

Clark Dietz
ENGINEERS

Basis of Design Report
for
Neal's Landfill Improvements 2011

Bloomington, Indiana

Prepared for
CBS Corporation, Inc.

April 2011

US EPA RECORDS CENTER REGION 5



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Prepared by
Clark Dietz, Inc.

**Basis of Design Report
for
Neal's Landfill Improvements 2011
Bloomington, Indiana**

CDI Project No. C0850040

Prepared for

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April 2011

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Neal's Landfill Improvements 2011**

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Chapter 1. EXISTING SYSTEM, PROBLEMS, AND DEFICIENCIES

Clark Dietz, Inc. has prepared this Basis of Design Report for the CBS Corporation to document the improvements to the Neal's Landfill Spring Treatment Facility (NLSTF) in Bloomington, Indiana. The improvements include the installation of a new pump station to capture emerging spring flows located in Conard's Branch downstream of existing treatment facilities, a forcemain, and a new gravity discharge pipe.

1.1 Background

Neal's Landfill is located approximately three miles due west of the City of Bloomington, in Monroe County, Indiana. The site consists of 17.6 acres that were used as a landfill for municipal and industrial wastes over the years. The landfill is located in a rural setting, surrounded primarily by farmland and woods. There are a few residences located within a one half-mile radius of the site. The site is situated in an area of karst terrain characterized by features such as sinkholes, caves and sinking streams.

Disposal operations at Neal's Landfill began in 1950. Municipal and industrial wastes were deposited at the landfill until 1972. During 1966 and 1967, electrical capacitors containing PCBs were deposited at Neal's Landfill from the Westinghouse Bloomington plant. The Neal's Landfill site was placed on the National Priorities List (NPL) in 1983. Initial site cleanup activities began in 1983.

The main groundwater emergences from Neal's Landfill are from a series of springs known as the Northwest Spring System (NWS), which are the head waters for the Conard's Branch stream. The NWS consists of the South Spring and associated storm overflow springs. These springs serve as the outlet for a main conduit cave stream which flows beneath the landfill. There is also an associated underflow spring known as North Spring (NS) which receives part of its drainage from the main conduit and part of its drainage from an adjacent small watershed with less PCB content than the main conduit water. The major features of the NWS are shown on Figure 1-2.

Under the terms of a 1985 Consent Decree:

- A stream bank and stream sediment removal project was completed in October 1988. Sediments and bank soils were removed from the entire 4,500 linear feet length of Conard's Branch.
- A water treatment plant was built by Westinghouse and began operation in February 1990. The Neal's Landfill Spring Treatment Facility (NLSTF) collects base groundwater flow from the main Neal's Landfill site groundwater emergences, North Spring and South Spring, and treats the water to remove suspended solids and PCBs. The plant also previously collected and treated water from the Southwest Seep (SW Seep). The plant was designed to treat

flows up to 1 cubic foot per second (450 gallons per minute, gpm) to a discharge level of 1 ppb (parts per billion) of PCBs per Consent Decree requirements.

In 1999, the remedy for the source area, the landfill itself, was completed to accomplish the following:

- Removal of materials with greater than 500 ppm (parts per million) PCBs to an offsite TSCA landfill
- Relocation to higher ground of all remaining waste from low-lying areas of the site that could be susceptible to groundwater back flooding.
- Reduction of the final footprint area of the landfill to be capped
- Placement of a RCRA Subtitle C cover on all remaining waste
- Management of surface runoff and potential run-on into lined storm water ditches which route clean water into surface streams. This minimizes groundwater recharge near the site, reducing spring flows and potentially reducing PCB loading to the springs and thereby to Conard's Branch.

One result of the 1999 source control remedy was that the SW Seep stopped flowing, allowing the SW Seep pumping station to be removed from operation.

After the installation of the NLSTF, a network of new springs opened up within the stream banks at the headwaters of Conard's Branch. These new springs bypassed the original water collection systems. Therefore, in 2002, a new water collection sump and pumping station were installed to collect this bypassing water. The new station is called the Conard's Branch pumping station.

One result of groundwater investigations conducted at the site from 1999 to 2004 was the discovery that low level PCB seepage enters the banks of Conard's Branch downstream of the present spring water collection systems.

In 2005, a computer model of the PCB discharge, transport, fate and bioaccumulation in fish was developed for the Conard's Branch/Richland Creek system. The main conclusions from the modeling work were:

- The greatest mass of PCBs is discharged during large storm events. However, since these large storm events are infrequent and short lived events, most of the PCB loading to the fish is derived instead from the continuous low level PCB exposure related to non-storm spring/bank seepages and sediments/soils along the creek.

- Remedial alternatives that maximize collection and/or removal of non-storm spring/bank discharges and sediment/soil PCB loads will provide for a relatively larger reduction in PCB concentrations in fish than those designed to manage storm discharges.

1.2 Existing Treatment Facility and Collection System

The existing NLSTF receives spring water emerging down gradient of Neal's Landfill and treats this water to remove suspended solids and PCBs. The existing system consists of the following components.

1.2.1 Spring Treatment Facility

A NPDES permit for the Spring Treatment Facility was issued in July 1988, and the system officially went online in February 15, 1990. The NPDES permit authorized the facility to discharge treated water from the associated collection system in accordance with the following criteria:

- The facility must treat up to 1 cfs or 450 gpm when flow is available.
- Samples of the influent and effluent had to be collected on the first and third Wednesday of each month and tested for PCBs.
- PCB concentrations in the effluent were not to exceed 1 ppb.

The collected spring water first enters the settling tank where the larger particles settle out. In normal operations mode, water is pumped by one (lead) pump from the settling tank through both prefilters (multiple bag filter), in parallel, and then through the carbon vessels where the PCBs are adsorbed on the carbon and removed from the water. The treated water is then discharged to Conard's Branch via a 12-inch PVC pipe approximately 160 feet downstream of the Conard's Branch pumping station.

1.2.2 South Spring Collection System

Flow from South Spring and Overflow Springs 1, 2, 3 are captured by the South Spring collection basin via collector pipes or overland flow. Continuous flow from the basin travels by gravity through a 12-inch PVC pipe to the STF. A berm separates Conard's Branch from the collection basin. The overflow from the South Spring collection basin discharges into Conard's branch. This berm is one foot lower than the clarifier overflow, therefore overtopping at the berm before the clarifier.

1.2.3 North Spring and Southwest Seep Pump Stations

The North Spring and Southwest Seep Pump Stations were built in 1990, along with the NLSTF. The North Spring and Southwest Seep stations are nearly identical. Flows at each pump station are collected in stone drainage fields to minimize debris from entering the pump station tanks. Flows that enter the stone drainage fields are

conveyed by gravity to a 1000-gallon storage tank through an 8" perforated line. A typical cross section of the tanks is shown in Figure 1-1.

