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Date: March 29, 2010

Subject: Remedial Enhancement Design Report

ARCADIS Project No.: AY000220.0014

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Remedial Enhancement Design Report

Aro Corporation Site
Cheektowaga, New York

March 2010

Christopher Davern *lic*

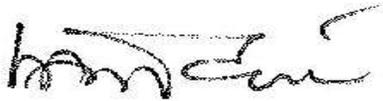
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**Remedial Enhancement
Design Report**

Aro Corporation Site
Cheektowaga, New York

Prepared for:
Ingersoll Rand Company

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Our Ref.:
AY000220.0014

Date:
March 29, 2010

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1. Introduction

ARCADIS of New York, Inc.(herein referred to as “ARCADIS”), on behalf of the Ingersoll Rand Company, has prepared this Remedial Enhancement Design Report for the Aro Corporation site in Cheektowaga, New York (Figure 1). The purpose of this Remedial Enhancement Design Report is to document the basis of design for the selected remedial enhancement which includes the expansion of the existing vacuum-enhanced recovery (VER) extraction network, and associated system process equipment and piping modifications. The remedial system expansion will include the installation of one additional VER well and remedial system enhancements to the VER process and treatment components. A copy of the design contract drawings is included as Appendix A in this document. Drawing G-1 shows the location of the proposed recovery well and piping and Drawing M-2 shows the process equipment upgrades.

Summary of remedial operations, basis of design, and remedial system enhancements are presented in the following sections.

2. Summary of Remedial Operations

The Aro Corporation Site is located on Broadway Street (Route 130) in the Town of Cheektowaga, Erie County, New York. The site is an inactive hazardous waste disposal site [New York State Department of Environmental Conservation (NYSDEC) Site Number 915147] and is currently designated as a Class “4” site requiring continued operation and maintenance activities. Remedial activities consist of the operation, maintenance and monitoring of a VER system to extract VOC mass in soil and groundwater at the site. The VER system has been operated continuously since its installment in 1998. The system has effectively remediated volatile organic compounds (VOCs) onsite and also mitigated offsite migration of dissolved phase constituents. Based on a review of Site conditions and evaluation of the VER system, ARCADIS implemented pneumatic fracturing (PF) technology in 2004 as a cost-effective method for increasing the efficiency of the VER system and enhancing the mass removal of VOCs in soil and groundwater at the Site. The following sections provide a summary of the VER system operations and treatment process as well as the implementation of PF at the site.

2.1 Existing Vacuum Enhanced Recovery System

The existing VER system is comprised of ten (10) extraction (recovery) wells, a liquid ring pump (LRP) to provide a high vacuum to recover groundwater and soil vapors, a knockout tank which separates the liquid/vapor phases, and liquid and vapor treatment systems. The remedial system layout, including the location of the extraction wells, the maintenance building, and VER process equipment is shown in Figure 2. The system equipment and instrumentation are interlocked to regulate system operation in automatic mode and to activate a system shutdown and alarm call out in the event of a system malfunction.

The recovered groundwater and vapor from the extraction wells are directed from a common manifold to knockout tank KT-210. The groundwater is transferred from the knockout tank utilizing a progressive cavity pump P-210; recovered groundwater is passed through a cartridge filter unit F-401 which removes particulates larger than 5 micrometers (μg) in diameter. The final treatment for the recovered groundwater consists of two (2) 1000 pound (lb) liquid-phase granular activated carbon (LPGAC) vessels. The average and cumulative extracted groundwater flows are monitored and recorded via a totalizing flow sensor (FQI-210) interlocked with a paper chart recorder.

The LPGAC vessels are designed to remove dissolved phase VOCs prior to discharge. Treated groundwater is discharged to an on-site sanitary sewer connection under an existing Industrial Wastewater Discharge Permit with the Erie County Department of Environment and Planning.

Following the knockout tank KT-210, the vapor stream passes through a particulate filter, the LRP, a secondary knockout tank, and is released to the atmosphere. The extracted vapor phase flows are monitored and recorded utilizing a pitot tube and pressure transmitter (FIT-200) to calculate a volumetric flowrate. The vapor phase treatment system, which is currently off-line, consists of two (2) 2000 lb granular activated carbon (VPGAC) vessels and two (2) Caru-Sorb vessels (made up of zeolite media impregnated with potassium permanganate). However, in July 2000; ARCADIS notified New York State Department of Environmental Conservation (NYSDEC) that the vapor phase treatment for VOC removal would be taken off-line because vapor phase concentrations had not exceeded Air Guide 1 levels during the operation of the remedial system.

Both the liquid and vapor phase treatment vessels are equipped with manifolds that can be valved for series, parallel, or isolated operation allowing flexibility in treatment

operation. The manifolds are equipped with sample collection ports on the inlet, mid, and discharge side of each vessel.

2.2 Pneumatic Fracturing Program

ARCADIS developed and implemented a pneumatic fracturing program at the site to further enhance mass recovery and to reduce the overall remediation time frame. A pneumatic fracturing pilot study was conducted in 2004, followed by two subsequent pneumatic fracturing events in 2006 and 2009. The recovery well areas targeted by each of the three pneumatic fracturing events are shown in the table below:

Table 2-1 Pneumatic Fracturing Locations and Target Wells

Year	Pneumatic Fracturing Locations	Target Recovery Wells
2004	PF-1, PF-2, PF-3 and PF-4	RW-1 and RW-10
2006	PF-5, PF-6, PF-7, PF-8 and PF-9	RW-3, RW-5 and RW-9
2009	PF-10, PF-11, PF-12 and PF-13	RW-1, RW-4 and RW-10

The post-PF monitoring results following the pneumatic fracturing events show that this technology was successful in developing a fracture network within the dense glacial till, and that VOC mass removal rates were increased with the existing VER system. This was demonstrated by the following key metrics:

- PF technology was effective in increasing the bulk permeability of the formation in each of the recovery well areas. This was confirmed by increases in both liquid and vapor flow rates in the vicinity of each of the recovery well areas;
- The increase in bulk permeability of the formation resulted in an overall increase in VOC mass removal rate. The historical high concentrations of liquid phase and vapor phase mass were removed by the system in 2008 and 2009, respectively. This is attributed to the additional flow pathways developed by the fracture network which allows enhanced extraction by the advective flow of groundwater to the recovery wells;

- Substantial pressure influences were observed at gauges installed on nearby wellheads during each PF event. This pressure response is a direct indication of fractures propagated within the subsurface; and,
- Hydraulic influence exerted by recovery wells has increased significantly when compared to pre-PF results. This was confirmed by a comparison of historical groundwater drawdown to drawdown observed during post-PF recovery well isolation tests.

The PF borehole locations were converted into permanent performance monitoring wells following each PF event and are shown on Figure 2.

3. Basis for Remedial Enhancement

As presented in the 2008 Annual Monitoring Report (ARCADIS 2009), the remedial enhancement program for the Aro site will include expansion of the VER extraction well network. Based on the results of the remedial alternatives evaluation completed during the Five-Year Review, as presented in the 2007 Annual Report (ARCADIS 2008), and the field and laboratory data obtained from the 2008 and 2009 O&M programs, the remedial enhancement program for 2010 will include the installation of an additional recovery well and VER system process upgrades.

The remedial enhancement design of the VER system (i.e. additional recovery well, and treatment system upgrades) is described in further detail in Section 4..

4. Remedial Enhancement Design

The following sections detail the remedial enhancement design, including the supplemental groundwater extraction and remedial piping layout, design parameters, a summary of VER technology and the specific modifications to the existing VER system.

4.1 Design Overview

One (1) additional recovery well (RW-11) will be installed at the monitoring well MW-3 location to provide additional extraction of the VOC mass present in that area of the site. The addition of the new recovery well will involve the installation of extraction piping from the recovery well to the VER system as well as modification of the system's existing recovery well manifold located inside the treatment building.

In addition to the installation of recovery well RW-11, several system upgrades will be necessary to accommodate the anticipated increase in groundwater extraction rate. Upgrades to the remote performance monitoring capabilities for the system will also be implemented to minimize the duration of system shutdowns due to the occurrence of alarm conditions.

The location of the proposed recovery well (RW-11) and its associated piping is shown on Figure 2.

4.2 Design Parameters

Several factors, including the presence of underground utilities (e.g. gas), former building slabs, groundwater concentrations in monitoring well MW-3, and the estimated effective radius-of-vacuum and hydraulic-influence were considered in locating the additional recovery well. The sizing of the mechanical process equipment and piping was based on anticipated groundwater and soil vapor extraction rates. The two primary design-parameters that were evaluated for the remedial enhancement included the observed groundwater concentrations and lack of induced vacuum influences in MW-3.

Specific design-data generated from isolation tests at recovery well RW-10 performed following the 2004 and 2009 pneumatic fracturing events (ARCADIS 2004 and 2009), as well as data generated as part of ongoing system operations and performance monitoring were used for design values. These data are summarized below:

- Trichloroethene (TCE) groundwater concentrations from MW-3 during the 2007, 2008, and 2009 reporting periods have ranged from 1,100,000 – 1,600,000 micrograms per liter ($\mu\text{g/L}$);
- Influent trichloroethene (TCE) groundwater concentrations from RW-10 during the 2007, 2008, and 2009 reporting periods have ranged from 3,000 – 27,000 micrograms per liter ($\mu\text{g/L}$);
- Induced vacuum observed at monitoring well MW-3 has ranged from approximately 0 – 0.08 inches of water column (in.W.C.);
- Groundwater drawdown observed at monitoring well MW-3 has ranged from approximately 5 – 9 feet;

- Soil samples from PF-13 and PF-14 (adjacent to MW-3 and RW-10) were screened for the measurable presence of VOCs by headspace analysis, using a portable Photoionization detector (PID). VOC concentrations ranged from 1 to >9,999 parts per million (ppm) at 2 to 18 ft below land surface (bls), respectively;
- Monthly and instantaneous system groundwater extraction rates have been observed as high as 3.7 gallons per minute (gpm) and greater than 19 gpm, respectively;
- Overall system influent groundwater VOC concentrations have ranged from 30 µg/L to 11,000 µg/L during the past two years;
- Overall system influent vapor phase VOC concentrations have ranged from 250 to 92,000 parts per billion by volume (ppbv) during the past two years; and,
- Consideration of site specific COCs, specifically DCE and TCE solvents, were looked at for their incompatibility issues with HDPE and rigid poly vinyl chloride (PVC) pipe. Based on ARCADIS' experience with these compounds, and after reviewing several case studies determining the affects of softening and/or swelling of PVC and/or HDPE by aqueous solutions of organic solvents, it has been determined that the concentrations (ppm levels) found at the site could have damaging effects on the PVC well screen.

4.3 General Technology and Process Description

The remedial technology (VER) operating at the Aro site will remain the same. The basic operating principals of VER technology are the following:

- Application of a high vacuum (up to 25 inches of mercury (in.Hg.) applied to the subsurface creates a vapor-phase pressure gradient toward the vacuum well. These vapor-phase pressure gradients are also transmitted directly to the groundwater;
- VER increases the hydraulic gradient and expands the capture zone (hydraulic radial influence) of a recovery well as compared to conventional pumping; and,
- Creates the movement of air through the de-watered zone which enhances volatilization of contaminants from the subsurface and increases the rate of mass removal relative to conventional pumping technology.

The VER system at the Aro site currently involves multiphase extraction of constituents in both the vapor and liquid phases from ten recovery wells. The remedial system enhancement will consist of one (1) additional recovery well (RW-11), extraction piping, upgrades to system controls, installation/upgrades of performance monitoring devices, and upgrades to the VER system above-grade process piping. The design drawings for the remedial enhancement are provided in Appendix A and include:

- Drawing G-1, "Site Plan and System Layout," which provides the remedial system layout, including the additional recovery well and associated piping;
- Drawing G-2, "VER Well and Process Piping Construction Details," which provides details of the recovery well construction, recovery wellhead, piping/trenching, and building entry of the recovery piping;
- Drawing M-1, "Equipment Descriptions and Legend," which provides the process and instrumentation diagram (P&ID) legend and major equipment specifications;
- Drawing M-2, "Piping and Instrumentation Diagram," which provides process flow, piping, and instrumentation details; and,
- Drawing M-3, "Equipment Layout," which provides the locations of treatment system components.

4.3.1 Recovery Well

Recovery well RW-11 will be constructed by over-drilling well MW-3 and installing the recovery well in the borehole at the MW-3 location (Figure 2). RW-11 will be constructed of 4-inch schedule 40 PVC riser pipe and screened from 11 to 26 feet bls with 0.020 slot stainless steel continuous wire wrapped well screen. The annulus around the well screen will be filled with a sand filter pack, topped with a 1-foot thick bentonite seal, and grouted up to approximately 1.5 feet bls. The recovery wellhead will be constructed with a flush mount protective casing. A drop tube will be installed using a pitless adapter to extract groundwater and soil vapor from recovery well RW-11. The recovery well and wellhead construction details are shown on Drawing G-2, in Appendix A.

RW-11 will be developed using standard well development procedures (e.g., bailer, pumping) until the purged water is visibly sediment free. Purged groundwater will be treated onsite with the existing treatment system.

4.3.2 Recovery Piping Network

The extraction pipe from RW-11 to the VER treatment system will be constructed of 1-inch diameter standard dimensioning ratio (SDR) 11 HDPE pipe. The RW-11 piping/trenching route will parallel the building slab to the south and penetrate the western wall of the existing treatment building at approximately 2.0 feet above grade. The pipe immediately outside the treatment building wall will be equipped with self-regulating heat tape, fiberglass insulation, and aluminum jacketing. The RW-11 pipe will connect to the existing recovery well manifold. The piping route, trench cross-section, and wall penetration details are shown on Drawing G-2, in Appendix A.

4.3.3 Process Equipment Modifications

To minimize system shutdowns due to the seasonal increases in groundwater extraction rates, the existing progressive cavity transfer pump P-210 will be replaced with a pump (P-220) rated for 30 gpm at 20 feet of total dynamic head to accommodate higher system flows. Replacing the transfer pump will also provide increased groundwater extraction capacity in the event that additional recovery wells are installed. The existing transfer pump (P-210) will remain in place as a secondary/backup transfer pump.

The existing liquid and vapor phase above-grade process piping and valves will be upgraded as needed to make new process connections.

The knockout tank, KT-210, provides primary separation of extracted soil vapors from extracted groundwater. A secondary knockout tank, KT-211, will be installed downstream from liquid ring pump LRP-200 to capture condensation from the vapor stream. A high liquid level sensor interlocked with the programmable logic controller (detailed in Section 4.3.4) will be installed in knockout tank KT-211, which will provide notification to the system operator prior to a system shutdown.

4.3.4 Process Controls and Operation

The existing relay-based control system will be upgraded to a programmable logic controller (PLC) interlocked with new and existing analog and discrete input devices (e.g. pressure transmitters, level switches, etc). The PLC will include shutdown alarm settings to ensure the safety of operating personnel and that extracted groundwater is properly treated. The PLC will also include warning alarm settings which will alert operating personnel that system conditions are approaching shutdown alarm settings,

and that maintenance activities should be scheduled in a timely manner, thereby minimizing the duration of system shutdowns. Operation of liquid ring pump LRP-200 and transfer pump P-220 will be controlled and monitored by the following sensors:

- Vacuum transmitters;
- Pressure transmitters;
- Level switches; and,
- Flow indicating transmitters.

New transmitters are shown on Drawing M-2 in Appendix A. A general summary of the alarm conditions is provided below:

- High and low applied vacuum at primary knockout tank;
- High and low pressure pre-cartridge filter unit;
- High and low pressure pre-LPGAC units;
- High and low vapor flow rate;
- Low liquid flow pumping rate;
- High liquid level in knockout tank(s); and,
- Motor faults.

Each of these alarms will notify the system operator via an alarm fax, e-mail, or phone call using an auto-dialer. This is intended to minimize any down time due to system shutdowns. Additionally, the system will include the capability of allowing remote operator(s) to observe and control the operation of the system through a desktop software package via an auto-dialer.

4.3.5 Performance Monitoring Devices

The following performance monitoring devices will be installed and interlocked with the PLC:

- Vacuum transmitter VT-200, located at the top of knockout tank KT-210;
- Pressure transmitters PT-210 and PT-211, located on the inlet and outlet side of cartridge filter unit F-401, respectively;
- Liquid flow meter transmitter FQI-210, capable of transmitting an instantaneous flow rate and a totalized flow value; and,
- Pressure/flow transmitter FIT-200, for measuring instantaneous vapor flow rate.

In addition to adding new electronic monitoring devices, each of the existing system gauges (e.g. pressure, temperature, and vacuum) will be replaced with new gauges. All new performance monitoring devices are shown on the Drawing M-2, located in Appendix A.

4.3.6 Soil Vapor Treatment

Preliminary modeling based on the anticipated concentrations of VOCs observed during the 2009 period and anticipated increased maximum recovery flow rate (100 scfm) (NYSDEC DAR-1, September 10, 2007), indicates that soil vapor treatment may be required. As described in Section 10, soil vapor samples will be collected during the system startup and operational period. The vapor phase analytical results will be analyzed against the NYSDEC DAR-1 AGC/SGC tables. If deemed necessary, the vapor phase treatment will be brought back online to pre-treat the soil gas prior to being discharged to the atmosphere.

5. Surveying

A licensed New York State Land Surveyor will identify and record the post-construction vertical and horizontal coordinates of the proposed recovery well and its associated piping. Elevations of the flush mount protective casing and corresponding water level measuring point for the new recovery well will also be surveyed.

6. Permitting and Approvals

Technical approval to construct, and a certificate to operate, a process, exhaust, or ventilation system will not be required, according to Section 201-3, "Exceptions and Trivial Activities," of the NYSDEC *Air Resources* guidance, as the site is considered a trivial source [Section 201-3.3 (item 28)]. Accordingly, an air-discharge permit will not

be required for the system-exhaust stack, per NYSDEC *Air Guide 1 Guidelines*. System process modifications will not result in new, different or increased discharges of liquid phase pollutants as stipulated in Erie County/Buffalo Pollutant Discharge Elimination System Permit (EC/BPDES), Permit No. 07-06-E1017, Part II General Conditions, Section B-1. Therefore, a modification to the existing permit will not be required.

7. Construction Quality Assurance

ARCADIS will provide construction quality assurance (CQA) during all construction related field activities. The CQA Plan will describe the methods and protocols that will be used to test, inspect and verify the performance of materials used during construction activities, and will be used to maintain consistency in the construction work. The components subject to the CQA testing include backfill material, pressure testing of all piping and fittings, and mechanical and electrical materials. Material specifications, minimum performance requirements, test methods and inspection techniques will be specified in the Technical Specifications (Appendix B).

8. Health and Safety Plan

The existing Health and Safety Plan prepared for the site (ARCADIS 2008) will be amended to incorporate construction and system operation activities. The amended plan will form the Remedial Action Contingency Plan and will identify potential site-related hazards and associated mitigation measures, which may be required during the remedial construction. These may include excavation controls, dust controls, noise and odor controls and other construction related issues.

9. Waste Management

The excavated soil from the proposed trenching locations will be field screened with a PID for VOCs and also visually inspected for impacts. If neither is detected, trench spoils will be deemed acceptable to utilize as backfill. In the event that additional fill material is needed to backfill the trench, certified clean fill will be imported from a NYSDEC-approved source. Recovery well installation soil cuttings will be placed in drums and disposed of under an existing waste profile at Waste Management's Model City disposal facility. The existing field Quality Assurance/Quality Control (QA/QC) program will be followed for sampling and analytical procedures for the remedial design and construction phases.

10. System Startup and Operational Testing

Following installation of RW-11 and construction of the VER system process modifications, a three day startup and operational testing period will be conducted to evaluate the hydraulic and vacuum influence of the new extraction well. System startup will immediately follow system construction and will consist of isolated pumping of RW-11 only. A description of system-startup procedures is provided below:

1. Pneumatic pressure testing will be performed to test piping and fittings associated with the new recovery well, LPGAC and VPGAC manifolds, and liquid discharge line for possible leaks.
2. System transmitters will be calibrated and gauges will be inspected for proper operation.
3. System alarms will be tested to verify proper system shutdown and alarm notification procedures.
4. A baseline measurement of water levels and wellhead pressure at all wells in the vicinity of RW-11, including RW-8, RW-9, RW-10, PF-3, PF-4, PF-7, PF-8, PF-12, PF-13, MW-2, MW-8, MW-9, MW-10R, and MW-29, will be recorded with the VER system offline.
5. The system will be started with only recovery well RW-11 online and operated for a 24 hour period.
6. At 30 minutes, 2 hours, 6 hours, and 24 hours after startup the following parameters will be collected:
 - Measurement of applied vacuum at recovery well RW-11;
 - Measurement of induced vacuum at wells RW-8, RW-9, RW-10, PF-3, PF-4, PF-7, PF-8, PF-12, PF-13, MW-2, MW-8, MW-9, MW-10R, and MW-29;
 - Measurement of water levels at wells RW-8, RW-9, RW-10, PF-3, PF-4, PF-7, PF-8, PF-12, PF-13, MW-2, MW-8, MW-9, MW-10R, and MW-29;
 - Collection of PID readings from the vapor phase system effluent; and,

- Collection of system parameters including applied vacuum, groundwater extraction rate, soil vapor flow rate, and process piping pressure.
7. At 6 hours after startup the following samples will be collected:
- Influent groundwater will be sampled for VOCs using USEPA Method 8260; and,
 - Influent soil vapor will be sampled for VOCs using Method AM 4.02.
8. At 24 hours after startup and isolation testing of RW-11, the system will be operated with RW-8, RW-9, and RW-10 online in addition to RW-11.
9. At 2 hours and 24 hours after bringing RW-8, RW-9, and RW-10 online, the following parameters will be collected:
- Measurement of applied vacuum at recovery wells RW-8, RW-9, RW-10, and RW-11;
 - Measurement of induced vacuum at wells PF-3, PF-4, PF-7, PF-8, PF-12, PF-13, MW-2, MW-8, MW-9, MW-10R, and MW-29R;
 - Measurement of water levels at wells PF-3, PF-4, PF-7, PF-8, PF-12, PF-13, MW-2, MW-8, MW-9, MW-10R, and MW-29R; and,
 - Collection of system parameters including applied vacuum, groundwater extraction rate, and soil vapor flow rate.

Following the completion of the startup period, the system will resume operation of all recovery wells, including the cyclic operation of the recovery wells, to focus remedial efforts at certain recovery well locations. Operation, maintenance, and monitoring (OM&M) activities will continue, to be performed as indicated in Quarterly and Annual Reports.

11. Schedule

A conceptual schedule for the design, bid document preparation/solicitation, and construction of the system improvements is outlined as follows:

Task	Target Date
NYSDEC Review/Approval	April 2010
Final Design	April - May 2010
Bid Document and Solicitation	May 2010
Construction Phase	June - July 2010

12. Certification

This is to certify that this *Remedial Enhancement Design Report* for the proposed VER system enhancements will be conducted at the site in accordance with the Order on Consent (B9-0353-90-11), as entered into by Ingersoll Rand and NYSDEC.

