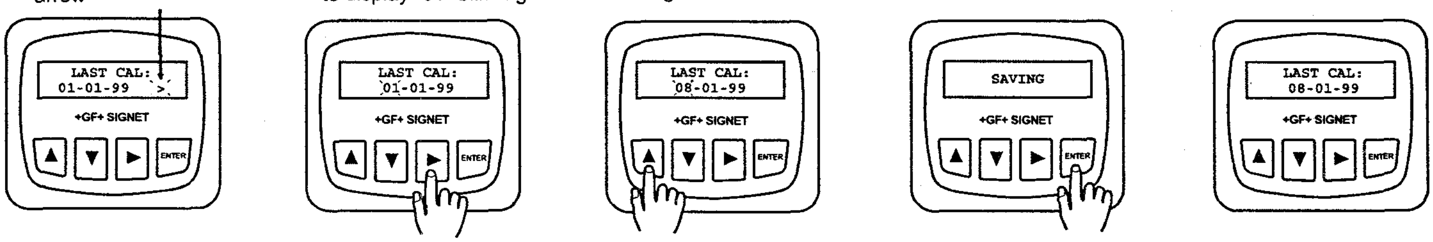
Menu Tips

- Right button scrolls to right, from top to bottom row, and allows editing when ">" symbol is shown.
- In CALIBRATE or OPTIONS menus, the transmitter will continue to measure and control outputs. When > is pressed, the input value is held at the last measured process value.
- When sensor is not connected, unit will display CHECK SENSOR and any output controlled by sensor will be at 3.6 mA or OFF.

Example

To change date, first enter CALIBRATE menu (Press ENTER button for 2 seconds; Press UP, UP, UP, DOWN buttons in sequence) Once in CALIBRATE menu, press UP button 1 time.

1. Display shows right arrow
2. Press RIGHT button to display "01" blinking
3. Press buttons to scroll through numbers.
4. Press ENTER button to save
5. Display now reads new date



Menu Functions

View Menu	Range
Flow units Total: >	00000 - 99999
Total Reset	**Lock: OFF**
► Reset Total?	00000000
Total Reset	**Lock: ON**
► Reset Total? Key Code —	▲ ▲ ▲ ▼
Perm: Total Units	00000000 - 99999999
Loop Output: mA	4-20 mA
Last Cal: Date	00-00-00 to 39-39-99

Calibrate Menu	Range	Preset
Flow Units: GPM >	a-z,A-Z,/,3, s,h,m,d s=seconds h=hours m=minutes d=days	GPM
Flow K-Factor: >	0.0000 to 99999	60.00
Total Units: Gallons >	a-z,A-Z,/,0-9 eight digit field	Gallons
Total K-Factor: 60.00 >	0.0000 to 99999	60.00
Loop Range: GPM 000.00->100.00>	0.0000 to 99999	0 to 100
Relay1 Mode: Low >	Off Low High Pulse	Low (Relay1) High (Relay2)
Low or High selected		
Relay1 Setpnt: 10.0 GPM >	0.0000 to 99999	10 (Relay1) 90 (Relay2)
Relay1 Hys: 5.0 GPM >	0.0000 to 99999	5 gpm
Pulse Selected		
Relay1 Volume: 100.00 Gallons >	0.0000 to 99999	100
Relay1 Plswdth: 0.1 Seconds >	0.1 to 999.9 seconds	0.1 seconds
Last Cal: 01-01-99 >	00-00-00 to 39-39-99	01-01-99

Settings repeat for Relay 2

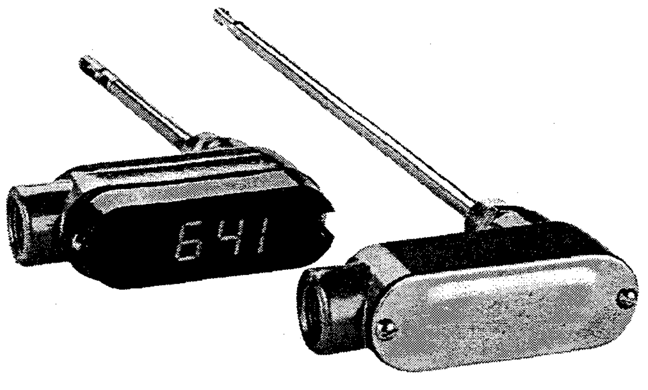
Options Menu	Range	Preset
Contrast: Level >	1-5	3
Flow Decimal: ***.** >	*.**** to *****.	****.*
Total Decimal: ********. >	******.** to ********.	********.
Averaging: Off >	Off Low (4secs) High(8secs)	Off
Total Reset: Lock Off >	On Off	Off
Loop Adjust: 4.00 mA >	3.8 to 5.0 mA	4.00 mA
Loop Adjust: 20.00 mA >	19.0 to 21.0 mA	20 mA
Test Loop: >	4-20 mA	N/A
Test Relay1: >	On or Off	N/A
Test Relay2: >	On or Off	N/A

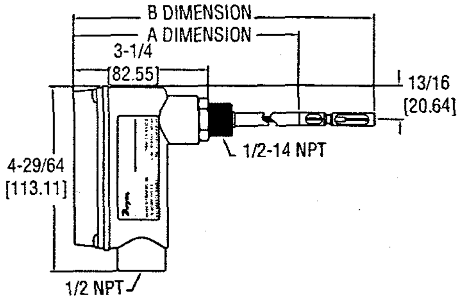
Troubleshooting

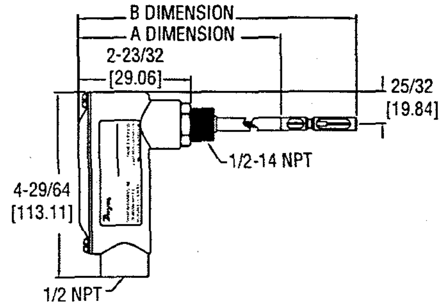
Display	Problem	Solution
——	Display timebase too large	Change flow timebase (S=seconds,M=minutes,H=hours,D=days) in CALIBRATE menu to a smaller value (e.g. GP**D** to GP**M**
Check settings for Output	Pulse width value too large for frequency input or pulse volume too small	Reduce output Plswidth setting or increase Output Volum setting.
SETUP READ ERROR Press Any Key	Memory fault occurred.	Press any key to reload presets, then reprogram setpoint:

Series 641 Air Velocity Transmitter

Specifications - Installation and Operating Instructions







641 AVT WITH DISPLAY OPTION	
A DIMENSION	B DIMENSION
7-63/64 [202.80]	9-13/16 [249.24]
13-63/64 [355.20]	15-13/16 [401.64]
19-63/64 [507.60]	21-13/16 [554.04]
26-63/64 [685.40]	28-13/16 [731.84]
32-63/64 [837.80]	34-13/16 [884.24]
37-63/64 [964.80]	39-13/16 [1011.24]

641 AVT WITHOUT DISPLAY OPTION	
A DIMENSION	B DIMENSION
7-7/16 [188.91]	9-9/32 [235.74]
13-7/16 [341.31]	15-9/32 [388.14]
19-7/16 [493.71]	21-9/32 [540.54]
26-7/16 [671.51]	26-9/32 [718.34]
29-7/16 [747.71]	34-9/32 [870.74]
37-7/16 [950.91]	39-9/32 [997.74]

The Series 641 Air Velocity Transmitter (AVT) uses a heated mass flow sensor technology. It has 8 user selectable ranges from 250 FPM to 15000 FPM with corresponding metric ranges of 1.25 MPS to 75 MPS. The 641 AVT provides an isolated 4-20 ma. output proportional to the velocity. With the optional 1/2″ 4-1/2 digit LED display, the 641 AVT will provide a highly visible local readout of the velocity.

INSTALLATION

Location: Select a location where the temperature will be within 32 to 140°F (0 to 60°C) to mount the enclosure. The transmitter may be located any distance from the receiver provided that the total loop resistance does not exceed 600 ohms. The probe should be located where conditions are representative of the overall environment being monitored. Avoid locations where turbulence, stagnation, or rapidly fluctuating velocities or temperatures are present as these conditions may affect the readings. The filter setting may be used to average velocity readings in turbulent conditions.

Position: The transmitter is not position sensitive and may be mounted in any orientation.

Mounting: An integral 1/2″ NPT allows direct mounting to pipe fittings or a pipe flange. The 641 AVT may also be mounted using a 5/16″ compression fitting. Arrows on the hex flats at the base of the probe indicate the direction of the calibrated airflow. Align these arrows in the direction of the process air. The case may be rotated independently of the probe for ease of connection.

Airflow: The 641 AVT is intended for use with clean dry air. Particulates in the air may cause sensor damage. Dust accumulation may impair the velocity measurement and will require probe cleaning.

SPECIFICATIONS

Service: Air and compatible, non-combustible gases.
Accuracy:
3% FS Process gas: 32 to 122° F (0 to 50°C).
4% FS Process gas: -40 to 32°F & 122 to 212°F (-40 to 0°C & 50 to 100°C).
Response Time: Flow: 1.5 seconds to 95% of final value (Output filter set to minimum).
Temperature Limits: Process: -40 to 212°F (-40 to 100°C). Ambient: 32 to 140°F (0 to 60°C).
Pressure Limit: 100 psi (6.89 bar) maximum.
Humidity Limit: Non-Condensing.
Power Requirements: 12–35 VDC, 10–16 VAC.
Output Signal: 4-20mA, isolated 24V source, 3 or 4-wire connection.
Output Filter: Selectable 0.5 –15 (seconds).
Loop Resistance: 600 ohms max.
Current Consumption: 300 mA max.
Electrical Connections: Screw Terminal.
Process Connections: 1/2″ male NPT.
Mounting Orientation: Unit not position sensitive. Probe must be aligned with airflow.
Weight: 12.6 oz. (357.2 grams).

OPTIONAL DISPLAY VERSION:

Display: 4-1/2 digit 1/2″ Red LED.
Resolution: 1 FPM, 0.01 MPS (10 FPM @ 10,000 and 15,000 FPM ranges).
Weight: 13.3 oz. (377 grams).

DWYER INSTRUMENTS, INC. P.O. BOX 373 • MICHIGAN CITY, INDIANA 46361, U.S.A.
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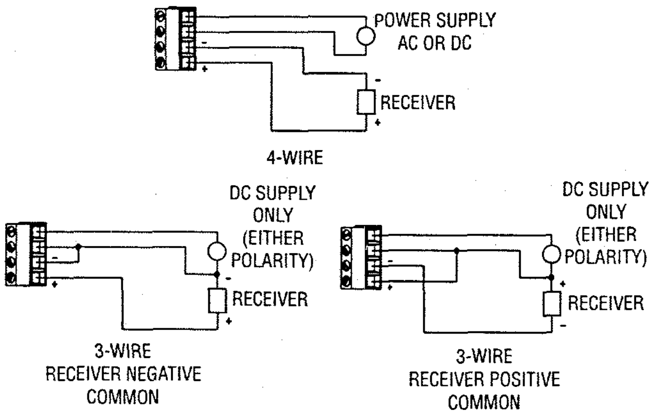
www.dwyer-inst.com e-mail: info@dwyer-inst.com

NOTE: Where conduit connections are not made, a 1/2" NPT cable seal should be used to prevent contaminants from entering the case. Where conduit connections are made, make sure that any possible condensation within the conduit will not flow into the transmitter housing.

ELECTRICAL CONNECTION

The 641 AVT has been designed for easy and flexible connection to power and loop receivers. Electrical connection is made inside the body of the device with a "Euro" style terminal block. The device features a current loop that is fully isolated from the power source. The current loop has an internal 24V isolated supply so no external loop power is required. With full isolation, loop grounding is not a concern. The input power requirements are also very flexible. The device may be powered from either an AC or DC power source.

3 or 4-Wire Connection



CAUTION: Do not exceed the specified supply voltage rating. Permanent damage not covered by the warranty may result. Do not use an external power source on the current loop connection.

Receiver-Transmitter Connection — The 641 AVT is designed as a three or four wire 4-20 ma device. The current loop output is isolated from the power supply input and provides an internal 24-volt loop supply. With a DC power supply, a three or four-wire connection may be used. Do not use a three-wire connection with an AC power source. In a three-wire connection either power supply wire may be used as the common. The total loop resistance should not exceed 600 Ohms.

CAUTION: Do not use a receiver with an internal power supply or use an external supply in the current loop. The current loop is powered from within the 641 AVT. Connecting an external supply to the current loop may destroy the transmitter. Using an external supply voids the warranty.

Power Supply Connection — The power supply may be either AC or DC. The DC power may be from 12 to 35 Volts. The power connection is not polarity sensitive so the positive and negative connections may be made to either power terminal. The AC connection may be from 10 to 16 VAC RMS. Do not exceed 20 VAC. When selecting a transformer please note that the specified output for transformers is at some specified current. With a load current less than the specified current transformer output may be significantly higher than the specified voltage. Transformers with secondary voltages of 10 to 16 VAC are recommended.

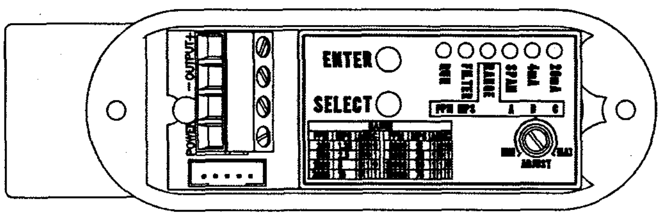
CAUTION: Do not use transformers with a secondary voltage rating greater than 16 VAC RMS.

Wire Type and Length — The wire selection for an installation is often overlooked or neglected and may contribute to improper or even intermittent operation. In all cases ensure that the connection meets all applicable national and local electrical codes. Although the 4-20 mA current loop systems are relatively immune to wire or wiring related problems, selection of the wire for some installations will be an important factor in ensuring satisfactory system operation. Twisted conductors will usually be immune to most stray electric and magnetic fields and to some extent electromagnetic fields, such as interference from RF transmitters. With twisted pair wiring the current loop and the power connections should be separate pairs. Avoid using flat or ribbon cable that has no regular conductor twist. Where interference is possible, it is recommended that shielded wire be used. The shield must not be used as one of the conductors and should be connected to ground at only one end, generally at the power supply. Similarly, if the installation uses conduit, the conduit should be connected to protective ground as specified by the applicable code and the signal wiring must not be connected to the conduit at more than one point or as specified by the code.
The maximum length of wire connecting the transmitter and receiver is a function of the wire resistance and receiver resistance. The total loop resistance must not exceed 600 Ohms, including the receiver resistance and wire resistance. The power supply connection must be designed so that the worst case voltage drop due to wire resistance will not cause the power supply voltage at the transmitter to drop below the specified value. Provided the power supply voltage is maintained within the specified voltage range, the 641 AVT is not affected by variations in power supply voltage.

TRANSMITTER SETUP

The 641 AVT has been designed for easy setup. It has five configuration parameters that may be adjusted by the user. These parameters are Output Filter, Range (In English or Metric), span, 4 mA set-point and 20 mA set-point. All of these may be adjusted at any time in the field. These adjustments may also be easily returned to factory default.

Interior Label Diagram



A set of controls and indicators are provided within the unit consisting of the select button, enter button, adjustment control, and six LED indicators. When operating normally, only the RUN LED indicator will be illuminated. During the setup operation the LED indicators will indicate the parameter selected, when it is being adjusted, and status of the adjustment process. If the unit is left in the setup mode for several minutes without any activity it will return to the normal operating mode.

Two buttons and a potentiometer control the setup process.
The SELECT button is used to scroll between the setup parameters.
The ENTER button allows access to each parameter for adjustment.
The ADJUST potentiometer is used to change the value of the parameters.
Holding the ENTER button for 2.5 seconds saves the new parameter value.

Making Adjustments

The adjustment process has three steps: select the parameter, adjust the parameter, save the new value. These are described in the following steps.

1. Select the parameter: Each time the SELECT button is pressed the LED indicator will advance to the next parameter. When the last parameter, SPAN, is selected, the next time the SELECT is pressed the unit will return to RUN mode. Press the SELECT button until the LED indicator illuminates the desired parameter. Press ENTER. The selected indicator will begin to blink, showing the parameter may now be adjusted. If the unit is left in the setup mode, after several minutes it will reset to the operate mode.

2. Adjust the parameter: Turn the ADJUST potentiometer until the desired setting is made. This may be adjusted using a small screwdriver or similar tool. Be careful not to force the control past its stops or damage will result.

3. Save the Parameter: To save the new parameter press and hold the ENTER button. The LED indicator will begin to flash at a faster rate. After about 2.5 seconds all of the LED indicators will flash when the parameter is saved. If you do not want to save the parameter press the SELECT button without entering the parameter. The adjusted value will be discarded and next LED indicator will be illuminated.

Adjusting the Output Filter

The output filter may be adjusted to smooth the readings when measuring turbulent flow. The time constant may be adjusted from 0.5 seconds to 15 seconds. To adjust the filter time constant, select the FILTER indicator. Press ENTER to enable adjustment. Turn the ADJUST until the desired amount of damping is achieved. To save the value press and hold the ENTER button until the LED indicators all flash, indicating the value was saved. To discard the adjustment press SELECT before pressing the ENTER button.

OUTPUT FILTER RESPONSE (values in seconds)

% of Full Velocity	Filter Setting on Adjust Dial		
	Min.	Mid.	Max.
63%	0.5	7.5	15
90%	1.1	17.3	34.5
95%	1.5	22.5	44.9
99%	2.3	34.5	69.0

Range Selection

The range selection allows you to select one of eight ranges in either feet per minute (FPM) or meters per second (MPS).

Ranges:
FPM: 250, 500, 1000, 2000, 3000, 5000, 10000, 15000
MPS: 1.25, 2.5, 5, 10, 15, 25, 50, 75

Select the RANGE indicator by pressing ENTER when the RANGE LED indicator is illuminated. The A,B,C LED indicators will display which range setting is currently active. Press ENTER to enable adjustment. Turn the ADJUST until the desired range indication is achieved. If you want to discard the adjustment press SELECT. If you want to save the range press and hold ENTER. The RANGE LED will blink at a faster rate for about 2.5 seconds then all of the LEDs will flash indicating the value was saved.

The range setting is displayed with the LED indicators. The function of these indicators is summarized on the control label inside the unit. The following table summarizes the indicator status for each range setting

				Span	4 mA	20 mA
Range/Units	Run	Filter	Range	A	B	C
250 FPM	1	0	1	0	0	0
500 FPM	1	0	1	0	0	1
1000 FPM	1	0	1	0	1	0
2000 FPM	1	0	1	0	1	1
3000 FPM	1	0	1	1	0	0
5000 FPM	1	0	1	1	0	1
10000 FPM	1	0	1	1	1	0
15000 FPM	1	0	1	1	1	1
1.25 MPS	0	1	1	0	0	0
2.5 MPS	0	1	1	0	0	1
5 MPS	0	1	1	0	1	0
10 MPS	0	1	1	0	1	1
15 MPS	0	1	1	1	0	0
25 MPS	0	1	1	1	0	1
50 MPS	0	1	1	1	1	0
75 MPS	0	1	1	1	1	1

1: Indicator on
0: Indicator off

Span Setting

The 641 AVT has been calibrated for standard sea level conditions. As a mass flow device it will always read the air velocity for standard conditions. Density changes due to barometric or absolute pressure are not corrected automatically. The span setting allows correction for altitude or other static pressure conditions that affect the density of the process air. This parameter allows for a ±50% adjustment in the span value.

To make the span adjustment you will need to know either the absolute static pressure or the corrected velocity of the process air. Set the air velocity to a known value, ideally about 3/4 of the full-scale range value. Press SELECT until the SPAN LED indicator is illuminated then press ENTER. The SPAN LED will begin to blink. Adjust the control for the desired velocity then press and hold the ENTER button until all of the LED's flash, indicating the new value was saved. If you know the absolute static pressure you can compute the corrected velocity using the following equation:

$$V_{cor} = \frac{P_o}{P_A} V_{rdg}$$

Where:
P0 is the standard pressure of 29.9 in. Hg. or 760 mm Hg.
PA is the absolute pressure reading
Vrdg is the indicated velocity
Vcor is the corrected velocity

4 mA Setting

To make this setting you will need a milliammeter connected in the current loop. Press SELECT until the 4 mA LED indicator is illuminated then press ENTER. The milliammeter will now read approximately 4.0 mA. Adjust the control for a 4.0 mA reading on the milliammeter. Press and hold ENTER to save the new setting. Pressing SELECT before pressing ENTER will restore the previous calibration value.

20 mA Setting

With the milliammeter connected in the current loop, press SELECT until the 20-mA LED indicator is illuminated. Press ENTER to begin adjustment of the 20-mA set point. The 20 mA LED will now be blinking. Adjust the control until the milliammeter reads 20.0 mA. Press and hold ENTER to save the new setting. Pressing SELECT before pressing ENTER will restore the previous calibration value.

Restoring Factory Default Settings

The 4 mA, 20 mA, and Range settings override factory default values. To restore these to the factory default settings, start with the unit in the RUN mode. Press and hold the ENTER button. The RUN LED indicator will begin to blink. After about 2.5 seconds all LED indicators will flash indicating the factory settings have been restored. Range and Filter settings are not affected by this operation. If you are unsure whether any have been altered, press the SELECT button six times to sequence through all settings. When you return to the RUN mode, the RUN LED indicator will blink several times if either the 4 mA, 20 mA, or span settings have been changed. The RUN LED will otherwise remain on.