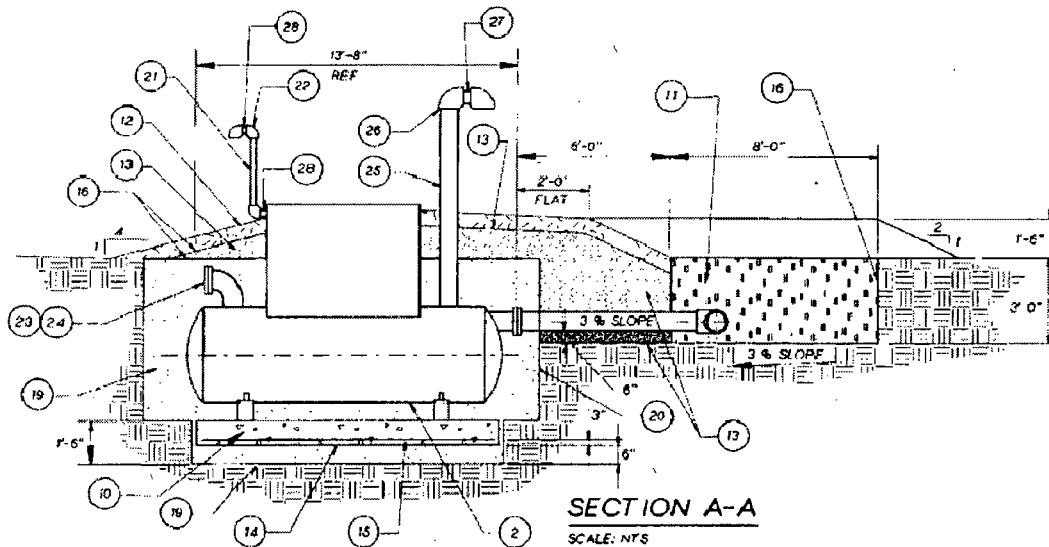


Figure 1-1 Seep Pumping Station Typical Cross Section

Liquid level monitors in the tanks control the operation of the two pumps. The pumps transfer the water from the storage tank to the settling tank at the NLSTF. If the flow into the basin is less than the outflow capacity of one pump, the water level in the tank falls until it trips the low level switch that turns off the pump. If the rate of the inflow to the tank is greater than the outflow capacity of one pump, the water level in the tank rises until it activates the high level switch that starts the second pump. Water is then transferred to the settling tank until the low level switch is tripped. If the rate of flow into the North Spring tank is greater than the capacity of both pumps the overflow goes to Conard's Branch by an existing spring channel. The existing pump station capacities are shown in Table 1-1.

Table 1-1 Existing Pumping Station Capacities and Data

	<i>NS Pump Station</i>	<i>SW Seep Pump Station</i>
Flow, gpm (1 pump)	135	90
Head, ft	58	162
Power, hp	10	15
Impeller dia., in.	5.2	6.6
RPM	3600	3600
Type	Vanton	Vanton
Model	SG-500B	SG-800B
Operation	Level Sensor	Level Sensor
VFD	No	No

To prevent solids from building up in the tanks, a small portion of the flow from the discharge line (5 gpm) can be returned to a sparger located in the bottom of the tank. The flow from the sparger keeps the solids in the water suspended so they can be pumped from the tank.

1.2.4 Conard's Branch Pump Station

In 2002, the Conard's Branch pumping station was installed to capture flows from Conard's Branch when excess treatment capacity exists at the STF. The Conard's Branch pumping station was sized to collect up to 150 gpm from Conard's Branch. The capacity and specifications of the pumps at the Conard's Branch pumping station are shown in Table 1-2.

Table 1-2 Conard's Branch Pumping Station Capacity and Data

	<i>Conard's Branch Pump Station</i>
Flow, gpm (1 pump)	75
Flow, gpm (2 pumps)	150
Head, ft	17
Power, hp	1
Type	Teel
Model	1P858
Operation	Level Sensor
VFD	No

1.2.5 Existing System Process Flow Diagram

A Process Flow Diagram of the existing NLSTF and collection system is illustrated in Figure 1-2.

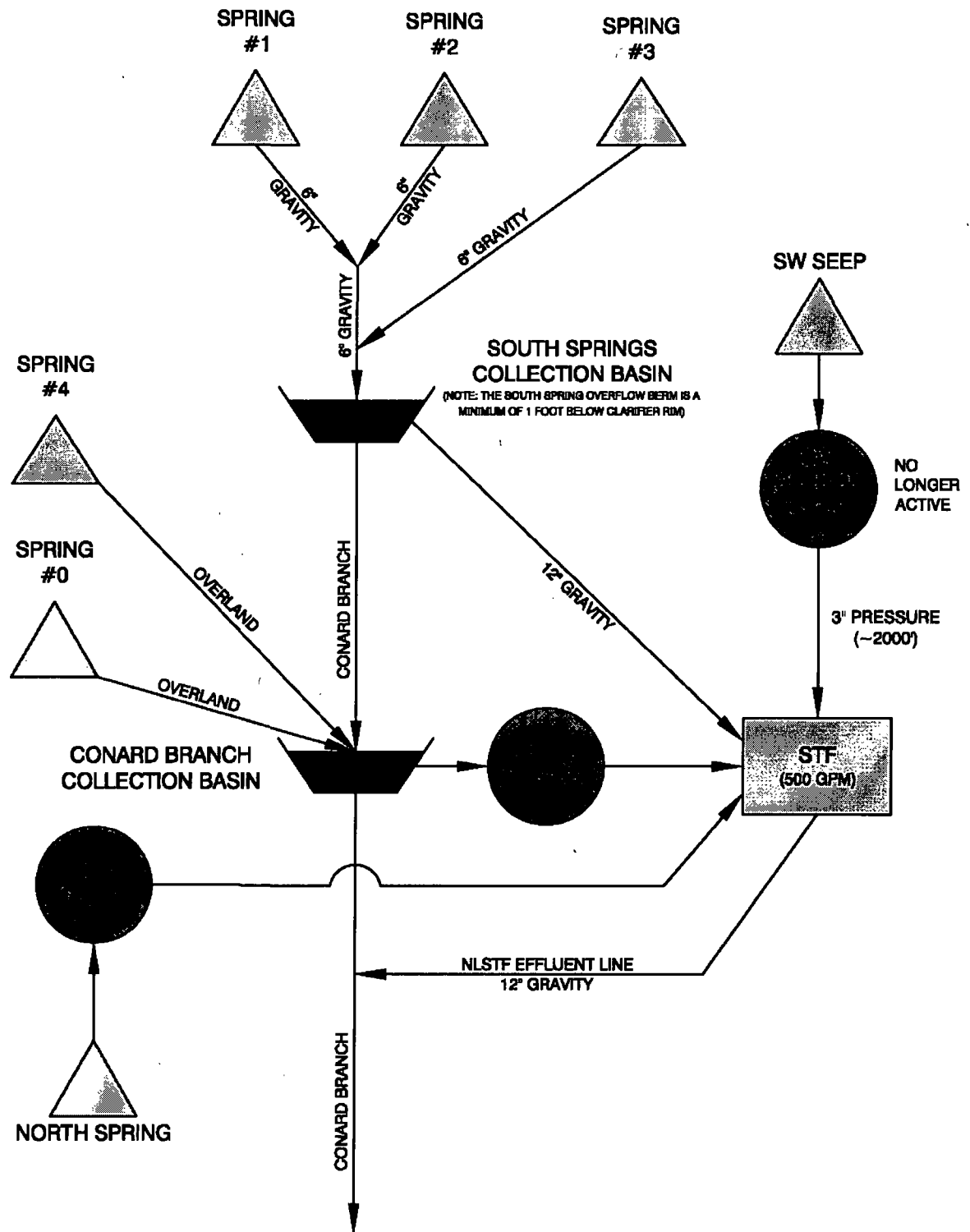


Figure 1-2 Existing System Process Flow Diagram

Chapter 2. GOALS AND OBJECTIVES

The purpose of this report is to provide a basis of design for modifications to the existing STF and collection system that will collect spring water from Conard's Branch emerging from springs and seeps downstream of the current collection systems. The improvements identified will also provide means for compliance with terms contained in the 2009 Consent Decree amendment with the government parties.