13. References

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Figures



ARO CORPORATION SITE • CHEEKTOWAGA, NEW YORK
REMEDIAL ENHANCEMENT

Site Location Map

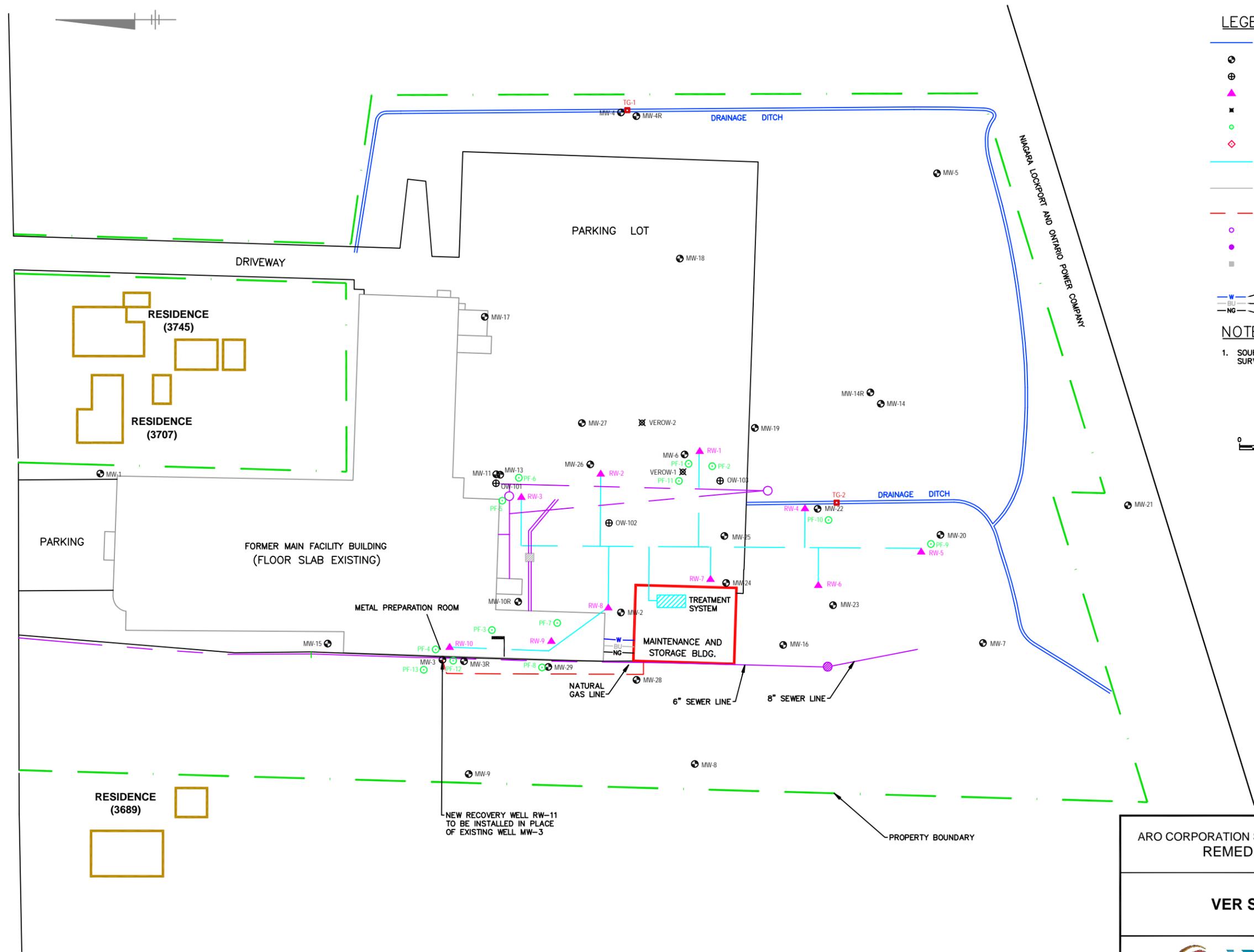


FIGURE

1

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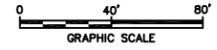
BROADWAY



- LEGEND**
- STORMWATER RUNOFF DRAINAGE DITCH
 - MONITORING WELL
 - ⊕ OBSERVATION WELL
 - ▲ RECOVERY WELL
 - ✖ VE OBSERVATION WELL
 - PNEUMATIC FRACTURING WELL
 - ◇ SOIL-GAS PROBE LOCATION
 - EXISTING RECOVERY SYSTEM TRENCH/PIPING
 - SUBSURFACE STORM WATER/SANITARY SEWERS
 - NEW RECOVERY SYSTEM TRENCH/PIPING
 - MANHOLE
 - SANITARY SEWER MANHOLE
 - DRAINAGE GRATE
- WATER
— BURIED UTILITIES
— NATURAL GAS

NOTE:

- SOURCE: RAY L. SONNENBERGER LAND SURVEYOR, 1997.



ARO CORPORATION SITE • CHEEKTOWAGA, NEW YORK
REMEDIAL ENHANCEMENT

VER SYSTEM LAYOUT



FIGURE
2

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Appendix A

Remedial Enhancement Design
Contract Drawings

CONTRACT DRAWINGS

REMEDIAL ENHANCEMENT DESIGN

FORMER ARO CORPORATION

KEY CONTACTS:

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INDEX TO DRAWINGS

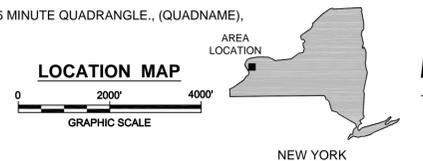
GENERAL	
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DATE ISSUED / DATE REVISED
MARCH 2010

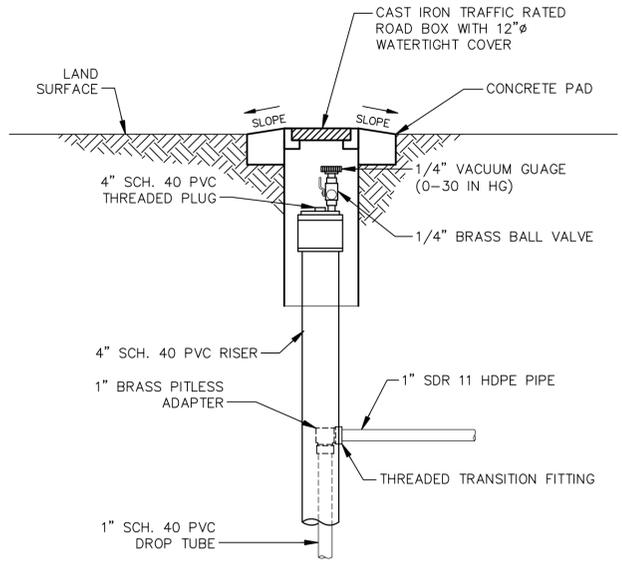
**INGERSOLL RAND
 ARO CORPORATION
 CHEEKTOWAGA, NEW YORK**

REFERENCE: BASE MAP USGS 7.5 MINUTE QUADRANGLE., (QUADNAME),
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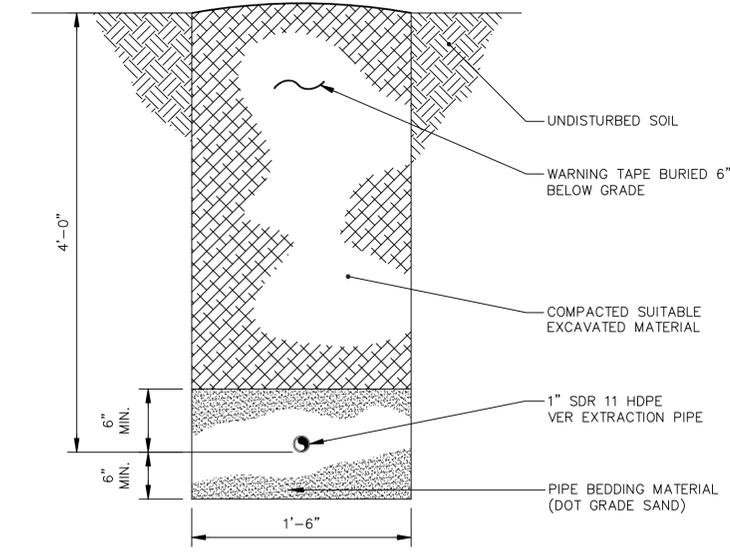


ARCADIS U.S., INC.

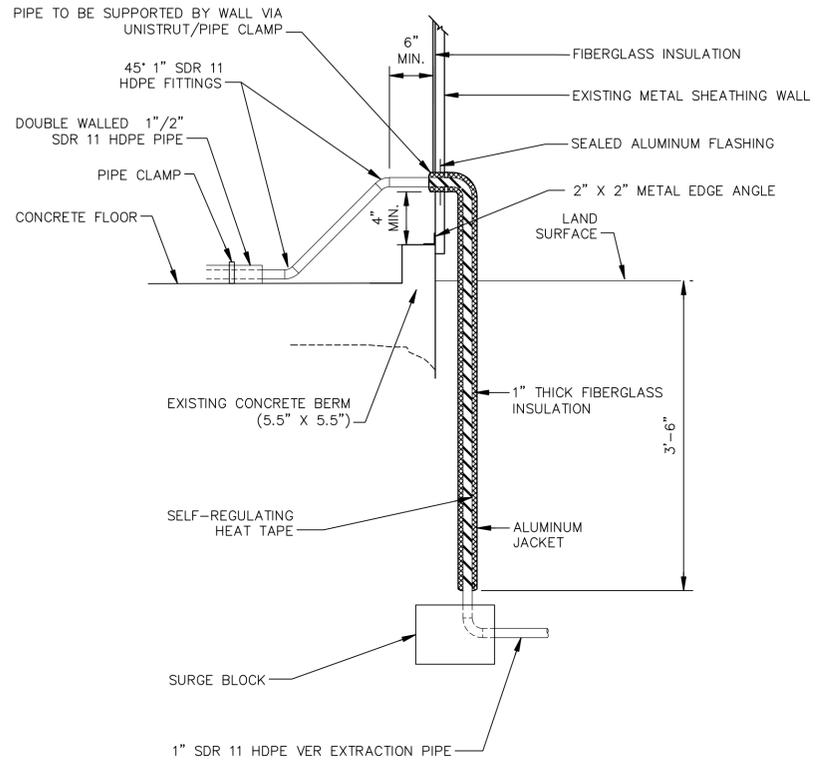
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 G:\ENVCAD\SYRACUSE\ACT\AY000220\001\4\00001\DWG\00220\02.dwg LAYOUT: G-2. SAVED: 3/16/2010 3:29 PM ACADVER: 17.05 (LMS TECH) PAGES: 17.05 (LMS TECH) PAGES: 17.05 (LMS TECH) PAGES: 17.05 (LMS TECH)
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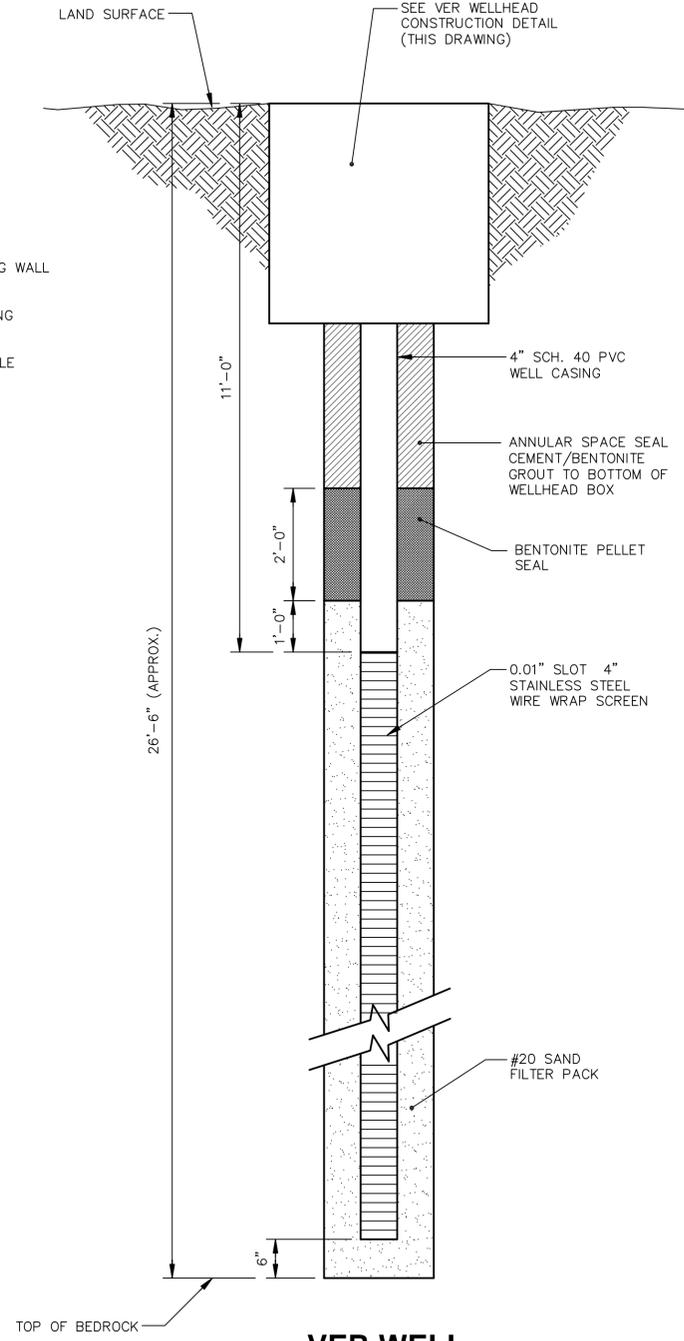
VER WELL HEAD CONSTRUCTION DETAIL 1
NOT TO SCALE



TYPICAL TRENCH CROSS SECTION 2
NOT TO SCALE



PROCESS PIPING BUILDING ENTRY 3
NOT TO SCALE



VER WELL CONSTRUCTION DETAIL 4
NOT TO SCALE

- CONSTRUCTION NOTES:**
- PIPE ROUTING SHOWN FOR CONSTRUCTION LAYOUT PURPOSES ONLY. ACTUAL ROUTING TO BE FIELD DETERMINED AND IS SUBJECT TO ENGINEER'S APPROVAL.
 - REFER TO PIPING AND INSTRUMENTATION DIAGRAM FOR THE SIZE AND MATERIAL USED FOR PROCESS PIPING.
 - RECOVERY WELL LOCATION(S) ARE SHOWN ON SITE PLAN/SYSTEM LAYOUT DRAWING. CONTRACTOR SHALL EXTEND ALL PROCESS PIPING AND MAKE ALL NECESSARY CONNECTIONS TO WELL VAULTS.
 - ALL PROCESS PIPING SHALL BE PRESSURE TESTED PNEUMATICALLY BY THE CONTRACTOR IN THE PRESENCE OF THE ENGINEER. PRESSURE TESTS SHALL BE PERFORMED AT 15 PSI FOR A DURATION OF 15 MINUTES. NO MORE THAN A 1 PSI PRESSURE DROP SHALL BE APPROVED AS A SUCCESSFUL PRESSURE TEST. ALL PIPING JOINTS SHALL BE EXPOSED DURING TESTING. IF APPROVED BY ENGINEER TESTS MAY BE PERFORMED ON SEPARATE SECTIONS OF PIPING TO EXPEDITE CONSTRUCTION. THE CONTRACTOR SHALL PROVIDE ALL PRODUCTS AND PROPERLY CALIBRATED TESTING EQUIPMENT REQUIRED TO PERFORM PRESSURE TESTING. TESTS SHALL BE PERFORMED PRIOR TO BACKFILL OF TRENCHES.
 - TRENCHING SHALL BE PERFORMED PER THESE TECHNICAL SPECIFICATIONS AND AS SHOWN HEREIN.
 - EXCAVATIONS SHALL BE KEPT FREE FROM STANDING WATER. IN THE EVENT THAT DEWATERING OF EXCAVATIONS IS NECESSARY, THE CONTRACTOR SHALL PROVIDE ALL EQUIPMENT NECESSARY TO DEWATER EXCAVATION AND STORE WATER FOR EVENTUAL TREATMENT BY EXISTING TREATMENT SYSTEM.
 - THE CONTRACTOR SHALL NOTIFY THE ENGINEER AT THE COMPLETION OF EXCAVATIONS AND TRENCHING TO ALLOW FOR INSPECTIONS.
 - THE CONTRACTOR SHALL PROVIDE APPROPRIATE SAFETY BARRICADES AROUND TRENCHING AND EXCAVATION TO PREVENT ACCIDENTS OR UNAUTHORIZED ENTRY.
 - BACKFILL OF TRENCHES WILL BE APPLIED IN 1-FOOT COMPACTION LIFTS SUCH THAT A MINIMUM OF 85% PROCTOR DENSITY IS ACHIEVED (95% PROCTOR DENSITY SHALL BE ACHIEVED IN PAVED AREAS).
 - DO NOT PLACE MATERIALS ON SURFACES THAT ARE MUDDY, FROZEN, OR THAT CONTAIN ICE OR FROST.
 - BACKFILL OF TRENCHES SHALL NOT BE PERFORMED WITH WET OR FROZEN MATERIAL. THE CONTRACTOR SHALL PROVIDE ADEQUATE COVER FOR MATERIAL TO BE USED AS BACKFILL SO AS TO MINIMIZE EXPOSURE TO RAIN OR SNOW.
 - THE CONTRACTOR SHALL PLACE A SINGLE STRIP OF UTILITY WARNING TAPE IN ALL TRENCHED AREAS. THIS TAPE SHALL CONTAIN A WIRE FOR METAL DETECTION OR HAVE AN ALUMINUM CORE. TAPE SHALL BE PLACED AT A DEPTH OF 6 INCHES IN NON-PAVED AREAS, AND BELOW THE SUB-BASE IN PAVED AREAS.
 - ALL CONCRETE AND PAVEMENT CUTS SHALL BE SMOOTH EDGE SAW CUTS BY CIRCULAR SAW BLADES.
- ADDITIONAL NOTES:**
- CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE OSHA AND STATE EXCAVATION SAFETY REGULATIONS RELATED TO HIS WORK.
 - CONTRACTOR SHALL LOCATE ALL UTILITIES PRIOR TO BEGINNING OF WORK. IT IS THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN EXISTING UTILITY SERVICES AND PROTECT ALL UTILITIES DURING CONSTRUCTION. DAMAGE TO UTILITIES WILL BE REPAIRED TO THE SATISFACTION OF THE UTILITY OWNER AND CONSULTANT AT THE CONTRACTOR'S EXPENSE.
 - ALL EXISTING DIMENSIONS AND ELEVATIONS RELEVANT TO THE WORK SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR.
 - NO EXCAVATION OR BOREHOLE SHALL BE LEFT OPEN OVERNIGHT, UNLESS PROPER PROTECTION IS PROVIDED AND APPROVAL IS GIVEN BY THE ENGINEER.
 - EXCESS EXCAVATION MATERIAL AND DRILL CUTTINGS SHALL BE STORED ON-SITE AT A LOCATION DIRECTED BY THE ENGINEER.
 - CONTRACTOR SHALL RESTORE ALL DISTURBED PAVEMENT (INCLUDING BITUMINOUS PAVEMENT, CONCRETE PAVEMENT AND CURBS), AND ANY OTHER DISTURBED GROUND SURFACE FEATURES TO THEIR ORIGINAL CONDITIONS, AND IN ACCORDANCE WITH THE SPECIFICATIONS.
 - ALL POURED IN PLACE CONCRETE TO HAVE A MINIMUM OF 3000 PSI COMPRESSIVE STRENGTH @ 28 DAYS.
 - THE CONTRACTOR SHALL SUPPLY TOOL FOR REMOVING THREADED PVC PLUGS LOCATED AT WELLHEAD(S).
 - HEAT TAPE SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
 - ALL VACUUM AND PRESSURE GAUGES SHALL BE OF THE FLUID-FILLED TYPE.
 - PROCESS PIPING RUNNING ALONG FLOOR INSIDE TREATMENT BUILDING SHALL BE SUPPORTED BY PIPE CLAMPS ANCHORED TO THE FLOOR EVERY 5'.
 - SURGE BLOCK DESIGN BY CONTRACTOR IS SUBJECT TO ENGINEER'S APPROVAL.
 - DRILLER SHALL HAND DIG TO A DEPTH OF 4' FOR THE INSTALLATION OF NEW RECOVERY WELL. CONTRACTOR SHALL HAND DIG TO A DEPTH OF 4.5' AT ALL LOCATIONS WITHIN 5' LINEAR OF MARKED UNDERGROUND UTILITIES.

SCALE(S) AS INDICATED		Professional Engineer's Name MOH MOHIUDDIN PhD, PE, DEE		 ARCADIS OF NEW YORK, INC.		ARO CORPORATION SITE • CHEEKTOWAGA, NEW YORK REMEDIAL ENHANCEMENT		ARCADIS Project No. AY000220.0014.00001	
THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING.		Professional Engineer's No. 074527				State: NY Date Signed: Project Mgr: MWS		Date: MARCH, 2010	
USE TO VERIFY FIGURE REPRODUCTION SCALE		2 3/16/10 SUBMIT TO NYSDEC CMD TMC 1 2/2010 DRAFT CMD TMC		State: NY Date Signed: Project Mgr: MWS		Date: MARCH, 2010		G-2	
THIS DRAWING IS THE PROPERTY OF THE ARCADIS ENTITY IDENTIFIED IN THE TITLE BLOCK AND MAY NOT BE REPRODUCED OR ALTERED IN WHOLE OR IN PART WITHOUT THE EXPRESS WRITTEN PERMISSION OF SAME.		No. Date Revisions By Ckd		Designed by: CMD Drawn by: NES Checked by: TMC					

Appendix B

Technical Specifications

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**SECTION 01010
SUMMARY OF WORK**

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Contract Description
- B. Definitions
- C. Scope of Work
- D. Principal Features
- E. Responsibilities
- F. Ownership
- G. Contractor's Use of Site and Premises
- H. Offsets
- I. Quality Assurance
- J. Materials and Equipment

1.2 CONTRACT DESCRIPTION

- A. Ingersoll Rand Company (collectively referred to as the client) has retained ARCADIS to prepare these technical specifications for the remedial enhancement design for the existing vacuum enhanced recovery (VER) system at the Aro Corporation Site in Cheektowaga, New York. The client has also retained ARCADIS to enhance the VER system by directly entering into contracts with contractors and vendors.

1.3 DEFINITIONS

- A. For the purpose of these technical specifications, remedial design drawings, and other contract documents, the following definitions apply:
 - 1. Owner/Client: Ingersoll Rand Company
 - 2. Consultant/Engineer: ARCADIS of New York Inc.