MAINTENANCE

In general the 641 AVT should require very little maintenance. In some installations dust may accumulate on the sensor over time. This can be removed by carefully brushing the probe with a small camel hairbrush. If too much force is applied during cleaning, the sensor of the 641 AVT may be damaged. Therefore, a trained technician should perform the cleaning operation. A jet of air may also dislodge the accumulated buildup however, again, the sensor is delicate and this operation should be done carefully with clean regulated air. Using a shop air supply may exert enough force to damage the sensor. Most air supplies of this sort will also contain water or oil that could damage the sensor. Technical grade denatured or isopropyl alcohol may be used where the dust accumulation does not respond to brushing. Do not use water. Always disconnect the power when performing a cleaning operation.

Aside from field calibration described above, the 641 cannot be field calibrated. Because of specialized computer instrumentation required, these units must be returned to Dwyer Instruments for factory calibration.

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Appendix C – Design Calculations

Design Notes
Piping and Blower Sizing
Former General Instrument Corporation Site
Hicksville, New York

Vacuum and Flow Relationship

- Vacuum and flow measurements from the UVB pilot test (ESC Engineering, July 2003) and interim operation are listed in the table below.
- Vacuum and pressure measurements were recorded as inches of water gauge (in. H_2O). Pressure readings are positive while vacuum readings are negative.
- Flow rates were calculated from pressure differential measurements recorded using a pitot tube (Dwyer DS-300 Series Flow Sensor).

UVB Pilot Test and Interim Operation Results

Number of Trays	Flow Rate from Pitot Tube (scfm)	Blower Discharge (Pressure)		Blower Inlet Vacuum		Vault Vacuum	
		(in. H_2O)	(in. Hg)	(in. H_2O)	(in. Hg)	(in. H_2O)	(in. Hg)
Single	580	5.2	0.38	-10.9	-0.80	-8.9	-0.65
Double	610	6.5	0.48	-9.9	-0.73	-7.4	-0.54

- For design, initially assume a vault vacuum of 15 in. H_2OV (incorporating second stripping tray and adding a factor of safety of 2 to account for increased air flow) and a corresponding flow of 1,000 scfm per well.

Carbon Vessel Sizing

- Size the carbon vessels taking into account size of units, pressure drop across media, and number of days between carbon change-outs.

Option	Total # Units			Vessel Length (feet)	Vessel Width (feet)	Pressure Drop Across Media		Velocity (ft/min)	Time Between Carbon Change-Outs (days)
	3,000	5,000	10,000			(in. H2O)	(in. HgV)		
#1	4	0	0	5	5	30.0	2.21	30.0	58
#2	0	4	0	8	6	7.0	0.51	31.3	98
#3	0	0	2	8	10	42.0	3.09	37.5	98

Note: The maximum vacuum loss along the piping was conservatively used in the design.

- Select (4) 5,000-pound vessels plumbed with 2 vessels in series in parallel with 2 other vessels in series.

Friction Loss Calculations, Transfer Pipe Sizing, and Blower Sizing

- Because the vapor is compressible, use the properties of the vapor at the midpoint of the piping run to calculate friction loss. (Lindeburg, Civil Engineering Reference Manual, 6th Edition, p.3-40: for pressure losses less than 10% of entrance pressure can use properties at any point; for pressure losses between 10% and 40% of entrance pressure, use properties at the midpoint of the piping run; for pressure losses greater than 40% of entrance pressure, use exact compressible flow equations)
- See friction loss worksheets for pressure loss calculations assuming 100% vapor flow.
- Applied a factor of safety of 1.2 to account for connection fittings and losses through the blower inlet.
- See printouts of the model results. Iterated on density and actual flow rate (acfm) to determine piping midpoint conditions for each leg. Results are tabulated below for the different wells.

Design Notes
Piping and Blower Sizing
Former General Instrument Corporation Site
Hicksville, New York

Friction Loss Calculations, Transfer Pipe Sizing, and Blower Sizing (Continued)

- Size the blower taking into account both vacuum losses in transfer piping and pressure drop across carbon.

Wells	Nominal Diameter (inches)	Length (feet)	UVB Vault Vacuum (in. H2OV)	Demister & Piping Vacuum Loss (in. H2OV)	Blower Inlet Vacuum (in. H2OV)	Discharge Piping & Carbon Pressure Losses (in. H2O)	TOTAL (in. H2O)
UVB-1	6	50	15.0	11.9	26.9	15.5	42.4
	8			5.3	20.3		35.8
UVB-2 (A)	8	1,100		23.2	38.2		53.7
	10			9.2	24.2		39.7
UVB-2 (B)	8	350		9.6	24.6		40.1
	10			4.6	19.6		35.1
UVB-3	8	330		9.7	24.7		40.2
	10			4.7	11.9		35.2

- Specify 8-inch diameter PVC pipe for UVB-1, UVB-2 (Option B), and UVB-3. Specify 10-inch PVC pipe for UVB-2 (Option A).
- Blower performance specification is 1,000 scfm with 25 wci vacuum at blower inlet and 16 wci pressure at blower outlet.

Vapor Flow Measurement

- Will measure vapor flow using a Dwyer Series 641 Air Velocity Transmitter
- Expected vapor velocities at design flow rates are shown in the table below.

Nominal Diameter (inches)	Inside Diameter (feet)	Inside Area (ft^2)	Velocity (sfpm) at Given Flow Rate (scfm) and Pipe Size		
			Flow Rate (scfm)		
			1,000	**1,500**	**3,000**
10	0.8647	0.5872	1,703	2,554	5,109

Table C-1

Friction Loss Calculations for the Full-Scale UVB System - UVB-1
Former General Instrument Corporation Site
Hicksville, New York

Parameters	6-Inch Line	8-Inch Line	Comments
Constants			
Molecular Weight of Air (MW_{air}) [lbm/lbmol]	29	29	
Universal Gas Constant (R) [ft-lbf/lbmol-degR]	1,545	1,545	
Gravity (g) [ft/s^2]	32.2	32.2	
Vacuum and Temperature Variables			
Gauge Vacuum at Piping Entrance (Vault) [in. H_2O]	15.0	15.0	
Calculated Gauge Vacuum at Piping Midpoint [in. H2O]	20.96	17.66	
Gauge Vacuum at Piping Midpoint [in. H2O]	23.94	18.99	Assumed value for the midpoint of the piping system. Iterate until calculated value matches assumed value.
Barometric Pressure [in. HgA]	30.06	30.06	
Barometric Pressure [in. H2O]	408.82	408.82	
Absolute Pressure at Piping Midpoint [in. H2O]	384.88	389.83	
Absolute Pressure at Piping Midpoint (p) [lbf/ft^2]	2,003	2,029	
Temperature [deg F]	60	60	
Temperature (T) [deg R]	520	520	deg R = deg F + 460
Density at Piping Midpoint (ρ) [lbm/ft^3]	0.0723	0.0732	$\rho = MW_{air}(p/RT)$
Kinematic Viscosity (υ) [ft^2/s]	0.0001580	0.0001580	at 60 deg F
Flow, Pipe Size, and Velocity Variables			
Flow [scfm]	1,000	1,000	
Actual Flow at Piping Midpoint [acfm]	1,057	1,044	$p_1Q_1 = p_2Q_2$ (Boyle's Law)
Actual Flow at Piping Midpoint (Q) [acfs]	17.62	17.40	
Pipe Type/Schedule	Schedule 40 PVC	Schedule 40 PVC	
Nominal Pipe Diameter [in]	6	8	
Inside Pipe Diameter (D) [feet]	0.5054	0.6651	
Inside Pipe Area (A) [ft^2]	0.2006	0.3474	
Actual Velocity at Piping Midpoint [afpm]	5,270	3,005	V = Q/A
Actual Velocity at Piping Midpoint (V) [afps]	88	50	V = Q/A
Reynolds Number (Re)	2.81E+05	2.11E+05	Re = VD/υ
Specific Roughness (ε)	5.00E-06	5.00E-06	For PVC pipe (in feet)
Relative Roughness (ε/D)	9.89E-06	7.52E-06	
Friction Factor (f)	1.49E-02	1.57E-02	$f = \{-2 \log [(\varepsilon/D)/3.7 - (5.02/Re) \log [(\varepsilon/D)/3.7 + (14.5/Re)]]\}^{-2}$ Sacham Equation. Check result against Moody Diagram. If not turbulent flow, use f=64/Re.
Pipe Length Between Well and Blower [ft]	50	50	

Table C-1

Friction Loss Calculations for the Full-Scale UVB System - UVB-1
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**6-Inch Line**		**8-Inch Line**		**Comments**
Equivalent Lengths for Pipe Fittings and Valves	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	
90 Degree Elbow	15.00	0	21.00	0	
Long Radius 90 or 45 Degree Elbow	10.00	9	14.00	9	Assumes losses in 22.5 degree elbow are same as 45 degree elbow
Tee, Through Flow	10.00	0	14.00	0	
Tee, Branch Flow	30.00	0	40.00	0	
Gate Valve, Fully Opened	6.50	0	9.00	0	
Check Valve, Swing	65.00	0	90.00	0	
Butterfly Valve, Fully Opened	23.00	0	27.00	0	
Pipe Inlet (K=0.78)	29.00	1	38.00	1	
Pipe Inlet (K=0.5)	18.00	0	24.00	0	
Total Equivalent Length (L_e) [ft]	169		214		$L_e = L + \Sigma[(L_i)(n_i)]$, where i = fitting type and n = quantity
Pressure Losses					
Friction Head Loss in Piping (h_f) [ft of air]	595		196		$h_f = (fL_eV^2)/(2Dg)$
Pressure Loss in Piping [psi]	0.30		0.10		$= (h_f)(\rho)/144$
Pressure Loss in Piping [in. H2O]	8.27		2.76		in. H2O = (psi)(2.307)*12
Factor of Safety (FS)	1.20		1.20		
Pressure Loss in Piping including FS [in. H2O]	9.92		3.31		
Demister Pressure Loss	2.00		2.00		
Gauge Vacuum at Piping Entrance (Vault) [in. H2O]	15.0		15.0		From above
Pressure Loss as % of Entrance Vacuum [%]	79%		35%		
Calculated Gauge Vacuum at Piping Exit [in. H2O]	**26.92**		**20.31**		

Table C-2

Friction Loss Calculations for the Full-Scale UVB System - UVB-2 (Option A)
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**	**10-Inch Line**	**Comments**
Constants			
Molecular Weight of Air (MW_{air}) [lbm/lbmol]	29	29	
Universal Gas Constant (R) [ft-lbf/lbmol-degR]	1,545	1,545	
Gravity (g) [ft/s^2]	32.2	32.2	
Vacuum and Temperature Variables			
Gauge Vacuum at Piping Entrance (Vault) [in. H_2O]	15.0	15.0	
Calculated Gauge Vacuum at Piping Midpoint [in. H2O]	26.62	19.58	
Gauge Vacuum at Piping Midpoint [in. H2O]	32.44	21.87	Assumed value for the midpoint of the piping system. Iterate until calculated value matches assumed value.
Barometric Pressure [in. HgA]	30.06	30.06	
Barometric Pressure [in. H2O]	408.82	408.82	
Absolute Pressure at Piping Midpoint [in. H2O]	376.38	386.95	
Absolute Pressure at Piping Midpoint (p) [lbf/ft^2]	1,959	2,014	
Temperature [deg F]	60	60	
Temperature (T) [deg R]	520	520	deg R = deg F + 460
Density at Piping Midpoint (ρ) [lbm/ft^3]	0.0707	0.0727	$\rho = MW_{air}(p/RT)$
Kinematic Viscosity (υ) [ft^2/s]	0.0001580	0.0001580	at 60 deg F
Flow, Pipe Size, and Velocity Variables			
Flow [scfm]	1,000	1,000	
Actual Flow at Piping Midpoint [acfm]	1,081	1,052	$p_1Q_1 = p_2Q_2$ (Boyle's Law)
Actual Flow at Piping Midpoint (Q) [acfs]	18.02	17.53	
Pipe Type/Schedule	Schedule 40 PVC	Schedule 40 PVC	
Nominal Pipe Diameter [in]	8	10	
Inside Pipe Diameter (D) [feet]	0.6651	0.8350	
Inside Pipe Area (A) [ft^2]	0.3474	0.5476	
Actual Velocity at Piping Midpoint [afpm]	3,112	1,920	V = Q/A
Actual Velocity at Piping Midpoint (V) [afps]	52	32	V = Q/A
Reynolds Number (Re)	2.18E+05	1.69E+05	Re = VD/υ
Specific Roughness (ε)	5.00E-06	5.00E-06	For PVC pipe (in feet)
Relative Roughness (ε/D)	7.52E-06	5.99E-06	
Friction Factor (f)	1.55E-02	1.63E-02	$f = \{-2 \log [(\varepsilon/D)/3.7 - (5.02/Re) \log [(\varepsilon/D)/3.7 + (14.5/Re)]]\}^{-2}$ Sacham Equation. Check result against Moody Diagram. If not turbulent flow, use f=64/Re.
Pipe Length Between Well and Blower [ft]	1,100	1,100	

Table C-2

Friction Loss Calculations for the Full-Scale UVB System - UVB-2 (Option A)
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**		**10-Inch Line**		**Comments**
Equivalent Lengths for Pipe Fittings and Valves	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	
90 Degree Elbow	21.00	0	24.00	0	
Long Radius 90 or 45 Degree Elbow	14.00	14	16.00	14	Assumes losses in 22.5 degree elbow are same as 45 degree elbow
Tee, Through Flow	14.00	0	16.00	0	
Tee, Branch Flow	40.00	0	50.00	0	
Gate Valve, Fully Opened	9.00	0	12.00	0	
Check Valve, Swing	90.00	0	120.00	0	
Butterfly Valve, Fully Opened	27.00	0	35.00	0	
Pipe Inlet (K=0.78)	38.00	1	49.00	1	
Pipe Inlet (K=0.5)	24.00	0	31.00	0	
Total Equivalent Length (L_e) [ft]	1,334		1,373		$L_e = L + \Sigma[(L_i)(n_i)]$, where i = fitting type and n = quantity
Pressure Losses					
Friction Head Loss in Piping (h_f) [ft of air]	1,303		427		$h_f = (fL_eV^2)/(2Dg)$
Pressure Loss in Piping [psi]	0.64		0.22		$= (h_f)(\rho)/144$
Pressure Loss in Piping [in. H2O]	17.71		5.97		in. H2O = (psi)(2.307)*12
Factor of Safety (FS)	1.20		1.20		
Pressure Loss in Piping including FS [in. H2O]	21.25		7.16		
Demister Pressure Loss	2.00		2.00		
Gauge Vacuum at Piping Entrance (Vault) [in. H2O]	15.0		15.0		From above
Pressure Loss as % of Entrance Vacuum [%]	155%		61%		
Calculated Gauge Vacuum at Piping Exit [in. H2O]	**38.25**		**24.16**		

Table C-3

Friction Loss Calculations for the Full-Scale UVB System - UVB-2 (Option B)
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**	**10-Inch Line**	**Comments**
Constants			
Molecular Weight of Air (MW_{air}) [lbm/lbmol]	29	29	
Universal Gas Constant (R) [ft-lbf/lbmol-degR]	1,545	1,545	
Gravity (g) [ft/s^2]	32.2	32.2	
Vacuum and Temperature Variables			
Gauge Vacuum at Piping Entrance (Vault) [in. H_2O]	15.0	15.0	
Calculated Gauge Vacuum at Piping Midpoint [in. H2O]	19.78	17.32	
Gauge Vacuum at Piping Midpoint [in. H2O]	20.87	17.76	Assumed value for the midpoint of the piping system. Iterate until calculated value matches assumed value.
Barometric Pressure [in. HgA]	30.06	30.06	
Barometric Pressure [in. H2O]	408.82	408.82	
Absolute Pressure at Piping Midpoint [in. H2O]	387.95	391.06	
Absolute Pressure at Piping Midpoint (p) [lbf/ft^2]	2,019	2,035	
Temperature [deg F]	60	60	
Temperature (T) [deg R]	520	520	deg R = deg F + 460
Density at Piping Midpoint (ρ) [lbm/ft^3]	0.0729	0.0735	$\rho = MW_{air}(p/RT)$
Kinematic Viscosity (υ) [ft^2/s]	0.0001580	0.0001580	at 60 deg F
Flow, Pipe Size, and Velocity Variables			
Flow [scfm]	1,000	1,000	
Actual Flow at Piping Midpoint [acfm]	1,049	1,041	$p_1Q_1 = p_2Q_2$ (Boyle's Law)
Actual Flow at Piping Midpoint (Q) [acfs]	17.48	17.34	
Pipe Type/Schedule	Schedule 40 PVC	Schedule 40 PVC	
Nominal Pipe Diameter [in]	8	10	
Inside Pipe Diameter (D) [feet]	0.6651	0.8350	
Inside Pipe Area (A) [ft^2]	0.3474	0.5476	
Actual Velocity at Piping Midpoint [afpm]	3,019	1,900	V = Q/A
Actual Velocity at Piping Midpoint (V) [afps]	50	32	V = Q/A
Reynolds Number (Re)	2.12E+05	1.67E+05	Re = VD/υ
Specific Roughness (ε)	5.00E-06	5.00E-06	For PVC pipe (in feet)
Relative Roughness (ε/D)	7.52E-06	5.99E-06	
Friction Factor (f)	1.56E-02	1.64E-02	$f = \{-2 \log [(\varepsilon/D)/3.7 - (5.02/Re) \log [(\varepsilon/D)/3.7 + (14.5/Re)]]\}^{-2}$ Sacham Equation. Check result against Moody Diagram. If not turbulent flow, use f=64/Re.
Pipe Length Between Well and Blower [ft]	350	350	

Table C-3

Friction Loss Calculations for the Full-Scale UVB System - UVB-2 (Option B)
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**		**10-Inch Line**		**Comments**
Equivalent Lengths for Pipe Fittings and Valves	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	
90 Degree Elbow	21.00	0	24.00	0	
Long Radius 90 or 45 Degree Elbow	14.00	7	16.00	7	Assumes losses in 22.5 degree elbow are same as 45 degree elbow
Tee, Through Flow	14.00	0	16.00	0	
Tee, Branch Flow	40.00	0	50.00	0	
Gate Valve, Fully Opened	9.00	0	12.00	0	
Check Valve, Swing	90.00	0	120.00	0	
Butterfly Valve, Fully Opened	27.00	0	35.00	0	
Pipe Inlet (K=0.78)	38.00	1	49.00	1	
Pipe Inlet (K=0.5)	24.00	0	31.00	0	
Total Equivalent Length (L_e) [ft]	486		511		$L_e = L + \Sigma[(L_i)(n_i)]$, where i = fitting type and n = quantity
Pressure Losses					
Friction Head Loss in Piping (h_f) [ft of air]	449		156		$h_f = (fL_eV^2)/(2Dg)$
Pressure Loss in Piping [psi]	0.23		0.08		$= (h_f)(\rho)/144$
Pressure Loss in Piping [in. H2O]	6.30		2.20		in. H2O = (psi)(2.307)*12
Factor of Safety (FS)	1.20		1.20		
Pressure Loss in Piping including FS [in. H2O]	7.55		2.64		
Demister Pressure Loss	2.00		2.00		
Gauge Vacuum at Piping Entrance (Vault) [in. H2O]	15.0		15.0		From above
Pressure Loss as % of Entrance Vacuum [%]	64%		31%		
Calculated Gauge Vacuum at Piping Exit [in. H2O]	**24.55**		**19.64**		

Table C-4

Friction Loss Calculations for the Full-Scale UVB System - UVB-3
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**	**10-Inch Line**	**Comments**
Constants			
Molecular Weight of Air (MW_{air}) [lbm/lbmol]	29	29	
Universal Gas Constant (R) [ft-lbf/lbmol-degR]	1,545	1,545	
Gravity (g) [ft/s^2]	32.2	32.2	
Vacuum and Temperature Variables			
Gauge Vacuum at Piping Entrance (Vault) [in. H_2O]	15.0	15.0	
Calculated Gauge Vacuum at Piping Midpoint [in. H2O]	19.85	17.35	
Gauge Vacuum at Piping Midpoint [in. H2O]	22.28	18.53	Assumed value for the midpoint of the piping system. Iterate until calculated value matches assumed value.
Barometric Pressure [in. HgA]	30.06	30.06	
Barometric Pressure [in. H2O]	408.82	408.82	
Absolute Pressure at Piping Midpoint [in. H2O]	386.54	390.29	
Absolute Pressure at Piping Midpoint (p) [lbf/ft^2]	2,012	2,031	
Temperature [deg F]	60	60	
Temperature (T) [deg R]	520	520	deg R = deg F + 460
Density at Piping Midpoint (ρ) [lbm/ft^3]	0.0726	0.0733	$\rho = MW_{air}(p/RT)$
Kinematic Viscosity (υ) [ft^2/s]	0.0001580	0.0001580	at 60 deg F
Flow, Pipe Size, and Velocity Variables			
Flow [scfm]	1,000	1,000	
Actual Flow at Piping Midpoint [acfm]	1,053	1,043	$p_1Q_1 = p_2Q_2$ (Boyle's Law)
Actual Flow at Piping Midpoint (Q) [acfs]	17.55	17.38	
Pipe Type/Schedule	Schedule 40 PVC	Schedule 40 PVC	
Nominal Pipe Diameter [in]	8	10	
Inside Pipe Diameter (D) [feet]	0.6651	0.8350	
Inside Pipe Area (A) [ft^2]	0.3474	0.5476	
Actual Velocity at Piping Midpoint [afpm]	3,030	1,904	V = Q/A
Actual Velocity at Piping Midpoint (V) [afps]	51	32	V = Q/A
Reynolds Number (Re)	2.13E+05	1.68E+05	Re = VD/υ
Specific Roughness (ε)	5.00E-06	5.00E-06	For PVC pipe (in feet)
Relative Roughness (ε/D)	7.52E-06	5.99E-06	
Friction Factor (f)	1.56E-02	1.64E-02	$f = \{-2 \log [(\varepsilon/D)/3.7 - (5.02/Re) \log [(\varepsilon/D)/3.7 + (14.5/Re)]]\}^{-2}$ Sacham Equation. Check result against Moody Diagram. If not turbulent flow, use f=64/Re.
Pipe Length Between Well and Blower [ft]	330	330	