2.1 Regulatory Requirements

In 2009, CBS and the government parties entered into a Consent Decree Amendment (CDA) that requires the following final remedial actions for the Neal's Landfill site:

- CBS will continue to operate the existing water collection system which collects water from South Spring and the Overflow Springs and design, construct and operate a new spring water collection system downstream in Conard's Branch to capture water emerging from springs and seeps downstream of the current collection systems.
- CBS will continue to collect water at the North Spring either through the existing or the new water collection system.
- Together, all of the spring water collected at the new and existing collection systems, up to a combined flow of 450 gpm, will be captured and conveyed to the water treatment plant for treatment. Combined flows over 450 gpm will be allowed to bypass the treatment system.
- CBS will install a new effluent line at the water treatment facility in order to extend the outfall to a discharge point in Conard's Branch downstream of the newly constructed spring water collection system.
- CBS will continue to operate the existing water treatment plant, which is capable of treating up to 500 gpm.
- CBS will implement a soil and sediment cleanup for in-stream sediments, bank soils and floodplain soils in Conard's Branch.

Chapter 3. DESIGN FLOWS AND REQUIREMENTS

Design flow information and technical requirements for modification to the NLSTF to capture water emerging from springs and seeps downstream of the current collection system, as provided by CBS Corporation, are summarized in this chapter.

3.1 Existing Flows and Technical Data

Design flows and technical requirements of the modified system include the following:

- Additional Conard's Branch seepage flow to be collected downstream of the current collection system is up to 100 gpm.
- Allow storm flows within Conard's Branch greater than 100 gpm to overflow within the existing stream bed.
- Collection system (new and existing) to collect and convey all flow up to 500 gpm to the STF for treatment.
- Flows greater than 500 gpm will bypass the collection/treatment system.
- Conard's Branch storm flows can reach over 12,000 gpm.
- Conard's Branch stream water contains 0.5 to 1.5 ppb PCBs; 8 mg/L TSS at flows up to 300 gpm and progressively higher during wet weather events.
- All non-consumable major components should have a minimum design life of 30 years.

3.2 Recommended Improvements

To capture emergent spring flows that have developed downstream of the existing spring collection systems, a new downstream (DS) pumping station is required. The new DS pumping station provides for the addition of a new supplemental collection structure and pump station to collect and pump a maximum of 100 gpm of flow from Conard's Branch to the STF. This improvement primarily consists of a new package pumping station, force main, stream collection structure, and new plant effluent line to discharge treated water downstream of the DS pump station. Details and design criteria for the improvements are in Chapter 4.

3.3 Proposed Process Flow Diagram

A process flow diagram illustrating the proposed improvements to the NLSTF and collection system is shown in Figure 3-1.

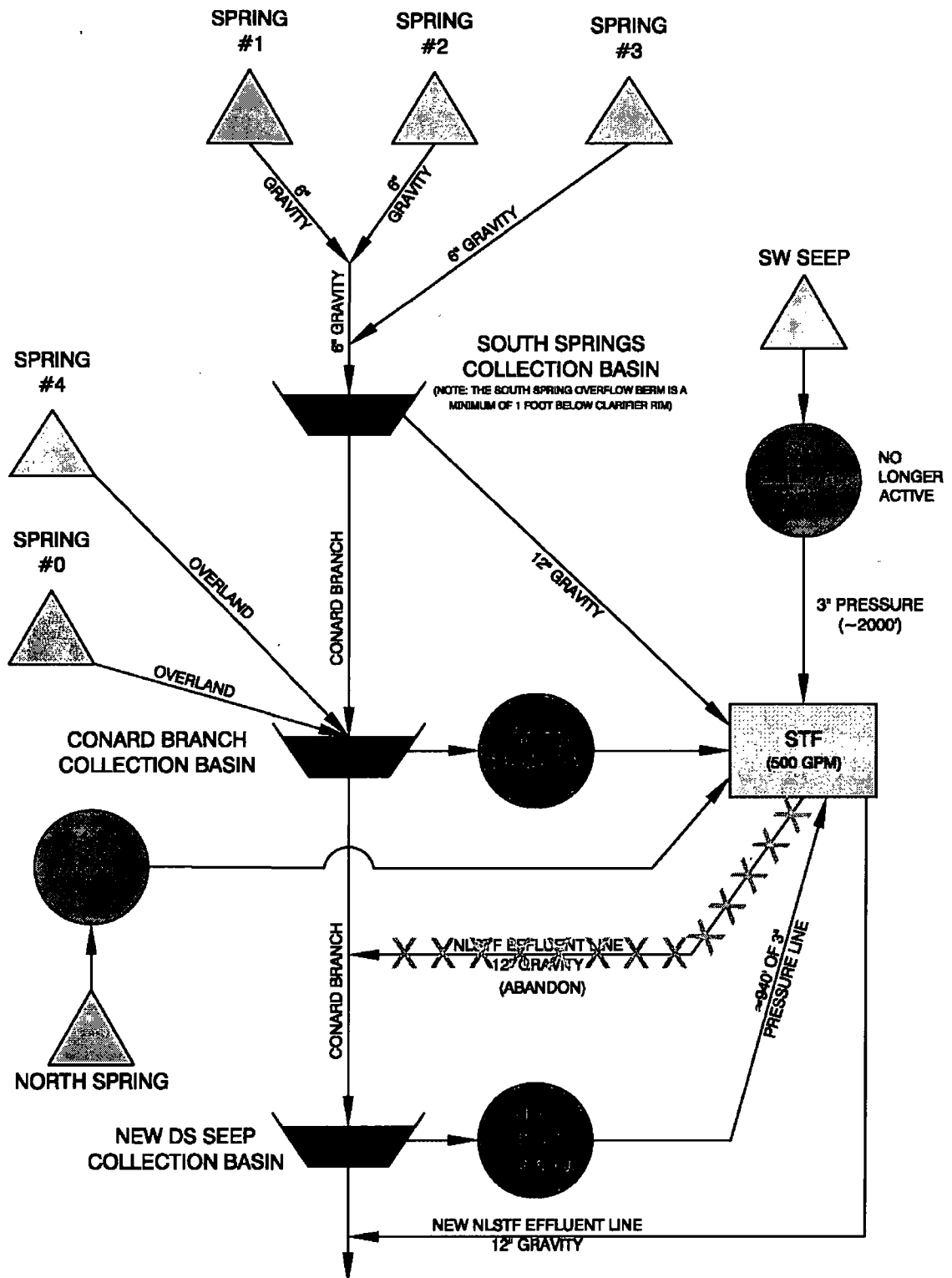


Figure 3-1 Proposed Process Flow Diagram

Chapter 4. DESIGN CRITERIA

4.1 DS Pump Station

This section describes the design criteria, recommended improvements, and operating conditions of the DS pumping station. Associated calculations are included in Appendix A. A preliminary Construction Project Manual and Construction Drawings the improvements described in this chapter are included in Appendices B and C, respectively.

4.1.1 Design Criteria

The DS Seep pumping station will meet the following design criteria:

- Single pump capacity will be 100 gpm minimum.
- Pumps are to be able to operate continuously or intermittently based on sump water level.
- Pumps are to be self priming and will not require manual priming or any manual attention to startup after long periods of no operation.
- Pump inlets will be protected from leaves and debris.
- Station to be powered from NS pumping station or STF.
- Station will have lighting.
- Pump control panel will allow manual operation of pumps locally.
- Instrumentation at pump station will include the following: pump run indicator lights, flow indicator lights, lead pump selector switch, pressure gage in each pump discharge line, and vacuum gage on each pump inlet line.
- Pump control panel will include a 120 VAC service receptacle.
- Pumps will have applicable interlocks and alarms tied into existing control and alarm system including alarm signal to treatment plant process control and remote indicator panels if level controls indicate that the pump should be on but pump flow is not detected.
- Station will include applicable surge and lightning protection.
- Station will be capable of operation during all seasons and will be weatherproof.