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SUMMARY OF WORK**

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3. Contractor: The individual, firm, partnership, or corporation designated as the contractor in these contract documents.
4. Vendor, supplier, or manufacturer: The individual, firm, partnership, or corporation selected to supply specific system equipment components.
5. Site: The area as indicated on the remedial design drawings.

1.4 SCOPE OF WORK

- A. The remedial enhancement design drawings and these technical specifications shall constitute the design and construction requirements for this project. The contractor shall provide the necessary supervision, labor, materials, equipment, tools, and appurtenances as required to affect a complete work, acceptable to the permitting authorities, the consultant/engineer, and in compliance with the respective codes. Work under this contract document includes the following list of items, which is meant as a guide and general description of the contractor's scope of work.
1. Obtain all required state, county, and local construction related permits
 2. Mobilize materials and equipment
 3. Obtain access to and locate all required utilities necessary to complete the work, including, but not limited to the following: electric power, telephone, fiber optics, sewer, and gas
 4. Supply and install the remedial system upgrades as indicated on the remedial design drawings, including but not limited to; installing recovery well RW-11 and associated recovery piping, transfer pump P-220 and associated piping, secondary knockout tank KT-211 and associated piping, remote performance monitoring upgrades, and all associated piping and electrical controls, in accordance with the remedial design drawings, these technical specifications, and manufacturers' recommendations
 5. Provide and install all necessary wiring, electrical devices, control panels, instrumentation, and controls to integrate system operation
 6. Install and connect electrical devices to appropriate electrical service
 7. Perform system start-up
 8. Clean-up and dispose of all waste generated during construction

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1.5 PRINCIPAL FEATURES

This section provides an overview and summary of the different processes associated with the VER system upgrades and the components associated with each portion of the work to be completed by the contractor, in accordance with the remedial design drawings and technical specifications.

A. Recovery Well RW-11 and Associated Piping

1. Recovery well RW-11 will be installed by over drilling well MW-3 and installing the recovery well in the borehole at the MW-3 location
2. Recovery well RW-11 will be constructed of 4-inch schedule 40 PVC riser pipe and screened from 11 to 26 feet below the land surface (bls) with 0.020 slot stainless steel continuous wire wrapped well screen. The recovery wellhead will be constructed with a flush mount protective casing
3. Extraction piping from RW-11 to the VER system will be 1-inch diameter standard dimension ratio (SDR) 11 HDPE (high-density polyethylene) pipe. Extraction piping will be installed below grade outside of the existing treatment building. The extraction piping will penetrate the existing treatment building wall above grade and run to the existing recovery well manifold along the building floor

B. Transfer Pump P-220

1. Transfer pump P-220 shall be installed and be rated for 30 gpm at 20 feet of total dynamic head. P-220 shall be located such that it does not hinder accessibility to the main control panel

C. Knockout Tank KT-211

1. Knockout tank KT-211 shall be installed. KT-211 will include a liquid level sensor which will be interlocked with the programmable logic controller (PLC)

D. Transmitters/Gauges

1. Pressure transmitters PT-210, PT-211 and PT-400 shall be installed and interlocked with the PLC. Pressure switch PSH-210 shall be installed and interlocked with the PLC
2. Vacuum transmitter VT-200 shall be installed and interlocked with the PLC

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3. Liquid flow indicating transmitter FQI-210 shall be installed and interlocked with the PLC
 4. Vapor flow indicating transmitter FIT-200 shall be installed and interlocked with the PLC
 5. Vacuum gauges VI-101 through VI-111, and VI-200 will be installed
 6. Pressure gauges PI-210, PI-211, PI-240, PI-407, PI-408, PI-409, and PI-410 will be installed
- E. Programmable Logic Controller (PLC)
1. The existing relay-based control system shall be upgraded to a PLC and interlocked with new and existing analog and discrete input devices. The PLC will include shutdown alarm settings to ensure the safety of operating personnel and that extracted groundwater is properly treated
 2. The upgraded control system will include the capability of allowing remote operators to observe and control the operation of the system through a desk-top software package via an auto-dialer
- E. Piping
1. Piping includes pipe supports (within above-grade structures), and all other associated appurtenances
- F. Electrical System
1. Provide and install all necessary wiring, electrical devices, control panels, instrumentation, and controls to provide for integrated system operation
 2. The electrical system shall include conduit, wiring, transformers, panel boxes, motor-control center (MCC), devices, instrumentation, and all other items necessary to make the system functional
 3. The control center for all system operations shall be a main control panel (MCP) equipped with a programmable-logic controller (PLC) that can be monitored remotely

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1.6 RESPONSIBILITIES

- A. The consultant/engineer's responsibilities:
1. Review the contractor's health and safety plan to ensure its consistency with the overall plan for the site
 2. Stop work should it not comply with the terms of the contract
 3. Review shop drawings, product data, and submittals
 4. Render approvals, clarifications, instructions, change orders, etc. (as appropriate)
 5. Inspect materials and equipment as required
 6. Observe and verify construction activities
 7. Provide design interpretation and technical support
 8. Approve changes in the work in writing
- B. The contractor's responsibilities:
1. Adhere to these technical specifications and the remedial design drawings
 2. Conduct all work in accordance with applicable local, state, and federal regulations
 3. Apply for and pay all permit and inspection fees
 4. Provide accurate schedules, adhere to the schedules, and receive approvals from the consultant/engineer for modifications to the schedules, if necessary
 5. Attend weekly progress meetings with the consultant/engineer
 6. Prepare, submit, and implement a site-specific health and safety plan
 7. Submit to the consultant/engineer for approval shop drawings, product data, and test results for the products, components, and equipment to be used

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8. Submit product data for all materials, and receive approvals from the consultant/engineer for all materials before they are delivered to the site
9. Arrange for delivery, receipt, unloading, and installation of all materials and equipment at the site and inspect for completeness or damage. Replace any items damaged after receipt
10. Store and secure all materials and equipment, as required
11. Submit changes in the work to the consultant/engineer for written approval. Obtain written approval from the consultant/engineer before the start of such changes
12. Accompany the consultant/engineer for a final inspection upon completion of the work. The consultant/engineer will prepare a punch-list and the contractor shall make craftspeople available to make corrections to the system after the inspection
13. Prepare and submit a complete set of operation and maintenance (O&M) instruction manuals for all equipment furnished by the contractor
14. Maintain a complete set of marked-up contract drawings to reflect all approved field changes and as-built information for the consultant/engineer to use in developing record drawings

1.7 OWNERSHIP

- A. The remedial design drawings and technical specifications prepared by the consultant/engineer are the consultant/engineer's property. They are not to be used on other projects or extensions to this project except by written agreement with the consultant/engineer. Submissions or distribution to meet official regulatory requirements, or other purposes in connection with this project, is not to be construed as publication in derogation of the consultant/engineer's and owner's rights.

1.8 CONTRACTOR'S USE OF SITE AND PREMISES

- A. In accordance with section 01012 ("Special Conditions"), the contractor shall be responsible for making sure the locations of all underground and overhead utilities and structures are known. Before doing any work at the site, the contractor shall notify the consultant/engineer of the locations of all utilities and structures in the area where construction activities will take place.

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SUMMARY OF WORK**

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- B. The contractor shall take all steps necessary to prevent disruptions or interference to areas adjacent to the site.
- C. The contractor shall limit construction operations to areas noted on remedial design drawings and designated by the consultant/engineer.
- D. The contractor shall restore all areas disturbed by construction activities to existing conditions unless otherwise specified by the consultant/engineer.
- E. All work shall be conducted during hours deemed appropriate by the consultant/engineer, owner, and/or local ordinance.

1.9 OFFSETS

- A. The remedial design drawings are diagrammatic in nature. Required size and termination of pipes and suggested routings are shown to conform to the site requirements, avoid creating obstructions, and preserve clearances. However, these documents are not intended to indicate all required offsets. The contractor bears specific responsibility to provide for offsets, horizontal and vertical control points and other surveying requirements in such a manner as to conform to the site features, and make all equipment requiring inspection, maintenance, and repair accessible.

1.10 QUALITY ASSURANCE

The contractor shall be responsible for quality assurance of the work as summarized below and in accordance with section 01400 ("Quality Control"). The contractor shall:

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in the installation, startup, and operating sequence.
- C. Should the manufacturer's instructions conflict with contract documents, request clarification from the consultant/engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the work, except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have the work performed by persons qualified to produce workmanship of specified quality.

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1.11 MATERIALS AND EQUIPMENT

The contractor shall be responsible for materials and equipment as summarized below and in accordance with section 01600 (“Materials and Equipment”):

A. Products

1. Products: means new material, components, fixtures, and systems comprising the work. Does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the work.

B. Storage and Protection

1. Equipment, products, backfill material, and all other construction materials shall be stored in an area designated by the consultant/engineer.
2. Store and protect products in accordance with manufacturers’ instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate-controlled enclosures.
3. The contractor will be responsible for providing heating and weather protection for equipment and materials that require such level of care.

C. Substitutions

1. Substitutions after project start may be considered when a product becomes unavailable through no fault of the contractor.
2. Substitution of components is allowed as follows:
 - a. Where specified as “or equivalent” shall mean that the contractor may use a material of equivalent quality, function, and value.
 - b. Where specified as “or approved equivalent” means that substitution is allowed upon approval by the consultant/engineer.
 - c. Where specified as “no substitutions” means substitutions will not be allowed unless compelling reasons exist to require the substitution, and the consultant/engineer concurs with the contractor and approves substitution
3. A request for substitution constitutes a representation that the contractor:

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- a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product
- b. Will provide the same warranty for the substitution as for the specified product
- c. Will coordinate installation and make changes to other work, which may be required for the work to be complete, at no additional cost to the consultant/engineer
- d. Waives claims for additional costs or time extension that may subsequently become apparent
- e. Consultant/engineer's approval of a request shall place the responsibility under this section on the consultant/engineer

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

**01010-9
SUMMARY OF WORK**

**SECTION 01012
SPECIAL CONDITIONS**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Utilities
- B. Ordinances, Permits, Licenses
- C. Emergency Responsibility
- D. Environmental Protection
- E. Consultant/engineer's Authority

1.2 UTILITIES

- A. Repair of damaged utilities caused by the contractor's work is the responsibility of the contractor. Utilities such as sewer, water, natural gas, telephone, and electric lines encountered in the work shall be protected from injury and maintained in service until removed, replaced, or abandoned as required for the complete work.

1.3 ORDINANCES, PERMITS, AND LICENSES

- A. The contractor shall at all times follow all applicable local, state, and federal laws. Neither the consultant/engineer, owner, nor any other party shall be liable or held responsible if contractor violates any of the above laws.
- B. The contractor must apply and pay for the cost of all local building permits.
- C. The required state environmental permits shall be in place before start of construction.

1.4 EMERGENCY RESPONSIBILITY

- A. In case of emergency that threatens damage of property and/or safety of life, the contractor shall act, without previous instructions from the consultant/engineer or owner, as the situation may warrant. The health and safety plan (HASP) required under section 01300 ("Submittals") shall contain all relevant information regarding emergency response and be completed per part 3 of this section of the technical specifications. The contractor shall notify the consultant/engineer of any emergencies immediately thereafter. Any claim for compensation by the contractor, together with substantiating documents regarding expenses, shall be submitted to the consultant/engineer and the amount of compensation shall be determined by agreement between the contractor and consultant/engineer.

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SPECIAL CONDITIONS**

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1.5 ENVIRONMENTAL PROTECTION

- A. General Requirements— The contractor shall provide and maintain environmental protection during the life of the contract. Environmental protection shall be provided to correct conditions that develop during all phases of construction. The contractor's operations shall comply with all federal, state, and local regulations pertaining to water, air, solid waste, and noise pollution.
- B. Protection of Natural Resources— The natural resources within the site and outside the limits of permanent work performed under this contract are to be preserved in their existing condition or restored to an equivalent or improved condition upon completion of the work. Construction activities shall be confined to areas defined by the contract documents.
1. The contractor shall restore damaged areas of the site to "Original Conditions" as applicable after performing required work. An inspection by the consultant/engineer shall determine work completion, and they shall approve repairs and restoration before the work is accepted. All restoration operations shall be performed at the contractor's expense.
 2. Signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction shall be eliminated in an approved way. Upon completion, all areas shall be clean and natural looking to the maximum extent possible.
 3. All work under this contract shall be performed in such a manner that any adverse environmental impacts are reduced to a level acceptable to the consultant/engineer and the New York State Department of Environmental Conservation (NYSDEC).
 4. Special measures shall be taken to prevent oily or hazardous substances from entering the ground, drainage areas, or local bodies of water.
- C. Control of Wastes— Wastes shall be picked up and placed in containers that are emptied on a regular schedule. Handling shall be conducted in a way that prevents contamination of the Site and any other areas.
1. All waste shall be transported and disposed of in a manner that complies with federal, state, and local requirements by the contractor. The contractor shall maintain and submit to the consultant/engineer a copy of any state and/or local permits or licenses that reflect such agency's approval and compliance with applicable solid-waste disposal regulations. The permits or licenses and the location of the disposal area shall be provided before transporting any waste material.

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2. During construction, the contractor shall use chemical toilets or comparably effective units, with sanitary wastes periodically emptied into municipal sanitary-sewage systems. Provisions shall be made for pest control and odor elimination .
 3. Fueling and lubricating of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spills and evaporation. Lubricants and waste oil shall be disposed of by the contractor at his expense, in accordance with approved procedures meeting federal, state, and local regulations.
- E. Dust Control— Dust shall be suppressed at all times, including non-working hours, weekends, and holidays. Site soil, haul roads, and other areas disturbed by construction operations shall be sprinkled with water as necessary to control dust. Only wet cutting of concrete blocks and concrete will be permitted. No unnecessary shaking of bags will be permitted where concrete mortar and plaster milling is done.
- F. Noise Control— The maximum use of “low-noise emission products” as certified by the U.S. Environmental Protection Agency shall be made when available. When not available, screens and/or barriers shall be used for noise control. No blasting or use of explosives will be permitted.

1.6 CONSULTANT/ENGINEER’S AUTHORITY

- A. When performing the work, the contractor shall abide by all orders, directions, and requirements of the consultant/engineer. The work shall be performed to the satisfaction of the consultant/engineer at the times and places, by the methods, and in the manner and sequence the consultant/engineer may require. The consultant/engineer shall determine the amount, quality, and acceptability of all phases of the work. The consultant/engineer shall interpret the plans, specifications, contract documents, and any extra work orders. The consultant/engineer shall decide all other questions in connection with the work. Upon request, the consultant/engineer shall confirm in writing any oral orders, directions, requirements, or determinations.

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

3.1 FIELD QUALITY-CONTROL

- A. The contractor shall collect samples and/or conduct tests in accordance with section 01400 (“Quality Control”) and with all applicable standards related to the item or system being tested.

01012 - 3 SPECIAL CONDITIONS

Remedial Enhancement Design Report

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3.2 HEALTH AND SAFETY

- A. The contractor shall be responsible for implementing the site-specific HASP prepared in accordance with section 01300 ("Submittals").
- B. The contractor shall provide adequate health and safety personal protection equipment (PPE) for their employees and others who might be affected by excavation and construction activities.
- C. Work procedures shall conform to all applicable OSHA, State of New York, county, local government, and other federal regulations.

3.3 PROJECT SCHEDULE

- A. Time is essential in construction. The contractor is responsible for meeting the system startup deadline.
- B. The contractor shall be responsible for achieving round-the-clock operation of the treatment system and addressing all punch-list items within five days of the notice to proceed.
- C. The contractor shall develop, implement, and maintain a project schedule that covering the duration of the project from notice to proceed to completion of all punch-list items on to fully automatic operation.
- D. The contractor will be responsible for all fines and extra costs associated with the contractor's failure to meet the deadline specified herein and in the contract documents.

Chapter 2 —END OF SECTION—

**SECTION 01039
COORDINATION AND MEETINGS**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Site Progress Meetings
- B. Weekly Progress Reports
- C. Coordination

1.2 SITE PROGRESS MEETINGS

- A. The owner or consultant/engineer shall designate, as necessary, progress meetings that will be conducted to review the progress of the work and any unexpected conditions or situations that may have arisen. The contractor is required to attend all progress meetings unless exempted by the consultant/engineer or owner. The consultant/engineer will ensure conformance with the financial plan. The contractor shall be fully responsible for any and all of the subcontractors and shall be responsible for subcontractor attendance and/or input into the meetings.
- B. The meetings shall be documented by the consultant/engineer and copies of the meeting minutes shall be distributed to the contractor.
- C. Progress meetings shall be held approximately weekly, at which time the weekly progress report will be reviewed.

1.3 WEEKLY PROGRESS REPORTS

- A. The contractor shall provide written weekly progress reports to the consultant/engineer outlining the status of the work, any projected budget impacts, unexpected conditions or situations, updated schedule, and any information pertinent to the progress of the work.

1.4 COORDINATION

- A. All on-site work shall be coordinated by the contractor, with the approval of the consultant/engineer.
- B. Site, facility, and utility access shall be coordinated through the owner's representative and/or the appropriate utility authority.
- C. Issues related to design and construction of the specified system shall be handled through the consultant/engineer in accordance with sections 01010 ("Summary of Work"), 01012 ("Special Conditions"), 01300 ("Submittals"), and 01400 ("Quality Control").

—END OF SECTION—

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COORDINATION AND MEETINGS**

SECTION 01090
REFERENCE STANDARDS

PART 1— GENERAL

1.1 REFERENCE STANDARDS

Where standards of the following organizations, or any other standards, codes, or specifications, are referred to in the technical specifications, the reference is to the particular standard, code, or specification cited, together with all amendments applicable at the date of the opening of bids, and shall apply except to the extent that said standards and requirements may be in conflict with applicable laws or ordinances.

<u>Acronym</u>	<u>Organization</u>
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AI	Asphalt Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BOCA	Building Officials Conference of America
CRSI	Concrete Reinforcing Steel Institute
IEEE	Institute of Electrical and Electronic Engineers
JIC	Joint Industrial Council
NCMA	National Concrete Masonry Association
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NYDOT	New York Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratories

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

01090-1
REFERENCE STANDARDS

**SECTION 01300
SUBMITTALS**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. General
- B. Submittal Procedures
- C. Shop Drawings
- D. Product Data
- E. Manufacturer's Instructions
- F. Warranties
- G. Proposed Supplier List
- H. Proposed Subcontractor List
- I. Health and Safety Plan (HASP)
- J. Construction Progress Schedules
- K. Weekly Progress Reports
- L. Operation and Maintenance Manuals
- M. As-Built Drawings

1.2 GENERAL

- A. All submittals shall be complete, neat, and orderly.
- B. Submittals shall be provided according to the contract schedule.

1.3 SUBMITTAL PROCEDURES

- A. Transmit one copy of each submittal to the consultant/engineer.
- B. Sequentially number the transmittal forms. Re-submittals shall have the original number with an alphabetic suffix.

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- C. Identify project, contractor name, subcontractor or supplier name, submission date, pertinent drawing sheet and detail number(s), and specification-section number(s) as appropriate.
- D. Apply contractor's stamp, signature, or initials certifying that review, verification of products, field dimensions, adjacent construction work, and coordination of information, is completed as required.
- E. All submittals are to be submitted to and approved by the consultant/engineer in writing before beginning work for the item that requires submittal.
- F. Distribute copies of reviewed submittals to the appropriate parties concerned. Instruct the parties to promptly report any inability to comply with provisions.
- G. Provide space for consultant/engineer to place review stamp.
- H. Revise and resubmit submittals as required by the consultant/engineer until approved; identify all changes made since previous submittal.

1.4 SHOP DRAWINGS

- A. The contractor shall furnish shop drawings to the consultant/engineer for review and approval within 21 calendar days after award of contract.
- B. Shop drawings shall show how the contractor intends to perform the work.
- C. The shop drawings should include:
 - 1. The location, elevation, size, and anchoring details of all service (mechanical and electrical) penetrations.
 - 2. Recovery well RW-11 piping-manifolds profile-layout and associated floor-penetration pipe-sleeve locations.
 - 3. Transfer pump P-220 component layout.
 - 4. Knockout tank KT-211 component layout.
 - 5. Control-panel including PLC layout.
 - 6. Warranties extended by the contractor for the work to be completed.

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- D. Two copies of the drawings and data submitted by the contractor will be returned to the contractor by the consultant/engineer with comments such as, "Review Date," "Approved," "Rejected" and "Comments." The contractor shall make all necessary revisions, corrections, or clarifications, if required, and resubmit one copy of the revised drawings and data within seven calendar days.

1.5 PRODUCT DATA

- A. The contractor shall supply the consultant/engineer with a proposed products list within seven calendar days after contract award. This list shall be subject to approval by the consultant/engineer.
- B. The proposed product list shall indicate all products the contractor believes will be incorporated. This list shall be interpreted as agreement by the contractor to use the specified products. Omission from this list of any product required by the contract documents shall not relieve the contractor of the responsibility to provide that product and complete the associated work as specified.
- C. The contractor shall submit for the consultant/engineer's approval, within 21 calendar days after contract award, all information and product data related to the products in the proposed products list. The product data shall be submitted with the shop drawings and include data called for under the specifications or requested by the consultant/engineer, including but not limited to:
 - 1. Manufacturers' descriptions, technical specifications, shop drawings, and data for each component specified that will not be fabricated on-site.
 - 2. Manufacturer warranties in accordance with section 01012 ("Special Conditions").
 - 3. Submittals shall indicate that the material or product conforms to or exceeds specified requirements. Submit supporting data or certifications as appropriate.

1.6 MANUFACTURER'S INSTRUCTIONS

- A. Contractor shall submit to the consultant/engineer printed instructions for delivery, storage, assembly, installation, and maintenance of specified components that will not be fabricated on-site. Instructions shall be provided at least seven calendar days before delivery.

1.7 PROPOSED SUPPLIER LIST

- A. A complete list of suppliers with product, name, and address shall be submitted for the consultant/engineer's review within seven calendar days after contract award.

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1.8 PROPOSED SUBCONTRACTOR LIST

- A. A final list of subcontractors with name, address, and experience shall be submitted for review to the consultant/engineer within seven calendar days after contract award.
- B. No work on the contract shall begin until all proposed subcontractors have been approved by the consultant/engineer in writing.

1.9 HEALTH AND SAFETY PLAN

- A. The contractor shall prepare a construction health and safety plan (HASP) in accordance with the HASP currently in place at the site. The HASP shall be submitted to the consultant/engineer for their review within seven calendar days after award of contract.
- B. Contractor shall be responsible for implementing the HASP in accordance with section 01012 ("Special Conditions").
- C. No work shall begin at the site until a HASP is in place.