Table C-4

Friction Loss Calculations for the Full-Scale UVB System - UVB-3
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**8-Inch Line**		**10-Inch Line**		**Comments**
Equivalent Lengths for Pipe Fittings and Valves	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	
90 Degree Elbow	21.00	0	24.00	0	
Long Radius 90 or 45 Degree Elbow	14.00	9	16.00	9	Assumes losses in 22.5 degree elbow are same as 45 degree elbow
Tee, Through Flow	14.00	0	16.00	0	
Tee, Branch Flow	40.00	0	50.00	0	
Gate Valve, Fully Opened	9.00	0	12.00	0	
Check Valve, Swing	90.00	0	120.00	0	
Butterfly Valve, Fully Opened	27.00	0	35.00	0	
Pipe Inlet (K=0.78)	38.00	1	49.00	1	
Pipe Inlet (K=0.5)	24.00	0	31.00	0	
Total Equivalent Length (L_e) [ft]	494		523		$L_e = L + \Sigma[(L_i)(n_i)]$, where i = fitting type and n = quantity
Pressure Losses					
Friction Head Loss in Piping (h_f) [ft of air]	460		160		$h_f = (fL_eV^2)/(2Dg)$
Pressure Loss in Piping [psi]	0.23		0.08		$= (h_f)(\rho)/144$
Pressure Loss in Piping [in. H2O]	6.42		2.26		in. H2O = (psi)(2.307)*12
Factor of Safety (FS)	1.20		1.20		
Pressure Loss in Piping including FS [in. H2O]	7.70		2.71		
Demister Pressure Loss	2.00		2.00		
Gauge Vacuum at Piping Entrance (Vault) [in. H2O]	15.0		15.0		From above
Pressure Loss as % of Entrance Vacuum [%]	65%		31%		
Calculated Gauge Vacuum at Piping Exit [in. H2O]	**24.70**		**19.71**		

Table C-5

Friction Loss (Pressure) Calculations for the Full-Scale UVB System
Former General Instrument Corporation Site
Hicksville, New York

Parameters	Stack	Piping in Parallel	Common Header	Blower to Manifold	Comments
Constants					
Molecular Weight of Air (MW_{air}) [lbm/lbmol]	29	29	29	29	
Universal Gas Constant (R) [ft-lbf/lbmol-deg R]	1,545	1,545	1,545	1,545	
Gravity (g) [ft/s^2]	32.2	32.2	32.2	32.2	
Pressure and Temperature Variables					
Gauge Pressure at Piping Exit [in. H_2O]	0.0	2.12	11.37	15.19	
Calculated Gauge Pressure at Piping Midpoint [in. H2O]	1.06	6.75	13.28	15.35	
Gauge Pressure at Piping Midpoint [in. H2O]	1.06	6.75	13.28	15.35	Assumed value for the midpoint of the piping system. Iterate until calculated value matches assumed value.
Barometric Pressure [in. HgA]	30.06	30.06	30.06	30.06	
Barometric Pressure [in. H2O]	408.82	408.82	408.82	408.82	
Absolute Pressure at Piping Midpoint [in. H2O]	407.76	402.07	395.54	393.47	
Absolute Pressure at Piping Midpoint (p) [lbf/ft^2]	2,122	2,092	2,058	2,048	
Temperature [deg F]	75	75	75	75	
Temperature (T) [deg R]	535	535	535	535	deg R = deg F + 460
Density at Piping Midpoint (ρ) [lbm/ft^3]	0.0744	0.0734	0.0722	0.0718	$\rho = MW_{air}(p/RT)$
Kinematic Viscosity (υ) [ft^2/s]	0.0001650	0.0001650	0.0001650	0.0001650	at 75 deg F
Flow, Pipe Size, and Velocity Variables					
Flow [scfm]	3,000	1,500	3,000	1,000	
Actual Flow at Piping Midpoint [acfm]	2,994	1,518	3,086	1,034	$p_1Q_1 = p_2Q_2$ (Boyle's Law)
Actual Flow at Piping Midpoint (Q)	49.90	25.30	51.44	17.24	
Pipe Type/Schedule	PVC Duct	PVC Duct	PVC Duct	PVC Duct	
Nominal Pipe Diameter [in]	10	10	10	10	
Inside Pipe Diameter (D) [feet]	0.8647	0.8647	0.8647	0.8647	
Inside Pipe Area (A) [ft^2]	0.5872	0.5872	0.5872	0.5872	

Table C-5

Friction Loss (Pressure) Calculations for the Full-Scale UVB System
Former General Instrument Corporation Site
Hicksville, New York

Parameters	**Stack**		**Piping in Parallel**		**Common Header**		**Blower to Manifold**		**Comments**
Flow, Pipe Size, and Velocity Variables									
Actual Velocity at Piping Midpoint	5,098		2,585		5,256		1,761		V = Q/A
Actual Velocity at Piping Midpoint (V) [afps]	85		43		88		29		V = Q/A
Reynolds Number (Re)	4.45E+05		2.26E+05		4.59E+05		1.54E+05		Re = VD/υ
Specific Roughness (ε)	5.00E-06		5.00E-06		5.00E-06		5.00E-06		For PVC pipe (in feet)
Relative Roughness (ε/D)	5.78E-06		5.78E-06		5.78E-06		5.78E-06		
Friction Factor (f)	1.36E-02		1.54E-02		1.35E-02		1.66E-02		$f = \{-2 \log [(\varepsilon/D)/3.7 - (5.02/Re) \log[(\varepsilon/D)/3.7 + (14.5/Re)]]\}^{-2}$ Sacham Equation. Check result against Moody Diagram. If not turbulent flow, use f=64/Re.
Pipe Length [ft]	20		50		25		5		
Equivalent Lengths for Pipe Fittings and Valves	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	**Equiv. Length**	**Qty.**	
90 Degree Elbow	24.00	0	24.00	0	24.00	0	24.00	0	
Long Radius 90 or 45 Degree Elbow	16.00	0	16.00	6	16.00	1	16.00	0	
Tee, Through Flow	16.00	0	16.00	0	16.00	2	16.00	0	
Tee, Branch Flow	50.00	1	50.00	1	50.00	1	50.00	0	
Gate Valve, Fully Opened	12.00	0	12.00	0	12.00	0	12.00	0	
Check Valve, Swing	120.00	0	120.00	0	120.00	0	120.00	0	
Butterfly Valve, Fully Opened	35.00	0	35.00	0	35.00	0	35.00	1	
Pipe Inlet (K=0.78)	49.00	0	49.00	0	49.00	0	49.00	0	
Pipe Inlet (K=0.5)	31.00	0	31.00	2	31.00	0	31.00	1	
Total Equivalent Length (L_e) [ft]	70		258		123		71		$L_e = L + \Sigma[(L_i)(n_i)]$, where i = fitting type and n = quantity
Pressure Losses									
Friction Head Loss in Piping (h_f) [ft of air]	124		133		230		18		$h_f = (fL_eV^2)/(2Dg)$
Pressure Loss in Piping [psi]	0.06		0.07		0.12		0.01		$= (h_f)(\rho)/144$
Pressure Loss in Piping [in. H2O]	1.77		1.87		3.19		0.25		in. H2O = (psi)(2.307)*12
Factor of Safety (FS)	1.20		1.20		1.20		1.20		
Pressure Loss Due to Carbon [in. H2O]	0.00		7.00		0.00		0.00		
Pressure Loss in Piping including FS [in. H2O]	2.12		9.25		3.82		0.30		
Calculated Gauge Pressure at Piping Entrance [in. H2O]	**2.12**		**11.37**		**15.19**		**15.50**		

Table C-6

Estimated Carbon Consumption Rates
Former General Instrument Corporation Site
Hicksville, New York

Parameter	**Option #1 VF-3000**	**Option #2 VF-5000**	**Option #3 VF-10000**
Total Number of Units (a):	4	4	2
Media Weight Per Unit (lbs):	3,000	5,000	10,000
Media Density (lbs/ft^3):	28	28	28
Flow Rate Per Unit (cfm):	1,500	1,500	3,000
Box Length (ft):	5	6	8
Box Width (ft):	5	8	10
Box Area (ft^2):	25	48	80
Velocity (ft/min):	30	31.3	38
Bed Thickness (ft):	4.3	3.7	4.5
Bed Thickness (inches):	51.4	44.6	53.6
Contact Time (sec):	8.6	7.1	7.1
Pressure Drop Per Unit (wci) (b):	15.0	3.5	21.0
Total Pressure Drop (wci):	**30.0**	**7.0**	**42.0**
Estimated Total VOC Loading Rate on Primary Unit (lbs/hr):	0.11	0.11	0.21
Estimated Total VOC Loading Rate on Primary Unit (lbs/day):	2.6	2.6	5.1
Assumed Carbon Consumption Before Breakthrough:	5%	5%	5%
Estimated Carbon Life Before Replacement Required (Days) (d):	58	98	98

a/ Option #1 includes 4 units, plumbed 2 in parallel with 2 in series
b/ Source of pressure drop data: Tetrasolv Filtration.
c/ Estimate of Total VOC Mass Loading Rate:

	UVB-1	**UVB-2**	**UVB-3**
Estimated Groundwater Concentration (μg/l):	3,050	1,390	3,419
Groundwater Extraction Rate (gpm):	60	60	60
Estimated VOC Mass Loading Rate onto Air Stripper (μg/min):	692,655	315,669	776,455
Estimated VOC Mass Loading Rate onto Air Stripper (lbs/hr):	0.092	0.042	0.10
Estimated Total VOC Removal Efficiency:	90%	90%	90%
Estimated VOC Mass Loading Rate onto Carbon (lbs/hr):	0.082	0.038	0.092
Estimated VOC Mass Loading Rate onto Carbon (lbs/day):	2.0	0.90	2.2
Total VOC Mass Loading Rate onto Carbon (lbs/hr):	0.21		
Total VOC Mass Loading Rate onto Carbon (lbs/day):	5.10		

d/ Estimated carbon life is based on primary unit only.

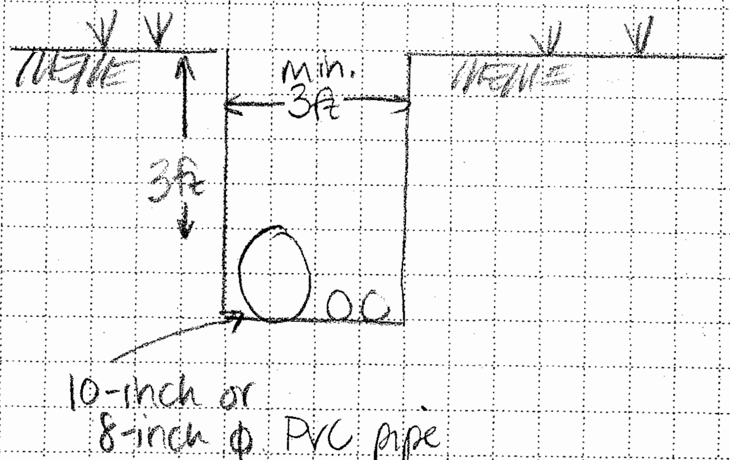
ESC ENGINEERING OF NEW YORK, P.C.

Subject: Pipe Deflection

By: CDA Date: 5/11/04 Checked By: _____ Date: _____

Project Name: Former GIC Site Project No.: 148927/04 Sheet 1 of 2

Objective: Determine maximum deflection in PVC pipe for installation at the former GIC Site.



Calculations: Using the Modified Iowa Equation, predict the deflection in buried flexible pipe:

$$\% \text{ Deflection} = \frac{(D_L K P + K W')(100)}{\frac{2E}{3(DR-1)^3} + 0.061E'}$$

where: D_L = Deflection lag factor = 1.0 (typical)

K = Bedding constant = 0.1 (typical)

P = prism load = weight of soil over pipe = $\frac{100\,lb}{ft^3} \cdot 3ft \times \frac{1\,ft^2}{144\,in^2} = 2.08\,psi$

W' = live load = 4.17 psi for H20 Highway load @ 3ft bgs

E = Modulus of elasticity = 400,000 psi minimum

(Sch. 40) $DR = \frac{OD}{t} = \frac{10.75\,in}{0.365\,in} = 29.45$ (source: Charlotte Pipe)

Bell End or $= \frac{8.625\,in}{0.322\,in} = 26.79$

ESC ENGINEERING OF NEW YORK, P.C.

Subject: Pipe Deflection
By: CDA Date: 5/11/04 Checked By: Date:
Project Name: Former GIC Site Project No.: 148927/04 Sheet 2 of 2

(Sch. 80) Plain End

$DR = \frac{OD}{t} = \frac{10.750\,in}{0.593\,in} = 18.13$

$DR = \frac{OD}{t} = \frac{8.625\,in}{0.500\,in} = 17.25$

E' = Modulus of Soil Reaction

- Based on grain-size distribution, soil is SP to SM with >12% fines

∴ E' = 1,000 for moderate compaction (85% - 95% Proctor, 40% - 70% relative density)

Accuracy in terms of % deflected ± 1%

Pipe	P(psi)	W'(psi)	E(psi)	DR	$3(DR-1)^3$	0.061E'	% Defl.
8-in Sch 40	2.08	4.17	400,000	26.79	51,460	61	0.817±1
10-in Sch 40	↓	↓	↓	29.45	69,082	61	0.861±1
8-in Sch 80	↓	↓	↓	17.25	12,873	61	0.508±1
10-in Sch 80	↓	↓	↓	18.13	15,080	61	0.548±1

Recommended deflections → ASTM = 7.5%
AWWA = 5%
(Failure is considered to be 30%)

∴ The PVC pipe will not deflect beyond recommended limits.

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PWPipe®

TECHNICAL BULLETIN

DESIGN **TB-D5**

February 2000

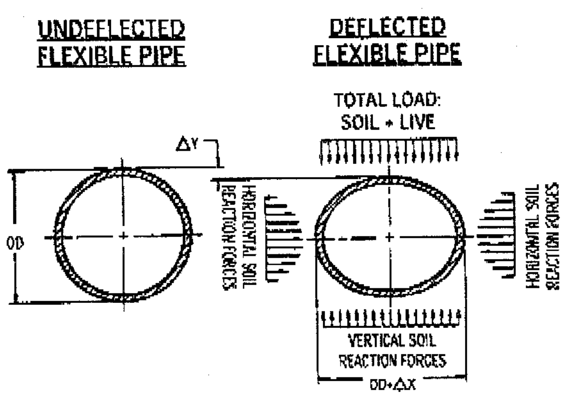
Depth of Burial For PVC Pipe

Flexible Pipe Theory

PVC pipes are classified as flexible pipes. They flex without breaking when loaded externally from soil weight and vehicular traffic. Rigid pipes, such as those made of concrete or clay, do not perceptibly flex when loaded and experience wall crushing when their load limit is reached. This mode of failure for rigid pipes has given rise to the terms "crush strength" and "D-Load", but these terms do **not** apply to PVC pipes.

When a PVC pipe encounters external loading, its diameter will begin to deflect, meaning its sides will move outward and slightly downward. If the pipe is buried in supportive soil, the stiffness of the soil will resist the deflection (see Figure 1). This action and reaction is the key to how a PVC pipe carries external loads.

Figure 1
Flexible Pipe Deflection



The combination of the embedment soil stiffness and the pipe stiffness form a system that acts to support external loads. By itself, the pipe may not support much weight, but the soil/pipe system can have tremendous load capacity.

A PVC pipe's resistance to deflection in an unburied state is measured by its "pipe stiffness". Pipe stiffness is usually less significant than soil stiffness in PVC pipe installations, but in general, a higher pipe stiffness results in a higher load capacity.

Soil stiffness is most affected by the level of compaction achieved, and to a lesser extent by the soil type. Soil stiffness values for various conditions and soil types have been derived through extensive testing.

Calculating Allowable Burial Depth

Because a PVC pipe flexes rather than breaks when loaded, the failure criterion is not fracture strength. Instead, a limit is placed on pipe diametric deflection. This limit is expressed in terms of percentage reduction in diameter due to external loading. Industry recommendations for maximum deflection are shown in Table 1.

Table 1
Maximum Recommended Diametric Deflection

PVC Pressure Pipes	5%
PVC Sewer / Drain Pipes	7½%
PVC Electrical Conduits	5%

A "failure" of a flexible pipe system from external loading is defined by the point at which the top of the pipe begins to experience inverse curvature. Research has shown this point occurs at a minimum of 30% deflection; recommendations for maximum deflection therefore incorporate safety factors of 4:1 or 6:1.

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In order to determine the suitability of a particular burial depth, a system designer estimates the pipe deflection through the use of an empirical equation called the "Modified Iowa Equation". A simplified, conservative version of the equation is presented below:

Modified Iowa Equation

$$\% \, DEFLECTION = \frac{0.1\,(W' + P)\,100}{0.149\,(PS) + 0.061E'}$$

where:

% DEFLECTION = predicted percentage of diametric deflection.

***W'* = Live Load (lbs/in²)**: pressure transmitted to the pipe from traffic on the ground surface. Live Load values are found in Table 2.

***P* = Prism Load (lbs/in²)**: pressure acting on the pipe from the weight of the soil column above the pipe (also called "Dead Load"). Prism Load values are found in Table 3.

***PS* = Pipe Stiffness (lbs/in²)**: a flexible pipe's resistance to deflection in an unburied state. Pipe Stiffness values for PWPipe products are found in Table 4.

***E'* = Modulus of Soil Reaction (lbs/in²)**: stiffness of the embedment soil. Values for Modulus of Soil Reaction are found in Table 5.

Table 2
Live Loads on PVC Pipe

Height of Cover (ft)	Live Load Transferred to Pipe, (lbs/in²) Highway H20[1]	Railway E80[2]	Airport[3]
1	12.50		
2	5.56	26.39	13.14
3	4.17	23.61	12.28
4	2.78	18.40	11.27
5	1.74	16.67	10.09
6	1.39	15.63	8.79
7	1.22	12.15	7.85
8	0.69	11.11	6.93
10	*	7.64	6.09
12	*	5.56	4.76
14	*	4.17	3.06
16	*	3.47	2.29
18	*	2.78	1.91
20	*	2.08	1.53
22	*	1.91	1.14
24	*	1.74	1.05
26	*	1.39	*
28	*	1.04	*
30	*	0.69	*
35	*	*	*
40	*	*	*

Table 3
Prism Load Soil Pressure (lbs/in²)

Height of Cover (ft)	Soil Unit Weight (lb/ft³) 100	110	120	125	130
1	0.69	0.76	0.83	0.87	0.90
2	1.39	1.53	1.67	1.74	1.81
3	2.08	2.29	2.50	2.60	2.71
4	2.78	3.06	3.33	3.47	3.61
5	3.47	3.82	4.17	4.34	4.51
6	4.17	4.58	5.00	5.21	5.42
7	4.86	5.35	5.83	6.08	6.32
8	5.56	6.11	6.67	6.94	7.22
9	6.25	6.88	7.50	7.81	8.13
10	6.94	7.64	8.33	8.68	9.03
11	7.64	8.40	9.17	9.55	9.93
12	8.33	9.17	10.00	10.42	10.83
13	9.03	9.93	10.83	11.28	11.74
14	9.72	10.69	11.67	12.15	12.64
15	10.42	11.46	12.50	13.02	13.54
16	11.11	12.22	13.33	13.89	14.44
17	11.81	12.99	14.17	14.76	15.35
18	12.50	13.75	15.00	15.63	16.25
19	13.19	14.51	15.83	16.49	17.15
20	13.89	15.28	16.67	17.36	18.06
21	14.58	16.04	17.50	18.23	18.96
22	15.28	16.81	18.33	19.10	19.86
23	15.97	17.57	19.17	19.97	20.76
24	16.67	18.33	20.00	20.83	21.67
25	17.36	19.10	20.83	21.70	22.57
26	18.06	19.86	21.67	22.57	23.47
27	18.75	20.63	22.50	23.44	24.38
28	19.44	21.39	23.33	24.31	25.28
29	20.14	22.15	24.17	25.17	26.18
30	20.83	22.92	25.00	26.04	27.08
31	21.53	23.68	25.83	26.91	27.99
32	22.22	24.44	26.67	27.78	28.89
33	22.92	25.21	27.50	28.65	29.79
34	23.61	25.97	28.33	29.51	30.69
35	24.31	26.74	29.17	30.38	31.60
36	25.00	27.50	30.00	31.25	32.50
37	25.69	28.26	30.83	32.12	33.40
38	26.39	29.03	31.67	32.99	34.31
39	27.08	29.79	32.50	33.85	35.21
40	27.78	30.56	33.33	34.72	36.11
41	28.47	31.32	34.17	35.59	37.01
42	29.17	32.08	35.00	36.46	37.92
43	29.86	32.85	35.83	37.33	38.82
44	30.56	33.61	36.67	38.19	39.72
45	31.25	34.38	37.50	39.06	40.63
46	31.94	35.14	38.33	39.93	41.53
47	32.64	35.90	39.17	40.80	42.43
48	33.33	36.67	40.00	41.67	43.33
49	34.03	37.43	40.83	42.53	44.24
50	34.72	38.19	41.67	43.40	45.14

[1]*Simulates 20 ton truck traffic + impact.*
[2]*Simulates 80,000 lb/ft railway load + impact.*
[3]*180,000 lbs. dual tandem gear assembly; 26-inch spacing between tires and 66-inch center-to-center spacing between fore and aft tires under a rigid pavement 12 inches thick + impact.*

* *Negligible live load influence.*

Table 4
PVC Pipe Stiffness' (PS)

PIP, Well Casing, and IPS SDR Water Pipes

Pressure Rating (psi)	SDR	Pipe Stiffness (psi)
63	64	7
80	51	14
100	41	28
125	32.5	57
160	26	115
200	21	224
315	13.5	916

PVC Sewer / Drain Pipes

SDR 35, PWRib

All have a minimum pipe stiffness of 46 psi.
SDR 26 has a minimum pipe stiffness of 115 psi.