4.1.2 Proposed Pump Station and Force Main

The new DS pumping station configuration was selected to be similar to the existing SW Seep Pumping Station in that it is a “package” station. The proposed DS pump station package consists of the following items:

- 1,120 gallon underground fiberglass tank with open top box for housing pumps and controls
- Two Vanton SG-800, 7.5 hp pumps
- All interconnecting Schedule 80 PVC piping, valves, flow switch, and pressure gauges
- Level controls
- Nema 4X control panel, breakers, transformers, switches, disconnects, on/off lights, and wiring
- Force main (outside pump station) will be 3-inch diameter Schedule 40 PVC piping with blocked or restrained joints
- Air relief valves will be placed at all intermediate apex points where air may accumulate in the force main
- New electrical service to proposed pump station, to be extended overhead from existing CBS-owned 7200V, 3-ph. overhead primary to new pole-mount 3-ph. transformer arrangement, complete with cutouts and lightning arresters

4.1.3 Pump Operating Conditions

A 3-inch force main allows the pumps to operate at an efficient duty point and provide a one pump capacity of 118 gpm at 65 feet of head. The two pump capacity of the station is 139 gpm. The pump performance for the selected Vanton SG-800, 7.5 hp pumps for the new DS Seep pump station utilizing a 3-inch force main is illustrated in Figure 4-1. Operating conditions of the proposed station are shown in Table 4-1. The calculations for this pump station are shown in Appendix A.

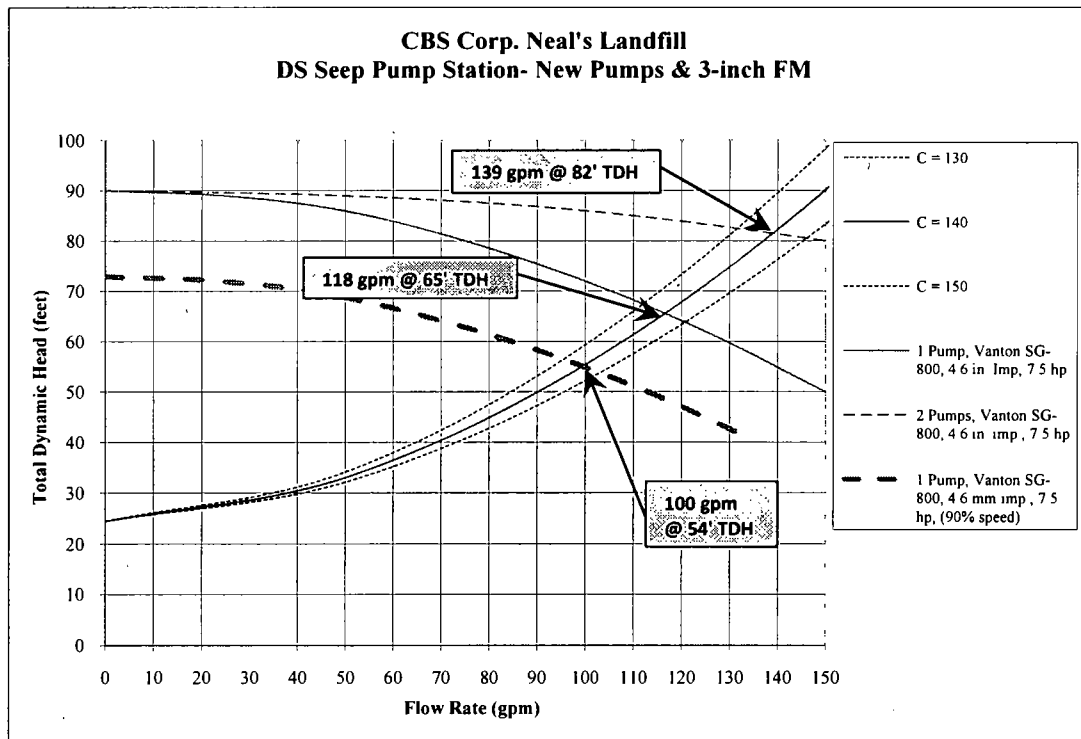


Figure 4-1 DS Seep Pumping Station Performance and System Curve

Table 4-1 DS Seep Pumping Station Operating Conditions

	<i>DS Seep Pump Station</i>
Flow, gpm (1 pump)	118
Flow, gpm (2 pumps)	140
Head, ft	65
Power, hp	7.5
Impeller dia., in.	4.6
Pump Discharge Size, in	2
RPM	3600
Type	Vanton
Model	SG-800
Force Main Size, in	3
Force Main Length, ft	975

4.2 Stream Collection Structure

This section describes the design criteria and recommended improvements for the DS pump station stream collection structure.

4.2.1 Design Criteria

The stream collection structure for the DS pump station will meet the following design criteria:

- Collect and convey flows up to 100 gpm to the DS pump station
- Prevent debris and leaves from entering pumping station storage tank
- Minimize clogging and maintenance of diversion due to debris and leaves

4.2.2 Proposed Stream Collection Structure

Several options have been evaluated for the configuration of the stream collection structure. The differences between the options are described in the following table. Final sizing of the collection mechanism will be done after the preferred alternative is determined by CBS. Product examples for the alternative collection mechanisms are included in Appendix E.

Table 4-2 Stream Collection Structure Options

Option	Collection Mechanism	Figures	Interceptor Manhole	Stream Ponding
1 – Scour Channel	Perforated pipe installed in a precast concrete or fiberglass trough oriented parallel to the stream flow	4-2, 4-3	Y	N
2 – Trench Drain	Trench drain set in a concrete pad oriented perpendicular to stream flow	4-4, 4-5	Y	N
3 – Catch Basin	Catch Basin set in concrete	4-6, 4-7	Y	N
4 – Low Rise Dam	Wedge wire Coanda screen	4-8, 4-9	N	Y