1.10 CONSTRUCTION PROGRESS SCHEDULES

The contractor shall:

- A. Submit initial project schedule within seven calendar days after award of contract.
- B. Submit revised schedules as substantial variations are identified or as required by the consultant/engineer.
- C. Show the complete sequence of construction by activity, identifying work in separate stages and in logically grouped activities. Indicate the start and finish dates and duration. The presentation shall be neat and accurate, using *MS Project*[®] or comparable project-tracking software.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. The contractor shall provide the consultant/engineer with equipment manufacturers' operation and maintenance manuals and warranty and service information within 15 days before system startup. The contractor shall prepare an operation and maintenance manual that addresses the following items:
 - 1. Operating Procedures: startup, break-in, and routine normal operating instructions and sequences, regulation, control, stopping, shut-down, emergency instructions, summer, winter, and any special operating instructions.

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2. Maintenance Requirements: routine procedures and guidance for troubleshooting, disassembly, repair, reassembly, alignment, adjusting, balancing, and equipment checking.
3. Manufacturer's parts list, illustrations, assembly drawings, and maintenance diagrams.
4. Manufacturer's record drawings and any additional submittal information.

1.12 AS-BUILT DRAWINGS

- A. The contractor shall furnish the consultant/engineer with drawings clearly indicating all technical information (including product data, manufacturer's instructions, and certificates) and all field modifications. All information necessary to create record drawings shall be provided by the contractor within 14 calendar days of substantial completion of construction.

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

**01300-5
SUBMITTALS**

**SECTION 01400
QUALITY CONTROL**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Contractor Quality Control and Assurance of Installation
- B. Workmanship

1.2 RELATED SECTIONS

- A. Section 01039— “Coordination and Meetings”
- B. Section 01300— “Submittals”

1.3 CONTRACTOR QUALITY CONTROL AND ASSURANCE OF INSTALLATION

The contractor shall:

- A. Monitor and exercise quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality.
- B. Comply fully with manufacturers’ instructions, including each step in an installation and startup sequence.
- C. If manufacturer’s instructions conflict with contract documents, contractor shall request clarification from the consultant/engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the work, except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by individuals qualified to produce workmanship of specified quality.
- F. Secure products and equipment in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- G. During freezing or inclement weather or other adverse conditions, no work shall be performed except that which can be performed in a manner that will ensure first-class construction throughout.

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1.4 WORKMANSHIP

- A. The intent of these technical specifications is to describe definitively and fully the character of materials and workmanship required with regard to all ordinary features, and to require first-class work and material in all particulars.
- B. For any unexpected features arising during the progress of the work and not fully covered herein, the specifications shall be interpreted by the consultant/engineer to require first-class work and materials, and such interpretation shall be accepted by the contractor.
- C. All labor shall be performed in the best and most competent manner by mechanics skilled in their respective trades. The standards of the work required throughout shall be of such grade as will bring only first-class results.
- D. Materials and methods used in the assemblage of the equipment shall comply with relevant standards, codes, or specifications related to the manufacture and operation of the specified equipment.

1.5 FIELD INSPECTION OF CONTRACTOR'S WORK

- A. The consultant/engineer will periodically inspect the contractor's work to ensure that the work is being performed in accordance with the remedial design drawings and these technical specifications, such that the product will conform to the remedial design drawings and technical specifications.
- B. The contractor is responsible for complete conformance to the remedial design drawings and technical specifications for all work on the project, including all subcontractors.
- C. The contractor will provide ample opportunity for safe and easy access to the inspectors to properly inspect the work.
- D. Inform the consultant/engineer in advance of periods when the contractor does not intend to work due to, but not limited to, inability to obtain materials or equipment or expected inclement weather.
- E. Upon completion of the work, the contractor shall notify the consultant/engineer to arrange for final system inspection . The contractor or their representative must accompany the consultant/engineer on the final inspection. The contractor shall have craftspeople available or on call to make changes or corrections to the system after or during the inspection, as determined by the consultant/engineer.

PART 2— PRODUCTS

2.1 BACKFILL AND PIPE-BEDDING MATERIALS

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- A. Any fill from an off-site location shall be a certified-clean fill material acceptable to the owner, consultant/engineer, and the New York State Department of Environmental Conservation. The contractor shall submit the results of chemical analyses of all fill material from off-site to confirm that it is free of contamination, and will provide the consultant/engineer and owner with documentation of the material's origin.

PART 3— EXECUTION

3.1 EXAMINATION

- B. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Beginning new work means acceptance of existing conditions.
- B. Examine and verify specific conditions described in individual specification sections.
- C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.2 FIELD QUALITY CONTROL

- A. Allow representatives of the testing laboratory access to the work at all times.
- C. Provide all equipment, labor, materials, and facilities required by the laboratory to properly perform its functions.
- D. Cooperate with and assist laboratory personnel during their work.
- E. Test specimens and samples shall be taken by the individual(s) designated in other sections, or as directed by the consultant/engineer. Conduct field sampling and testing in the presence of the consultant/engineer.

3.3 PREPARATION

- A. Clean substrate surfaces before applying the next material or substrate.
- B. Seal cracks or openings in substrate before applying the next material or substance.
- C. Apply manufacturers' required or recommended substrate primer, sealer, or conditioner before applying any new material or substance in contact or to bond.

—END OF SECTION—

**01400-3
QUALITY CONTROL**

**SECTION 01450
PIPE TESTING**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Piping tests
- B. Pipe-leakage testing shall comply with the limitations established in the attached schedule

1.2 RELATED SECTIONS

- A. Section 01400— “Quality Control”

1.3 DEFINITIONS

- A. Leakage— The quantity of water to be supplied into the newly laid pipe, any valved section thereof, or other appurtenance, necessary to maintain the specified leakage-test pressure after the pipe has been filled with water and the air expelled.

1.4 QUALITY ASSURANCE

The contractor shall:

- A. Before substantial completion, pressure pipes shall meet specific leakage requirements. These leakage requirements shall be satisfied by the basic materials alone. Where joint filters and the like have been specified, primarily to protect jointing materials, and secondarily to provide a safety factor, they shall not be applied until after leakage tests have been completed and accepted by the consultant/engineer.
- B. The consultant/engineer will witness all tests. Tests not witnessed will be considered as not having been performed.
- C. Work shall not be closed or covered up until it has been observed for proper and satisfactory construction and installation in compliance with the contract documents. Should incomplete or unacceptable work be covered, the contractor shall, at their own expense, uncover all work so that it may be properly observed. After such observations, repair and replace the work that was found defective, unsatisfactory, and not in accord with the contract documents. After such repair and replacement, bring all work to completeness and status as it was before it was closed and covered, all at the contractor's expense. The contractor shall submit for review and approval the means and methods for correcting failed systems.

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- D. Successful completion of required tests shall in no way be interpreted as relieving the contractor of responsibility for defects that become apparent subsequent to the test. The consultant/engineer has the sole right to determine whether defects exist. Retest, before substantial completion, all portions of the work deemed by the consultant/engineer in need thereof.

1.5 SUBMITTALS

- A. Submit under provisions of section 01300
- B. Complete details and specifications on testing apparatus
- C. At the consultant/engineer's discretion, when working conditions or the standard of workmanship have been altered, testing of additional sections of pipelines may be required as soon as pipe is laid and before backfilling.

PART 2— PRODUCTS

2.1 TESTING APPARATUS

- A. Provide labor, plugs, measuring equipment, and other apparatus, complete, to perform testing.
- B. Provide clean water, air, nitrogen, and other materials as required to accomplish testing.
- C. Provide plugs and caps capable of withstanding test pressures.
- D. Provide temporary flanges, plugs, bulkheads, thrust blocks, weighing, bracing and other items necessary to prevent joints from separating, and to prevent injuries or damage.

PART 3— EXECUTION

3.1 PREPARATION

- A. Plug open ends, adequately block bends, tees, ends, and other fittings, and do whatever is necessary to brace the piping system so that it will safely withstand the pressures developed under the tests and so that no damage or injury occur to the pipeline, people, or property.
- B. Before tests are conducted, isolate, or remove any regulator, gauge, trap, or other apparatus or equipment that may be damaged by test pressures.

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3.2 GENERAL

- A. Trapped Air: Trapped air may cause a false indication of the leakage rate. Points of concern include ends of lines, stubs, house connections, and high points in pipelines. No credit will be made for this condition and no adjustment will be made to the allowable leakage. When trapped air is suspected of causing a test failure, do whatever is necessary to evacuate the air and repeat the tests until the actual leakage is equal to or less than allowable rate of leakage. All air shall be removed from the test section of the pipe before beginning leak testing.
- B. Water Absorption: No credit will be given for absorption of water in pipe. If necessary, fill pipes and manholes with water well in advance of testing and allow them to soak in order to eliminate or minimize the effects of absorption.

3.3 TESTS FOR PRESSURE PIPES

- A. General
1. Leakage shall include the main exiting pipe, service connections, and other appurtenances on the section of pipeline being tested.
 2. Test pipes before applying insulation and before they are concealed or furred-in.
 3. Provide all necessary gauges. Gauges shall be standard pressure type with a minimum 6-inch diameter dial and a pressure range not to exceed 50% of the maximum required test-pressure.
 4. Provide and maintain at the site a gauge stand with an approved laboratory-calibrated test gauge. Periodically check the site gauge used for testing against the laboratory-calibrated test gauge, and whenever requested by consultant/engineer.
 5. Where necessary for testing, tap pipes and insert approved plugs after testing is completed.
 6. Provide a hand or motor-driven compressor to maintain the required test-pressure-constant throughout the test's duration. If a water pump is used, pump water from a container with a known volume of water. If an air or inert gas pump is used, leakage shall be determined and calculated by pump cycling.
 7. Provide test gauges at each end of the line being tested.
 8. Conduct the leakage test in accordance with the requirements of paragraph 3.06 herein.

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B. Pneumatic Testing

1. All sections of newly installed piping shall be subjected to pneumatic testing and leakage tests at 15 psi. The contractor shall follow the pipe manufacturer's pressure-testing procedure recommendations.
2. The pneumatic test will last at least 15 minutes.
3. No more than 1 psi pressure drop shall be approved.

3.4 ALLOWABLE LEAKAGE

- A. The maximum allowable leakage for the various piping systems is presented in the schedule.
- B. This contract is intended to secure piping systems without leakage. No section of pipe shall exceed the allowable leakage. This contract is also intended to secure a piping system free of visible drips, streams, and leaks. Therefore, even if a portion of the system meets the requirements for allowable leakage, visible leaks are not permitted and shall be repaired.
- C. Leakage tests will be considered to have been satisfactorily passed when the rate of leakage is equal to or less than the stipulated allowances and when no visible leaks or other system defects are evident.

3.5 RETESTING

- A. Pipes not passing these tests shall have all defects corrected to the satisfaction of and with methods approved by the consultant/engineer, and shall be retested and re-corrected as often as necessary until the test requirements are met.
- B. This contract is intended to obtain work meeting test requirements on their own and solely through the use of the normal integral-sealing-components. Joint leaks shall not be stopped using concrete, caulking, mortar, or other patching materials. Leaking pipe joints shall be re-jointed or replaced if necessary.

—END OF SECTION—

**01450-4
PIPE TESTING**

SECTION 01600
MATERIALS AND EQUIPMENT

PART 1— GENERAL

1.1 SECTION INCLUDES:

- A. Equipment and Products Specified
- B. Storage and Maintenance of Materials
- C. Equipment and Material Installation
- D. Cutting, Patching, and Painting

1.2 RELATED SECTIONS

- A. Section 01300— “Submittals”
- B. Section 01400— “Quality Assurance”

1.3 EQUIPMENT AND PRODUCTS SPECIFIED

- A. In the various detailed sections of the specifications where any item of equipment or product is specified by proprietary name or trade name, with the addition of such expressions as or “approved equivalent,” understand that equivalent-quality equipment or products of either a manufacturer named or of a manufacturer not named which meet the detailed requirements of the specifications are intended, subject to the approval of the consultant/engineer as to the equivalence thereof. The contractor must also demonstrate that no adverse impact to the project schedule and no additional cost to the consultant/engineer will result from the substitution.
- B. Substitutions after project start may also be considered when a product becomes unavailable through no fault of the contractor.
- C. The consultant/engineer shall review the technical data for substitutions and shall accept or reject the substitution offered.
- D. The contractor is responsible for all delays in the project schedule associated with the review of offered substitutions. Such delays shall be incorporated into the contractor’s projected construction schedule and shall be compensated for such that the overall project schedule is not affected.

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- E. Substitution of components is allowed as follows:
1. Where specified, as “or equivalent” shall mean that the contractor may use material of equivalent quality, function, and value.
 2. Where specified, as “or approved equivalent” means that substitution is allowed upon approval by the consultant/engineer.
 3. “No substitution,” or unspecified, means substitutions will not be allowed unless compelling reasons exist to require the substitution, and the consultant/engineer concurs with the contractor and approves the substitution.
- F. A request for substitution constitutes a representation that the contractor:
1. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the submission as for the specified product.
 3. Will coordinate installation and make changes to other work such as may be required for the work to be complete, with no additional cost to consultant/engineer or delay to the project schedule.
 4. Waives claims for additional costs or time extension that may subsequently become apparent.
 5. Understands that the consultant/engineer’s approval of a requested change does not place responsibility under this section upon the consultant/engineer.

1.4 STORAGE AND MAINTENANCE OF MATERIALS

- A. All materials provided and work performed under this contract shall be protected from damage before and after installation. The contractor shall be responsible for work, equipment, and materials until inspected, tested, and finally accepted in accordance with this section and these technical specifications.

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- B. All arrangements for delivery, storage, and handling of equipment specified herein shall be the contractor's responsibility. The contractor shall store equipment and materials so as to ensure the preservation of their quality and fitness for work. When considered necessary, they shall be placed on wooden platforms or other hard, clean surfaces, and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection.
- C. Where materials or products called for under this contract are installed before the erection of adequate protective structures, the contractor, without additional compensation, shall provide approved, effective, and durable covers to fully protect such materials or products against damage from the elements or from any other causes.
- D. All machinery, equipment, piping, accessories, and appurtenances shall be adequately supported and safeguarded against all damage or injury during performance of work under this contract. The contractor shall be responsible for all damage or injury resulting from his operations and shall repair such damage immediately and to the satisfaction of the consultant/engineer.
- E. The contractor shall store and protect products in accordance with the manufacturer's recommendations and the requirements specified in these contract documents, and shall submit the manufacturer's storage and maintenance instructions before delivery.
- F. The contractor shall make all arrangements and provisions necessary to store materials and equipment. All excavated material, construction equipment, and materials and equipment to be incorporated into the work shall be placed so as not to injure any part of the work or existing facilities, and so that free access to all parts of the work can be achieved at all times, including all unrelated portions of the owner's facility and all public utility installations near the work. Materials and equipment shall be neatly and compactly stored in locations that will cause minimal inconvenience to other contractors, public travel, adjoining owners, tenants, occupants, and the owner.
- G. Areas available on the job site for storing materials and equipment shall be as shown, specified, or designated and approved by the consultant/engineer. All materials and equipment must be consigned to the contractor directly. No delivery of materials and equipment will be accepted by the consultant/engineer, and all expenses incurred by the consultant/engineer in handling materials or equipment that has been consigned or directed to the consultant/engineer will be charged to the contractor.

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- H. Materials and equipment which are to become the property of the owner shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the work, including proper protection against damage by freezing and moisture. They shall be placed inside storage areas, unless otherwise shown, specified or acceptable to the consultant/engineer.
- I. The contractor shall be fully responsible for loss or damage to stored materials.
- J. Any material or equipment which, in the opinion of the consultant/engineer, has been damaged due to improper storage and/or handling and is unfit for its specified or intended use shall be properly removed from the site or work. The contractor shall receive no compensation for the damaged material or its removal or replacement. The contractor shall be responsible for replacing any such materials with undamaged material as specified and shall be liable for any damages associated with removal and replacement of damaged materials, as well as damages— direct or consequential— resulting from delays in the project schedule that occur due to the damaged materials.

1.5 EQUIPMENT AND MATERIAL INSTALLATION

- A. Install per manufacturer's instructions and specifications.
- B. Maintain plumb and be within specified tolerances.
- C. Locate and install in accordance with plans and specifications.
- D. Install in accordance with accepted quality construction practice to assure proper operation and full design life of the system and components.

1.6 CUTTING, PATCHING, AND PAINTING

- A. The contractor shall perform all cutting and patching required to properly install the equipment. If cutting will harm the structural integrity or mar the appearance, consult the consultant/engineer for approval before proceeding. Patching shall meet with the consultant/engineer's approval.
- B. Equipment furnished by the contractor in a painted condition shall be free from scratches, blemishes, or rust spots.
- C. Contractor shall request the consultant/engineer's approval before cutting or altering items specified in contract documents.

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PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

**01600-5
MATERIALS AND EQUIPMENT**

**SECTION 01650
STARTING OF SYSTEMS**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Scope
- B. Division of Responsibilities
- C. Process Testing

1.2 RELATED SECTIONS

- A. Section 01010— “Summary of Work”
- B. Section 01012— “Special Conditions”
- C. Section 01039— Coordination and Meetings
- D. Section 01300— “Submittals”
- E. Section 01400— “Quality Assurance”

1.3 SCOPE

- A. This section delineates the division of responsibilities between the consultant/engineer and contractor for activities during the startup/shakedown and turnover period (10 working days) after substantial construction has been accomplished.

1.4 DIVISION OF RESPONSIBILITIES

- A. Certain specific activities are to be completed before the final turnover notice will be issued to the contractor to signify substantial completion of a portion (or all) of the work. Following issuance of a turnover notice, the contractor shall continue to complete all unfinished work covered by a “punch-list” resulting from known deficiencies.
- B. Undoubtedly, a certain amount of “make-good” work will be required after issuance of a turnover notice; for example, insulation, paint, or paving may require repair through no fault of the consultant/engineer or owner. In such instances, the

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contractor will be expected to make such repairs promptly and to the satisfaction of the consultant/engineer and owner.

- C. The contractor shall be responsible for subcontractor and/or vendor representatives/ technicians being available on the site during the first running of equipment and is to arrange for the manufacturer to check out equipment as required. The contractor shall provide subcontractor and vendor services at no charge to the owner or consultant/engineer for all subcontractors and vendors contracted through the contractor.

1.5 PROCESS TESTING

- A. The contractor or manufacturer's representative shall perform functional testing before start-up. Manufacturer's representative or the contractor shall be available (on-site) during start-up, in accordance with the relevant section(s) of the technical specifications.
- B. Instrumentation, controls, and complete system-integration shall be tested by the contractor before system start-up.
- C. The engineer/consultant shall collect samples for evaluation and/or laboratory analyses to verify the performance of the process equipment.

1.6 EQUIPMENT ADJUSTMENT AND CALIBRATION

- A. All mechanical and electrical equipment, including related control systems, shall be subjected to preliminary operation and testing before the individual facilities and systems are put into operation. Tests shall be made to determine whether the equipment has been properly assembled, aligned, adjusted, wired, or connected.
- B. The demonstration test of each piece of equipment shall include check-out from the control panel. All alarm systems and safety lockout systems shall be demonstrated for proper function along with all process instrumentation and controls.
- C. The contractor shall coordinate and be present during all such tests.

1.7 SYSTEM STARTUP AND OPERATION

- A. The contractor shall place the various items of equipment into operation, along with related piping and metering systems. After satisfactory startup of these individual systems, including all related equipment, they will remain in continuous or intermittent operation as required. System start-up shall be conducted for a period

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of three days following installation of all process equipment, piping, and electrical devices as defined in section 1010 ("Summary of Work").

- B. All equipment and accessories shall be adjusted and calibrated before any startup, as specified under these special conditions. Any equipment placed into temporary operation before final completion of the total project shall be readjusted and/or calibrated.

- C. The contractor shall supervise, control, and be responsible for the operation and maintenance of the new equipment and/or system after each individual item is placed into operation. An adequate number of competent startup personnel shall be furnished until the equipment is functional and working properly. The contractor shall remain responsible for making any required changes, repairs, or replacements to the new installation during the startup period.

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

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**SECTION 01700
CONTRACT CLOSEOUT**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Procedures
- B. Cleanup
- C. Substantial Completion
- D. Final Inspection
- E. Project Record Documents
- F. Contractor's Closeout Submittals

1.2 RELATED SECTIONS

- A. Section 01300— "Submittals"

1.3 PROCEDURES

- A. Comply with requirements stated in the conditions of the contract and in specifications for administrative procedures in closing out the work.

1.4 CLEAN-UP

- A. Remove all waste, debris, rubbish, tools, equipment, machinery, and surplus materials to the satisfaction of the consultant/engineer.
- B. Dispose of all wastes, debris, and rubbish in accordance with applicable federal, state, and local regulations.
- C. Clean all visible surfaces. Leave work clean and ready for the owner's possession.

1.5 SUBSTANTIAL COMPLETION

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- A. When the contractor considers that the work is substantially complete, they shall submit the following to the consultant/engineer:
 - 1. A written notice that the work, or designated portion thereof, is substantially complete.
 - 2. A list of items to be completed or corrected.
- B. Within a reasonable time after receipt of such notice, the consultant/engineer will make an inspection to determine the status of completion.
- C. Should the consultant/engineer determine that the work is not substantially complete, the following shall occur:
 - 1. The consultant/engineer will promptly notify the contractor in writing, giving the reasons thereof.
 - 2. The contractor shall remedy the deficiencies in the work and send a second written notice of substantial completion to the consultant/engineer.
 - 3. The consultant/engineer will re-inspect the work.
- D. When the consultant/engineer finds that the work is substantially completed, the consultant/engineer will:
 - 1. Prepare and deliver to the owner a tentative "Certificate of Substantial Completion" with a tentative list of items to be completed or corrected before final payment.
 - 2. After consideration of any comments made by the owner as provided in the conditions of the contract, the consultant/engineer will execute and deliver to the contractor a definite "Certificate of Substantial Completion" with a revised tentative list of items to be completed or corrected.

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1.6 FINAL INSPECTION

- A. When the contractor considers the work complete, the contractor shall submit written certification that:
 - 1. The contract documents have been reviewed.
 - 2. Work has been inspected for compliance with contract documents.
 - 3. Work has been constructed in accordance with contract documents.
 - 4. Equipment and systems have been tested and are operational.
 - 5. Work is completed and ready for final inspection.
 - 6. "Certificate of Completion"
- B. The consultant/engineer will inspect the work to verify the status of completion with reasonable promptness after receipt of such certification.
- C. Should the consultant/engineer consider that the work is incomplete or defective, the following shall apply:
 - 1. The consultant/engineer will promptly notify the contractor in writing, listing the incomplete or defective work.
 - 2. The contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to the consultant/engineer.
 - 3. The consultant/engineer will re-inspect the work.
- D. When the consultant/engineer finds that the work is acceptable under the contract documents, the consultant/engineer shall request that the contractor make closeout submittals.

1.7 PROJECT RECORD DOCUMENTS

- A. The contractor shall legibly mark actual construction on the remedial-design drawings, showing horizontal and vertical location of underground utilities, field

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changes of dimension and detail, and changes made by change orders and details not included on the original remedial-design drawings.