ASTM D 2729 - Drain Line

Size (inches)	Pipe Stiffness (psi)
3	19
4	11
6	3

AWWA C900 Water Pipes

Pressure Class (psi)	DR	Pipe Stiffness (psi)
100	25	129
150	18	364
200	14	815

AWWA C905 Water Pipes

Pressure Rating (psi)	DR	Pipe Stiffness (psi)
165	25	129
235	18	364

Schedule 40 CoExcel DWV Pipe

Size (inches)	Pipe Stiffness (psi)
1½	600
2	300
3	300
4	200
6	120

PVC Electrical Utility Ducts

Type	Pipe Stiffness (psi)
EB-20	20
EB-35	35
DB-60	60
DB-100	100
DB-120	120

Water Pipe, Well Casing, and Electrical Conduits

Schedule 40

Size (inches)	Pipe Stiffness (psi)
½	5,928
¾	3,136
1	2,547
1¼	1,397
1½	1,008
2	596
2½	784
3	509
4	307
6	154
8	104
10	78
12	64

Schedule 80

Size (inches)	Pipe Stiffness (psi)
½	17,066
¾	9,078
1	6,995
1¼	3,930
1½	2,911
2	1,846
2½	2,141
3	1,473
4	949
6	607
8	417
10	356
12	330

Table 5
AVERAGE VALUES OF MODULUS OF SOIL REACTION, E' (for Initial Flexible Pipe Deflection)

Pipe Bedding Materials		E' for Degree of Compaction of Pipe Zone Backfill, psi			
SOIL CLASS	**SOIL TYPE** (Unified Classification System[a])	**LOOSE**	**Slight <85% Proctor, <40% relative density**	**Moderate 85%-95% Proctor, 40%-70% relative density**	**High >95% Proctor, >70% relative density**
Class V	Fine-grained Soils (LL>50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use E' = 0			
Class IV	Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
★ **Class III**	Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles Coarse-grained Soils with Fines GM, GC, SM, SC[c] contains more than 12% fines	100	400	1,000	2,000
Class II	Coarse-grained Soils with Little or No Fines GW, GP, SW, SP[c] contains less than 12% fines	200	1,000	2,000	3,000
Class I	Crushed Rock	1,000	3,000	3,000	3,000
	Accuracy in Terms of Percentage Deflection	±2	±2	±1	±0.5

[a]ASTM Designation D 2487, USBR Designation E-3.
[b]LL = Liquid limit.
[c]Or any borderline soil beginning with one of these symbols (i.e. GM-GC, GC-SC).
[d]For ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%.
Note: Values applicable only for fills less than 50 ft (15m). Table does not include any safety factor. For use in predicting initial deflections only; appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/cu ft (598,000 J/m³) (ASTM D 698, AASHTO T-99, USBR Designation E-11). 1psi = 6.9kN/m².

SOURCE: "Soil Reaction for Buried Flexible Pipe" by Amster K. Howard, U.S. Bureau of Reclamation, Denver, Colorado. Reprinted with permission from American Society of Civil Engineers Journal of Geotechnical Engineering Division, January 1977, pp. 33-43.

A pipe system designer uses this equation to predict PVC pipe deflection given type of PVC pipe, burial depth, soil density, type of traffic, type of embedment soil, and compaction density of embedment soil. The designer then compares the predicted deflection to the recommended maximum deflection in Table 1 to check if the burial depth is appropriate.

Example 1: Shallow Burial

A pipe system designer is interested in using ASTM D 3034 SDR 35 PVC sewer pipe in a shallow-burial installation with the following characteristics:

- 1 foot burial depth
- 120 pounds per cubic foot soil density
- H20 highway traffic
- sand embedment material
- 90% Proctor density embedment soil compaction

$$\% \, DEFLECTION = \frac{0.1\,(P+W')\,100}{0.149\,(PS) + 0.061E'}$$

$$\% \, DEFLECTION = \frac{0.1\,(0.83 + 12.5)\,100}{0.149\,(46) + 0.061(2{,}000)}$$

$$\% \, DEFLECTION = 1.0 \pm 1\%$$

The maximum predicted deflection is 2.0%, well below the maximum recommended for PVC sewer pipe in Table 1 of 7½%.

Minimum Burial Depth: The minimum recommended burial depth for PVC pipes beneath a highway is one foot. This recommendation assumes proper specification of embedment materials and compaction, and proper installation.

Example 2: Deep Burial

A pipe system designer is interested in using ASTM D 3034 SDR 35 PVC sewer pipe in a deep-burial installation with the following characteristics:

- 45 foot burial depth
- 120 pounds per cubic foot soil density
- H20 highway traffic (Note: Live loads are negligible for deep burials)
- sand embedment material
- 90% Proctor density embedment soil compaction

$$\% \, DEFLECTION = \frac{0.1\,(P+W')\,100}{0.149\,(PS) + 0.061E'}$$

$$\% \, DEFLECTION = \frac{0.1\,(37.5 + 0)\,100}{0.149\,(46) + 0.061(2{,}000)}$$

$$\% \, DEFLECTION = 2.9 \pm 1\%$$

The maximum predicted deflection is 3.9%, well below the maximum recommended for PVC sewer pipe in Table 1 of 7½%.

For more information, see the following PWPipe Technical Bulletins:

- PVC Pipe Trench Construction
- Deflection Testing of PVC Sewer Pipe
- PVC Sewer and Drain Pipe Burial Depth Charts
- PVC Water Pipe Burial Depth Charts

For additional technical bulletins telephone 800-347-0200 or FAX 541-984-4750.

only to a particular series of numbers, i.e., 51, 41, 32.5, 26, 21, etc. This series of "preferred numbers" is based on a geometric progression, and was developed by a French engineer named Charles Renard. These numbers are often called "Renard's Numbers."

The term DR became widely used, in 1975, with the publication of AWWA C900, which governs production of small diameter PVC pressure pipe. AWWA allowed the desired pressure capacity to dictate wall thickness. Since the OD/t values generated did not happen to fall on any of Renard's Numbers, AWWA removed the "standard" designation from the SDR term.

It is interesting to note that the most widely used product for small diameter sanitary sewer in the U.S., ASTM D 3034, SDR 35, provides an apparent contradiction in terms. While 35 is not a Renard Number, it is still referred to as a standard dimension ratio. In fact, all OD/t ratios in D3034 are listed as SDRs whether they are included in Renard's "preferred numbers" or not. This was probably for convenience' sake. D3034 was written in 1972, prior to the popularization of the DR term. Accordingly, ASTM may have allowed all OD/t ratios to be called SDRs.

The bottom line is simple: the two terms are interchangeable. SDR=DR=OD/t.

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Q: What is flexible conduit deflection and how is it calculated?

A: A flexible pipe derives its soil load carrying capacity from its flexibility. Under soil load, the pipe tends to deflect (reduction of pipe diameter in the vertical direction), thereby developing passive soil support at the sides of the pipe. At the same time, the ring deflection relieves the pipe of the major portion of the vertical soil load, which is then carried by the surrounding soil through the mechanism of an arching action over the pipe. Allowable limits of deflection have been set by both ASTM (7.5%) and AWWA (5%).

The Modified Iowa Equation is used for predicting deflection in buried flexible pipe:

[illegible]

Where: D_L = Deflection Lag Factor=1.0 (Typical)

K = Bedding Constant=0.1 (Typical)

P = Prism Load=Weight of soil over pipe

W' = Live Load

E = Modulus of Elasticity=400,000 psi minimum for PVC

DR = Dimension Ratio (OD/t)

E' = Modulus of Soil Reaction

AVERAGE VALUES OF MODULUS OF SOIL REACTION, E'
(For Initial Flexible Pipe Deflection)

Soil type-pipe bedding material (Unified Classification System[a]) (1)	E' for Degree of Compaction of Pipe Zone Backfill, psi: Loose (2)	Slight <85% Proctor, <40% relative density (3)	Moderate 85%-95% Proctor, 40%-70% relative density (4)	High >95% Proctor, >70% relative density (5)
Fine-grained Soils (LL > 50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use E' = 0			
Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
★ Fine-grained Soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles; Coarse-grained Soils with Fines GM, GC, SM, SC[c] contains more than 12% fines	100	400	1,000	2,000
Coarse-grained Soils with Little or No Fines GW, GP, SW, SP[c] contains less than 12% fines	200	1,000	2,000	3,000
Crushed Rock	1,000	3,000	3,000	3,000
Accuracy in Terms of Percentage Deflection[d]	±2	±2	±1	±0.5

[a]ASTM Designation D 2487, USBR Designation E-3.
[b]LL = Liquid limit.
[c]Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC).
[d]For ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%.
Note: Values applicable only for fills less than 50 ft (15 m). Table does not include any safety factor. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E' value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/cu ft (598,000 J/m³) (ASTM D 698, AASHTO T-99, USBR Designation E-11). 1 psi = 6.9 kN/m².

SOURCE: "Soil Reaction for Buried Flexible Pipe," by Amster K. Howard, U.S. Bureau of Reclamation, Denver, Colorado. Reprinted with Permission from American Society of Civil Engineers Journal of Geotechnical Engineering Division, January 1977, pp. 33-43.

This final parameter required to determine predicted pipe deflection is the Modulus of Soil Reaction. Amster Howard, of the United States Bureau of Reclamation, compiled a table of average E' values for various soil types and densities. This information is provided here.

For a more detailed explanation of flexible conduit deflection, see our publication Uni-TR-1, "Deflection: The Pipe/Soil Mechanism", on our literature page.

Click here to download External Load Design Software for Free!

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Q: What is the maximum allowable depth of bury for PVC pipe?

A: Allowable depth of bury can be calculated based on the allowable deflection as described above. Uni-Bell member products have been installed successfully at depths of fifty feet or more. The following tables are provided as quick reference.

Calculated Deflections of Buried AWWA C900 PVC Pipe (%)

Charlotte Pipe

PHYSICAL PROPERTIES OF ABS AND PVC MATERIALS

PROPERTY	UNITS	ABS	ASTM NO.	PVC	ASTM NO.
Specific Gravity	g/cc	1.05	D 792	1.40	D 792
Tensile Strength (73°F) Minimum	Psi	4,500	D 638	7,000	D 638
Modulus of Elasticity in Tension (73°F) Minimum	Psi	240,000	D 638	400,000	D 638
Flexural Strength (73°F)	Psi	10,585	D 790	14,000	D 790
Izod Impact (notched at 73°F) Minimum	ft lb/ in.	6.00	D 256	0.65	D 256
Hardness (Durometer D)		70	D 2240	80 ± 3	D 2240
Hardness (Rockwell R)		100	D 785	110 - 120	D 785
Compressive Strength (73°F)	Psi	7,000	D 695	9,600	D 695
Hydrostatic Design Stress	Psi	N/A		2,000	D 1598
Coefficient of Linear Expansion	in./ in./ °F	5.5×10^{-5}	D 696	3.0×10^{-5}	D 696
Heat Distortion Temperature at 264 psi Minimum	degrees F	180	D 648	160	D 648
Coefficient of Thermal Conductivity	BTU/ hr/sq ft/ °F/ in.	1.1	C 177	1.2	C 177
Specific Heat	BTU/ °F/lb	0.35	D 2766	0.25	D 2766
Water Absorption (24 hrs at 73°F)	% weight gain	0.40	D 570	.05	D 570
Cell Classification - Pipe		42222	D 3965	12454-B	D 1784
Cell Classification - Fittings		32222	D 3965	12454-B	D 1784

Above data is based upon information provided by the raw material manufacturers. It should be used only as a recommendation and not as a guarantee of performance.

ABS and PVC Standards

TYPE PIPE / FITTING	STANDARD SPECIFICATIONS	
	MATERIAL	DIMENSIONS
ABS DWV		
Schedule 40 DWV Foam Core Pipe	ASTM D 3965	ASTM F 628
Schedule 40 DWV Fittings	ASTM D 3965	ASTM D 2661
PVC DWV		
Schedule 40 DWV Pipe	ASTM D 1784	ASTM D 2665 & ASTM D 1785
Schedule 40 DWV Foam Core Pipe	ASTM D 4396	ASTM F 891
Schedule 40 DWV Fittings	ASTM D 1784	ASTM D 2665
PVC Pressure		
Schedule 40 Plain End Pipe	ASTM D 1784	ASTM D 1785
Schedule 40 Bell End Pipe	ASTM D 1784	ASTM D 1785
Schedule 40 Bell End Well Casing	ASTM D 1784	ASTM D 1785 & ASTM F 480
SDR 21 (PR 200) Bell End Pipe	ASTM D 1784	ASTM D 2241
SDR 26 (PR 160) Bell End Pipe	ASTM D 1784	ASTM D 2241
Schedule 40 Fittings	ASTM D 1784	ASTM D 2466
Schedule 80 Plain End Pipe	ASTM D 1784	ASTM D 1785
Schedule 80 Fittings	ASTM D 1784	ASTM D 2464 & ASTM D 2467

Appendix D – Polyethylene Joining Procedures

PLASTICS PIPE INSTITUTE

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A Division of the Society of the Plastics Industry, Inc.

Polyethylene Joining Procedures

CHAPTER 6
POLYETHYLENE JOINING PROCEDURES

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FOREWORD

Polyethylene Joining Procedures is one of the chapters being prepared for inclusion in the Plastics Pipe Institute's *PPI Handbook of Polyethylene Piping, which* will be issued as a complete volume in the future. Other topics to be addressed in the handbook will include design of polyethylene piping systems, joining procedures, engineering properties, relevant codes and standards, and a variety of related information.

PPI is a division of The Society of the Plastics Industry, Inc. (SPI), and the major U.S. trade association representing all segments of the plastics industry.

The *Municipal and Industrial (M&I) Division of PPI are producing the PPI Handbook of Polyethylene Piping*. M&I membership consist of major North American manufacturers of polyethylene (PE) pipe and fittings, PE piping materials, machinery, and equipment used for joining and installing PE piping, related test laboratories, and professional organizations.

PPI maintains additional groups that address other applications such as gas distribution. PPI provides technical and promotional support for the effective use and continued application of thermoplastics pipe and related products, consistent with the best public interest. PPI membership also includes producers of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polybutylene (PB), and crosslinked PE (PEX) piping products and materials.

For a list of other publications available from PPI and/or further information, please contact:

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The Society of the Plastics Industry, Inc.
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http://www.plasticpipe.org

March, 1998

CHAPTER 6
POLYETHYLENE JOINING PROCEDURES

INTRODUCTION

This Chapter of the manual has been prepared for the benefit of producers, users, engineers, code officials, contractors, installers, and others interested In plastic piping. It is a discussion of the recommended procedures for the most common methods of joining polyethylene pipe and fittings. While reasonable efforts have been made by The Plastics Pipe Institute, the members of its technical groups, and its technical staff to provide reliable information in this report, it is recognized that the information may be incomplete. However, it is often possible to obtain more detailed information on joining plastic pipe or fitting materials from manufacturers. Safety considerations are very important when joining polyethylene materials, but they are not a part of this document; the user of this joining information must consult and follow appropriate safety instructions, which are available from manufacturers.

An integral part of any pipe system is the method used to join the system components. Proper engineering design of a system will take into consideration the type and effectiveness of the techniques used to join the piping components and appurtenances as well as the durability of the resulting joints. The integrity and versatility of the joining techniques used for polyethylene pipe allow the designer to take advantage of the performance benefits of polyethylene in a wide variety of applications.

GENERAL PROVISIONS

Polyethylene pipe or fittings are joined to each other by heat fusion or with mechanical fittings. Plastics may be joined to other materials by means of compression fittings, flanges, or other qualified types of manufactured transition fittings. There are many types and styles of fittings available from which the user may choose. Each offers it's particular advantages and limitations for each joining situation the user may encounter. Contact with the various manufacturers is advisable for guidance in proper applications and styles available for joining as described in this document. There will be joining methods discussed in this document covering both large and small diameter pipe. Those persons who are involved in joining gas piping systems must note certain qualification requirements of the U.S. Department of Transportation Pipeline Safety Regulations [1].

HEAT FUSION

Introduction

There are three types of heat fusion joints currently used in the industry; Butt, Saddle, and Socket Fusion. Additionally, there are two methods for producing the socket and saddle heat fusion joints.

The principle of heat fusion is to heat two surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion. When fused according to the pipe and/or fitting manufacturers' procedures, the joint area becomes as strong as or stronger than the pipe itself in both tensile and pressure properties. As soon as the joint cools to near ambient temperature, it is ready for handling. The following sections of this chapter provide a general procedural guideline for each of these heat fusion methods.

NOTE: This is a general discussion. Pipe and fitting manufacturers have established qualified fusion procedures[9] which should be followed precisely when using their specific products.

One method, used for all three types of joints, uses special heating tools for heating the parts to be joined. The other method, 'electrofusion', is used only for socket and saddle-type joints. Heat is generated by inducing electric current into a wire coil that is a part of the fitting.

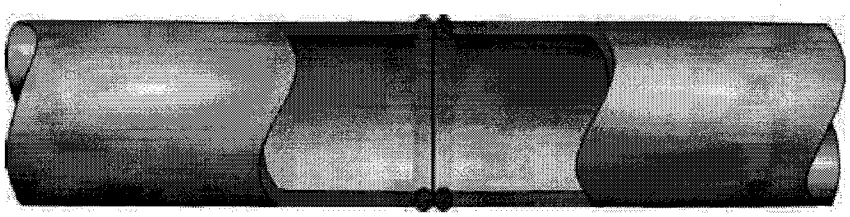

Figure 1 Standard Butt Fusion Joint

Butt Fusion

The most widely used method for joining individual lengths of large diameter polyethylene pipe is by heat fusion of the pipe butt ends as illustrated in Figure 6.1. This technique, which precludes the need for specially modified pipe ends or couplings, produces a permanent, economical and flow-efficient connection. Field-site butt fusions may be made readily by trained operators using specially developed butt fusion machines (see Figure 6.2) that secure and precisely align the pipe ends for the fusion process.

The six steps involved in making a butt fusion joint are:

1. Securely fasten the components to be joined
2. Face the pipe ends
3. Align the pipe profile
4. Melt the pipe interfaces
5. Join the two profiles together
6. Hold under pressure

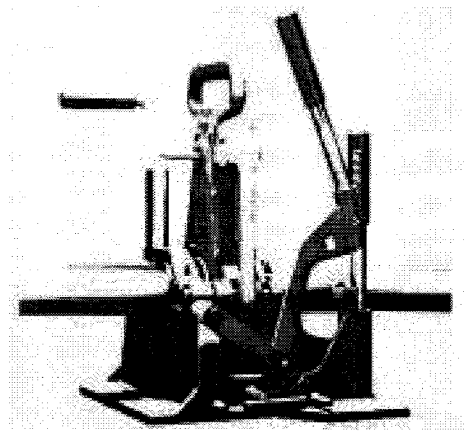

Figure 2 Typical Butt Fusion machine for Smaller Diameter Pipe
(Butt Fusion machines are available to fuse pipe up to 72 inches in diameter)

Secure

Each component that is to be fused must be held in position so that it will not move unless it is moved by the clamping device.

Face

The pipe ends must be faced to establish clean, parallel mating surfaces. Most, if not all, equipment manufacturers have incorporated the rotating planer block design in their facers to accomplish this goal. Facing is continued until a minimal distance exists between the fixed and movable jaws of the machine and the facer is locked firmly and squarely between the jaws. This operation provides for a perfectly square face, perpendicular to the pipe centerline on each pipe end and with no detectable gap.

Align

The pipe profiles must be rounded and aligned with each other to minimize mismatch (high-low) of the pipe walls. This can be accomplished by adjusting the clamping jaws until the outside diameters of the pipe ends match. The jaws must not be loosened or the pipe may slip during fusion.

The minimal distance requirement between fixed- and moveable-jaws mentioned above allows the pipe to be rounded as close as possible to the joint area. The closer to the joint area that the pipe can be clamped, the better control the operator has in properly aligning the pipe.

Melt

Heat the ends of the pipe to the pipe manufacturer's recommended temperature, interface pressure, and time duration. By doing so, the heat will penetrate into the pipe ends and a molten "bead" of material will form at the pipe ends. Heating tools which simultaneously heat both pipe ends are used to accomplish this operation. These heating tools are normally furnished with thermometers to measure internal heater temperature so the operator can monitor the temperature before each joint is made. However, they can be used only as a general indicator because there is some heat loss from internal to external surfaces, depending on factors such as ambient temperatures and wind conditions. A pyrometer or other surface temperature measuring device should be used periodically to insure proper temperature of the heating tool. If temperature indicating crayons are used, do not to use them on a surface which will come in contact with the pipe or fitting. Additionally, heating tools are usually equipped with suspension and alignment guides which center them on the pipe ends. The heater faces which come into contact with the pipe should be coated by the manufacturer to prevent molten plastic from sticking to the heater faces. Remaining molten plastic can interfere with fusion quality and must be removed according to the tool manufacturer's instructions.