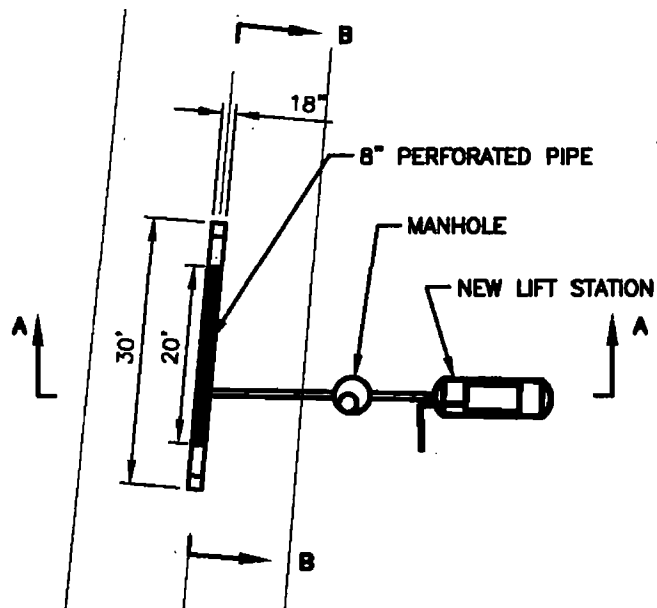
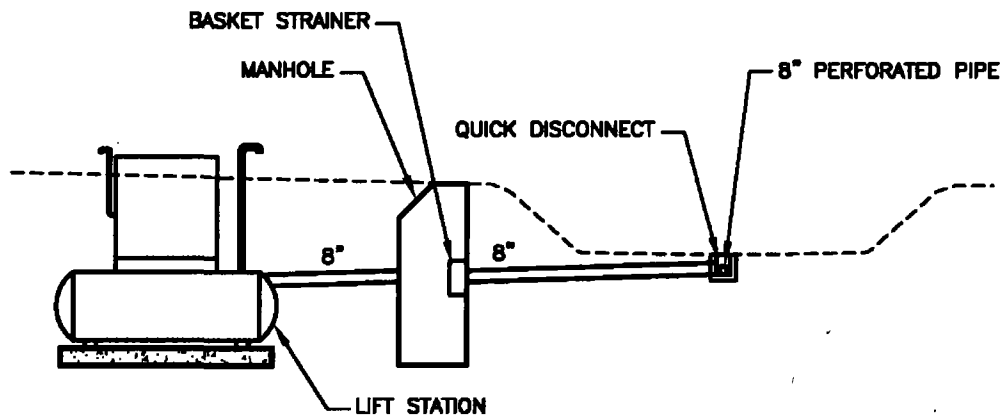
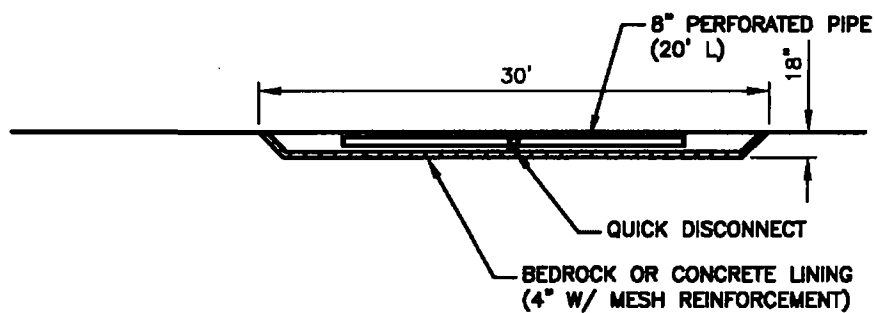


Figure 4-2 Option 1 Scour Channel - Plan View



SECTION A-A



SECTION B-B

Figure 4-3 Option 1 Scour Channel – Profiles

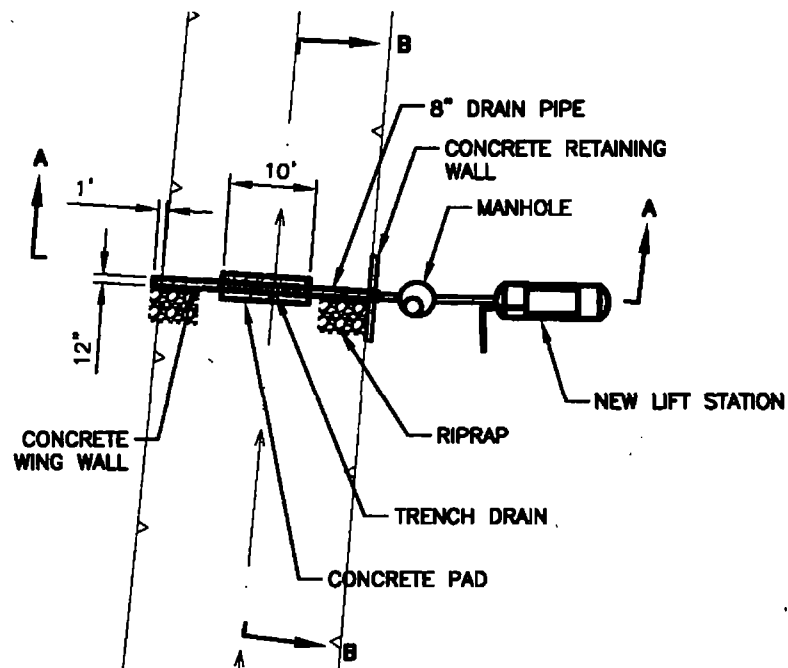
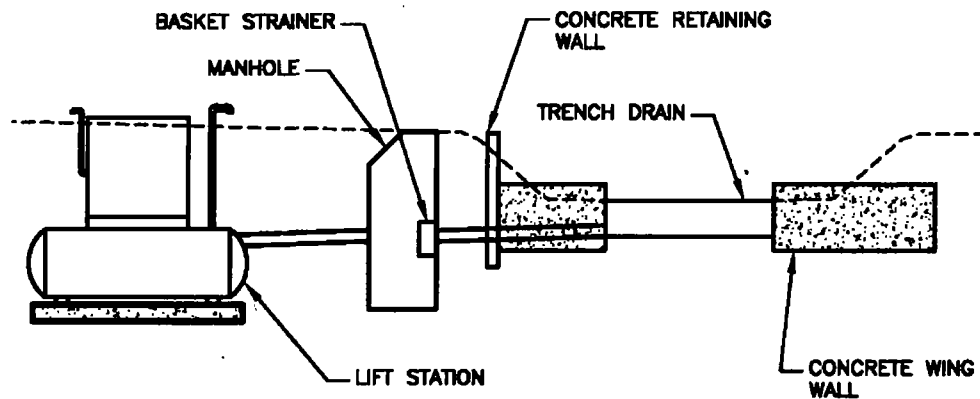
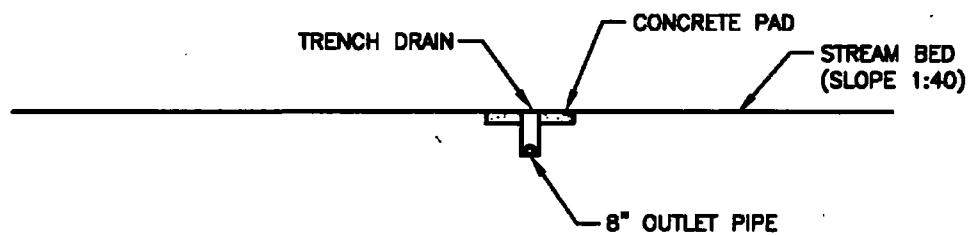