- B. At project completion, the contractor shall deliver to the consultant/engineer record documents (i.e., as-builts) as indicated, consisting of annotated remedial-design drawings to be used in preparing the as-built drawings.

1.8 CONTRACTOR'S CLOSEOUT SUBMITTALS

- A. Evidence of payment and release of liens shall be according to the requirements of the submittal procedures and special conditions.

PART 2— PRODUCTS

Not used

PART 3— EXECUTION

Not used

—END OF SECTION—

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CONTRACT CLOSEOUT**

**SECTION 01740
WARRANTIES AND BONDS**

PART 1— GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general contract provisions, including general and supplementary conditions and other division-1 specification sections, apply to this section.

1.2 SUMMARY

- A. This section specifies general administrative and procedural requirements for warranties and bonds required by the contract documents, including manufacturers' standard warranties on products and special warranties.
 - 1. Refer to the "General Conditions" for terms of the contractor's special warranty of workmanship and materials.
 - 2. General closeout requirements are included in the "Project Closeout" section.
 - 3. Specific requirements for warranties for the work, products, and installations specified to be warranted are included in the individual sections of divisions-2 through -16 of the technical specifications.
 - 4. Certifications and other commitments and agreements for continuing services to the consultant/owner are specified elsewhere in the contract documents.
- B. Disclaimers and limitations: manufacturer's disclaimers and limitations on product warranties do not relieve the contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the contractor.
- C. Separate Prime Contracts: Each prime contractor is responsible for warranties related to their own contract.

1.3 DEFINITIONS

Not used

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1.4 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access to correct the warranted work.
- B. Reinstatement of Warranty: when work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equivalent to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition, complying with all requirements of the contract documents. The contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether the consultant/owner has benefited from use of the work through a portion of its anticipated useful service life.
- D. Consultant/Owner's Recourse: Written warranties made to the consultant/owner are in addition to implied warranties and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: The consultant/owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the contract documents.
- E. The consultant/owner reserves the right to refuse to accept work for the project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.5 WARRANTY PERIOD

- A. In accordance with section 01300 ("Submittals") and these special conditions, the contractor shall obtain and submit in writing warranties and bonds, executed in duplicate by responsible suppliers, and manufacturers. Except for items put into use with the consultant/engineer's permission, the beginning of the warranty will be the date of substantial completion.

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- B. The contractor shall guarantee and furnish the manufacturer's warranty against manufacturing and mechanical defects on all equipment provided for a period of one year from the date of initial operation.
- C. In the event that any material, part, or equipment proves defective during this period, the contractor/manufacturer shall, at their expense (including labor), furnish and replace the defective item.

1.6 SUBMITTALS

- A. Submit written warranties to the consultant before the date certified for substantial completion. If the consultant's "Certificate of Substantial Completion" designates a start date for warranties other than the date of the work's substantial completion (or completion of a designated portion of the work), submit written warranties upon the consultant's request.
 - 1. When a designated portion of the work is completed and occupied or used by the consultant/owner, by separate agreement with the contractor during the construction period, submit properly executed warranties to the consultant within 15 days of completion of that designated portion of the work.
- B. When a special warranty must be executed by the contractors and/or a subcontractor, supplier or manufacturer, prepare a written document containing appropriate terms and identification, ready for execution by the required parties. Submit a draft to the consultant through the engineer for approval before final execution.
 - 1. Refer to individual sections of the technical specifications for specific content requirements and particular requirements for submittal of special warranties.
- C. Form of Submittal: At final completion, compile two copies of each required warranty and bond properly executed by the contractor, subcontractor, supplier, or manufacturer (as applicable). Organize the warranty documents into an orderly sequence based on the table of contents of the project manual.
- D. Bind warranties and bonds in heavy-duty, commercial quality, durable three-ring vinyl-covered loose-leaf binders, sufficiently thick to accommodate its contents, and sized to receive 8- $\frac{1}{2}$ "x11" paper.

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1. Provide heavy-paper dividers with celluloid-covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of the installer.
2. Identify each binder on its front and spine with the typed or printed title "Warranties and Bonds," the project title or name, and the name of the contractor.
3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 – PRODUCTS

Not used

PART 3— EXECUTION

3.1 SCHEDULE OF WARRANTIES

- A. Provide warranties and bonds as specified in individual sections of the technical specifications.

—END OF SECTION—

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WARRANTIES AND BONDS**

**SECTION 02211
ROUGH/FINAL GRADING**

PART 1— GENERAL

1.1 RELATED SECTIONS

- A. Section 01010— “Summary of Work”
- B. Section 01400— “Quality Control”
- D. Section 01600— “Material and Equipment”
- E. Section 02225— “Trenching and Backfilling”

1.2 GRADING

- A. Rough grading in conjunction with installation of underground piping shall be performed at all places indicated on the remedial-design drawings, to within a vertical tolerance of 0.2 foot of final lines, grades, and slopes as compared to pre-excavation activities.
- B. Final grades shall be carried to the lines, grades, and slopes shown on the drawings, within a tolerance of 0.1 foot.
- C. All material encountered, of whatever nature, within the limits indicated shall be used as backfill or removed and disposed of as directed by the consultant/engineer. During grading, the subgrade shall be maintained in such condition that it will be well drained at all times. The graded area shall be protected from surface water run-on.
- D. The consultant/engineer reserves the right to make minor adjustments or revisions in lines or grades if necessary as the work progresses to obtain satisfactory construction.
- E. Contractor is responsible for protecting all above/below-grade pipelines, utilities, and adjacent structures.

PART 2— PRODUCTS

Not used

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ROUGH/FINAL GRADING**

PART 3— EXECUTION

3.1 PROTECTION

- A. The contractor shall adhere to the following:
1. The contractor shall maintain and protect all utilities that pass through the work area or structures in or adjacent to the work area.
 2. The contractor shall take steps to control dust wherever the contractor works on this project.

—END OF SECTION—

**02211-2
ROUGH/FINAL GRADING**

**SECTION 02222
EXCAVATION**

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Excavation for pipe trenches

1.2 RELATED SECTIONS

- A. Section 02223— “Backfilling”

1.3 REFERENCES

- A. 29 CFR Part 1926 Subpart P— “Safety and Health Regulations for Construction—
Excavations, Trenching, and Shoring”

1.4 SUBMITTALS

- A. Submit under provisions of section 01010 (“General Requirements”)
- B. Submit a construction-drainage plan showing the collection and disposal of surface and subsurface water that may be encountered during construction.
- C. Before beginning any excavation five or more feet deep, the contractor shall submit a shoring plan (if necessary) in accordance with the requirements of section 01010 (“General Requirements”).

1.5 FIELD MEASUREMENTS

- A. Verify that survey benchmarks and intended elevations for the work are as indicated.

PART 2— PRODUCTS

2.1 SURFACE WATER CONTROL MATERIALS

- A. Silt Fence: The contractor shall supply silt fencing in sufficient quantities to control surface-water runoff and sediment. Acceptable silt-fence material shall be as follows:

- 1. Propex[®] Silt-Stop

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2. Mirafi® 100X
3. Beltech® 755, or
4. An approved equivalent

The contractor shall submit manufacturers' product data to the consultant/engineer for approval a minimum of one week before installation. Silt fencing shall be replaced at a frequency consistent with the manufacturer's directions, or as directed by the consultant/engineer.

- B. Straw Bales: The contractor shall supply straw bales in sufficient quantities to control sedimentation as needed. Straw bales shall be replaced at a minimum of every two months, or as directed by the consultant/engineer.

PART 3— EXECUTION

3.1 PREPARATION

- A. Underpin adjacent structures and roads that may be damaged by excavation work, including utilities and pipe chases.
- B. Identify required lines, levels, contours, and datum.
- C. Identify known underground, above ground, and aerial utilities. Stake and flag their locations.
- D. Coordinate utility relocation or removal with the engineer.
- E. Protect above- and below-grade utilities that are to remain. Support exposed utilities as needed.
- F. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- G. Protect benchmarks, structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

3.2 EXCAVATION

- A. Excavate subsoil required to accommodate building foundations, slabs-on-grade, paving, utilities, site structures, and construction operations. The maximum slope inclinations shall comply with OSHA requirements.

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- B. Excavate to working elevation[s] for sheet-pile work.
- C. The excavation cut shall not interfere with normal 45-degree-bearing splay of foundations.
- D. Notify the engineer/consultant promptly in writing of unexpected subsurface conditions before such conditions are disturbed and discontinue affected work in the area until notified to resume work.
- E. Correct unauthorized excavation at no extra cost to the consultant.
- F. If direct load-out of soils is not used, then stockpile excavated material in a designated area on site. Cover stockpiled material to protect it from rain. Take preventive measures to ensure that water containing soil from excavations or stockpiles does not enter surface waters and/or storm drains.
- G. Stockpiled excavated-material will consist of a base liner (i.e., polyethylene sheeting) over the ground or pavement surface to provide a protective barrier between the excavated soil and underlying surface. A double layer of 6-mil polyethylene sheeting will be placed on the ground within a perimeter berm and sloped to a sump, to contain and remove water.

3.3 FIELD QUALITY CONTROL

- A. Field inspection will be performed under the provisions of section 01400 ("Quality Control").

3.4 PROTECTION

- A. Protect excavations as required to ensure life, safety, and property protection. Comply with all applicable laws and standards.

—END OF SECTION—

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EXCAVATION**

**SECTION 02225
TRENCHING AND BACKFILLING**

PART 1— GENERAL

1.1 WORK INCLUDED

- A. Trench and backfill for piping
- B. Backfill for utilities

1.2 RELATED SECTIONS

- A. Section 01010— “Summary of Work”
- B. Section 01012— “Special Conditions”
- C. Section 01400— “Quality Control”
- D. Section 02211— “Rough/Final Grading”
- F. Section 15000— “Process Piping and Accessories”

1.3 BACKFILLING

- A. The contractor shall be responsible for procuring suitable backfill materials to perform the work.
- B. All backfill shall be free of frozen particles, clay lumps, trash, roots, wood, metal, scrap material, other vegetable matter, and refuse. Backfill shall contain no stones larger than four inches in their greatest dimension.
- C. Not more than 70% by weight shall pass the No. 40 mesh sieve, and not more than 10% shall pass the No. 200 mesh sieve, as determined by washing through the sieves in accordance with ASTM designation D-422.
- D. Backfill shall be placed in layers not more than 12 inches in loose depth, and each layer shall be compacted as specified hereafter, at a moisture content suitable for obtaining the required density. Backfill shall be placed around structures, to the extent practicable, as the work progresses. Backfilling of trenches shall progress as rapidly as construction and testing of the work permits.

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- E. Excavations for pipe shall not be backfilled until the pipe has been tested by the contractor and approved by the consultant/engineer.
- F. After the consultant/engineer has approved the testing, fill around and over the pipe shall be compacted, unless otherwise noted, for the entire depth of the excavation. Backfilling to one foot above the top of the pipes shall proceed uniformly on each side of the pipe to prevent unbalanced loading.
- G. Provide 6" minimum of compacted non-frost-susceptible base beneath exterior slabs and rigid and flexible pavements.
- H. If the existing subbase is not well draining to a minimum depth of three feet, it shall be removed and replaced with non-frost-susceptible material, and compacted as per section 3.3.
- I. Any fill from an off-site location shall be certified-clean fill material acceptable to the owner, consultant/engineer, and the New York State Department of Environmental Conservation. The contractor shall submit the results of chemical analyses of all fill material from off-site to confirm that it is free of contamination, and will provide the consultant/engineer and owner with documentation of the material's origin.

1.4 UNDERGROUND UTILITIES

- A. The contractor shall locate existing underground utilities before earthwork begins by hand-digging exploratory pits where earthwork will be done near the utilities, and at locations where offsets in utility lines are likely to exist. Have a representative of the respective utility company and the consultant/engineer present during this exploratory work.
- B. The contractor shall comply with utility company rules and directives for excavation work.
- C. The contractor shall protect exposed utility lines and be responsible for repairing or replacing damage.

PART 2— PRODUCTS

2.1 BACKFILL MATERIAL

- A. Suitable backfill material shall include borrow material capable of being compacted to the required density at the proper moisture content, containing a maximum of 30% by dry weight of particles passing a No. 200 sieve, and of such type and characteristics as have been approved by the consultant/engineer. No rock,

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broken concrete, demolition material, frozen material, topsoil, nor any material designated as unsuitable in paragraph B shall be used for fill material.

- B. Unsuitable material shall include, but not be limited to, all grass, weeds, vegetation of any type, roots, trash, rocks, boulders, debris, demolition materials, or any layer, strata, formation, or deposit of soil determined by the consultant/engineer to be unsuitable to support footings, slabs, or for any other intended purpose. No material will be classified as unsuitable solely based on excessive moisture content.
- C. Granular material shall be the same as defined for "Suitable Material" above, except that it shall contain a maximum of 12% by dry weight of particles passing the No. 200 sieve, and a maximum of 40% passing the No. 40 sieve.
- D. Borrow material shall be the same as defined for "Suitable Material" above, except that it shall be obtained from approved sources off the site. As specified in section 01400 ("Quality Control"), the contractor shall verify and document to the consultant/engineer that proposed borrow material is certified-clean fill.

2.2 PIPE BEDDING MATERIAL

- A. Material furnished shall be suitable and conform to the following requirements:
 - 1. Gradation— the material shall have the following gradation:

<u>Sieve Size</u>	<u>% Passing by Weight</u>
1-inch	100
¾-inch	90–100
No. 4	0–10
No. 8	0–8

- 2. Soundness— the material shall be substantially free of shale or other soft particles of poor durability.
 - 3. No trench spoils shall be used for pipe bedding.

PART 3— EXECUTION

3.1 TRENCHING

- A. Sheeting and Shoring— Provide sheeting and shoring, as required, to prevent collapse of excavations and where required by local codes and regulations. Use

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timbers, cribbing, planking, or sheet piling, as required. All sheeting and shoring shall be approved by the consultant/engineer before being used in the work.

- B. Hand Excavation— Excavation within three feet of any existing utility line shall be done by hand and in accordance with the requirements of the utility company involved. Coordinate with the utility company and make necessary arrangements to avoid damage. Be responsible for damage during excavation to existing pipe, conduit, or equipment, and repair any damage.
- C. Trench Depth— Excavate trenches to the depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.
- D. Trench Length— No trench shall be opened more than 100 linear feet in advance of pipe installation without the express permission of the consultant/engineer.
- E. Drainage and Dewatering— Keep pipe trenches free of water from any source during excavation, installation, and backfilling. Construct a berm or grade to prevent surface run-off into the excavation.
 - 1. The contractor shall dewater the trench excavation as necessary if groundwater is encountered during trenching.
 - 2. The contractor shall be responsible for off-site disposal or on-site treatment and discharge of the water as directed by the consultant/engineer. Groundwater encountered during trenching shall be pumped to an appropriately sized frac-tank for temporary storage for on-site treatment.
- F. Protection— Protect the excavation bottom from freezing when the temperature is less than 32° F.

3.2 PIPE BEDDING

- A. Place a uniform blanket of loose bedding material under the piping.
- B. Where soil at the bottom of trench is unsuitable, remove material and stabilize the trench bottom with bedding material. Provide depth of stabilization as required to construct a firm subgrade for the bedding material.

3.3 PLACING BACKFILL

The contractor shall:

- A. Backfill lifts— Unless otherwise specified, all fill shall be placed in approximately horizontal lifts not exceeding 12 inches in loose thickness. So far as is practicable,

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each layer of materials shall extend the entire length and width of the area being filled.

1. Do not place material on surfaces that are muddy, frozen, or that contain frost. No frozen fill shall be placed.
- B. Moisture Content— The moisture content of the backfill shall be reduced by aeration or increased by uniform sprinkling of water as necessary, to achieve optimal moisture content to facilitate compaction. The moisture content of the fill shall be within $\pm 2\%$ of the optimum. Backfill shall not be placed in water.
- C. Surface Drainage— The backfill surface shall be sloped to facilitate removal of run-off from the site and to prevent ponding of surface water. When inclement weather is anticipated, the surface of the backfill shall be graded and sealed as directed by the owner or consultant/engineer to preclude percolation of surface water.
- D. Place the backfill or bedding material in 12-inch lifts that conform to the dimensions shown on the construction drawings.
- E. Compact the backfill using suitable compaction equipment, such as rammers or plate compactors.
- F. The compaction technique used shall be to the satisfaction of the consultant/engineer to obtain a non-yielding surface after compaction.
- G. Remove and properly dispose of all surplus backfill materials.
- H. Do not place backfill during freezing or excessively wet field conditions.
- I. Grade backfill to existing elevations or as shown in the construction drawings.

3.4 COMPACTION

- A. Equipment— Steel-wheel vibratory rollers shall be used to compact predominantly granular soils. Sheepsfoot or tamping rollers shall be used only to compact fine-grained, plastic soils.
- B. Compact each layer of material to a minimum of at least 85% of maximum dry density determined in accordance with ASTM D1557 (“Modified Proctor”) unless otherwise specified.
- C. Make sufficient passes to obtain the specified densities.

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- D. As compaction of fill in each work area is completed, leave the area undisturbed for a reasonable period for testing, in accordance with section 01400 ("Quality Control"). Do not place fill over a layer that has not been tested by the contractor and accepted by the consultant/engineer.
- F. Maintain moisture content of the exposed lift; desiccation cracking shall result in removal and reinstallation of affected area by the contractor at their own expense.
- G. All tests, including sieve analysis, will be performed by the contractor.
- H. The moisture content of the specified densities shall be within $\pm 3\%$ of the optimum. When the required density cannot be obtained with the material in place, it shall be blended with appropriate binder soil and compacted.

—END OF SECTION—

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TRENCHING AND BACKFILLING**

**SECTION 03110
CONCRETE FORMWORK**

PART 1— GENERAL

1.1 WORK INCLUDED

This section prescribes materials and methods to be used in fabricating, erecting, and removing forms for cast-in-place concrete. The contractor shall furnish all form design, forms, shoring, ties, form coating, materials, and all labor, equipment, and other items necessary or convenient to the contractor to fabricate, erect, and remove formwork.

1.2 RELATED SECTIONS

- A. Section 01300— “Submittals”
- B. Section 03300— “Cast-in-Place Concrete”

1.3 GENERAL

- A. Forms shall be fabricated, erected, and removed as specified herein and shall be of a type, size, shape, quality, and strength to produce hardened concrete with the shape, lines, and dimensions indicated on the construction drawings. Forms shall be true to line and grade in accordance with the tolerances specified in section 03300 (“Cast-in-Place Concrete”) and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. Surfaces of forms shall be smooth and free of irregularities, dents, sags, and holes that would deface the finished surfaces.
- B. The contractor shall be responsible for designing, erecting, supporting, bracing, and maintaining formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. The contractor is responsible for correctly assessing and analyzing erection stresses induced upon the structure, its elements, and supporting foundations during construction. Since the consultant/engineer does not dictate or determine the contractor’s sequence of construction operations, the consultant/engineer cannot determine erection stresses and therefore assumes no responsibility or obligation to do so.
- C. The contractor shall be responsible for adequate formwork design for construction of cast-in-place reinforced concrete.
- D. Except as modified herein, form design, fabrication, and erection shall conform to the requirements of the latest editions of ACI 347 and ACI 318 and shall be acceptable to the consultant/engineer. Design criteria for plywood shall conform to APA form V345.

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- E. Formwork shall comply with ANSI A10.9 and OSHA construction standards, Part 1926, Subpart Q, "Concrete, Concrete Forms, and Shoring."

1.4 SUBMITTALS

- A. The contractor shall submit to the consultant/engineer for review shop drawings and design calculations for formwork the contractor intends to use during construction in accordance with section 01300 ("Submittals").
- B. Product data for the formwork shall be submitted as indicated in section 01300 ("Submittals").

1.5 STORAGE

All form materials and accessories shall be stored above-ground on framework or blocking and shall be covered with a suitable waterproof covering that provides adequate air circulation and ventilation.

PART 2— PRODUCTS

2.1 FORMS

- A. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood-panel forms, job-built plywood forms, or forms lined with plywood or fiberboard.
- B. Plywood or lined forms will not be required for surfaces normally below grade or not ordinarily exposed to view. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.
- C. Forms for cast-in-place concrete shall conform with the following requirements:
 - Prefabricated Steel Forms: shall be Simplex "Industrial Steel-Frame Forms," Symons "Steel Ply," Universal "Uniform," or equivalent.
 - Plywood Forms: shall be product-standard PS-1, waterproof, resin-bonded, exterior-type Douglas fir. For normal finish, face adjacent to concrete shall be grade B or better. For architectural finish, face adjacent to concrete shall be grade B or better with plastic overlay.
 - Lumber Forms: Straight, dressed on all sides, uniform width and thickness, and free of knots, offsets, holes, dents, and other surface defects.

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- Fiberboard Forms: Federal specification LLL-B-810, Type IX, tempered, waterproof, screenback, concrete-form hardboard.
 - Chamfer Strips: Clear white pine; surface against concrete shall be planed.
- D. Reuse of job-built plywood forms shall be permitted only when specifically approved by the consultant/engineer. Plywood shall be furnished and placed in 48-inch widths and uniform lengths of not less than 96 inches, except where the dimension of the component to be formed is less. Where plywood is attached directly to studs or joists, the panels shall be no less than $\frac{5}{8}$ -inch thick. Studs provided shall be sufficiently sized and spaced to prevent bulging of the plywood sheeting.
- E. Where earth is too unstable to serve as a form for sides of footings and foundations, the sides against the earth may be formed with $\frac{3}{4}$ -inch thick No. 2C Yellow Pine with tight butt-joints, securely braced to hold a straight line.

2.2 FORM TIES

Form ties shall be approved by the consultant/engineer and shall be snap-cone or she-bolt-with-cone type and manufactured by a recognized manufacturer of concrete-forming accessories. Cones shall leave a hole or depression in the concrete no larger than $\frac{7}{8}$ -inch-diameter. Plain snap-ties or flat bar-ties, unless otherwise approved by the consultant/engineer, shall not be used. Ties shall be of a type that will accurately tie, lock, and spread the forms. Tie spacing shall be designed to withstand concrete pressures without bulging, spreading, or lifting of the forms. The tie shall be of such a design that when forms are removed no metal shall be within two inches of any surface unless stainless-steel ties are used, in which case no metal shall be within one inch of any surface. Permanently embedded portions of form ties that are not provided with threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete.

2.3 FORM COATINGS

Where specified herein, forms shall be coated with a nonstaining form-release agent before concrete placement. Form coatings shall be industrial lubricants "Nox-Crete Form Coating," L&M "Debond," Prater "Pro-Cote," Richmond "Rich Cote," or equivalent.

PART 3— EXECUTION

3.1 FABRICATION AND ERECTION

- A. Forms shall be substantial and sufficiently tight to prevent concrete leakage. Forms shall be braced or tied to maintain the desired position, shape, and alignment

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during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows. The forms shall produce finished surfaces that are free of offsets, ridges, waves, and concave or convex areas.