Join

After the pipe ends have been heated for the proper time and to the proper temperature, the heater tool is removed and the molten pipe ends are brought together with sufficient pressure to properly mix the pipe materials and form a homogeneous joint. The pipe manufacturer's instructions may specify either interface pressure or bead size of molten material as a guide for a proper joint. There are machines available for pipe sizes from 5/8-inch through 72-inch diameters that will assist the operator to apply sufficient force to obtain the proper fusion pressure. Machines for 4-inch diameter and smaller sizes are normally lever-operated. Many of these smaller machines can be fitted with torque wrenches to obtain a theoretical value which allows the operator to consistently apply the approximate force required to properly fuse a joint. Larger machines employ hydraulics with various types of control systems such as:

1. Manual with hydraulic hand pump.
2. Semi-automatic with motorized hydraulics including pressure reducing, selector, and directional control valves.
3. Fully automatic with computer- or microprocessor-control of the heat and fusion cycles and pressures.

Hold

The molten joint must be held immobile under pressure until cooled adequately to develop strength. The designs of the machines vary from a lever-arm-assist to manual or automatic locking devices that assist the operator to accomplish this step. The proper cooling times for the joint are material-, pipe-diameter-, and wall-thickness-dependent and are established by the pipe manufacturer. Allowing proper times under pressure for cooling prior to removal from the clamps of the machine is important in achieving joint integrity.

OPTIONAL BEAD REMOVAL

In some pipe system usage, the bead from the butt fusion process may be undesirable. Inside beads may create minor flow turbulence of liquids or may become an obstacle on which solids in the fluids may become lodged. Furthermore, outside beads may be a hinderance to sliplining operations. Equipment is available to remove the bead if that is desirable.

SADDLE/SIDEWALL FUSION

The technique to join a saddle to the sidewall, illustrated in Figure 6.3, consists of simultaneously heating both the external surface of the pipe and the matching surface of the "saddle" type fitting with concave and convex shaped heating tools until both surfaces reach proper fusion temperature. This may be accomplished by using a saddle fusion machine that has been designed for this purpose.

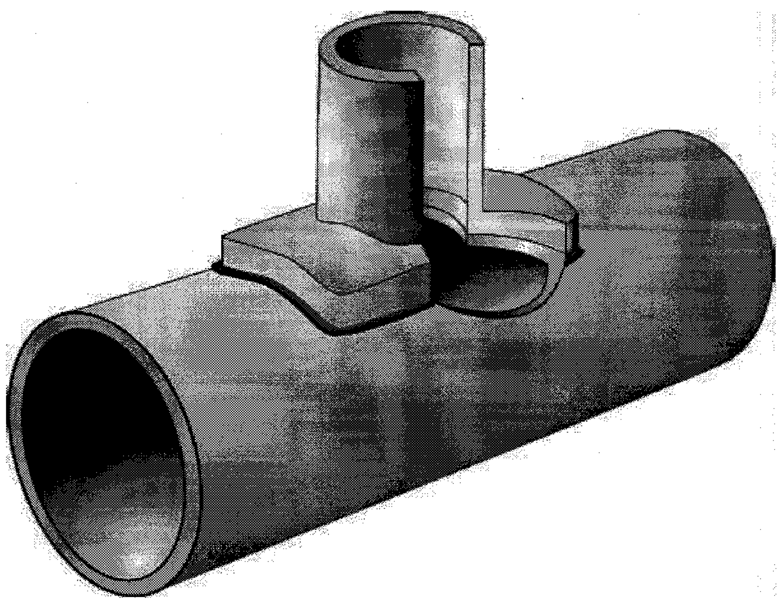

Figure 3 Standard Sidewall Fusion Joint

Saddle fusion, using a properly designed machine, provides the operator better alignment and force control, which is very important to fusion joint quality. The Plastics Pipe Institute recommends that sidewall-type fusion joints be made only with a mechanical assist tool unless hand fusion is expressly allowed by the pipe and/or fitting manufacturer[8]. If hand saddle fusion must be performed, it should be done only by following specific instructions provided by the pipe and fitting manufacturer.

There are eight sequential steps that are normally used to create a saddle fusion joint:

1. Clean the pipe
2. Install heater saddle adapters
3. Install the saddle fusion machine on the pipe
4. Prepare the surfaces of the pipe and fitting
5. Align the parts
6. Heat both the pipe and the saddle fitting
7. Press and hold the parts together
8. Cool the joint and remove the fusion machine

Clean the Pipe

Remove any dirt or coating that might interfere with the proper installation of the fusion machine.

Install the Heater Saddle Adapters

Install the proper size heater saddle adapters on the heater plate. Do not overtighten, but insure that mating surfaces of the heater and adapters are clean and flush. Any gap indicates a dirty or rough surface which will retard and limit heat transfer and thereby affect joint integrity. Allow the heater to come to the temperature specified by the pipe and fitting manufacturer.

Install the Saddle Fusion Machine

Install the saddle fusion machine to the pipe using appropriate tooling and the manufacturer's instructions to straighten and round the pipe. Use caution when tightening the clamping fixture so the pipe is not flattened.

Prepare Surfaces

Remove any mud or other contaminants. Then, using 50 or 60 grit utility cloth, clean and roughen the pipe surface and fitting saddle contour to expose fresh material. Brush away residue with a clean, dry cloth after roughening the surfaces. Avoid using sandpaper or other abrasive materials which are likely to leave grit or deposits of other foreign materials on the pipe surface.

Fitting Alignment

Assure that the proper saddle-fitting holding inserts are in the fusion machine. Position the fitting on the pipe and place the fitting into the insert. Apply a slight downward force on the fitting and inspect to insure a precise fit to the pipe. Move the fitting away from the pipe, then back to the pipe and inspect again for precise alignment.

Heating

Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or other surface temperature measuring device. If temperature indicating crayons are used, do not use them on a surface which will come in contact with the pipe or fitting. Place the heater tool in position to heat the pipe and fitting surfaces in accordance with the pipe and fitting manufacturers' instructions. Procedures will vary with different materials. Follow the instructions carefully.

Fusion

After the prescribed heating requirements have been met, remove the heater from the heated pipe and fitting surfaces with a "snap" action and quickly inspect the melt pattern on both the fitting and the pipe. Join the fitting to the pipe with the prescribed fusion force.

Cooling

Continue to hold the force during the cooling cycle as prescribed by the fitting and pipe manufacturer. Allow the joint to cool to the touch or to reach ambient temperature. Do not subject the joint to any external stresses until the fusion joint has cooled.

SOCKET FUSION

Figure 4 Standard Socket Fusion Joint

This technique consists of simultaneously heating both the external surface of the pipe and the internal surface of the socket fitting until the material reaches fusion temperature; inspecting the melt pattern; inserting the pipe end into the socket; and holding it in place until the joint cools. Figure 6.4 illustrates a typical socket fusion joint. Mechanical equipment is available and should be used for sizes larger than 2-inch diameter to attain the increased force required and to assist in alignment. Follow these general steps when performing socket fusion:

1. Select the equipment
2. Square and prepare the pipe ends
3. Heat the parts
4. Join the parts
5. Allow to cool

Equipment Selection

Select the proper size tool faces and heat the tools to the fusion temperature recommended for the material to be joined. For many years, socket fusion tools were manufactured without benefit of any industry standardization. As a result, variances of heater and socket depths and diameters, as well as depth gauges, do exist. More recently, ASTM Fl056[6] was written, establishing standard dimensions for these tools. Therefore, mixing various manufacturers' heating tools or depth gauges is not recommended unless the tools are marked "F1056," indicating compliance with the ASTM specification.

Square and Prepare Pipe

Cut the end of the pipe square. Chamfer the pipe end for sizes 1'/4-inch diameter and larger (chamfering of smaller pipe sizes is acceptable and sometimes specified in the instructions). Remove any scraps, burrs shavings, oil, or dirt from the surfaces to be joined. Clamp the cold ring on the pipe at the proper position, using the integral depth gauge pins or a separate (thimble type) depth gauge. The cold ring will assist in re- rounding the pipe and provide a stopping point for proper insertion of the pipe into the heating tool and coupling during the fusion process.

Heating

Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or other surface temperature measuring device. If temperature indicating crayons are used, do not use them on a surface that will come in contact with the pipe or fitting. Bring the hot clean tool faces into contact with the outside surface of the end of the pipe and with the inside surface of the socket fitting, in accordance with pipe and fitting manufacturers' instructions. Procedures will vary with different materials. Follow the instructions carefully.

Joining

Simultaneously remove the pipe and fitting from the tool using a quick "snap" action. Inspect the melt pattern for uniformity and immediately insert the pipe squarely and fully into the socket of the fitting until the fitting contacts the cold ring. Do not twist the pipe or fitting during or after the insertion, as is a practice with some joining methods for other pipe materials.

Cooling

Hold or block the pipe in place so that the pipe cannot come out of the joint while the mating surfaces are cooling. These cooling times are listed in the pipe or fitting manufacturer's instructions.

ELECTROFUSION

This technique of heat fusion joining is somewhat different from the conventional fusion joining thus far described. The main difference between conventional heat fusion and electrofusion is the method by which the heat is applied. In conventional heat fusion joining, a heating tool is used to heat the pipe and fitting surfaces. The electrofusion joint is heated internally, either by a wire coil at the interface of the joint or, as in one design, by a conductive polymer. Heat is created as an electric current is applied to the conductive material in the fitting. Figure 6.5 illustrates a typical electrofusion joint and Figure 6.6 illustrates an electrofusion control box and fitting.

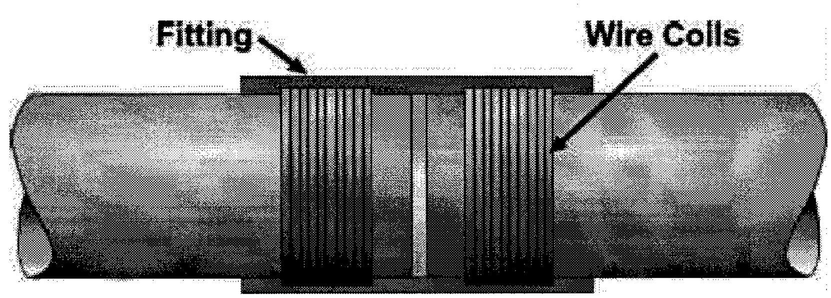

Figure 5 Typical Electrofusion Joint

General steps to be followed when performing electrofusion joining are:

1. Prepare the pipe
2. Clamp the fitting and pipe(s)
3. Apply the electric current
4. Cool and remove the clamps

Prepare the Pipe

First clean the pipe surface in the joint area. Cut the end of the pipe square (omit this operation for saddle-type electrofusion joints). Mark on the pipe surface the proper positioning of the fitting to be installed. Scrape the surface of pipe area to be joined, removing all surface degradation and contamination. Exercise caution to avoid contamination of the scraped pipe surfaces. There are tools available to assist the operator in this procedure.

Clamp the Fitting and Pipe(s)

Place the pipe(s) and fitting in the clamping fixture to prevent movement of the pipe(s) or fitting. Give special attention to proper positioning of the fitting on the prepared pipe surfaces.

Apply Electric Current

Connect the electrofusion control box to the fitting and to the power source. Apply electric current to the fitting as specified in the manufacturer's instructions. If the control does not do so automatically, turn off the current when the proper time has elapsed to heat the joint properly.

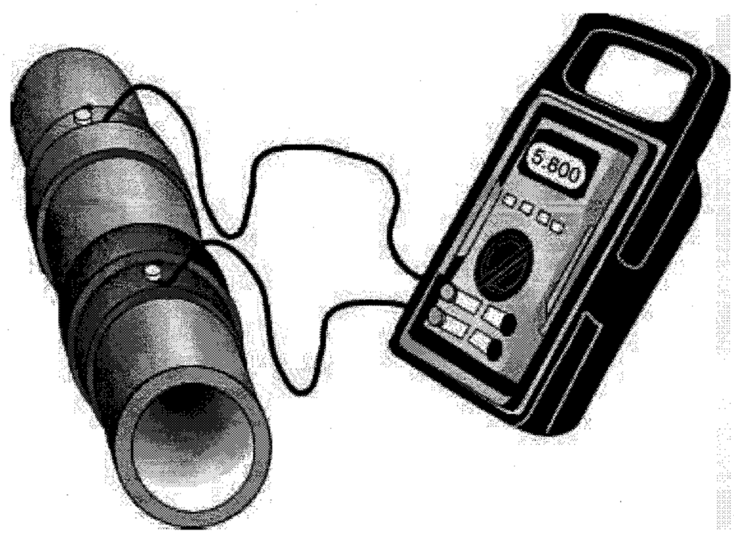

Figure 6 Typical Electrofusion Control Box and Leads with Clamps and Fittings

Cool Joint and Remove Clamps

Allow the joint to cool for the recommended time and remove the clamping fixtures. Premature removal from the clamps and any strain on a joint that has not fully cooled can be detrimental to joint performance.

HEAT FUSION JOINING OF UNLIKE POLYETHYLENE PIPE AND FITTINGS

Research has indicated that polyethylene pipe and fittings made from unlike resins can be heat-fused together to make satisfactory joints. Some gas companies have been heat-fusion joining unlike polyethylenes for many years with success. Extra caution in training operators in conventional heat fusion methods (butt-socket-saddle) of unlike materials is recommended. Guidelines for heat fusion of unlike materials are outlined in TN 13[10], issued by the Plastics Pipe Institute. Manufacturers of pipe and fittings can also be consulted. Electrofuslon joining of dissimilar materials requires no special procedures.

Mechanical Connections

INTRODUCTION

As in the heat fusion methods, many types of mechanical connection styles and methods are available. Each of the mechanical connections has particular advantages or limitations of performance in some applications. This section does not address these advantages or limitations; it is, rather, a general description of these types of fittings and how they might be utilized.

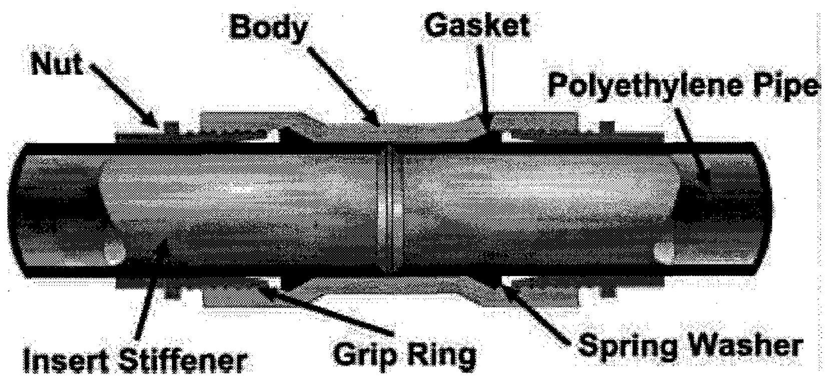

Figure 7 Typical Compression Nut Type Mechanical Plastic Coupling for Joining Polyethylene to Polyethylene

The Plastics Pipe Institute recommends that the user be well informed about the performance limitations of the particular mechanical connector being utilized. A mechanical tapping saddle for connecting the main to the service line is another connection used when fusion is not used.

MECHANICAL COMPRESSION FITTINGS

This style of fitting comes in many forms and materials. The components are generally a body; a threaded compression nut or a follower and bolt arrangement; an elastomer seal ring; a stiffener; and, with some, a gripping ring. Normally the design concept of this type of fitting typically includes an elastomer seal in the assembly.

The seal, when compressed by tightening of a threaded compression nut, as illustrated in Figure 6.7 or by bolts as illustrated in Figure 6.8, grips the outside of the pipe, effecting a pressure-tight seal and, in some designs, providing pull-out resistance. It is important that the inside of the pipe wall be supported by the stiffener under the seal ring and under the gripping ring (if incorporated in the design), to prevent collapse of the pipe. A lack of this support could result in a loss of the seal effected by the seal ring or the gripping of the pipe for pull-out resistance. This fitting style is normally used in service lines for gas or water pipe 2-inches in diameter and smaller. It is also important to consider that two categories of this type of joining device are available. One type is recommended to provide a seal only, and another is recommended to provide a seal plus pipe restraint against pull-out.

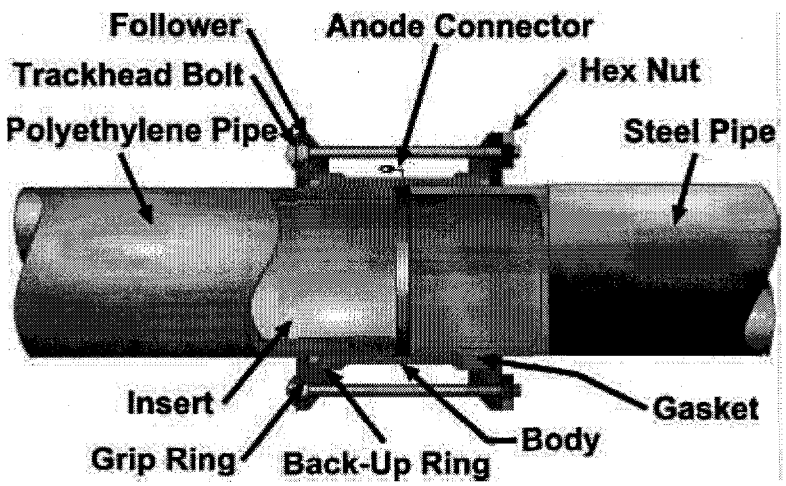

Figure 8 Bolt Type Mechanical Coupling for Joining Steel Pipe to Polyethylene or for Joining Two Polyethylene Pipes

STAB TYPE MECHANICAL FITTINGS

Here again many styles are available, but materials are limited to "Gas Grade" PE2406 and PE3408[2] resins. The design concept is similar in most styles. Internally there are specially designed components including an elastomer seal, such as an "O" ring, and a gripping device to effect pressure sealing and pull-out resistance capabilities. Self-contained stiffeners are included in this design. With this style fitting the operator would have to prepare the pipe ends, mark the stab depth on the pipe, and "stab" the pipe in to the depth prescribed for the fitting being used. These fittings are available in sizes from 1/2 CTS through 2 IPS and are all of ASTM D2513[2] Category I design, indicating seal and full restraint against pull-out.

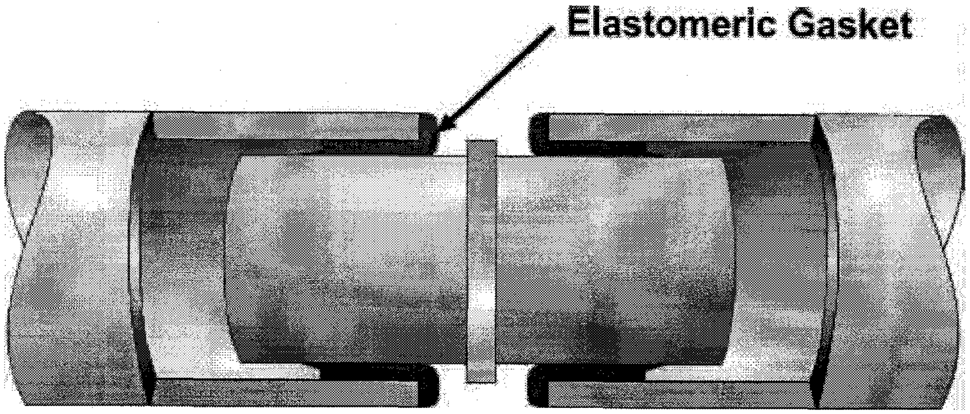

Figure 9 Double Bell Type Fitting

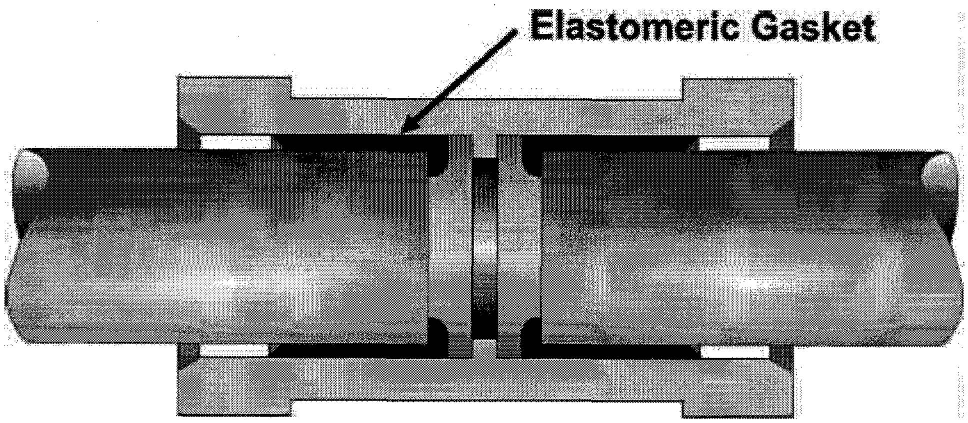

Figure 10 Double Spigot Type Fitting

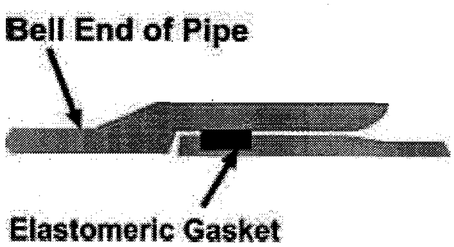

Figure 11 Bell & Spigot Pipe End Joint

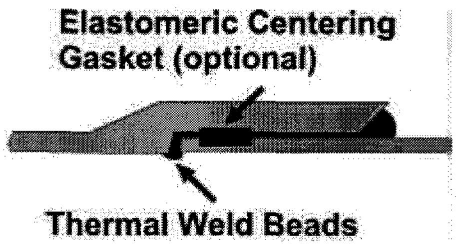

Figure 12 Bell & Spigot Pipe End Joing with Additional Weld Beads

JOINING OF PROFILE PIPE

The "profile" type pipes normally used in gravity flow and low pressure applications may be joined by some of the previously mentioned methods such as butt fusion or electrofusion, or with flange adapters. Profile pipe also utilizes "Bell" and "Spigot" types of joining methods. In this type of joining, the "Bell" or the "Spigot" may be separate components as illustrated in Figures 6.9 and 6.10, or actually formed on the profile pipe ends as illustrated in Figure 6.11. In either concept, the "Bell" always slips over the "Spigot" and an elastomeric gasket between the two surfaces effects a seal. If deemed necessary, the joint may also be anchored and a seal effected by use of a portable field extruder, forming a weld bead around the jointed surfaces. An example of this method is illustrated in Figure 6. 12. More detailed information on profile type pipe may be found in ASTM F894[4].