Figure 4-4 Option 2 Trench Drain - Plan View



SECTION A-A



SECTION B-B

Figure 4-5 Option 2 Trench Drain - Profiles

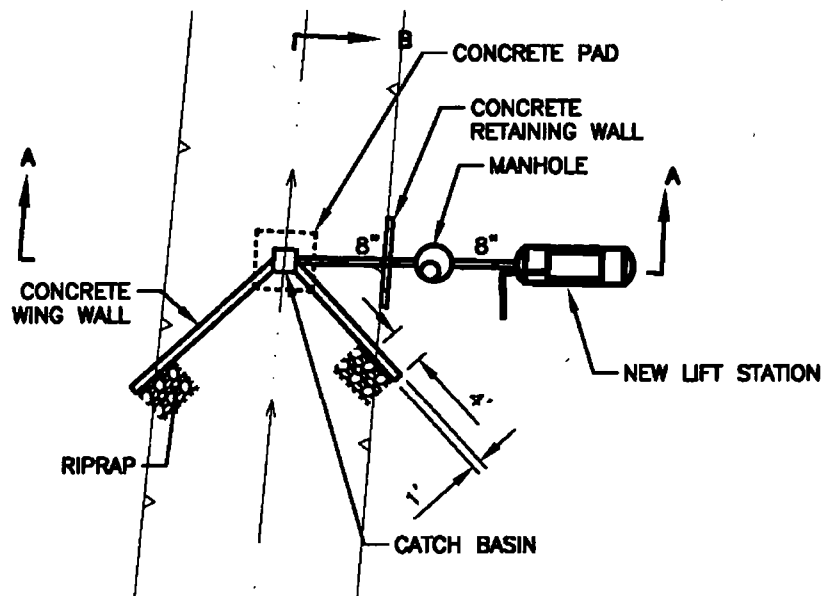
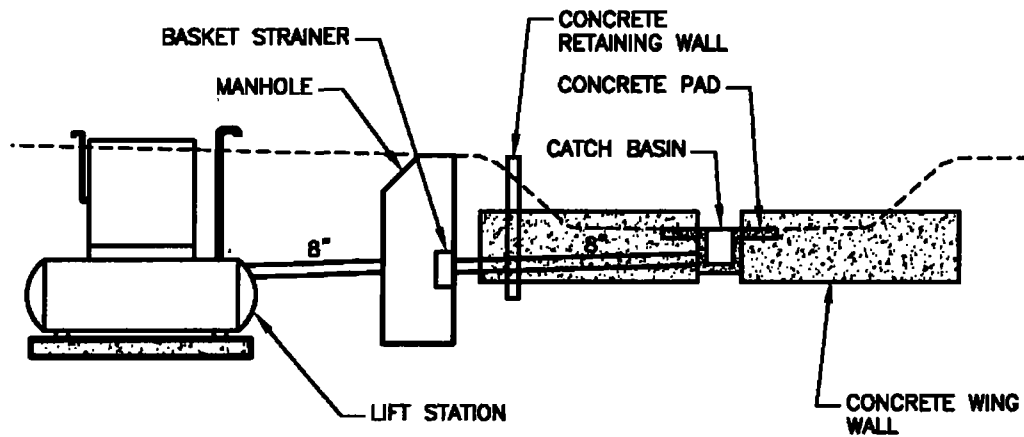
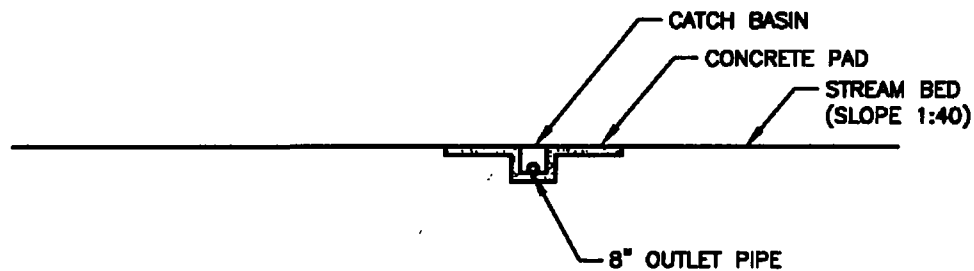


Figure 4-6 Option 3 Catch Basin - Plan View



SECTION A-A



SECTION B-B

Figure 4-7 Option 3 Catch Basin - Profiles

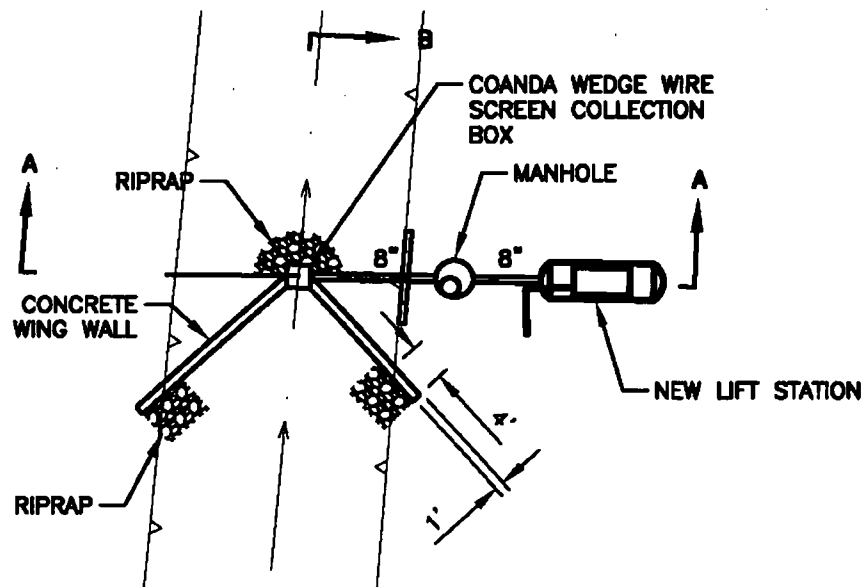


Figure 4-8 Option 4 Low Profile Dam - Plan View

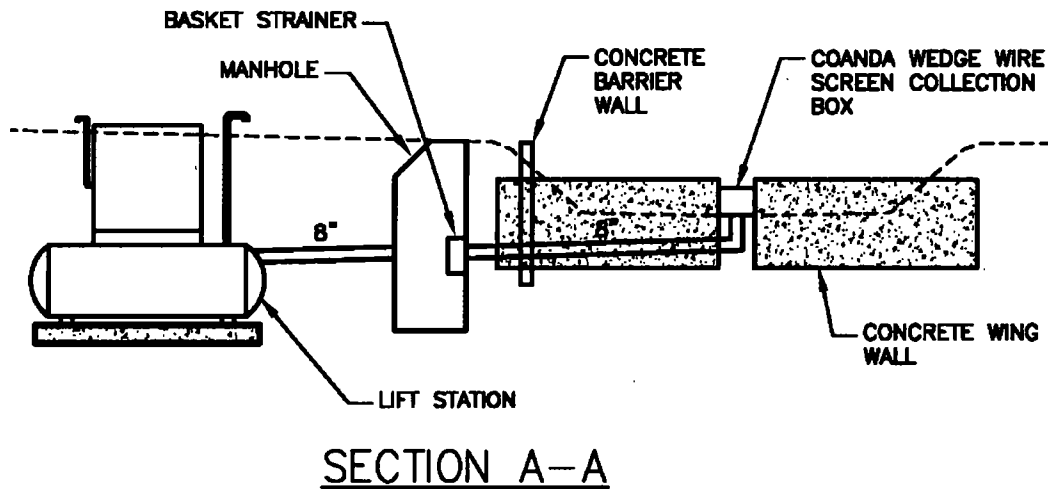


Figure 4-9 Option 4 Low Profile Dam - Profiles

The fractured limestone of the area leads to cracks in the stream channel and banks. Therefore, it is preferable to avoid ponding water above existing grade in the stream channel to minimize the likelihood of bypasses around the collection structure. Since Option 4, the low rise dam, would create ponding in the stream it is not the preferred alternative.

Options 1, 2, and 3 are alternatives to collect stream flow without creating an impoundment. The disadvantage with these alternatives is that there is no means of settling sand, silt, and gravel prior to collection and each alternative will have challenges to screen organic floating material such as leaves, twigs, and invertebrates. Several design features are included to compensate for their inherent disadvantages, though any of these options will require frequent cleaning and maintenance.

- An interceptor manhole is proposed prior to the lift station. This will be a location prior to the lift station where solids can be collected before entering the lift station.
- A basket strainer will be placed below the gravity discharge pipe into the interceptor manhole to catch larger materials such as leaves and twigs.
- The collection mechanisms will be relatively simple to disassemble and clean.

It was determined that Option 1 would collect the 100 gpm base flow with the fewest screening challenges. The collection trough will be excavated into the bedrock under the streambed with gradual entrances and exits intended to mimic a natural scour pool. Bedrock investigations will be performed at the proposed diversion location and a determination will be made as to whether the collection trough will be lined with concrete.