- B. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- C. All form panels shall be placed in a neat, symmetrical pattern with level and continuous horizontal joints. The contractor shall pay special attention to mating forms to previously placed walls, to minimize steps or rough transitions. Form panels shall be of the largest practical size, to minimize joints and improve rigidity.
- D. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing supports for the beams or slabs.
- E. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms for concrete that are to be finished to a specified elevation, slope, or contour shall be brought to a true line and grade, or a wooden guide-strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction-joints in walls, the forms on one side shall not extend more than two feet above the joints.
- F. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection before concrete placement.
- G. Unless shown otherwise specified by the consultant/engineer, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a $\frac{3}{4}'' \times \frac{3}{4}''$ chamfer formed by a wood or metal chamfer strip.
- H. Forms for exposed surfaces and all steel forms shall be coated with a nonstaining form-release agent that shall be applied just before placement of steel reinforcement. After coating, any surplus form-release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating immediately before concrete placement, except in freezing weather, when form-release coating shall be used.

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- I. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measures shall be taken to ensure acceptable lines and surface to required dimensions and cross sections.
- J. If any forms bulge or, in the opinion of the consultant/engineer, show excessive deflection, the concrete shall be removed and the forms rebuilt and strengthened at the contractor's expense.

3.2 FORM REMOVAL

- A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.
- B. No forms shall be removed without the approval of the consultant/engineer. In general, under normal conditions, the consultant/engineer will approve removal of forms after the following time has elapsed:

<u>Item</u>	<u>Time After Placement</u>
Elevated Slabs and Beams	14 days
Columns	7 days
Walls	3 days
Other Concrete	2 days

- C. When ambient air temperatures during curing fall below 45° F, form removal will be based on job-cured test-cylinder strength only.
- D. Care shall be taken in removing forms to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified in section 03300 ("Cast-in-Place Concrete") of these specifications.

—END OF SECTION—

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SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1— GENERAL

1.1 WORK INCLUDED

- A. Formwork
- B. Cast-in-place concrete foundation, slabs, pipe supports and trench
- C. Concrete curing and finishing

1.2 RELATED WORK

- A. Section 01400— “Quality Control”

1.3 REFERENCES

- A. ACI-318— *Building Code Requirements of Reinforced Concrete*
- B. ACI-MCP-1-74— *Manual of Concrete Practice*
- C. ASTM C 33— “Concrete Aggregates”
- D. ASTM C 94— “Ready-Mixed Concrete”
- E. ASTM C 150— “Portland Cement”
- F. RP 4-6-1— “Reinforced Concrete Foundation”

1.4 QUALITY ASSURANCE

- A. Test and place concrete in accordance with section 01400 of these technical specifications and ACI 301.
- B. Obtain materials from same source throughout the work.
- C. Defective Work: Any concrete found to be defective from any cause whatever, at any time before the final acceptance of the work, shall be either repaired or removed and replaced at the expense of the contractor.

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D. Codes and Standards:

1. ACI 301, "Specifications for Structural Concrete for Buildings"
2. ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete"
3. ACI 308, "Standard Practice for Curing Concrete"
4. ACI 318, "Building Code Requirements for Reinforced Concrete"
5. Concrete Reinforcing Steel Institute, "Manual of Standard Practice"

1.5 TESTS

A. Compression Tests: During the progress of the work, compression tests shall be made in accordance with the "Standard Method of Making and Curing Concrete Test Specimens in the Field" (ASTM designation C 31-84) and "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens" (ASTM serial designation C 39-83b).

1. The contractor shall arrange for laboratory testing of the compression cylinders by the construction-quality assurance (CQA) laboratory.
2. Strength tests shall be performed not less than once a day, one per pour, and once for each truckload of concrete.
3. The concrete used shall have a minimum ultimate strength of 4,000 pounds per square inch (psi) at 28 days.

B. Slump Tests:

1. The contractor shall perform slump tests. The slump for all concrete shall be within ± 1 " of that determined for the design mix (2.02 E). In no case shall the slump be more than four inches.
2. Obtain samples for one slump test for each pour, in accordance with ASTM C-172.
3. Not less than four specimens shall be made for each test. Concrete used in making slump tests shall not be used to make test cylinders. No water shall be added to the batch after the test cylinders are taken.

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PART 2— PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150 Type I— All cement shall be dry, free of lumps, and its color shall be a uniform bluish-gray.
- B. Ready-Mix Concrete: ASTM C94/C 94M
- C. Fine Aggregates: ASTM C 33—Fine aggregates shall be clean, high-silica sand, with more than 3% by weight of foreign matter such as loam, clay, dirt, or other impurities, and shall be free of injurious amounts of organic impurities. Fine aggregates shall be well graded from coarse to fine.
- D. Coarse Aggregates: ASTM C33— Coarse aggregate, unless otherwise specified, shall be well graded.
- E. Admixtures: ASTM C260— Admixtures to the concrete may be used to help reduce water, increase density, improve workability, control shrinkage, or control the rate of setting, but only with the consultant/engineer's permission.
 - 1. The admixture selected shall produce an air content in the freshly mixed concrete of 6% plus or minus 1% as determined in accordance with "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method," ASTM designation C 231-82; or "Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method," ASTM designation C 173-78.
 - 2. Acceptable evidence must be presented to the consultant/engineer that such proposed admixtures, in addition to imparting the desired quality, shall cause no detrimental effect in any of the concrete's other desirable properties.
 - 3. The admixture, if used, shall be added by means of an approved dispenser to accurately control the amount used in each batch of concrete.
- F. Water: Water used in mixing concrete shall be clean and accurately measured for each batch. In general, all water for mixing and curing purposes shall be obtained from a local municipal water supply. Water contaminated with sewage or oil, or water containing dirt, clay, filth, vegetable matter, or river or lake water shall not be used.

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2.2 FORMWORK

- A. Forms for exposed surfaces shall be of metal or plywood, adequately supported, or shall be lined with plywood, Masonite[®] board or similar lining, and/or with metal. Form design shall be satisfactory to the consultant/engineer, but need not be submitted for approval unless specifically requested.
- B. Metal wall-ties shall be of a type that will permit removal to a distance approximately 1½-inches from the face of the wall, free from spilling, and allowing for patching immediately after removal of forms.
- C. Twisted wire-ties will not be permitted: Concrete blocks or other approved means must be used to maintain proper distance between steel and forms.

2.3 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615, grade 60, deformed
- B. Steel Wire: ASTM A82, plain, cold-drawn steel
- C. Fibermesh: ASTM 1116/C, 1116M

2.4 ACCESSORIES

- A. Moisture Barrier: Provide a moisture barrier over prepared subbase material in the concrete slab area. Use only materials that are resistant to decay when tested in accordance with ASTM E154 as follows: polyethylene sheet not less than 6 mils thick.

PART 3— EXECUTION

3.1 PREPARATION

- A. Design, erect, support, brace, and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms to the sizes, shapes, lines, and dimensions shown, and obtain accurate alignment, location, grades, and level in finished structures. Provide for

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openings, offsets, keyways, anchorages, and inserts, and other features required in the work. Use selected materials to obtain required finishes.

- D. Provide and install pipe penetrations as shown on the remedial-design drawings or as directed by the consultant/engineer.
- E. All forms shall be thoroughly cleaned and wetted just before placing the concrete, and, if necessary to secure a smooth surface, they shall be coated with an approved non-staining substance. Suitable moldings or bevel strips shall be placed in the forms to prevent sharp edges inside or outside. No sharp edges will be permitted in the finished work. All exposed corners and edges of concrete shall have $\frac{3}{4}$ -inch chamfer unless otherwise shown on the remedial-design drawings.
- F. Verify that anchors, pre-cast sections, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.

3.2 PLACING REINFORCEMENT

- A. Comply with the Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean the reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete-placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement as shown on remedial-design drawings and as herein specified.

3.3 PLACING CONCRETE

- A. Notify the consultant/engineer a minimum of 24 hours before the start of concreting operations. Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as herein specified.
- B. Delivery: Weigh-tickets shall be prepared for each truck showing the normal batch size, the actual weights of cement, aggregate, and water, and the time of loading at the plant.

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1. A blank shall also be provided on the weigh ticket for the time of arrival at the site, to be filled in and initialed by the contractor's superintendent or job supervisor.
 2. A copy of the weigh-ticket shall be delivered to the consultant/engineer for each batch of concrete delivered to the site.
- C. Rejection of Concrete: Ready-mixed concrete (central-mixed and transit-mixed) will be rejected if any of the following is evident:
1. Improper proportions of ingredients, inclusive of water
 2. Initial set
 3. More than 60 minutes transpires after batching or mixing before concrete is placed
 4. Mixers or trucks are overloaded
 5. Successive batches are not uniform
- D. Except as provided herein, water shall not be added to the concrete mixtures at the site unless approved by the consultant/engineer for each instance.
- E. Consolidation: Concrete shall be consolidated by means of mechanical vibration equipment.
1. Vibrators shall be immersion type and shall maintain a speed of not less than 7,000 impulses per minute when operating submerged in concrete.
 2. They shall be used only by personnel experienced in their use, and shall be inserted and removed vertically (not dragged horizontally) at such regular intervals as to ensure uniform consolidation throughout the entire section of concrete being placed.
 3. In no case shall vibrators be used to transport concrete inside the forms.
 4. The number of vibrators used shall be sufficient to consolidate the concrete properly.
 5. At least one standby vibrator shall be on hand at all times.

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- F. Sloped Surfaces: In special cases, as where concrete is deposited on slopes, a comparatively dry mixture may be used, but care shall be exercised to spread such concrete evenly, in layers not more than four inches thick, and to ram it thoroughly. In general, the methods shall be such as to give a compact, dense, and impervious concrete with a smooth surface.
- G. Ensure that reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
- H. In no case shall the concrete have a free fall sufficient to cause segregation of the aggregate. In general, the limit of free fall shall be six feet.

3.4 CONCRETE COVER/SPACING

- A. The minimum concrete cover to protect embedded steel reinforcement, unless specified otherwise in the construction drawings, shall be as follows:

Surfaces cast against crushed rock, sand, or earth:

All bar sizes 3 inches

Surfaces exposed directly to water, backfill, or weather after form removal:

All bar sizes 2 inches

3.5 FINISHING

- A. In general, forms shall not be removed until the concrete has attained sufficient strength to assure structural stability under all dead and construction loads, and until removal can be accomplished without marring concrete surfaces.
- B. All form ties shall be carefully snapped back, to a depth of at least 1½-inches below the concrete surface. Tie holes shall be patched with the driest 1:2 cement-sand mortar that can be made to stay in place.
- C. All horizontal surfaces shall receive the following initial floating operation:
 - 1. The concrete surface shall be accurately struck off and leveled with a long straight edge to the required elevation; suitable guides shall be used, as necessary, to carry the proper grade, pitch, or slope
 - 2. The surface shall be bull-floated to an even surface, with no unevenness exceeding 1/8-inch in 10 feet in any direction.

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- D. The bottom slabs of all tanks, channels, conduits, sumps, pits, and similar surfaces shall be given a non-slip, heavy-patterned finish with a wood float. All other floor slabs, decks, or horizontal surfaces, unless otherwise indicated in the room-finish schedule or elsewhere in these specifications, shall be given a smooth finish with a steel float.
- E. Float Finish: After screeding, consolidating, and leveling concrete slabs, do not work the surface until it is ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate the surface with power-driven floats, or by hand floating if the area is small or inaccessible to power units. Check and level the surface plane so that depressions between high spots do not exceed $\frac{5}{16}$ -inch under a 10-foot straight-edge. Cut down high spots and fill low spots. Uniformly slope surfaces as shown in the remedial-design drawings. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.
- F. Unless otherwise directed, all edges and corners that will be exposed in the finished work shall be beveled or rounded by use of appropriate forms or form inserts. Be careful to avoid chipping or cracking finished edges.

3.6 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under the provisions of section 01400 ("Quality Control").
- B. Maintain records of placed concrete items. Record the date, location of pour, quantity, air temperature, and test samples taken.

3.7 CONCRETE CURING AND PROTECTION

- A. Immediately after placement, protect the concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary to hydrate the cement and harden the concrete.
- C. Concrete shall be maintained in a continuously moist condition above 50° F for at least the first 72 hours after placement. Curing compounds shall not be used. Concrete curing shall be in accordance with ACI 308, "Standard Practice for Curing Concrete."

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3.8 WEATHER CONDITIONS

- A. When the temperature is below 40° F, or predicted to go below 36° F in the next 24 hours, or predicted to go below 32° F in the next 72 hours, no concrete shall be poured without the express permission of the consultant/engineer. All concrete placed during cold weather shall conform to AC1 306R.
 - 1. Permission so granted shall be for the day and location only, and must again be requested on subsequent days when temperatures are as above.
 - 2. When such permission is granted, no concrete shall be poured until adequate covering material is on site, and until a sufficient number of workers are present to expedite finishing and covering, to keep both as close behind the pouring as is practicable.
- B. All concrete materials, reinforcement, forms, inserts, and ground with which the concrete is to come in contact shall be free of frost.
- C. All concrete placed shall have a temperature between 50–90° F.
- D. The housing, covering, or other protection used in connection with curing shall remain in place and intact at least 24 hours after artificial heating is discontinued.
- E. When concrete is mixed during extremely warm weather, the consultant/engineer may require the contractor to pre-cool aggregates with water sprays and to schedule placement of successive layers of concrete so as to cause maximum release and dissipation of the heat of setting. All concrete placed during hot weather shall conform to AC1 305R.

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3.9 INSERTS AND OPENINGS

- A. The contractor shall build into the concrete the steel reinforcement, sleeves, anchor bolts, sump, and other inserts as shown on the remedial-design drawings or as directed. Be extremely careful to keep inserts and openings at proper lines and grade, and to thoroughly tamp under and around them to eliminate any passage for water. Where inserts are placed in the floors for openings, the top of such shall be four inches above the elevation of the finished floor, unless otherwise specified. In addition, pipe sleeves shall be sealed with a watertight seal following installation.

3.10 EQUIPMENT BASES

- A. Where the remedial-design drawings or these specifications call for concrete foundations to support equipment, such bases shall be formed as shown on the remedial-design drawings.
1. Anchor bolts, where required, shall be positioned by template (furnished under the equipment item) to proper elevation and secured in place. Upper edges shall be chamfered on all sides.
- B. After the equipment has been set in position and shimmed to elevation, the space between the concrete foundation and the equipment's metal-base shall be completely filled with a non-shrink, non-metallic grout such as "Masterflow 713 Grout" by Master Builders, "Supreme Grout" by Gifford-Hill and Company, Inc., or approved equivalent.
1. Exterior edges of the fill shall be projected slightly beyond the equipment metal base and chamfered.

—END OF SECTION—

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SECTION 15000
PROCESS PIPING AND ACCESSORIES

PART 1— GENERAL

1.1 SECTION INCLUDES

- A. Related Sections
- B. Work Description
- C. References

1.2 RELATED SECTIONS

- A. Section 01300— “Submittals”
- B. Section 01400— “Quality Control”
- C. Section 01450 – “Pipe Testing”

1.3 WORK DESCRIPTION

- A. The contractor is responsible for installing all process piping and accessories including, but not limited to, the following items as shown on the remedial-design drawings: high-density-polyethylene pipe and fittings, SCH 80 PVC-pipe and fittings, valves, pipe sleeves, pipe supports, pipe hangers, fasteners, mounting hardware, flow meters, pressure indicators, and sample taps.
- B. Piping Tests

1.4 REFERENCES

- A. ASTM D1784— “Standard Specification for Rigid Polyvinyl-Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Compounds”
- B. ASTM D2466— “Standard Specification for Polyvinyl Chloride (PVC) Socket-Type Fittings”
- C. ASTM D3350 – “Standard Specification for Polyethylene Plastic (PE) Pipe and Fittings Materials”

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- D. ASTM F714— “Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter”
- E. ASTM F402— “Standard Practice for Safe Handling of Solvent Cement and Primer Used for Joining Thermoplastic Pipe and Fittings”
- F. *BOCA Union Plumbing Code*
- G. ANSI B16.5— “Pipe Flanges and Flanged Fittings”
- H. ASTM A53— “Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless”
- I. ASTM A105— “Carbon-Steel Forgings and Fittings”

PART 2— PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Materials and equipment supplied for the work shall conform to the requirements of these technical specifications and remedial-design drawings. Suggested suppliers are indicated in some cases, however the contractor may offer substitute material and equipment that is equivalent in all respects to that indicated. The contractor shall provide technical data defining the offered substitute and supporting the substitution as equivalent to the equipment or materials specified. The engineer will review the technical data submittals from the contractor and accept or reject the substitution. If the offered substitution is rejected, the contractor shall be responsible for compensating the consultant/engineer’s costs to review the offered substitute. All submittals and substitutions shall be handled in accordance with section 01300 of these technical specifications.

2.2 PIPE SLEEVES

- A. All pipes passing through walls and floors of the well vaults and treatment building shall be provided with sleeves. All pipe penetrations shall be made watertight as specified or indicated on the remedial-design drawings.

2.3 HANGERS, SUPPORTS AND ANCHORS FOR PIPING

- A. All piping shall be supported by means of an approved combination of hangers, supports, and attachments, assuring that no weight is imposed on the connected equipment.

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- B. All piping and supports shall use the building mounting/uni-strut system.

PART 3— EXECUTION

3.1 WORK SCHEDULING

- A. The contractor shall coordinate and schedule mechanical installation with the consultant/engineer to accommodate the consultant/engineer's requirements.

3.2 PROTECTION OF WORK

- A. The contractor shall protect all piping from the entry of dirt, pipe cuttings, lubricants, debris, storm water, and other foreign material. The contractor shall remove any foreign materials and clean piping to the satisfaction of the consultant/engineer.

3.3 PIPE PREPARATION

- A. The contractor shall:
 - 1. Mark pipe sections with required identification before assembly
 - 2. Inspect for defective or damaged spool pieces before assembly
 - 3. Remove scale, dirt, pipe fittings, and lubricants from the inside and outside of piping before assembly
 - 4. Complete piping connections to equipment with flanges or unions

3.4 PIPE INSTALLATION

- A. The contractor shall cut the pipe to exact measurement and install without forcing or springing.
- B. The contractor shall install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- C. The contractor shall provide adequate clearance, install unions, and orient fittings and appurtenances for ease of equipment installation and access to valves, fittings, and appurtenances.
- D. The contractor shall install all piping and equipment as indicated on the remedial-design drawings. In the event of an unclear installation-requirement, the contractor

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shall consult with the consultant/engineer before proceeding with the work in question.

- E. The contractor shall install all couplings, elbows, tees, and valves as shown on the remedial-design drawings. However, the contractor may install additional fittings as necessary to complete the work. The contractor shall consult with the consultant/engineer before installation of additional fittings.

3.5 PIPE SLEEVE INSTALLATION

The contractor shall:

- A. Install pipe sleeves around pipes protruding through walls and roofs before installing the pipe, as shown on the remedial-design drawings.
- B. Seal all pipe-sleeve openings with non-shrink caulking.
- C. Rigidly anchor pipe to stable structures where necessary. Provide pipe guides so that movement takes place only along the axis of pipe.

3.6 HANGERS, SUPPORT, AND ANCHORS INSTALLATION

- A. Hangers must be absolutely vertical and are to be secured to supplementary steel, using clamps as attachments, wherever possible. Where necessary to obtain the required vertical alignment, furnish and install angle or channel irons of ample strength and length to bridge between walls and ceilings to receive hanger attachments or supports for piping, ductwork, and equipment. Structural-equipment storage-container members shall not be drilled, otherwise weakened, or overloaded. Hangers shall not be attached to piping and shall not pierce or be sustained from ductwork. Supplementary steel must be kept as high as possible.
- B. Wire, rope, wood, perforated band-iron, tape, or other makeshift material shall not be used for hangers or attachments. Threaded hangers shall have lock nuts.
- C. Interior piping shall be supported, guided and anchored to maintain the required alignment and pitch, without sagging or swaying, and to provide controlled expansion, using adjustable split-clevis or trapeze-type hangers. Spacing of hangers and sizes shall be in accordance with ANSI B31.1. All interior piping and hangars shall use the building mounting/uni-strut system.
- D. A set of piping drawings shall be marked with approximate hanger locations. A standard hanger-sheet showing typical random support-arrangements shall be furnished for field guidance.

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- E. The consultant/engineer shall have the option to direct the contractor to either support piping from above or below at any time, at no additional cost to the consultant/engineer or owner.
- F. Fittings with support bases cast with the fitting shall be used to support pipe from floors or walls whenever possible, or as directed by the consultant/engineer. Piping shall be supported from the floor by means of pipe-stanchion saddles and U-bolts. Maximum spacing of hangers shall comply with ASA B31.3. Arrangements and location of all anchors shall be submitted to the consultant/engineer for approval before installation.

3.7 IDENTIFICATION MARKER INSTALLATION

The contractor shall identify:

- A. Flow Meters and Valves: Identify all valves and flow meters on the system with brass tags with the valve or flow-meter designation permanently stamped on the tag (dog-tag style). The contractor shall prepare a valve schedule including alpha-numeric designations for each valve, as designated on the remedial-design drawings, and submit the schedule to the consultant/engineer for approval before purchasing and installing the tags. The valve schedule shall include the valve and flow-meter designation, type, and location, and shall be submitted in accordance with section 01300 ("Submittals").
- B. Piping: Identify concealed and exposed piping with plastic pipe-markers. Identify service, flow direction, contents, and pressure. Install in clear view and align with the piping axis. Locate identification so as not to exceed 10 feet on straight runs, including risers and drops, adjacent to each valve and branch tee and at each point of penetration of enclosures, and at other obstructions to the pipe run.
- C. Insulated sections of piping and valves, if any, shall be identified on the pipe and on the exterior of the insulation jacketing.

3.8 MARKER TAPE

- A. Marker tape installed over all direct-burial process-piping shall be six inches wide and shall be "Terra Tape D" detectable as manufactured by Griffolyn, Inc., or an approved equivalent. The tape shall be an inert, bonded-layer plastic material with a metallized foil-core, so that process-piping locations can be determined with a metal detector. The tape shall be blue with the following imprint:

"CAUTION! BURIED PROCESS PIPING LINE BELOW!"

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3.9 TESTING

- A. Field inspection and testing shall be performed under provisions of section 01450 of these technical specifications. Equipment not included in the test shall be disconnected from the piping or isolated by valves.
- B. Leak tests shall be performed on all piping. If tests indicate the work does not meet specified requirements, remove the work, replace, and retest at the contractor's expense.
- C. The tests for piping shall be observed by the consultant/engineer. Written acceptance shall be given to the contractor after successful completion of the test.
- C. Any damaged or defective pipe, fittings, valves, or joints discovered following the pressure tests shall be repaired or replaced at no cost to the owner or consultant/engineer. The test shall be observed by the consultant/engineer and written acceptance shall be given to the contractor after successful test completion.