FLANGED CONNECTIONS

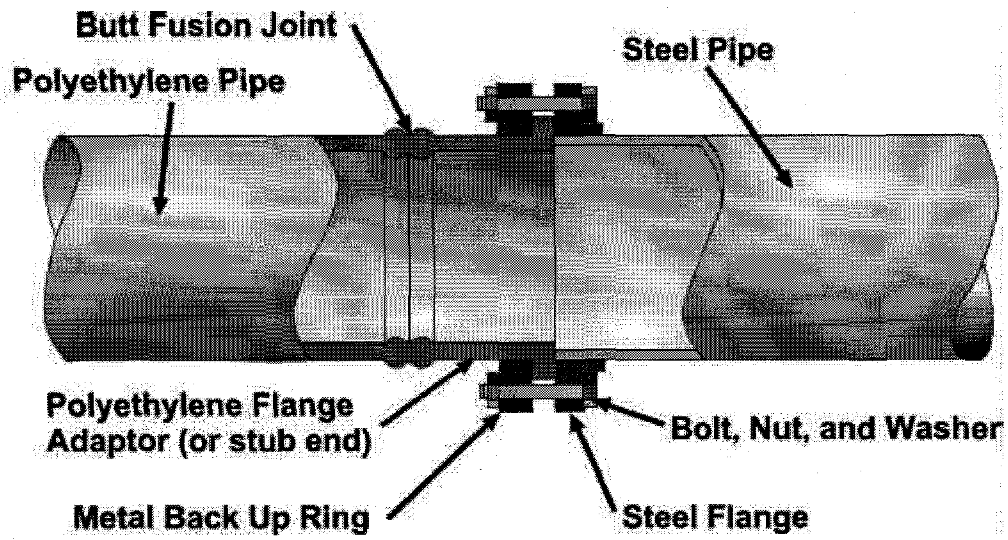

Figure 13 Typical Application of Polyethylene Flange Adapter or Stub End

When joining to metal or to certain other piping materials, or if a pipe section capable of disassembly is required, polyethylene flange adapters are available. The "Flange Adapter" and it's shorter version, the "Stub End", are designed so that one end is sized the same as the plastic pipe for butt fusion to the plastic pipe. The other end has been especially made with a flange-type end that, with a metal back up ring, permits bolting to the non-plastic segment of a pipe line—normally a 1 50-pound ANSI flanged [1].

The procedures would be:

1. Slip the metal ring onto the plastic pipe section, far enough away from the end to not interfere with operation of the butt fusion equipment.
2. If a stub end is used, first butt-fuse a short length of plastic pipe to the pipe end of the stub end. If a "flange adapter" is used, the plastic pipe-sized end is usually long enough that this step is unnecessary.
3. Butt fuse the flange adapter to the plastic pipe segment.
4. Position the flanged face of the adapter at the position required so that the back up ring previously placed on the plastic pipe segment can be attached to the metal flange.
5. Install and tighten the flange bolts in an alternating pattern normally used with flange type connections, drawing the metal and plastic flange faces evenly and flat. Do not use the flanges to draw the two sections of pipe together.

TRANSITION FITTINGS

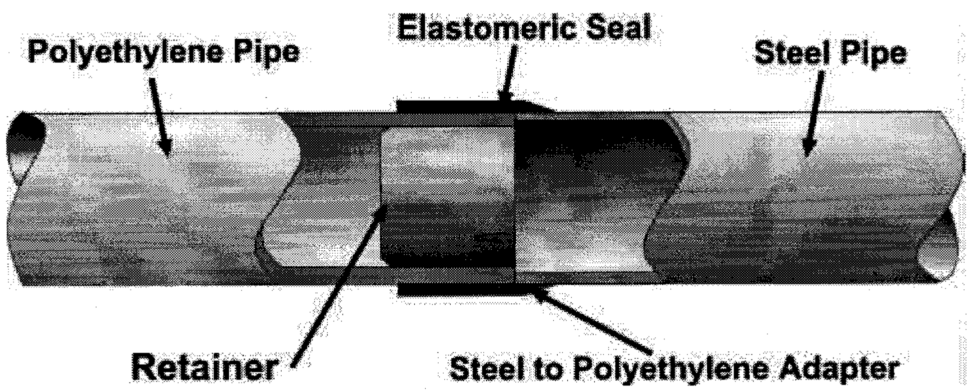

Figure 14 Standard Fitting for Plastic Pipe to Steel Pipe Transition

Other methods are available that allow joining of plastic to metal. Transition fittings are available which are pre-assembled at the manufacturer's facility. These transition fittings are normally pull-out resistant and seal tight with pressure and tensile values greater than that of the plastic pipe part of a system. However, the user should insist on information from the manufacturer to confirm design capabilities or limitations. Transition fittings are commonly available with a short segment of plastic pipe for joining to the plastic pipe section. The metal end is available with a bevel, for butt welding, with male pipe threads, or is grooved for a Victaulic[13] style or flanged for connecting to an ANSI 150-pound flanged [1].

THREADED CONNECTIONS OF PLASTIC

Polyethylene pipes can be threaded the same as metal pipes for a tapered NPT thread for joining to a matching female NPT thread. Caution must be used in this type of application. Polyethylene materials are subject to creep and cold flow under long-term stress. The life of a polyethylene threaded joint is very dependent on proper anchoring against pull-out forces and pressure regulations. These values will vary with pipe materials. Contact the pipe manufacturer before making this type of installation for possible limitations. Many federal, state, and local codes do not allow threaded plastic connections for containment of certain products.

FLARED CONNECTIONS

The practice of making polyethylene joints by "flaring" is one which has gradually been used less and less. The process is accomplished by "Cone Flaring" where heat is applied from an external source, or by "Spin Flaring" where the heat is produced by friction. These flared pipe ends are used with mechanical flare nuts and couplings to form a joint. Recent changes in AWWA C901(7) and other written codes by PPFA(12) and IAPMO(11) have discouraged or specifically prohibited flaring of PE pipe. The possibility of an unsatisfactory joint is much greater with this type of joint than with the other available joining techniques. The Plastics Pipe Institute recommends that the pipe manufacturer be contacted to determine if flared connections are recommended on the particular pipe material being considered for flare-type joining. Refer to ASTM D3140(3) for guidance on how this type joint should be made.

ADHESIVE JOINING

At this time, there are no known adhesives or solvent cements that are suitable for pressure sealing or that have sufficient strength characteristics to join polyethylene pipes.

SQUEEZE-OFF

Regardless of the joining method applied in the installation of polyethylene pipe, it may become necessary to shut off the flow in the system. With PE pipe materials, squeeze-off of the pipe with specially-designed tools is a common practice. Consult the pipe manufacturer for guidance in tool selection and instructions for squeeze-off of their pipe material. General procedures for squeeze-off of polyethylene pipe can be found In ASTM F1041(5).

SUMMARY

The applications for polyethylene piping products continue to expand at an accelerating rate. Gas distribution lines, potable water systems, submerged marine installations, gravity and force main sewer systems, and various types of above-ground exposed piping systems are but a few of the installations for which polyethylene pipe and fittings have been utilized.

A key element to this continued success is the diversity of methods available to join polyethylene pipe and fittings. The integrity of the butt and socket fusion joining technique has been proven by the test of time in a variety of applications. The manufacturers of polyethylene pipe and fittings have made every effort to make the systems as comprehensive as possible by producing a variety of fittings and components to insure compatibility with alternate piping materials and system appurtenances.

The purpose of this chapter has been to provide the reader with an overview of the various methods by which polyethylene piping materials may be joined. As a result, hopefully, the reader has developed a further appreciation for the flexibility, integrity, and overall utility afforded in the design, installation, and performance of polyethylene piping systems and components.

It should be noted that this document does not purport to address any safety problems associated with the use of these procedures. Information on safe operating procedures can be obtained from the manufacturers of the various types of joining equipment or polyethylene products.

REFERENCES:

1. ASME/ANSI B16.5-1988. American National Standard on Pipe Flanges and Flanged Fittings, American National Standards Institute, New York, NY, 1988.
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3. ASTM D3140-85. Standard Practice for Flaring Polyolefin Pipe and Tubing, Annual Book of Standards, American Society for Testing and Materials (ASTM), Philadelphia, PA, 1990.
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5. AASTM F104 1-87. Standard Guide for Squeeze-Off of Polyolef n Gas Pressure Pipe and Tubing, Annual Book of Standards, American Society for Testing and Materials (ASTM), Philadelphia, PA, 1990.
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13. Victaulic General Catalog on Mechanical Piping Systems, Victaulic Company of America, Easton, PA, 1988.

ACKNOWLEDGEMENTS

This chapter has been produced by an industry task force of authors and reviewers, working under the direction of Steve Sandstrum, Solvay Polymers, Inc., chief editor of the PPI Handbook of Polyethylene Piping. Other members of the task force include:

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INDEX OF DRAWINGS

DRAWING NUMBER	SHEET NUMBER	DESCRIPTION
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14892749	2	EXISTING CONDITIONS
14892750	3	SITE PLAN (OPTION A)
14892751	4	SITE PLAN (OPTION B)
14892752	5	UVB WELL CONSTRUCTION AND SITE WORK DETAILS
14892753	6	EQUIPMENT BUILDING LAYOUT
14892754	7	PROCESS AND INSTRUMENTATION DIAGRAM

FULL-SCALE GROUNDWATER CIRCULATION WELL SYSTEM
OPERABLE UNIT NO. 2

(DESIGN PACKAGE, REVISION NO. 1)

FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR

LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

REVISIONS

REV	DESCRIPTION		
1	Revised:	Chkd:	Appr.:
2	Revised:	Chkd:	Appr.:
3	Revised:	Chkd:	Appr.:

SEAL

DATE

DRAWN BY	EGC
CHECKED	CDA
APPROVED	

TITLE SHEET
FULL-SCALE GROUNDWATER CIRCULATION WELL SYSTEM – OPERABLE UNIT NO. 2
FORMER GENERAL INSTRUMENT CORPORATION SITE
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PREPARED FOR
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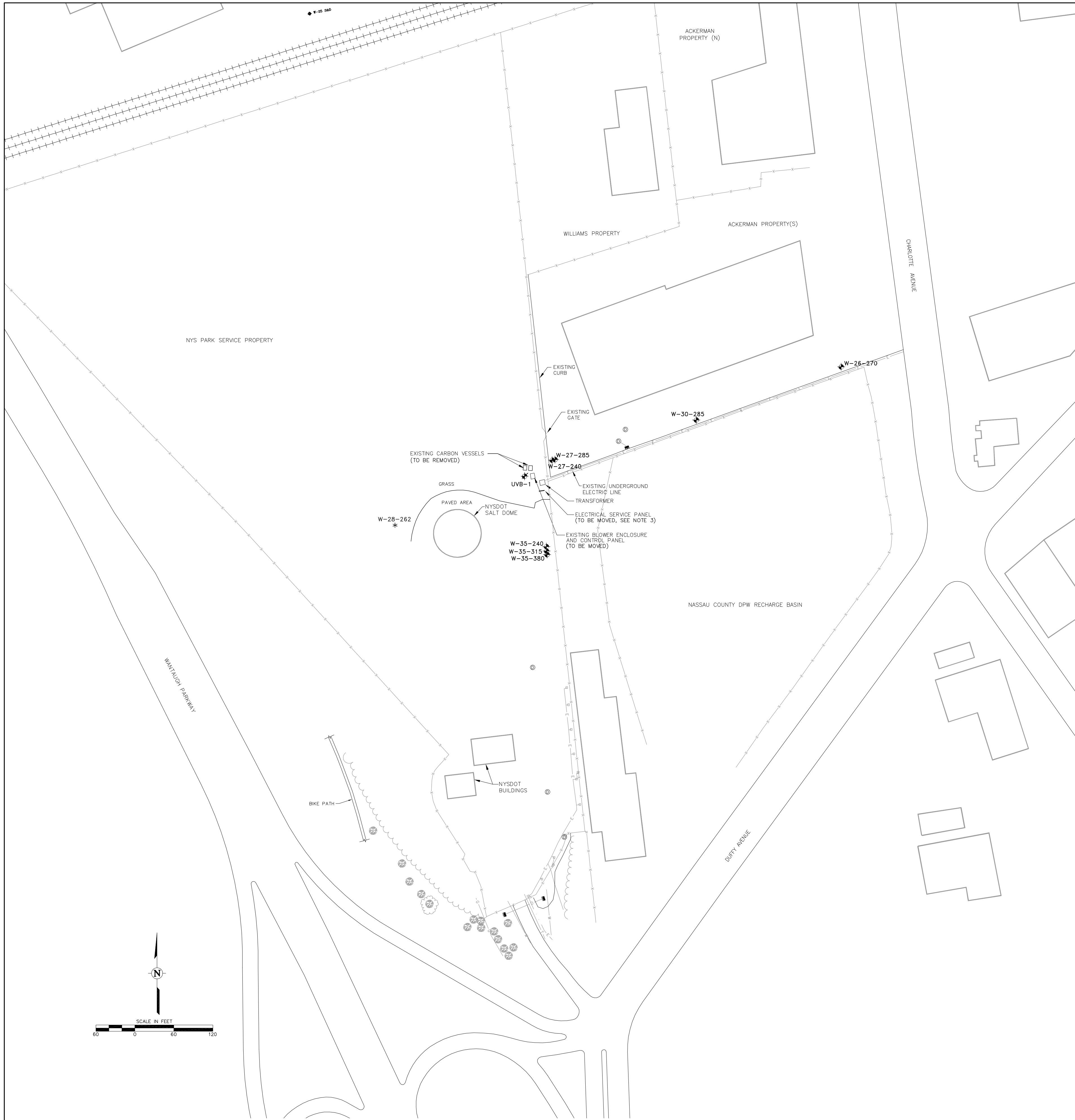
ROSELAND, NEW JERSEY

ESC ENGINEERING OF NEW YORK, P.C.

SHEET 1

Drawing Number
14892748



LEGEND

- FENCE LINE
- EXISTING WATER LINE
- EXISTING TELEPHONE LINE
- EXISTING GAS LINE
- EXISTING ELECTRIC LINE
- EXISTING TREE LINE
- MONITORING WELL LOCATION
- GROUNDWATER CIRCULATION WELL LOCATION
- MONITORING WELL (TO BE ABANDONED)
- EXISTING STORM SEWER DRAIN
- EXISTING TREES

NOTES:

1. UVB – UNTERDRUCK-VERDAMPFER-BRUNNER
2. MONITORING WELL W-28-262 IS DAMAGED AND WILL BE ABANDONED.
3. ELECTRICAL SERVICE PANEL TO BE RELOCATED INSIDE EQUIPMENT BUILDING BY INSTALLATION SUBCONTRACTOR.
4. WELL LOCATIONS BASED ON MEASUREMENTS BY A NYS-LICENSED SURVEYOR. LOCATIONS OF OFFSITE FENCE LINES, ROADS, BUILDINGS, AND OTHER DETAILS ARE BASED ON AERIAL IMAGERY AND ARE CONSIDERED APPROXIMATE.

REVISIONS

REV	DESCRIPTION		
1	ADJUSTMENTS DUE TO SURVEY	EGC	JS

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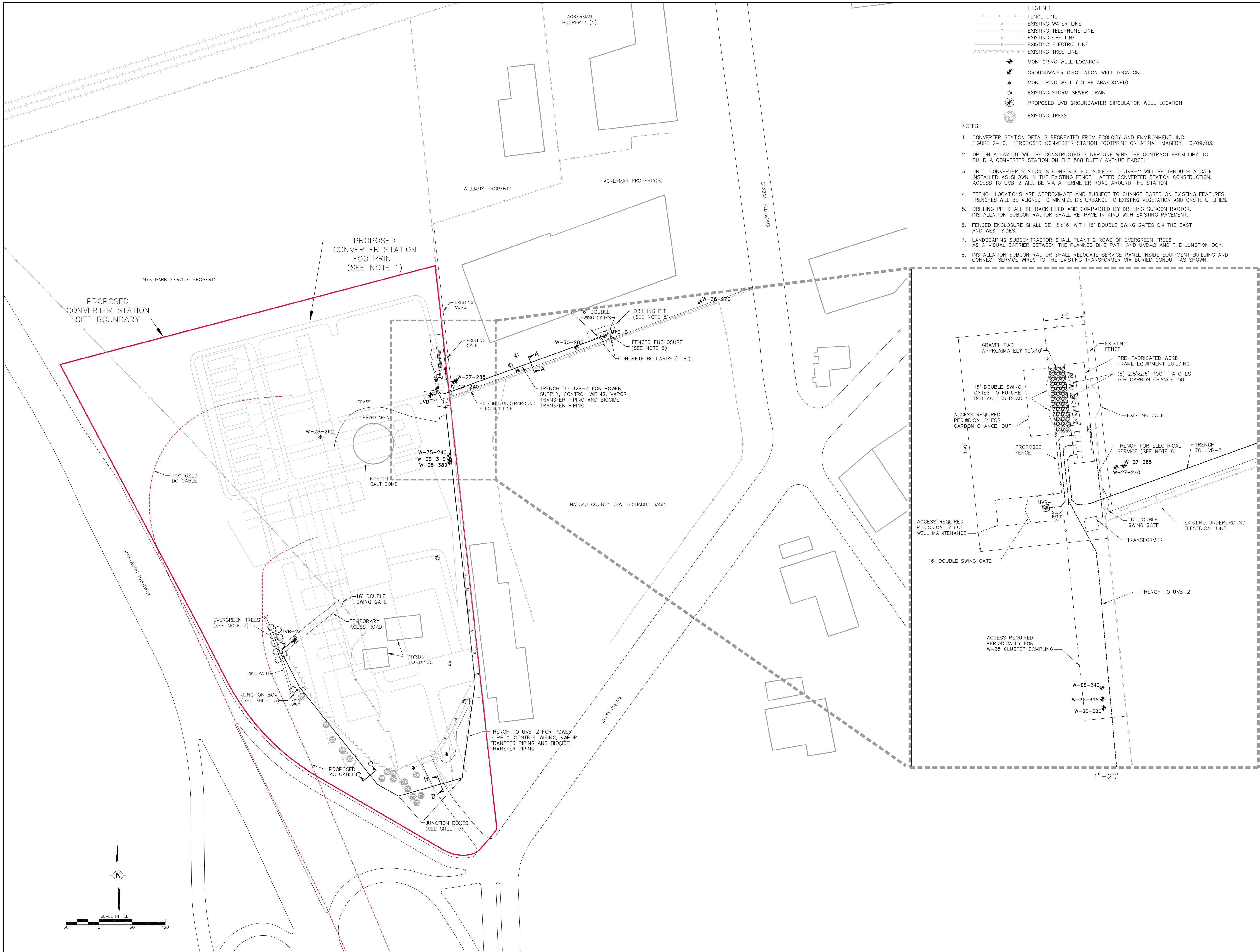

LEGEND

- FENCE LINE
- EXISTING WATER LINE
- EXISTING TELEPHONE LINE
- EXISTING GAS LINE
- EXISTING ELECTRIC LINE
- EXISTING TREE LINE
- MONITORING WELL LOCATION
- GROUNDWATER CIRCULATION WELL LOCATION
- MONITORING WELL (TO BE ABANDONED)
- EXISTING STORM SEWER DRAIN
- PROPOSED UVB GROUNDWATER CIRCULATION WELL LOCATION
- EXISTING TREES

NOTES:

1. CONVERTER STATION DETAILS RECREATED FROM ECOLOGY AND ENVIRONMENT, INC. FIGURE 2-10. "PROPOSED CONVERTER STATION FOOTPRINT ON AERIAL IMAGERY" 10/09/03.
2. OPTION A LAYOUT WILL BE CONSTRUCTED IF NEPTUNE WINS THE CONTRACT FROM LIPA TO BUILD A CONVERTER STATION ON THE 508 DUFFY AVENUE PARCEL.
3. UNTIL CONVERTER STATION IS CONSTRUCTED, ACCESS TO UVB-2 WILL BE THROUGH A GATE INSTALLED AS SHOWN IN THE EXISTING FENCE. AFTER CONVERTER STATION CONSTRUCTION, ACCESS TO UVB-2 WILL BE VIA A PERIMETER ROAD AROUND THE STATION.
4. TRENCH LOCATIONS ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON EXISTING FEATURES. TRENCHES WILL BE ALIGNED TO MINIMIZE DISTURBANCE TO EXISTING VEGETATION AND ONSITE UTILITIES.
5. DRILLING PIT SHALL BE BACKFILLED AND COMPACTED BY DRILLING SUBCONTRACTOR. INSTALLATION SUBCONTRACTOR SHALL RE-PAVE IN KIND WITH EXISTING PAVEMENT.
6. FENCED ENCLOSURE SHALL BE 16'x16' WITH 16' DOUBLE SWING GATES ON THE EAST AND WEST SIDES.
7. LANDSCAPING SUBCONTRACTOR SHALL PLANT 2 ROWS OF EVERGREEN TREES AS A VISUAL BARRIER BETWEEN THE PLANNED BIKE PATH AND UVB-2 AND THE JUNCTION BOX.
8. INSTALLATION SUBCONTRACTOR SHALL RELOCATE SERVICE PANEL INSIDE EQUIPMENT BUILDING AND CONNECT SERVICE WIRES TO THE EXISTING TRANSFORMER VIA BURIED CONDUIT AS SHOWN.