4.3 Effluent Discharge Line

This section describes the design criteria and recommended improvements for the STF effluent discharge line that will convey flows to a point downstream of the proposed DS pump station.

4.3.1 Design Criteria

The STF new effluent discharge line will meet the following design criteria:

- Convey flows up to 600 gpm by gravity to a point downstream of the new DS pump station.
- Installation to provide bury depth adequate to prevent freezing and allow traffic over top.
- Pipe lengths will be maximized to minimize the number of joints on the line.
- Joints will be watertight.

4.3.2 *Proposed Effluent Discharge Line*

The proposed discharge line consists of the following key components and performance capabilities:

- Approximately 975 lineal feet of 12-inch polypropylene ADS N-12 HP piping. Polypropylene pipe (ADS N-12 HP) is a relatively new proprietary product provided by ADS/Hancor Corporation. Although it is a relatively new product, it has been used in several locations in Indiana. It has also been specified by the CBS Corporation for some of their other Indiana projects.
- Pre-cast concrete manhole structures located at some points of alignment change.
- Minimum full flow capacity of 1,225 gpm to a point downstream of the DS pump station.
- Grades of installed sewer will provide for a minimum of 36 inches of earthen cover over the proposed discharge pipe where possible.

Capacity of the effluent line was calculated using Manning's Equation, a roughness coefficient of 0.011, and a minimum slope of 0.50%.

The discharge line alignment will connect to the existing line just prior to the existing discharge point and after the existing line passes beneath the backwash tank.

Chapter 5. PROJECT IMPLEMENTATION SCHEDULE

In order to comply with the terms of the 2009 Consent Decree Amendment, the upgrades to the STF and collection system, as described in this report, will be completed in accordance with the proposed schedule below.

Table 5-1 Implementation Schedule

<i>Milestone</i>	<i>Date</i>
50% Preliminary Design Plans to CBS for review	4/08/11
50% Preliminary Design Plans to Government Parties for review	4/22/11
Receive Comments on 50% Plans from Government Parties	5/22/11
Final Design Plans to CBS for review	6/06/11
Receive Comments on Final Plans from CBS	6/08/11
Final Design Plans to Government Parties	6/10/11
Prepare Construction Bid Package for CBS review	6/10/11
Finalize Construction Bid Package	6/17/11
Advertise for Bids	6/20/11
Receive Bids	7/05/11
Recommend Award of Construction Contract	7/11/11
Construction Notice to Proceed	8/10/11
Substantial Completion Date	10/6/11
Final Completion Date	11/6/11

APPENDIX A CALCULATIONS

CBS Corporation - Neal's Landfill Spring Treatment Facility - DS Seep Pump Station (Existing Pumps)

C0850040

Preliminary Design

Existing Pumps - System Curve

Design

Physical Information

Pump Suction (centerline)	702.94 ft
Influent Pipe Invert	704.61 ft
Suction Level (setpoint)	704.00 ft
Discharge Level (c/l of discharge)	728.50 ft
Mixer Nozzle	ft
Overflow (max water elev)	704.90 ft
Pumping Capacity	100 gpm

Note

Minor Losses for valves, fittings, etc., are always computed at C=140 in the Adjusted Headloss calculations.

Therefore, the summary table at the end does not agree when using the same C values.

See Sanks "Pumping Station Design", Chapter 19-1, Simplified Headloss Calculations, Page 486.

Minor Losses for PVC fittings and valves, 2"-4" in size, were calculated based upon data provided by Harvel Plastics, see table this sheet.

System Static Head	24.50 ft
Pump Static Suction Head	1.06 ft
Pump Dynamic Suction Head (C=120) at 500	1.06 ft
Velocity Head at 500	0.63 ft
Pump Dynamic Suction Gauge Pressure at 500	0.43 ft
Barometric Pressure	33.06 ft
Vapor Pressure (Temp=70, VP=0.8, Temp=50, VP=0.4)	0.60 ft
Minimum NPSH Safety Factor	5.00 ft
Net Positive Suction Head Available	28.52 ft

Maximum System Flow (gpm) 500

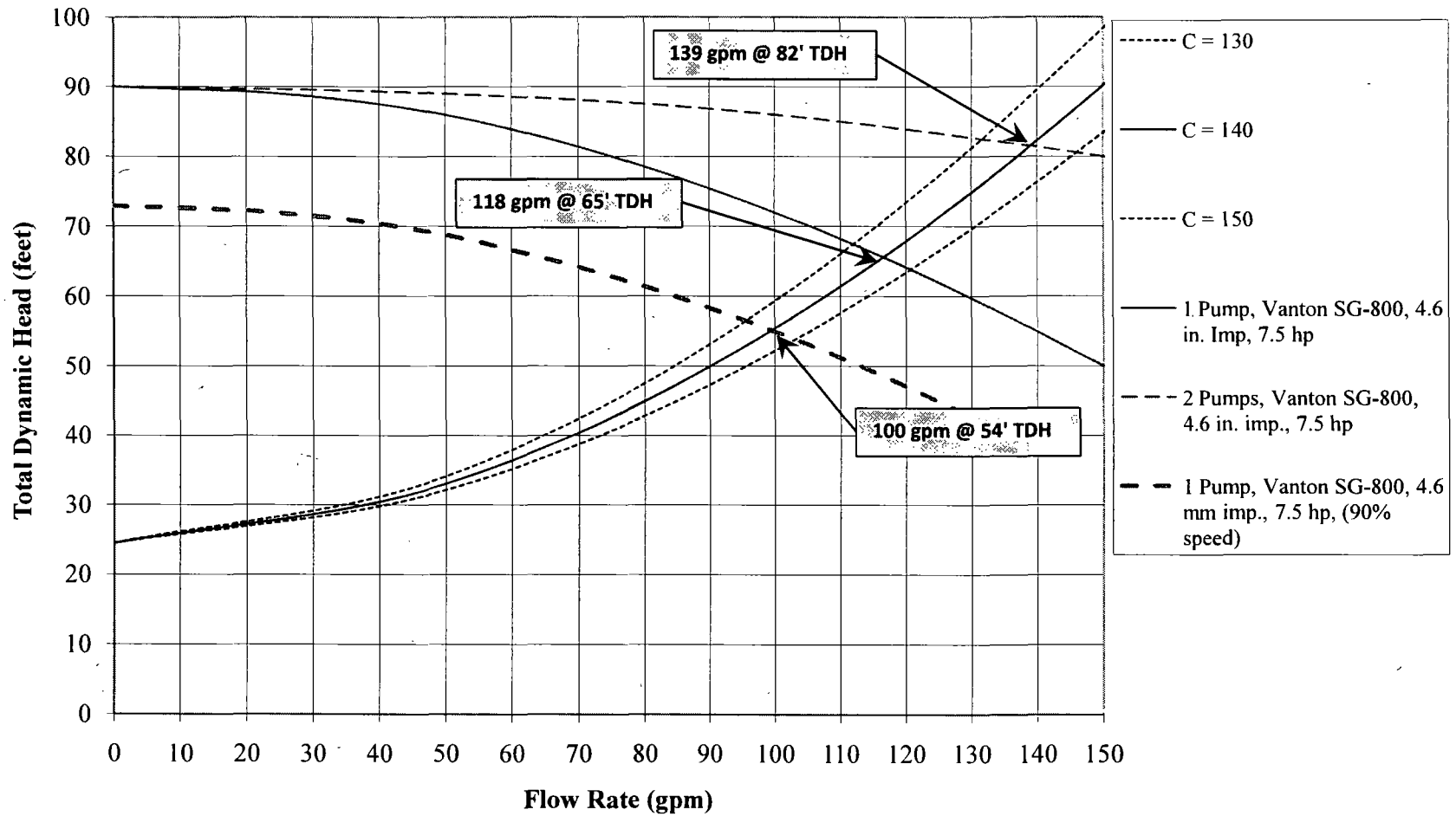
Pumps Operating 2

[illegible]