—END OF SECTION—

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**SECTION 15060
PUMPS AND APPURTENANCES**

PART 1— GENERAL

1.1 WORK INCLUDED

- A. This specification applies to the installation of pumps and associated drivers. All components necessary for the safe and satisfactory operation of the specified equipment that are not specifically included shall be considered a part of this specification. The contractor shall supply, deliver, and install all pumps and associated drivers as described in these technical specifications and remedial-design drawings.
- B. Design Criteria

1.2 RELATED SECTIONS

- A. Section 15000— “Piping and Accessories”
- B. Section 15099 – “Valves and Appurtenances”

1.3 SUBMITTALS

- A. The contractor shall submit shop drawings and technical specifications, for all proposed pumps in accordance with section 01300 (“Submittals”).

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall store equipment and materials so as to ensure the preservation of their quality and fitness for the work. When considered necessary, they shall be placed on wooden platforms or other hard, clean surface and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection. In the event any material, part, or equipment is damaged during this period, the contractor shall notify the consultant/engineer. The contractor shall coordinate re-delivery of another part/equipment and install it at no additional cost to the consultant/engineer or the owner.

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1.5 TECHNICAL INSPECTION

- A. All work shall be subject to inspection by the consultant/engineer, but such inspection shall not relieve the contractor of the obligation to perform said work in accordance with these specifications and manufacturer's requirements. Any modifications thereof, other than as herein provided, shall be corrected and made good by the contractor whenever so ordered by the consultant/engineer, without reference to any previous oversight or error in inspection.
- B. All directions given to the contractor by the consultant/engineer or manufacturer's representative pertaining to the scope of work during routine inspection shall be binding on the contractor.

1.6 WARRANTY

- A. For 12 months from the date of initial operation, the manufacturer shall guarantee and furnish a manufacturer's warranty against manufacturing and mechanical defects on all equipment provided.

In the event any material, part, or equipment proves defective during this period, the manufacturer shall, at their expense (including labor) furnish and replace the defective item.

- B. The manufacturer shall guarantee in writing the structural integrity of the system for five years.
- C. The manufacturer shall guarantee the performance of the equipment and its components for two years. Performance shall meet or exceed that described in paragraph 2.2 ("General Description") of these technical specifications.
- D. All warranties shall be provided in writing and signed by an officer of the manufacturing company.

PART 2— PRODUCTS

2.1 MANUFACTURER

- A. The transfer pump will be a Moyno 65501 progressive cavity pump or approved equivalent.

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2.2 GENERAL DESCRIPTION

- A. The transfer pump shall be capable of pumping 30 gpm at 20 feet of total dynamic head. The system shall be configured as shown on the construction drawings and as described in these technical specifications.

2.3 INSTRUMENTATION AND CONTROLS

- A. General
1. Instrumentation and controls shall be provided as specified herein and as shown on the construction drawings.
 2. All instrumentation and controls shall be suitable for the operation in area designated as unclassified per NEC.
 3. All instrumentation, controls, and control panels shall be supplied and installed by the contractor or electrical subcontractor.
 4. A central control-panel, located in the treatment building, shall house a programmable-logic controller (PLC) to monitor and integrate the operation of the complete system (transfer pumps, liquid ring pump). The panel shall be connected to each major component in the VER system and will provide an interface for remote access via through a desk-top software package via an auto-dialer. This panel shall be supplied by the contractor or electrical subcontractor.

PART 3— EXECUTION

3.1 INSTALLATION

- A. Installation of all pumps shall be completed per these technical specifications and remedial-design drawings, and in accordance with the manufacturer's instructions.
- B. Installation shall include furnishing and applying an initial supply of grease and oil of a type recommended by the pump and motor manufacturer, if applicable.

3.2 TESTING

- A. Field Tests
1. The contractor shall furnish all facilities, certified-calibrated instruments, personnel, and the service needed for their preparation and execution.

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2. The consultant/engineer, at their own and exclusive option, may provide substitutes for some or all of the instruments supplied by the contractor. Proper calibration of every measuring device shall be checked and agreed upon between the contractor and the consultant/engineer before running any test.
3. A preliminary field test shall be made to determine the adequacy of the instruments and apparatus. When conditions do not permit such a preparatory run, operations may be started, and later when conditions are satisfactory, the test shall be made.
4. A careful inspection shall be made before, during, and after the field tests to ensure the proper operation of each pump. The following items shall be inspected:
 - a. Pump alignment
 - b. Rotation and flow direction
 - c. Electrical connections
 - d. Gauge openings
 - e. Lubricating-system operation (if applicable)
 - f. Liquid passages

The pumps' liquid passages should be inspected before installation to guard against error during the test due to obstructions clogging the passage. If obstructions are found in the pump, the test shall be re-run.

5. Complete records shall be kept of all information relevant to all field tests, with test-report copies to be submitted to all interested parties.

3.3 START-UP

- A. Contractor shall verify that structures, pipes, and equipment are compatible.
- B. Make adjustments required to place the system in proper operating condition.

—END OF SECTION—

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PUMPS AND APPURTENANCES**

**SECTION 15099
VALVES AND APPURTENANCES**

PART 1— GENERAL

1.1 WORK INCLUDED

- A. This specification applies to the installation of valves and miscellaneous piping appurtenances. The contractor shall supply, deliver, and install all valves and miscellaneous piping appurtenances as described in these technical specifications and remedial-design drawings.

1.2 RELATED SECTIONS

- A. Section 01300— “Submittals”
- B. Section 01400— “Quality Control”

1.3 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality-assurance/quality-control measures shall conform to the requirements of the conditions of the contract, as follows:
 - 1. The contractor shall comply with applicable provisions and recommendations of the following standards except as otherwise shown on the remedial-design drawings or specified herein:
 - a. American Society for Testing and Materials (ASTM)
 - b. American National Standards Institute (ANSI)
 - 2. Obtain all valves of the same type from a single manufacturer
 - 3. All valves of a given type shall be the product of one manufacturer that has had valves of like size and design in similar services for at least five years.

1.4 SUBMITTALS

- A. The contractor shall submit shop drawings and technical specifications, for all proposed valves, in accordance with section 01300 (“Submittals”).

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall store materials so as to ensure the preservation of their quality and fitness for the work.
- B. Seal valve ends to prevent entry of foreign matter into the valve body. Box and protect valves, operators, and accessories from accumulation of foreign matter.
- C. Store valves, operators, and accessories in an area protected from weather, moisture, or possible damage. Stored materials shall be located so as to facilitate prompt inspection. Do not store material directly on the ground. When considered necessary, such items shall be placed on wooden platforms or other hard, clean surfaces and shall be placed under cover when directed.
- D. The contractor shall notify the consultant/engineer if any material, part, or accessories are damaged during delivery, storage or handling. The contractor shall coordinate the re-delivery of another part/equipment and install it at no additional cost to the consultant/engineer or the owner.

1.6 TECHNICAL INSPECTION

- A. All work shall be subject to inspection by the consultant/engineer, but such inspection shall not relieve the contractor of the obligation to perform said work in accordance with these specifications and manufacturers' requirements. Any modifications thereof, except as herein provided, shall be corrected and made good by the contractor whenever so ordered by the consultant/engineer, without reference to any previous oversight or error in inspection.
- B. All directions given to the contractor by the consultant/engineer or manufacturer's representative, pertaining to the scope of work during routine inspection, shall be binding on the contractor.

PART 2— PRODUCTS

- 2.1 Valves for the process piping shall be manufactured by an approved supplier with pressure ratings conforming to those of the piping. The contractor shall submit their selection of a manufacturer and technical data to the engineer for approval before installation.
 - 1. All similar valves shall be purchased from one manufacturer.

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VALVES AND APPURTENANCES**

PART 3— EXECUTION

3.1 INSTALLATION

- A. Installation of all valves shall be completed per these technical specifications and remedial-design drawings, and in accordance with manufacturer's instructions.
- B. Valve size shall be equal to the line piping in which valve is installed, unless approved by consultant/engineer.
- C. Install valves with the valve operator in a position for convenient operation. Ensure that space is available to operate lever- or hand-wheel-operated valves without interference from wall, piping, or equipment.
- D. Before installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- E. Clean all debris, dirt, gravel, etc. from inside of piping before placing valves in place.
- F. Erect and support valves in their respective positions free of distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and materials. Clean out debris and foreign material from valve openings and seats, test operating mechanisms for proper functioning, and check nuts and bolts for tightness. Repair valves and other equipment that does not operate easily or is otherwise defective.

3.2 VALVE IDENTIFICATION

- A. Identify plumbing-system valves and indicate their function and the system served. Before tagging or labeling, submit a final list of valves to the consultant/engineer for their approval.

3.3 ADJUSTMENTS

- A. Check and adjust valves and accessories for smooth operation.

3.4 TESTING

- A. Test valves with piping as specified in section 01450.

—END OF SECTION—

**15099-3
VALVES AND APPURTENANCES**

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1— GENERAL

1.1 WORK INCLUDED

- A. The work covered by this section consists of furnishing and installing all materials, equipment, labor, supervision, and services necessary to complete all electrical work specified herein.
- B. Principal Features:
1. Furnish and install new programmable logic controller (PLC) control panel, power-distribution network, and control connection(s).
 2. Furnish and install new vacuum transmitters, pressure transmitters, liquid flow indicating transmitters, and vapor flow indicating transmitters as indicated on the construction drawing M-2.
 3. Provide connections between new equipment and the upgraded control panel as shown on the construction drawings and described herein.
 4. Provide hand-off-auto switches on the upgraded control panel for new/existing equipment, as depicted on the drawings, and described in these technical specifications.
 5. Install the system in compliance with all local, state, and federal regulations.
 6. Install all conduit and remote mounted-instrumentation to complete the system as described in these technical specifications and in the construction drawings.
 7. Provide labor, equipment, and materials to construct the power distribution and control system for the control upgrades as shown in the construction drawings and described in these technical specifications.
 8. Provide appropriate trade labor at startup to assist with any necessary equipment calibration, modification, or repairs.

1.2 RELATED DOCUMENTS

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- A. General provisions of the contract apply to this and the other sections of division 16 of these technical specifications.
- B. The following drawings apply to this division:
 - 1. Drawing M-1— “Equipment Descriptions/Legend”
 - 2. Drawing M-2— “Piping and Instrumentation Diagram”
 - 3. Drawing M-3— “Equipment Layout”
- C. General: This section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this section to expand the requirements specified in division 1:
 - 1. Submittals
 - 2. Coordination drawings
 - 3. Record documents
 - 4. Maintenance manuals
 - 5. Rough-ins
 - 6. Electrical installations
 - 7. Cutting and patching
 - 8. Delivery, storage, and handling

1.3 REFERENCES

- A. New York State and National Electrical Codes
- B. *National Electrical Code* (National Fire Protection Association (NFPA 70)), 2008 Edition
- C. National Fire Protection Association (NFPA) *Life Safety Code 101*
- D. National Electrical Contractors Association (NECA) *Standards of Installation*

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- E. All Applicable NFPA Codes
- F. Underwriters Laboratories (UL)
- G. American National Standards Institute (ANSI)
- H. National Electrical Manufacturers Association (NEMA)
- I. Occupational Safety and Health Administration (OSHA)
- J. Insulated Cable Engineers Association (ICEA)

1.4 FEES AND TESTS

- A. Contractor shall be responsible for all fees for permits, inspections, and tests necessary to complete the work described herein. Contractor shall demonstrate to the consultant/engineer that all items of equipment installed are completely operational and free of defects in all modes.

1.5 COORDINATION WITH OTHER TRADES

- A. Contractor shall furnish and locate all anchor bolts, inserts and supports for installation by the other trades as required. Contractor shall coordinate the location of all fixtures, outlets, equipment, and devices with other trades to avoid conflicts.

1.6 INSPECTION OF THE SITE AND EXISTING CONDITIONS

- A. Before submitting a bid, contractor shall visit the site and determine existing conditions and all existing structures to become familiar with existing conditions and electrical systems that may, in any manner, affect the work required under this contract.
- B. The contractor shall carry out any work involving shutdown of the existing services to any piece of equipment now functioning in the work area at such time as to provide the least amount of inconvenience to the consultant/engineer. Contractor shall do such work when directed by the consultant/engineer.
- C. After contract award, the contractor shall confer with the consultant/engineer to verify, at each stage of construction, the location(s) of existing utilities and facilities. Contractor shall protect all underground utilities during construction. The contractor shall pay for all required repairs for damage inflicted during construction with no increase in contract cost.

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- D. Responsibility: The contractor shall be responsible for completing the systems in accordance with the intent of these contract documents.
1. Coordination of the details of the facility equipment and construction for all technical specification divisions that affect the work covered under division 16, "Electrical."
 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good trade-practice to provide complete and functioning systems.
- E. Departures from the Contract Documents: The contractor shall submit to the consultant/engineer, in writing, details of any necessary, proposed departures from these contract documents, and the reasons therefore. Such requests must be submitted as soon as is practicably possible and within 30 days after contract award. No such departures shall be made without the consultant/engineer's written review.
- F. Substitution of Materials and Equipment: In accordance with provisions elsewhere in these contract documents, manufacturers' names and catalog numbers stated herein are intended to indicate the type and quality of equipment or materials desired. Unless substitution is specifically forbidden, proposed alternatives may be submitted for review.

1.7 SUBMITTALS

- A. General: Follow the procedures specified in the division 1 section "Submittals."
- B. Additional copies may be required by individual sections of these specifications.
- C. List of Proposed Materials: The contractor shall submit a complete list of the proposed manufacturers for each of the items listed in these electrical specifications. Additional submittal data, sufficient to determine equivalence, shall be required if the contractor proposes to substitute another manufacturer's equipment. The opinion of the consultant/engineer shall be final in the decision to accept or reject proposed manufacturer(s) and substitutions.

1.8 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with the division 1 section on "Submittals," to a scale of $\frac{1}{4}" = 1' 0"$ or larger, detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where

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space is limited for installation and access and where sequencing and coordination of installations are important to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials, including:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance
 - b. Exterior wall and foundation penetrations
 - c. Fire-rated wall and floor penetrations
 - d. Equipment connections and support details
 - e. Sizes and location of required concrete pads and bases
 - f. Service entrance, disconnect, and utility metering equipment
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare schematic, connection, and interconnection-wiring diagrams required for installation, checkout, troubleshooting, and maintenance. Interconnection drawings are required for wiring between equipment items not covered by connection diagrams supplied by equipment vendors. Interconnection drawings shall use the same terminal numbers and device and conductor designations as are used in connection diagrams.

1.9 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in the division 1 section on "Submittals." In addition to the requirements specified in division 1, indicate installed conditions for:
 1. Size and location of major exterior and interior raceway-systems, control-device locations, distribution and branch electrical-circuitry, and fuse and circuit-breaker size and arrangements.

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2. Locations of exposed and concealed equipment, dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and documentation of actual equipment and materials installed.

1.10 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with the division 1 section "Summary of Work." In addition to the requirements specified in division 1, include the following equipment information:
 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures, including instructions for start-up, break-in, routine and normal operations, regulation, control, stopping, shutdown, emergencies, and summer and winter operations.
 3. Maintenance procedures for routine preventive maintenance and troubleshooting, disassembly, repair, reassembly, aligning, and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to the project properly identified products, with names, model numbers, types, grades, compliance labels, and other necessary identifying information.

PART 2— PRODUCTS

2.1 REFERENCE TO DRAWINGS

- A. Make reference to drawing schedules, details, notes, and specifications for the manufacturer, model, catalog number, size, capacity, performance, ratings, and installation of equipment and material.

2.2 CHOICE OF MATERIALS AND EQUIPMENT

- A. In submitting substitutions, bidders should note the following minimum considerations: (1) capacities shown are the absolute minimum and must be

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equaled, (2) physical size limitations for the space allotted, (3) structural properties, (4) noise level, (5) interchangeability, (6) compatibility with other materials and assemblies, (7) similar items shall be from the same manufacturer and of the same style wherever possible, and (8) electrical hazardous-area classification of equipment shall not be downgraded under any circumstances.

- B. All materials and equipment for which a UL, ANSI, or NEMA standard is established shall be so approved, and be labeled or stamped as such.
- C. Adhesives are not an acceptable technique for mounting, supporting, or assembling any system components or assemblies, unless otherwise noted herein.

2.3 SUBMITTALS DURING CONSTRUCTION

- A. Certified arrangement drawings, outline dimensions, and weights for all major (engineered) equipment
- B. Functional description or logic diagrams for all control systems furnished under division 16, "Electrical," and not listed above
- C. Characteristic curves for all protective devices
- D. Schematic (elementary) drawings for any electrical control and bills of material for equipment including, but not limited to:
 - 1. Upgraded control panel.
- E. Connection diagrams, showing all internal wiring and required field connections for the following:
 - 1. All controls and instrumentation
- F. Interconnection elementary-diagrams for each of the following conductor types:
 - 1. Service conductors, feeder conductors, and any branch-circuit conductors with a connection point between the branch-circuit over-current protection or motor starter and the equipment using the power
 - 2. Discrete control-conductors
 - 3. Analog control-conductors

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PART 3— EXECUTION

3.1 ROUGH-INS

- A. Contractor shall verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

3.2 ELECTRICAL INSTALLATIONS

- A. The contractor shall be responsible for all electrical power, control, and instrumentation wiring and connections to all equipment requiring electrical power. This responsibility applies to all equipment supplied by the contractor, as well as all equipment supplied under this and other divisions of the technical specifications, and/or by the consultant/engineer.
- B. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
1. Coordinate electrical systems, equipment, and materials installation with other building and well installation components.
 2. Verify all dimensions by field measurements.
 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 4. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with governing regulations.
 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to the greatest extent possible. Conform to arrangements indicated by the contract documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination

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requirements conflict with individual system requirements, refer the conflict to the consultant/engineer.

9. Install systems, materials, and equipment level, plumb, parallel, and perpendicular to other building systems and components, where the installation is exposed in finished spaces.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. To the extent practicable, connect equipment for ease of disconnection, with minimum interference with other installations.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. General: Cut and patch in accordance with the requirements specified below:

1. Cut, fit, and patch electrical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to the contract-document requirements.
 - d. Remove samples of installed work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the consultant/engineer, uncover and restore work to allow the consultant/engineer to observe concealed work.
2. Protection of Installed Work: During cutting and patching, protect adjacent installations.

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3.4 RECORD AND AS-BUILT DRAWINGS

- A. Contractor shall maintain at the job site a set of contract documents kept current by indicating thereon all changes, revisions, and substitutions between the work as specified and as installed.
- B. Contractor shall furnish the consultant/engineer with one complete set of reproducible drawings and two complete, clean sets of specifications showing installed locations, sizes, catalog numbers, etc., of all work and material as taken from record documents.
- C. For each piece of equipment, the contractor shall provide four sets of manufacturer's printed catalog pages of operating and maintenance instructions and wiring and connection diagrams. This information shall be bound into 8¹/₂"×11" notebooks.

3.5 EQUIPMENT OPERATION

- A. This Division is Responsible for: (1) proper motor rotation, (2) observing that lubrication has been properly performed, (3) that motors operate within nameplate limits, and (4) adjustment or circuit breaker and motor-controller trip settings.

3.6 IDENTIFICATION

- A. Contractor shall identify all major items of equipment, including: controls, panel-boards, switches, contactors, motor starters and enclosures, junction boxes, and metering with permanent nameplates and verbiage approved by the consultant/engineer. Secure any nameplates using stainless-steel screws or rivets. Adhesives are acceptable on components within NEMA 1 enclosures only.
- B. Nameplates, after installation, shall be easily visible and bear notations identical to those shown on record drawings. Piping and Instrumentation Diagram (P&ID) tag-designations shall be used wherever available.
- C. Each instrument shall be identified with a stamped stainless-steel-tag (Brady or approved equivalent). Instrument tags shall be permanently attached to each individual instrument and stamped with the appropriate tag designation, as described in the instrument specification section.
- D. Each wire and/or cable shall be identified with a permanent label (Brady catalog number B-292, with printed legends, or approved equivalent). Instrumentation cables shall be labeled with the appropriate instrument number of the originating

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signal (e.g., "FT-201"). Multiplex cables, power, and control cables shall be labeled with the appropriate cable number as shown in the conduit and cable schedule.

- E. All lighting panels, pump-control panels, control cabinets, and transformers shall be identified with permanently mounted phenolic labels.
- F. All power and lighting panels shall have breaker schedules typed and mounted inside their respective door(s).

3.7 TEST PERIOD

- A. Each piece of equipment shall continue to meet performance specifications throughout the first year of operation, beginning with the date of acceptance of completed work. The contractor shall replace or repair any defect due to faulty workmanship or material that shall develop within one calendar year from the date of acceptance. This warranty shall cover both material and workmanship.

3.8 ELECTRICAL TESTING AND STARTUP

A. General:

1. Before energizing any equipment, the contractor shall thoroughly vacuum clean the equipment with an industrial-type vacuum cleaner. Any sheet-metal parts shall be thoroughly cleaned with degreaser to remove any oil deposited during fabrication or installation. The outside of all electrical equipment shall be cleaned and touched up with vendor-supplied touch-up paint, to leave the equipment in an "as-purchased" condition.
2. During new equipment startup, the contractor shall provide a workforce sufficient to aid with start-up of the electrical equipment, to remove any faults, and to make any necessary adjustment for the proper operation of electrical equipment.
3. All testing equipment shall be furnished by the contractor.
4. All failures under tests due to defective material or poor workmanship shall be corrected by the contractor, at no expense to the consultant/engineer.
5. The contractor shall not, under any circumstances, energize any electrical equipment covered by these specifications without first obtaining the consultant/engineer's permission.

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- B. All power and replacement fuses, bulbs, and spare parts necessary for testing shall be furnished and paid for by the contractor under this item. All spare parts and fuses shall be obtained before startup.

—END OF SECTION—

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**SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS**

PART 1— GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including general and supplementary conditions and division-1 specification sections, apply to this section.
- B. Requirements specified in division 16, section 16010 (“Basic Electrical Requirements”) apply to this section.

1.2 SUMMARY

- A. This section includes limited-scope general-construction materials and methods applicable to electrical installations as follows:
 - 1. Miscellaneous metals for support of electrical materials and equipment.

1.3 SUBMITTALS

- A. Shop drawings detailing fabrication and installation for metal fabrications and anchorage for electrical materials and equipment.
- B. Welder certificates, signed by the contractor, certifying that welders have complied with requirements specified under the “Quality Assurance” article of this section. This shall include “Cadwelding.”

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to install the electrical equipment and “Cadweld” terminations.

1.5 SEQUENCE AND SCHEDULING

- A. Coordinate shut-off and disconnection of electrical service with the consultant/engineer (if necessary).