REVISIONS

REV	DESCRIPTION
1	ADJUSTMENTS DUE TO SURVEY — Revised: EGC Chkd: JS Appr.:
2	Revised: Chkd: Appr.:
3	Revised: Chkd: Appr.:

SEAL

DATE

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CHECKED	JS
APPROVED	

SITE PLAN
(OPTION A)

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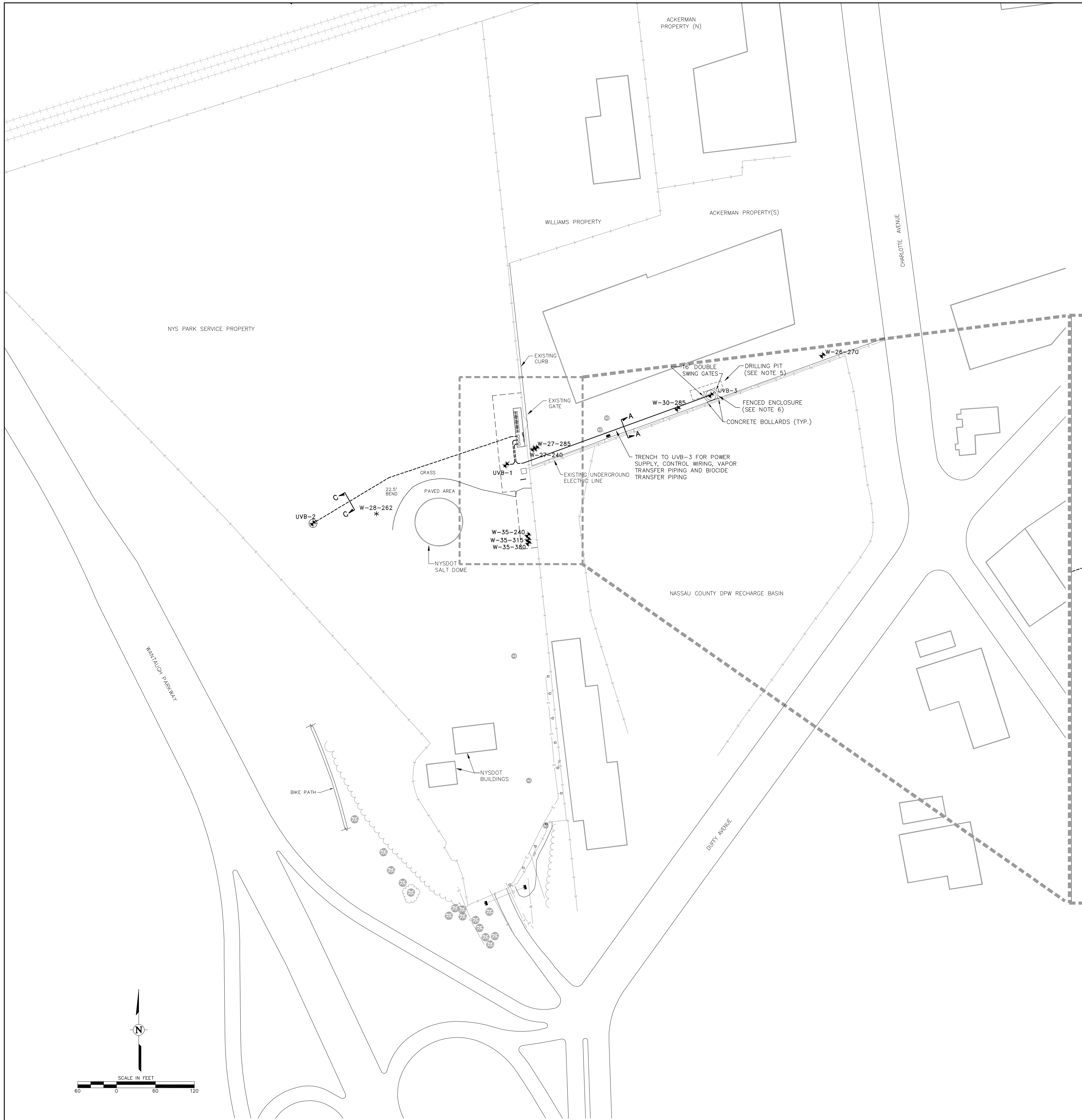
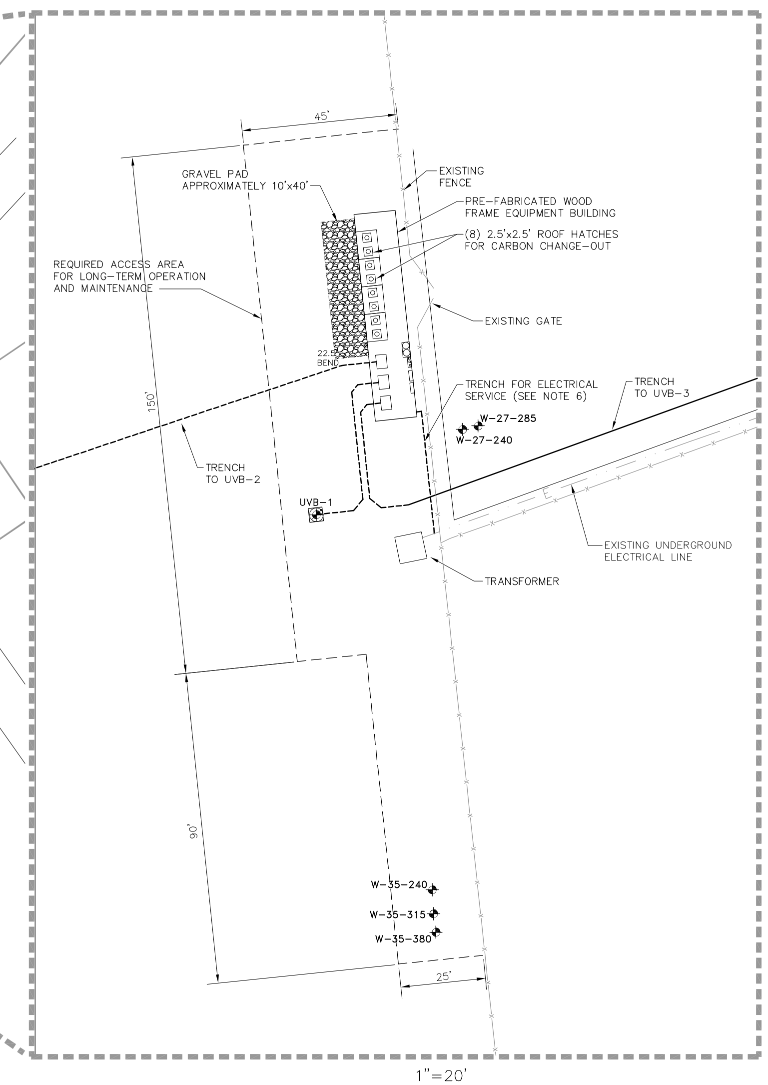
SHEET 3

Drawing Number
14892750





1"=20'

LEGEND

- FENCE LINE
- EXISTING WATER LINE
- EXISTING TELEPHONE LINE
- EXISTING GAS LINE
- EXISTING ELECTRIC LINE
- EXISTING TREE LINE
- MONITORING WELL LOCATION
- GROUNDWATER CIRCULATION WELL LOCATION
- MONITORING WELL (TO BE ABANDONED)
- EXISTING STORM SEWER DRAIN
- PROPOSED UVB GROUNDWATER CIRCULATION WELL LOCATION
- EXISTING TREES

NOTES:

1. OPTION B LAYOUT WILL BE CONSTRUCTED IF NEPTUNE DOES NOT WIN THE CONTRACT FROM LIPA TO BUILD A CONVERTER STATION ON THE 508 DUFFY AVENUE PARCEL.
2. TRENCH LOCATION TO UVB-2 WILL BE COORDINATED WITH DOT PERSONNEL. THE TRENCH WILL BE DESIGNED TO ALLOW DOT TO CONTINUE EXISTING OPERATIONS IN THIS AREA AFTER CONSTRUCTION IS COMPLETE.
3. TRENCH LOCATIONS ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON EXISTING FEATURES. TRENCHES WILL BE ALIGNED TO MINIMIZE DISTURBANCE TO EXISTING VEGETATION AND ONSITE UTILITIES.
4. DRILLING PIT SHALL BE BACKFILLED AND COMPACTED BY DRILLING SUBCONTRACTOR. INSTALLATION SUBCONTRACTOR SHALL RE-PAVE IN KIND WITH EXISTING PAVEMENT.
5. FENCED ENCLOSURE SHALL BE 16'x16' WITH 16' DOUBLE SWING GATES ON THE EAST AND WEST SIDES.
6. INSTALLATION SUBCONTRACTOR SHALL RELOCATE SERVICE PANEL INSIDE EQUIPMENT BUILDING AND CONNECT SERVICE WIRES TO THE EXISTING TRANSFORMER VIA BURIED CONDUIT AS SHOWN.

REVISIONS

REV	DESCRIPTION		
1	ADJUSTMENTS DUE TO SURVEY Revised: EGC	Chkd: JS	Appr.:
2	Revised:	Chkd:	Appr.:
3	Revised:	Chkd:	Appr.:

SEAL

DATE

DRAWN BY	EGC
CHECKED	JS
APPROVED	

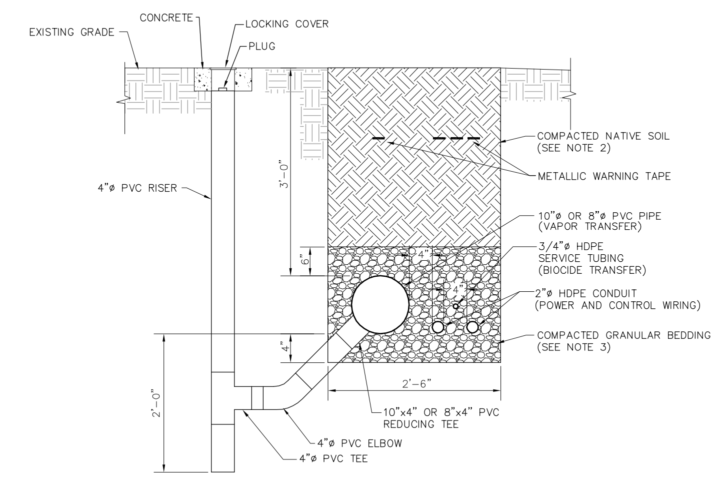
SITE PLAN
(OPTION B)
FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

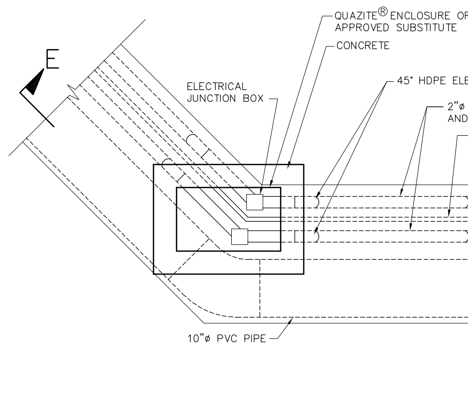
ESC ENGINEERING OF NEW YORK, P.C.

SHEET 4

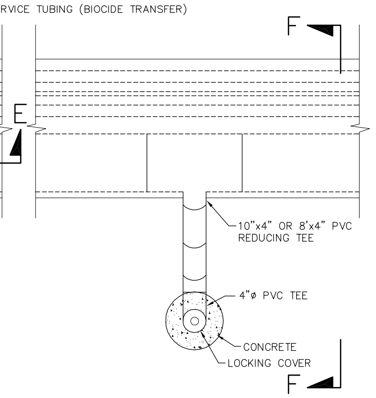
Drawing Number
14892751



SECTION F–F
SCALE: 1"=1'-0"



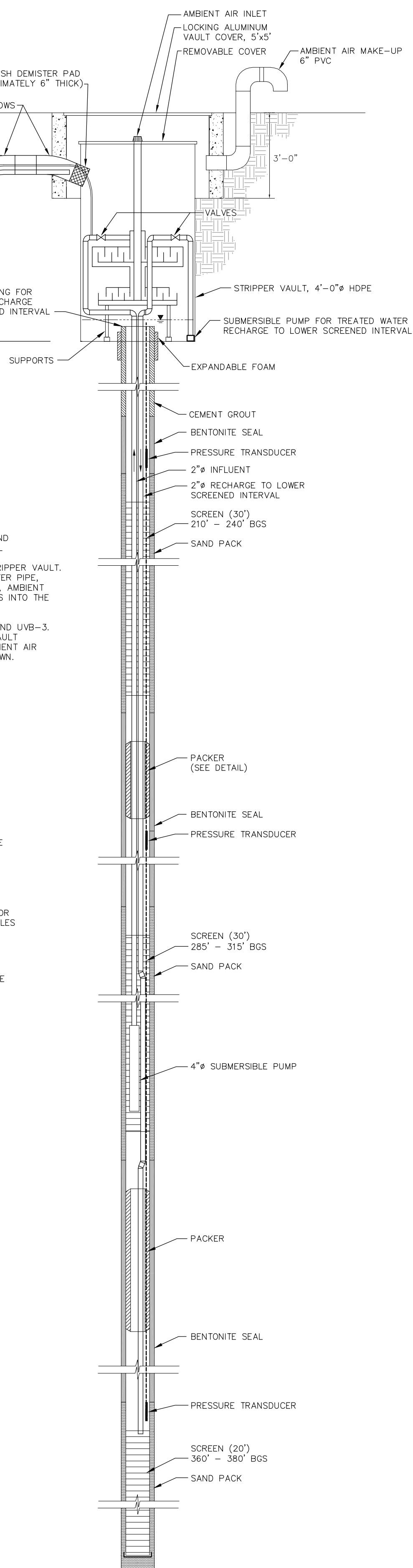
JUNCTION BOX DETAIL
SCALE: 1"=1'-0"



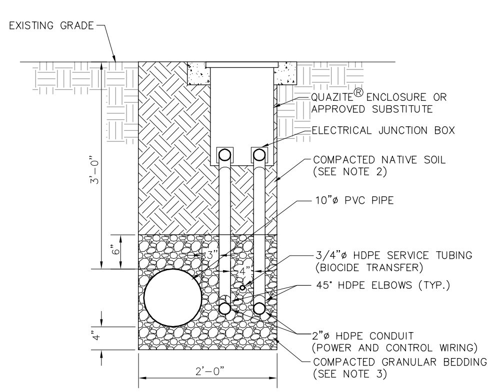
CONDENSATE COLLECTION DETAIL
SCALE: 1"=1'-0"

NOTES:

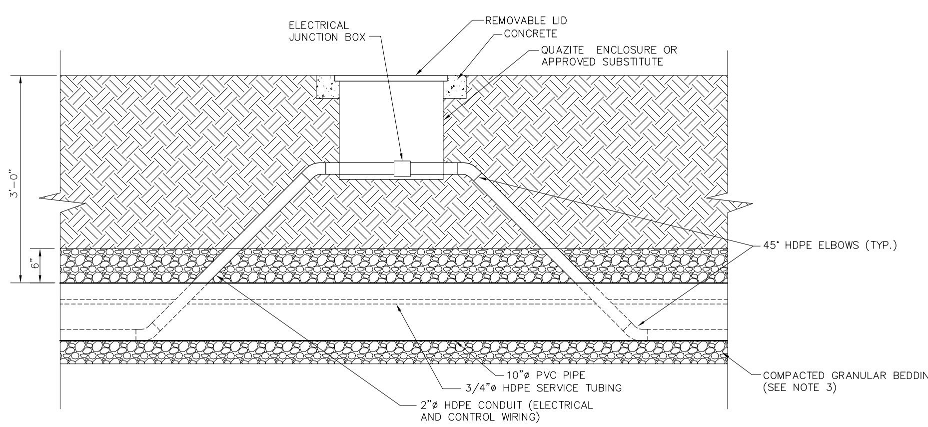
1. UVB VENDOR SHALL SUPPLY AND INSTALL THE STRIPPER VAULT AND ALL COMPONENTS INTERNAL TO THE UVB WELL AND STRIPPER VAULT.
2. UVB VENDOR SHALL SUPPLY TWO 5'x5' LOCKING ALUMINUM VAULT COVERS WITH 3'-0" SKIRTS FOR UVB-2 AND UVB-3.
3. INSTALLATION SUBCONTRACTOR SHALL EXCAVATE AROUND WELLS UVB-2 AND UVB-3 TO DEPTHS OF 8'-0" BELOW GROUND SURFACE, CUT THE 20" STEEL SURFACE CASING AND 10" STEEL WELL CASING TO DEPTHS SPECIFIED BY ESC ENGINEERING, AND PREPARE A LEVEL EXCAVATION FLOOR FOR THE STRIPPER VAULT.
4. INSTALLATION SUBCONTRACTOR SHALL SUPPLY AND INSTALL VAPOR TRANSFER PIPE, BIOCIDE TRANSFER PIPE, POWER WIRING CONDUIT, CONTROL WIRING CONDUIT, AMBIENT AIR MAKE-UP, AND POLY MESH DEMISTER PADS AS SHOWN. PENETRATIONS INTO THE STRIPPER VAULT SHALL BE EXTRUSION WELDED.
5. INSTALLATION SUBCONTRACTOR SHALL INSTALL ALUMINIUM VAULT COVERS (SUPPLIED LOOSE BY UVB VENDOR) IN CONCRETE AS SHOWN FOR UVB-2 AND UVB-3.
6. INSTALLATION SUBCONTRACTOR SHALL REMOVE EXISTING 5'x5' ALUMINUM VAULT COVER WITH 1' SKIRT FROM UVB-1, INSTALL TRANSFER, CONDUIT, AND AMBIENT AIR MAKE-UP AS SHOWN, AND RESET THE VAULT COVER IN CONCRETE AS SHOWN.



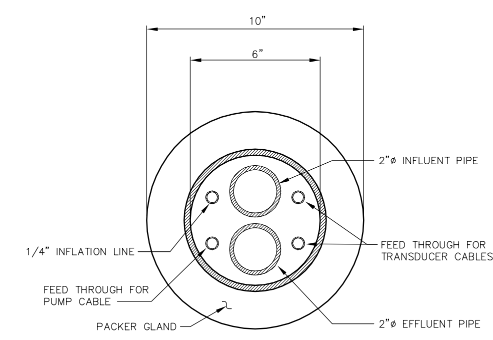
UVB AND WELL VAULT DETAIL (TYPICAL)
NOT TO SCALE



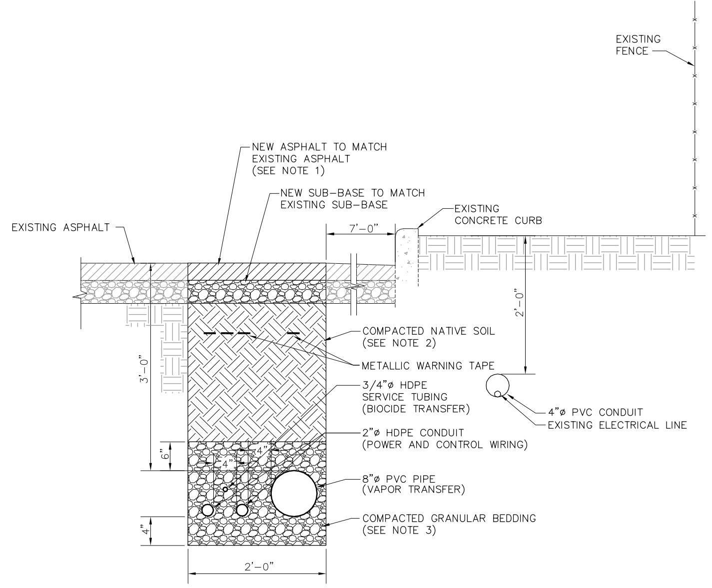
SECTION D–D
SCALE: 1"=1'-0"



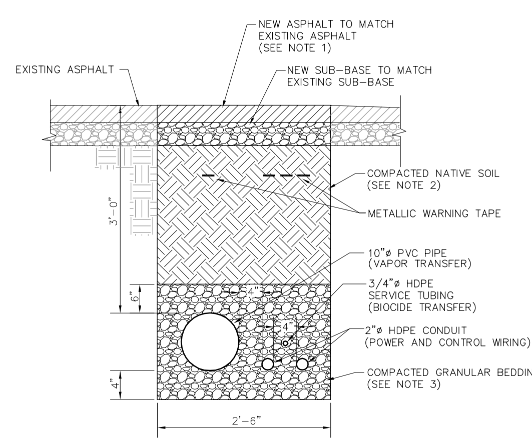
SECTION E–E
SCALE: 1"=1'-0"



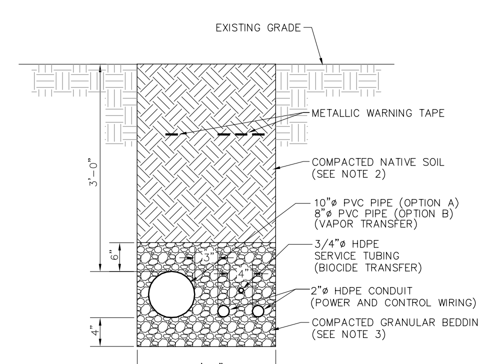
UPPER PACKER DETAIL
NOT TO SCALE



SECTION A–A
SCALE: 1"=1'-0"



SECTION B–B (OPTION A)
SCALE: 1"=1'-0"



SECTION C–C
SCALE: 1"=1'-0"

NOTES:

1. ASPHALT SHALL BE SAWCUT, REMOVED FROM TRENCH, AND DISPOSED OFFSITE. PAVEMENT AND SUB-BASE SHALL BE REPLACED IN KIND.
2. BACKFILL SHALL BE PLACED IN MAXIMUM 6-INCH LIFTS AND COMPACTED USING A MINIMUM OF 2 PASSES WITH A VIBRATORY PLATE.
3. IF REQUIRED, GRANULAR BEDDING SHALL BE CLEAN FILL FROM AN OFFSITE SOURCE AND SHALL BE FREE OF ROCKS AND DEBRIS. BEDDING SHALL BE PLACED IN MAXIMUM 4-INCH LIFTS AND COMPACTED USING A MINIMUM OF 2 PASSES WITH A VIBRATORY PLATE.

REVISIONS

REV	DESCRIPTION

SEAL

DATE

DRAWN BY: EGC
CHECKED
APPROVED

UVB WELL CONSTRUCTION AND SITE WORK DETAILS
OPERABLE UNIT NO. 2
FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

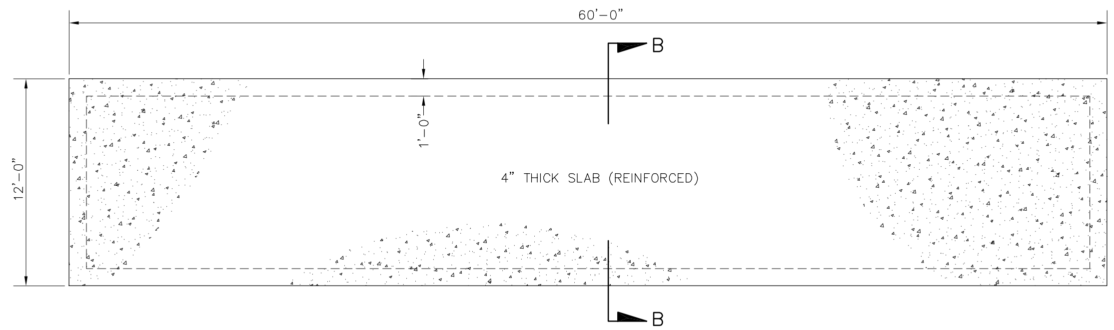
ESC ENGINEERING OF NEW YORK, P.C.

SHEET 5

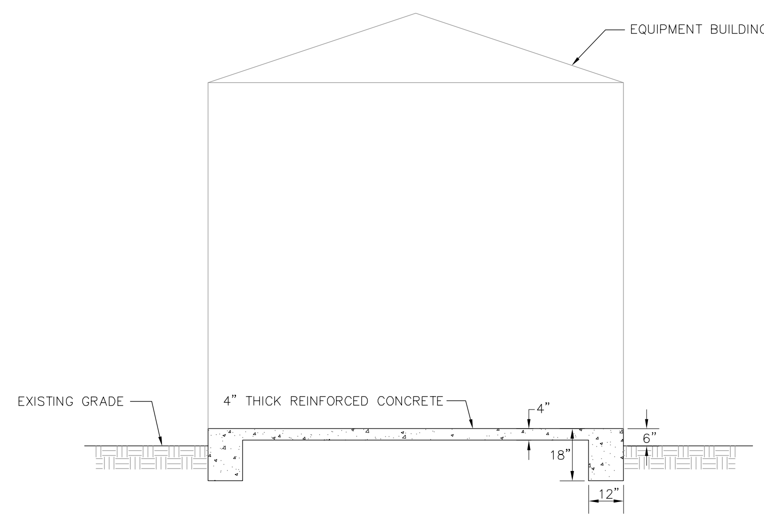
Drawing Number
14892752

NOTES:

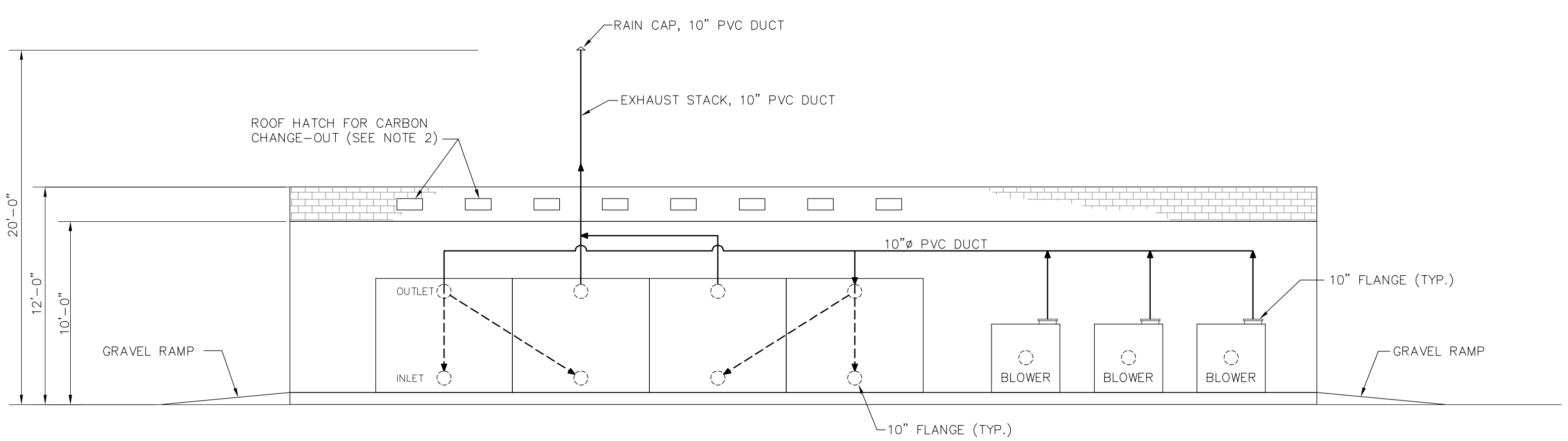
1. BUILDING FOUNDATION TO BE CONSTRUCTED ACCORDING TO MANUFACTURER'S REQUIREMENTS AND APPLICABLE BUILDING CODE.
2. ROOF HATCHES APPROXIMATELY 2.5'x2.5' SHALL BE INSTALLED AS SHOWN TO FACILITATE CARBON CHANGE-OUTS. LOCATIONS OF THE HATCHES ARE APPROXIMATE AND SUBJECT TO CHANGE AS DIRECTED BY ESC ENGINEERING'S FIELD REPRESENTATIVE.



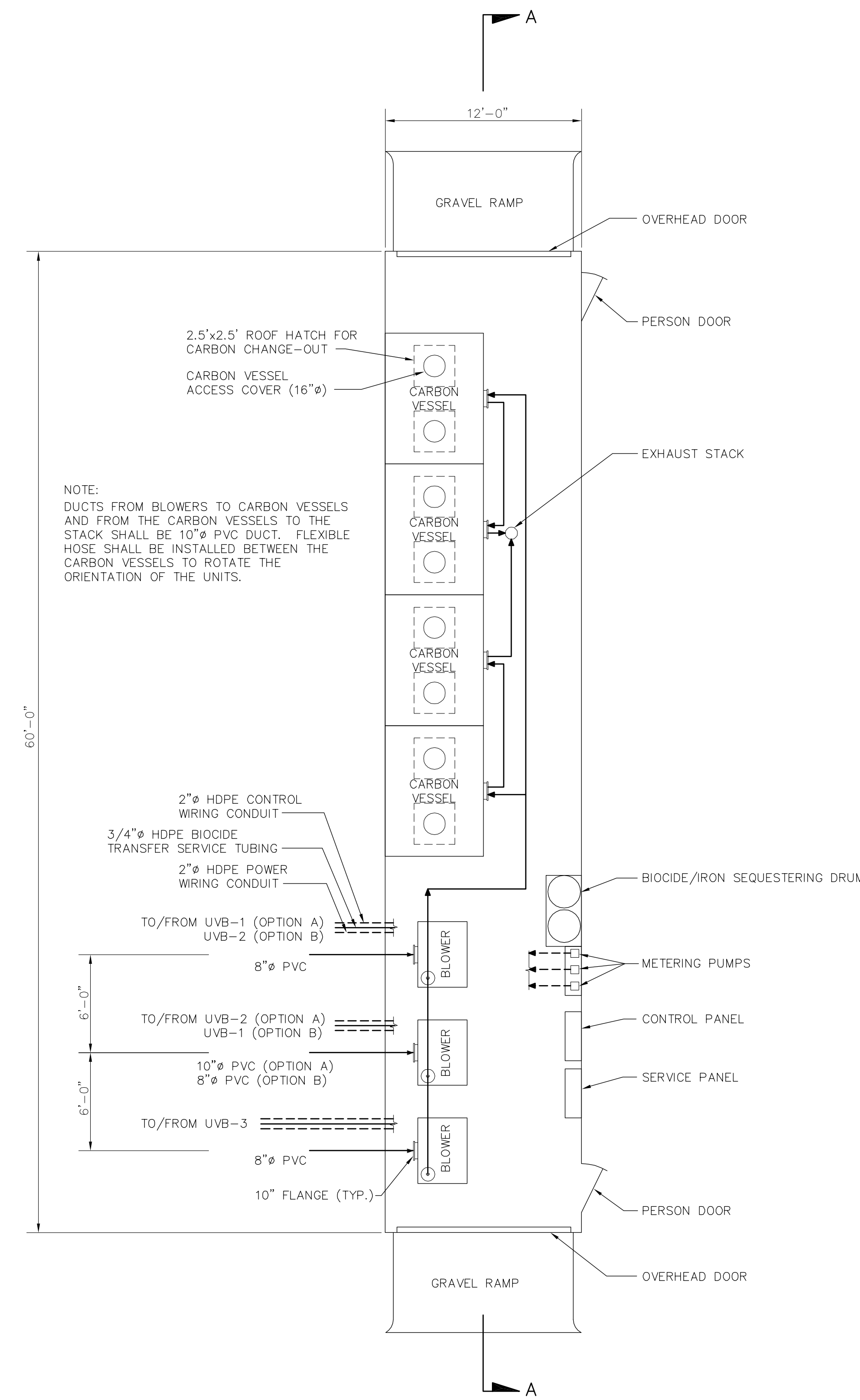
EQUIPMENT BUILDING FOUNDATION DETAIL – PLAN VIEW
SCALE: 1"=4'-0"



EQUIPMENT BUILDING FOUNDATION – SECTION B-B
SCALE: 1"=2'-0"



EQUIPMENT BUILDING LAYOUT – SECTION A-A LOOKING EAST
SCALE: 1"=4'-0"



EQUIPMENT BUILDING LAYOUT – PLAN VIEW
SCALE: 1"=4'

REVISIONS

REV	DESCRIPTION

SEAL

DATE

DRAWN BY: EGC
CHECKED: CDA
APPROVED:

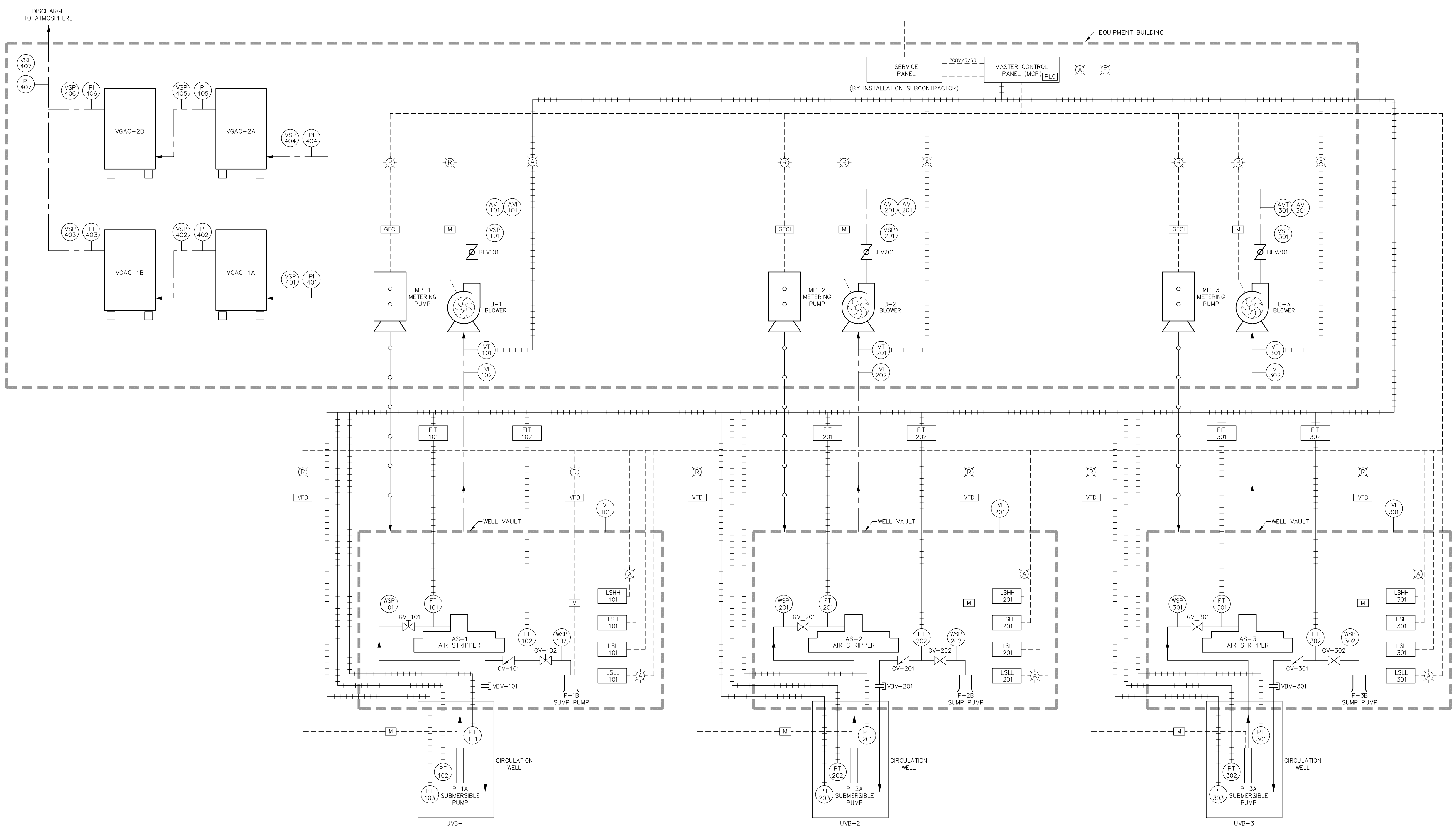
EQUIPMENT BUILDING LAYOUT
FULL-SCALE UVB SYSTEM – OPERABLE UNIT NO. 2
FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

ESC ENGINEERING OF NEW YORK, P.C.

SHEET 6

Drawing Number
14892753



SUPPLIED BY UVB VENDOR

DESIGNATION	DESCRIPTION	SPECIFICATION	NO. EXISTING	NO. TO BE SUPPLIED
AS-1, AS-2, AS-3	AIR STRIPPER	IEG TECHNOLOGIES, LABYRINTH 1000, 2 STRIPPING TRAYS, 80 GPM MAX	1	2
P-1A	SUBMERSIBLE PUMP	GRUNDFOS 60S30-5, 3 HP, 40-75 GPM, 3PH, 208-230V, EQUIPPED WITH VFD	1	0
P-2A, P-3A	SUBMERSIBLE PUMP	GRUNDFOS 75S30-5, 3 HP, 45-95 GPM, 3PH, 208-230V, EQUIPPED WITH VFD	0	2
P-1B	SUMP PUMP	EBARA 50DW61.1, 1.5 HP, 30 GPM AT 40 FEET HEAD, 3PH, 208-230V, EQUIPPED WITH VFD	1	0
P-2B, P-3B	SUMP PUMP	EBARA 50DW61.5, 2 HP, 40 GPM AT 50 FEET HEAD, 3PH, 208-230V (OR APPROVED EQUIVALENT), EQUIPPED WITH VFD	0	2
PT101, PT102, PT103, PT201, PT202, PT203, PT301, PT302, PT303	PRESSURE TRANSDUCER	GEOKON VIBRATING WIRE TRANSDUCER	3	6
LSHH101, LSHH201, LSHH301 LSH101, LSL 101, LSLL101, LSH201, LSL201, LSLL201, LSH301, LSL301, LSLL301	LIQUID LEVEL SWITCH	NOT SPECIFIED	4	8
FT101, FT102	FLOW TRANSMITTER	+G+ SIGNET 515 ROTOR-X (FLOW SENSOR) +G+ SIGNET 8512 (FLOW TRANSMITTER) WITH PANEL MOUNTED FIT. SIGNAL MUST TRANSMIT 50 FEET MINIMUM OR TRANSMITTERS MUST BE REPLACED	2	0
FT201, FT202	FLOW TRANSMITTER	PADDLEWHEEL FLOW SENSOR WITH PANEL MOUNTED FIT. SIGNAL MUST TRANSMIT 1,100 FEET (OPTION A) OR 350 FEET (OPTION B) MINIMUM	0	2
FT301, FT302	FLOW TRANSMITTER	PADDLEWHEEL FLOW SENSOR WITH PANEL MOUNTED FIT. SIGNAL MUST TRANSMIT 330 FEET MINIMUM	0	2
WSP101, WSP102, WSP201, WSP202, WSP301, WSP302	WATER SAMPLING PORT	BALL VALVE, RATED FOR WATER SERVICE AT MIN. 150 PSI, SIZED TO FIT TUBING	1	5
GV101, GV102, GV201, GV202, GV301, GV302	GATE VALVE	BRONZE GATE VALVE, 2-INCH DIAMETER, CLASS 125, W.O.G. SERVICE	1	5
VI101, VI201, VI301	VACUUM INDICATOR	0-30 WCI VACUUM, 1/4" MNPT	1	2
CV-101, CV-201, CV-301	CHECK VALVE	CHECK VALVE, SPRING LOADED, 2 PSI CRACKING PRESSURE MIN.	0	3
VBV-101, VBV-201, VBV-301	VACUUM BREAKING VALVE	NOT SPECIFIED	0	3

SUPPLIED BY EQUIPMENT VENDOR

DESIGNATION	DESCRIPTION	SPECIFICATION	NO. EXISTING	NO. TO BE SUPPLIED
B-1, B-2, B-3	BLOWER	TWIN CITY FAN & BLOWER TBN TURBO PRESSURE BLOWER, 1,000 CFM AT 25 WCI INLET VACUUM AND 16 WCI OUTLET PRESSURE (OR APPROVED EQUIVALENT)	0	3
BFV101, BFV201, BFV301	BUTTERFLY VALVE	10" DIAMETER BUTTERFLY VALVE MOUNTED ON BLOWER OUTLET	0	3
VT101, VT201, VT301	VACUUM TRANSMITTER	0-40 WCI VACUUM RANGE	0	3
AVT101/AVI101, AVT201/AVI201, AVT301/AVI301	AIR VELOCITY TRANSMITTER/AIR VELOCITY INIDICATOR	DWYER SERIES 641 WITH LED INDICATOR	0	3
MP-1, MP-2, MP-3	METERING PUMP	0.5-1.5 GPH FLOW RANGE. PLC PROGRAMMED TO OPERATE PUMP ON A TIMER.	0	3
VGAC-1A, VGAC-1B, VGAC-2A, VGAC-2B	VAPOR-PHASE CARBON	TETRASOLV VF-5000, 6'X8'X6'8" HIGH, 10" 150# FLANGE INLET/OUTLET	0	4

SUPPLIED BY INSTALLATION SUBCONTRACTOR

DESIGNATION	DESCRIPTION	SPECIFICATION	NO. EXISTING	NO. TO BE SUPPLIED
VI102, VI202, VI302	VACUUM INDICATOR	0-60 WCI VACUUM, 1/4" MNPT	0	3
PI401, PI402, PI403, PI404, PI405, PI406, PI407	PRESSURE INDICATOR	0-30 WCI PRESSURE, 1/4" MNPT	0	7
VSP101, VSP201, VSP301, VSP401, VSP402, VSP403, VSP404, VSP405, VSP406	VAPOR SAMPLING PORT	McMASTER-CARR 5012K75, ACETAL QUICK-DISCONNECT TUBE COUPLING WITH SHUTOFF VALVE, 1/4" COUPLER X 1/4" MNPT	0	9

LEGEND

VAPOR LINE
WATER LINE
BIOCIDE/IRON SEQUESTRATION LINE
CONTROL LINE
ANALOG LINE

AVI	AIR VELOCITY INDICATOR
AVT	AIR VELOCITY TRANSMITTER
FIT	FLOW INDICATOR TOTALIZER
FT	FLOW TRANSMITTER
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
LSH	LEVEL SWITCH HIGH
LSLL	LEVEL SWITCH LOW LOW
LSL	LEVEL SWITCH LOW
PLC	PROGRAMMABLE LOGIC CONTROLLER
PT	PRESSURE TRANSMITTER/TRANSDUCER
PI	PRESSURE INDICATOR
M	MOTOR
VFD	VARIABLE FREQUENCY DRIVE
VI	VACUUM INDICATOR
VSP	VAPOR SAMPLING PORT
VT	VACUUM TRANSMITTER
WSP	WATER SAMPLING PORT
A	ALARM LIGHT
E	EMERGENCY STOP
R	RUN LIGHT
GV	GATE VALVE
BFV	BUTTERFLY VALVE
CV	CHECK VALVE
	VACUUM BREAKING VALVE

REVISIONS

DRAWN BY EGC
CHECKED CDA
APPROVED

PROCESS AND INSTRUMENTATION DIAGRAM
FULL-SCALE UVB SYSTEM – OPERABLE UNIT NO. 2
FORMER GENERAL INSTRUMENT CORPORATION SITE
HICKSVILLE, NEW YORK

PREPARED FOR
LOWENSTEIN SANDLER, P.C.
ROSELAND, NEW JERSEY

ESC ENGINEERING OF NEW YORK, P.C.

SHEET 7

Drawing Number
14892754