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PART 2— PRODUCTS

2.1 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36
- B. Cold-formed steel tubing: ASTM A 500
- C. Hot-rolled steel tubing: ASTM A 501
- D. Steel pipe: ASTM A 53, Schedule 40, welded
- E. Fasteners: Zinc-coated, type, grade, and class as required

PART 3— EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with the installation until unsatisfactory conditions have been corrected.

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately with respect to their location, alignment, and elevation, to support and anchor electrical materials and equipment.

—END OF SECTION—

SECTION 16100
CONDUITS AND RACEWAYS

PART 1— GENERAL

1.1 RELATED DOCUMENTS

- A. Design Documents
- B. Requirements of the following division 16 sections apply to this section:
 - 1. Section 16010: “Basic Electrical Requirements”
 - 2. Section 16050: “Basic Electrical Materials and Methods”

1.2 SUMMARY

- A. This section includes raceways for electrical wiring, including the following types:
 - 1. Rigid galvanized-steel conduit
 - 2. Rigid nonmetallic conduit
 - 3. Liquid-tight flexible conduit
- B. Related Sections: The following division 16 sections contain requirements that relate to this section:
 - 1. “Wires and Cables” for other wiring methods.
 - 2. “Supporting Devices” for raceway supports.
 - 3. “Cabinets, Boxes, and Fittings” for boxes used with conduit and tubing systems.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and division 1 specification sections.
- B. Product data for the following products:
 - 1. Rigid galvanized-steel conduit

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2. Rigid nonmetallic conduit
 3. Liquid-tight flexible conduit
- C. Installation Instructions: Manufacturer's written installation instructions for wireway galvanized-steel raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of Underwriters Laboratories (UL) standards pertaining to electrical raceway-systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate with other work, including metal and concrete-deck installation, as necessary to interface installation of electrical raceways and components with other work.

PART 2— PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from the following manufacturers:
1. Rigid galvanized-steel conduit:
 - a. Allied Tube and Conduit
 - b. Wheatland
 - c. General Electric
 - d. Other manufacturer of an approved equivalent

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2. Rigid nonmetallic conduit
 - a. Carlon
 - b. Borg-Warner
 - c. Other manufacturer of an approved equivalent

3. Conduit Bodies:
 - a. Appleton Electric Co.
 - b. Crouse-Hinds Division, Cooper Industries, Inc.
 - c. O-Z/Gedney
 - d. Spring City Electrical Mfg. Co.

5. Conduit Fittings and Bushings:
 - a. O-Z/Gedney, Type B
 - b. Thomas & Betts Company
 - c. Panduit Manufacturing
 - d. Appleton Electric Co.
 - e. Myers Electric Products, Inc.

2.2 CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.

2.3 GALVANIZED-STEEL CONDUIT

- A. General: Rigid-metal conduit shall be heavy-wall, mild-steel conduit conforming to ANSI C80.1 and federal specification WW-C-581, hot-dip galvanized both inside and out. All conduits shall bear the UL stamp of approval.
- B. Rigid Steel Conduit: ANSI C80.1
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1 steel and malleable-iron fittings
- D. Conduit (or cable) schedules shown on drawing 15

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2.4 LIQUID-TIGHT FLEXIBLE METAL-CONDUIT

- A. General: Flexible conduit shall have an oil-resistant, liquid-tight jacket, in combination with flexible metal-reinforcing tubing and shall be designed for use with waterproof fittings. An integral ground-wire shall also be included. Only UL listed fittings shall be used.

2.5 RIGID NONMETALLIC CONDUIT

- A. General: Rigid nonmetallic-conduit for voltages 600V and less shall be SCH 80 heavy wall polyvinyl chloride (PVC) electrical conduit rated for 90° Centigrade (C) conductors conforming to NEMA TC-2, Type EPC-80-PVC. It shall be UL-listed in conformance with the NEC. Conduit fittings, elbows, and joint cement shall be produced by the same manufacturer as the conduit.

2.6 CONDUIT FITTINGS AND BUSHINGS

- A. General: Wherever conduits terminate in sheet-steel boxes, cast hubs shall be used to form the conduit connection to the box. All bushings shall be insulated metallic-type, equal to O. Z. Electrical Manufacturing Company, Type B; T & B Company, 1200 Series; Appleton Electric Company, Type BU-I; or equivalent.
- B. All conduits terminating at motor-control centers shall be suitably grounded to the motor-control-center ground bus using grounded-type insulated bushings equivalent to O. Z. Electrical Manufacturing Company, BLB or IGB; Appleton, Type BIB; Thomas and Betts, 3800 Series; or equivalent.

PART 3— EXECUTION

3.1 WIRING METHOD

- A. Connection to Vibrating Equipment: Including transformers and hydraulic, pneumatic, electric-solenoid or motor-driven equipment: liquid-tight flexible galvanized-steel conduit or explosion-proof flexible conduit, as appropriate for the atmospheric classification and code requirements.

3.2 GENERAL

- A. Install electrical raceways in accordance with manufacturer's written installation instructions, applicable NEC requirements, and as follows:
1. Use galvanized-steel conduit for above-grade raceways unless otherwise specified.

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2. Use rigid nonmetallic-conduit for below-grade raceways, unless otherwise specified.
- B. Expose conduit, unless indicated otherwise, on walls, and ceilings. Keep raceways at least six inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations. Do not block access to openings, louvers, equipment, etc.
- C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping. All conduit runs shall be routed overhead unless explicitly called out otherwise in either the specifications or drawings.
- D. Installation of all electrical raceways shall be completed before starting installation of conductors within raceways.
- E. Supports for raceways shall be provided and installed as specified elsewhere in division 16.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage and corrosion where conduits rise from floor slabs. Arrange so the curved portion of bends is not visible above the finished slab. Provide a pitch-pocket to 4" above the floor slab.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings of types compatible with the associated raceway and suitable for the use and location.
- J. Run concealed raceways with a minimum of bends in the shortest practicable distance, considering the type of building construction and obstructions, except as otherwise indicated.
- K. Raceways embedded in slabs: Install in the middle third of the slab thickness where practical, and leave at least one-inch of concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space the raceways laterally to prevent voids in the concrete. Run conduit larger than one-inch trade-size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the slab supports.

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- L. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practicable. Where conduit is run overhead, clearance above floor shall not be less than the vertical opening of the overhead door.
- M. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed in parallel. This requires a change in the plane of the run, such as from wall to ceiling, and that the raceways be of the same size. In other cases, provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations watertight. Where terminations are subject to vibration, use flexible liquid-tight galvanized-steel conduit or explosion-proof flexible conduit, as required by the NEC and atmospheric classification.
- O. Terminations: All conduit terminations in sheet-metal enclosures shall use O-ring-type oil-tight hub-connections manufactured by Thomas & Betts or equivalent. Terminations shall be separable and watertight.
- P. Where terminating in threaded hubs, screw the raceway or fitting tightly into the hub, so the end bears against the wire-protection shoulder.
- Q. Install pull-wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament-plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
- R. Telephone and Signal System Raceways 2" Trade Size and Smaller: In addition to the above requirements, install raceways 2" and smaller trade-size in maximum lengths of 150 feet with a maximum of two 90-degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- S. Install raceway-sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound from the same manufacturer as the sealing fitting. For concealed raceways, install each fitting in a flush steel-box with a blank cover-plate with a finish similar to that of adjacent plates or surfaces. Raceway sealing shall comply with NFPA 70 Section 501-5, "Sealings and Drawings." Install raceway-sealing fittings at the following points and elsewhere as indicated:

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1. Where conduits pass from indoor to outdoor spaces
 2. Where conduits enter or exit hazardous areas
 3. Within 18" of entering or exiting any enclosure located in the classified area
- T. Flexible Connections: Use short lengths (maximum two feet) of flexible metal-conduit for connections to motors, equipment subject to vibration, noise transmission, or movement, and include a built-in, continuous copper-ground conductor and terminating fittings suitable to assure adequate bonding connection to conduit.
- U. Buried Conduits: All buried conduits shall be a minimum of 24" below finished grade. All fill material for the first 6" of backfill above buried conduit(s) shall be free of stones, pebbles, or other debris larger than $\frac{1}{4}$ " diameter. Buried conduits shall be vertically separated from process piping by a minimum of 6" of compacted fill material. Provide continuous plastic warning-tape 6" above all buried conduits.

—END OF SECTION—

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**SECTION 16120
WIRES AND CABLES**

PART 1— GENERAL

1.1 WORK INCLUDED

- A. Work covered by this section included furnishing all labor, equipment and materials required to install, connect and test all wire and cable, including splices, terminations, connectors, and accessories for a complete installation as shown on the drawings and/or specified herein.

1.2 RELATED DOCUMENTS

- A. Design Documents and Drawings
- B. Requirements of the following division 16 sections apply to this section:
 - 1. “Basic Electrical Requirements”

1.3 SUMMARY

- A. This Section includes wires, cables, and connectors for power, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 2— “Site Work” for trenching and backfilling
 - 2. Division 16— Section 16135 “Cabinets, Boxes and Fittings” for connectors for terminating cables in boxes and other electrical enclosures

1.4 SUBMITTALS

- A. Product data for electrical wires, cables, and connectors.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of NFPA 70, *National Electrical Code*.

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1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
- B. UL Compliance: Provide components listed and labeled by Underwriters Laboratories (UL) under the following standards:
 1. UL Std. 83: “Thermoplastic-Insulated Wires and Cables”
 2. UL Std. 486A: “Wire Connectors and Soldering Lugs for Use with Copper Conductors”
 3. UL Std. 854: “Service-Entrance Cable”
- C. NEMA/ICEA Compliance: Provide components which comply with the following standards:
 1. WC-5: “Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy”
 2. WC-7: “Cross-Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy”
- D. IEEE Compliance: Provide components that comply with the following standard.
 1. Std. 82: “Test procedures for Impulse Voltage Tests on Insulated Conductors”

1.6 SIZING OF CONDUCTORS

- A. No wire for power or motor control circuits shall be smaller than No. 12 AWG. No wire for instrumentation and low-level signal transmission shall be smaller than No. 18 AWG for single pairs or No. 20 AWG for bundled cable.

PART 2— PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following manufacturers:
 1. Wire and Cable:
 - a. American Insulated Wire Corp.

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- b. Carol Cable Co. Inc.
 - c. Senator Wire and Cable Co.
 - d. Southwire Company
2. Connectors for Wires and Cable Conductors:
- a. AMP
 - b. 3M Company
 - c. O-Z/Gedney Co.
 - d. Square D Company

2.2 WIRES AND CABLES

- A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed.
- B. Conductors: Provide solid conductors for power and lighting circuits No. 10 AWG and smaller. Provide stranded conductors for sizes No. 8 AWG and larger.
- C. Conductor Material: Copper for all wires and cables.
- D. Insulation: Provide XHHW insulation for all conductors for branch-circuit power, lighting, control, signal and alarm wiring, 120–480 volts. Where cable is for signal wiring below 120 volts, the cable shall be #18 twisted-pair similar to above, with aluminum/polyester shield and PVC jacket. All wire shall have an insulation rating not less than 600 volts.
- E. Color-coding for phase identification in accordance with Table 1 in part 3 below.
- F. Flexible power-cords shall be moisture-resistant, oil-resistant, neoprene-sheathed service cable designed for extra hard usage, Type SO, rated 600 volts at 90° C continuous conductor-temperature. All flexible cords shall be UL-listed.
- G. Instrumentation wiring shall consist of a shielded, twisted pair of conductors, with a minimum conductor size of No. 18 AWG. Shield coverage should be 100%. Instrumentation wiring shall be provided by Belden, Inc.

2.3 CONNECTORS FOR CONDUCTORS

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services

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indicated. Use connectors with temperature ratings equivalent to or greater than those of the wires upon which used.

- B. For wires #10 and smaller in non-hazardous locations, use King watertight twist-on insulation “wire nuts,” or equivalent.

PART 3— EXECUTION

3.1 WIRING METHOD

- A. Use the following wiring methods as indicated:
 - 1. Wire: install all wire in raceway as indicated.
 - 2. Service Entrance Cable Type USE: for underground-service feeders.

3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable installation with other work.
- C. Pull conductors simultaneously where more than one is being installed in the same raceway. Use UL-listed pulling-compound or lubricant, where necessary.
- D. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches to pull attachments to wire or cable.
- E. Install exposed cable parallel and perpendicular to surfaces or exposed structural members. Follow surface contours where possible.
- F. Keep conductor splices to minimum.
- G. Install splice and tap connectors of equivalent or better mechanical strength and insulation rating than the conductors being spliced.
- H. Use splice and tap connectors compatible with conductor material. Provide appropriate compression connectors, and make watertight with heat-shrink tubing.
- I. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with

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conductors larger than No. 10 AWG cabled in individual circuits. Make terminations with no bare conductor at the terminal.

- J. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.
- K. Identification: All conductors, including power, control, and instrumentation, shall be clearly labeled at each end using Brady B-500 cloth/wire-markers, Thomas and Betts "EZ-Code" markers, or approved equivalent.
- L. Unless otherwise specified, splices shall be made at outlet or conduit boxes, pull or junction boxes, manholes or vaults. No splice shall be drawn into a conduit. Splices in wiring rated 600 volts and below shall be made with enough spare wire for two splices to be remade with the same wire at the same location.

3.3 FIELD QUALITY CONTROL

- A. Before energizing, check installed wires and cables with megohm meter to determine insulation resistance-levels to assure that requirements are fulfilled.
- B. Before energizing, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate their proper functioning. Correct malfunctioning units and retest to demonstrate compliance.
- D. TABLE 1: "Color-Coding for Phase Identification:"

Color-code secondary service-, feeder-, and branch- circuits as follows:

<u>240/208/120 Volts</u>	<u>Phase</u>	<u>480/277 Volts</u>
Black	A	Yellow
Red	B	Brown
Blue	C	Orange
White	Neutral	White
Green	Ground	Green

—END OF SECTION—

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**SECTION 16135
CABINETS, BOXES, AND FITTINGS**

PART 1— GENERAL

1.1 WORK INCLUDED

- A. The work covered by this section consists of furnishing all materials, tools, equipment, and labor necessary to install all electrical cabinets, enclosures, boxes, and fittings indicated in the construction drawings and in this specification.
- B. Cabinets and enclosures covered by this section include, but are not limited to the following:
 - 1. All outlet and device boxes
 - 2. All pull and junction boxes
 - 3. All cabinets
 - 4. All hinged-door enclosures

1.2 RELATED DOCUMENTS

- A. Design Documents and Drawings
- B. Requirements of the following division 16 sections apply to this section:
 - 1. Section 16010— “Basic Electrical Requirements”
 - 2. Section 16050— “Basic Electrical Materials and Methods”

1.3 REFERENCES

- A. NEMA 250— “Enclosures for Electrical Equipment (1000 Volts Maximum)”
- B. ANSI/NEMA ICS-1— “Industrial Controls and Systems”
- C. ANSI/NEMA ICS-4— “Terminal Blocks for Industrial Control Equipment and Systems”
- D. ANSI/NEMA ICS-6— “Enclosures for Industrial Control Equipment and Systems”

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1.4 SUBMITTALS

- A. General: Submit the following in accordance with conditions of the contract and division 1 specification sections:
 - 1. Product data for cabinets and enclosures with classification higher than NEMA 1
 - 2. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS-1

1.5 DEFINITIONS

- A. Cabinets: An enclosure designed either for surface- or flush-mounting and having a frame or trim in which a door or doors may be mounted.
- B. Device Box: An outlet box designed to house a receptacle device or a wiring box housing a switch.
- C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.
- D. Hinged Door Enclosure: An enclosure designed for surface mounting with swinging doors or covers secured directly to and telescoping with the box walls.
- E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply the equipment using it.
- F. Wiring Box: An enclosure designed to provide access to wiring systems or to mount indicator devices or switches to control electrical circuits.

1.6 QUALITY ASSURANCE

- A. UL Listing and Labeling: Items under this section shall be listed and labeled by UL.
- B. Nationally Recognized Testing Laboratory Listing and Labeling (NRTL): Items under this section shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA regulation 1910.7.
- C. National Electrical Code Compliance: Components and installation shall comply with NFPA 70, *National Electrical Code*.

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- D. NEMA Compliance: Comply with NEMA standard 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."

PART 2— PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products from the following manufacturers:
1. Cabinets, Pull, and Junction Boxes:
 - a. Erickson Electrical Equipment Co.
 - b. Hoffman Engineering Co.
 - c. Spring City Electrical Mfg. Co.
 - d. Square D Co.

2.2 CABINETS, BOXES AND FITTINGS, GENERAL

- A. Electrical Cabinets, Boxes, and Fittings: Of the indicated types, sizes, and NEMA enclosure-classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations. Boxes mounted indoors shall have a minimum environmental rating of NEMA 12. All boxes and cabinets deployed outdoors or below grade (in vaults) shall be 316 SS units of NEMA 4X rating.

2.3 MATERIALS AND FINISHES

- A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
- B. Fasteners: Stainless-steel screws and hardware.
- C. Cast Metal for Boxes, Enclosures, and Covers: Copper-free aluminum, except as otherwise specified.
- D. Exterior Finish: Gray baked-enamel for items exposed in finished locations, except as otherwise indicated.
- E. Painted Interior Finish: Where indicated, white baked-enamel.

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- F. Fittings for Boxes, Cabinets, and Enclosures: As appropriate for corresponding raceways.

2.4 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES

- A. General: Conform to UL 514A, "Metallic Outlet-Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of a type, shape, size, and depth to suit each location and application. Boxes shall be type FS or FD, or other appropriate to the device and wiring.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with no knockouts. Threaded screw holes and accessories shall be suitable for each location, including mounting brackets and straps, cable clamps, exterior rings, and fixture studs. Indoor boxes shall be NEMA 12.

2.5 PULL AND JUNCTION BOXES

- A. General: Comply with UL 50, "Electrical Cabinets and Boxes," for boxes more than 100 cubic inches in volume. Boxes shall have screwed- or bolted-on covers of the same material as the box and shall be of a size and shape to suit the application.
- B. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, constructed with internal structural-steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- C. Install Appleton Model PBFW pull-fittings or approved equivalents for every 100 feet of straight run.

2.6 STEEL ENCLOSURES WITH HINGED DOORS

- A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."
- B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated and arranged for surface mounting.
- C. Doors: Hinged directly to the cabinet and removable, with approximately $\frac{3}{4}$ -inch flange around all edges, shaped to cover the edge of the box. Provide multiple doors where required.
- D. Mounting Panel: Provide painted, removable, internal-mounting panel for component installation, as noted.

**16135-4
CABINETS, BOXES, AND FITTINGS**

PART 3— EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with the division 16 section on “Supporting Devices.”
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than the sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel. Boxes deployed outdoors shall have all conduit penetrations on the bottom of the box. No top or side penetrations shall be permitted.

3.2 APPLICATIONS

- A. Hinged-Door Enclosures: NEMA type 12 enclosure, except as indicated.
- B. Hinged-Door Enclosures Outdoors, Below Grade, or in Wet Locations: NEMA Type 4 and 4X, of stainless-steel or painted carbon-steel construction— install a drip-hood factory-tailored to individual units.

3.3 INSTALLATION OF PULL AND JUNCTION BOXES

- A. Box Selection: For boxes in main-feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed six entering- and six leaving-raceways in a single box.
- B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cables at least every 30-inches inside boxes.
- C. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50% larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

**16135-5
CABINETS, BOXES, AND FITTINGS**

**Remedial Enhancement Design Report
Aro Corporation Site
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3.4 INSTALLATION OF CABINTS AND HINGED DOOR ENCLOSUSRES

- A. Mount with fronts straight and plumb.
- B. Install with bottoms 24 inches above floor or ground level.

3.5 GROUNDING

- A. Electrically ground metallic cabinets, boxes, and enclosures. All wiring shall include a grounding conductor. Provide a grounding terminal inside each cabinet, box, or enclosure.

3.6 CLEANING AND FINISH REPAIR

- A. Inspect components upon installation completion. Remove burrs, dirt, and construction debris and repair any damage to the finish, including chips, scratches, abrasions, and weld marks.
- B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the enclosure manufacturer.
- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

—END OF SECTION—

**16135-6
CABINETS, BOXES, AND FITTINGS**

SECTION 16170
CIRCUIT AND MOTOR DISCONNECTS

PART 1— GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and division 1 specification sections, apply to this section.
- B. Requirements of the following division 16 section apply to this section:
 - 1. Section 16010— “Basic Electrical Requirements”

1.2 SUMMARY

- A. This section includes circuit- and motor-disconnects not included as part of the control panel.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 16 section 16490-1— “Motor Starter Specifications” for combination-type starters that incorporate disconnect switches in the same enclosure as the starter, and manual motor-starters that include the disconnect function as part of the starter-switch assembly

1.3 SUBMITTALS

- A. Product data for each type of product specified.
- B. Include maintenance data for circuit- and motor-disconnects in the *Operation and Maintenance Manual* specified in division 1 and in the division 16 section “Basic Electrical Requirements.”

1.4 QUALITY ASSURANCE

- A. Electrical Component Standards: Provide components complying with NFPA 70, *National Electrical Code*, and which are listed and labeled by Underwriters Laboratories (UL). Comply with UL standard 98 and NEMA standard KS 1.

16170-1
CIRCUIT AND MOTOR DISCONNECTS

PART 2— PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Appleton Electric Co.
 2. Crouse-Hinds Co.
 3. Cutler-Hammer Inc.
 4. General Electric Co.
 5. Square D Company
 6. Allen-Bradley

2.2 CIRCUIT AND MOTOR DISCONNECT-SWITCHES

- A. General: Provide circuit and motor disconnect-switches in types, sizes, duties, features ratings, and enclosures as indicated. Provide NEMA 12 enclosure for indoor switches. For all outdoor and vault-mount/below-grade disconnect switches, provide NEMA 4/4X enclosures of 315 SS construction, with rain-tight hubs and “O-ring” gasket seal. For motor- and motor-starter-disconnects, provide units with horsepower ratings suitable to the loads.
- B. Fusible Switches: Heavy-duty switches, with fuses of classes and current ratings indicated. See the section on “Fuses” for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable features suitable only for current limiting type fuses.
- C. Non-fusible Disconnects: Heavy-duty switches of classes and current ratings as indicated.
- D. Hazardous Locations: Where the disconnect is deployed in a hazardous location, provide a device suitable for the atmosphere in which it is deployed. Hazardous area classification is noted on the drawings, where applicable.

2.3 ACCESSORIES

- A. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated.

16170-2 CIRCUIT AND MOTOR DISCONNECTS

PART 3— EXECUTION

3.1 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS

- A. General: Provide circuit and motor disconnect-switches as indicated and where required by the above code. Comply with switch manufacturers' printed installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect-switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with the circuit unloaded. Open each switch enclosure and inspect the interior, mechanical and electrical connections, fuse installation, and to verify the type and rating of the fuses installed. Correct deficiencies, and then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

—END OF SECTION—