Total Flow (gpm)	Total Dynamic Head				
	C =	C =	C =	C =	C =
	150 (feet)	140 (feet)	130 (feet)	100 (feet)	80 (feet)
0	24 5	24 5	24 5	24 5	24 5
50	32 1	33 0	34 1	39 4	46 4
100	52 2	55 4	59 3	78 4	103 7
150	83 4	90 2	98 4	138 8	192 5
200	125 1	136 6	150 7	219 4	310 8
250	176 8	194 2	215 5	319 4	457 5
300	238 3	262 7	292 5	438 1	631 6
350	309 4	341 7	381 4	575 1	832 4
400	389 7	431 2	482 0	729 9	1059 3
450	479 2	530 7	593 9	902 2	1311 9
500	577 7	640 3	717 2	1091 7	1589 6

[illegible][illegible]

**CBS Corp. Neal's Landfill
DS Seep Pump Station- New Pumps & 3-inch FM**



APPENDIX B

CONSTRUCTION PROJECT MANUAL

DRAFT

Project Manual – 50% Design Specifications

Neal's Landfill Improvements 2011

**Neal's Landfill Spring Treatment Facility
in Bloomington, Indiana
for CBS Corporation**

April 2011

**Design Firm
Registration No.: 184-00450**

TECHNICAL SPECIFICATIONS
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Neal's Landfill Spring Treatment Facility
Bloomington, Indiana
Downstream Seep Pumping Station

CBS Corporation, Inc.

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Downstream Seep Pumping Station

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SECTION 01010

SUMMARY OF WORK

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. The WORK to be performed under this Contract shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. The WORK of this Contract comprises the construction of the new package pump station for the Neal's Landfill Treatment Facility in Bloomington, Indiana. The improvements will include:
 - 1. Furnish and install one (1) package pump station rated to pump 100 gpm
 - 2. Installation of one (1) collection basin
 - 3. Furnish and install one (1) rail mounted leaf basket strainer
 - 4. Furnish and install one (1) sediment collection manhole
 - 5. Install approximately 950 linear foot of new 3-inch force main from the pump station to the existing stormwater seep force main
 - 6. Installation of approximately 1,000 linear foot of 15-inch effluent discharge line with outfall downstream of the new pump station
 - 7. Installation of piping, valves
 - 8. Installation of yard piping
 - 9. Furnish and install one (1) pump station control panel and electrical service
 - 10. Treatment system startup
- B. The WORK for the construction will be located at the Neal's Landfill located in Bloomington, Indiana.

1.3 CONTRACT METHOD

- A. The WORK hereunder will be constructed under a lump sum contract per the Contract Documents.

1.4 WORK BY OTHERS

- A. Where two or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the OWNER will determine the sequence and order of the WORK in either or both contracts. When the Site of one contract is the necessary or convenient means of

access for performance of work under another, the OWNER may grant privilege of access or other reasonable privilege to the CONTRACTOR so desiring, to the extent, amount, and in manner and at time that the OWNER may determine. No OWNER determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The CONTRACTOR shall conduct its operations so as to cause a minimum of interference with the work of such other contractors, and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

- C. Interference With Work On Utilities: The CONTRACTOR shall cooperate fully with all utility forces of the OWNER or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the WORK, and shall schedule the WORK so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.5 WORK SEQUENCE

- A. The CONTRACTOR's construction activities shall be limited to the hours and days stipulated in the Contract Documents.
- B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed written plan and schedule for the WORK a minimum of two [2] weeks in advance of the time that such WORK is planned. Any modifications to the plan requested by the ENGINEER shall be resubmitted in writing by the CONTRACTOR. No such WORK shall begin until the CONTRACTOR receives written approval for the WORK from the ENGINEER.
- C. The overall project is defined as the WORK contained in the Contract Documents with specific completion requirements and Liquidated Damages as provided for in the Agreement. Construction of the Work is expected to occur in the following assumed general sequence:
 - 1. Following the receipt of the Notice to Proceed, the CONTRACTOR will begin the Work and move onto the sites per its schedule developed for the Project. It is solely the CONTRACTOR's responsibility to coordinate activities within the project site between CONTRACTOR's employees and Subcontractors.
 - 2. The CONTRACTOR shall maintain adequate security to protect the Work and the public safety at both sites throughout the duration of the Project.
 - 3. Construction of the new treatment system shall proceed after schedules and submittals are approved and site security is installed.
 - 4. No shutdowns of the existing treatment system are anticipated to be required as part of the new treatment system installation. CONTRACTOR shall notify the ENGINEER and OWNER if a shutdown is believed necessary. Shutdowns of the existing treatment system will be limited to 4 hours.

5. Connection to the existing storage tank overflows shall occur after installation of the new treatment system is complete. Shutdowns shall be coordinated with the OWNER; if inclement weather is likely, the OWNER may require the shutdown be rescheduled at no additional cost.
6. The OWNER must have access to the ICS treatment buildings at all times therefore the access road must remain passable to vehicular traffic during construction.

1.6 CONTRACTOR USE OF SITE

- A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.
- B. The CONTRACTOR shall limit activities to within the physical boundaries shown in the Drawings.

1.7 OWNER USE OF THE SITE

- A. The OWNER may utilize all or part of the existing Site and access existing facilities during the entire period of construction for the conduct of the OWNER's normal operations and maintenance activities. The CONTRACTOR shall cooperate and coordinate with the OWNER and ENGINEER to facilitate the OWNER's operations and to minimize interference with the CONTRACTOR's operations at the same time. In any event, the OWNER shall be allowed access to the Site during the period of construction.

1.8 PROJECT MEETINGS

- A. Preconstruction Conference
 1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR's Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:
 - a. ENGINEER and the Resident Project Representative.
 - b. Representatives of OWNER.
 - c. Governmental representatives as appropriate.
 - d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.
 2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with General Conditions 6.17.
 3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be

furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.

- a. Status of CONTRACTOR's insurance and bonds.
 - b. CONTRACTOR's tentative schedules.
 - c. Transmittal, review, and distribution of CONTRACTOR's submittals.
 - d. Processing applications for payment.
 - e. Maintaining record documents.
 - f. Critical work sequencing.
 - g. Field decisions and Change Orders.
 - h. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
 - i. Major equipment deliveries and priorities.
 - j. CONTRACTOR's assignments for safety and first aid.
 - k. Daily Report Form which the ENGINEER will furnish.
 - l. Submittal Transmittal Form which the ENGINEER will furnish.
4. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.
 5. The CONTRACTOR and its subcontractors should plan on the conference taking up to 6 hours.

B. Progress Meetings

1. The ENGINEER will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by OWNER, CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors. OWNER's attendance will be discretionary, however no meeting shall be held without the OWNER's knowledge and opportunity to attend. Every reasonable effort shall be made by the CONTRACTOR to accommodate the OWNER's schedule so that meetings may be attended.
2. The ENGINEER will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each

meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

1.10 LOCAL REQUIREMENTS

- A. All storm water drainage facilities shall comply, at a minimum, with the Construction Specifications for City of Bloomington Utilities, current edition. This manual is available online at the following internet address:
<http://bloomington.in.gov/media/media/application/pdf/6632.pdf>.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01310

SCHEDULES, REPORTS, PAYMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.

1.2 COORDINATION

- A. Coordinate both the listing and timing of activities required by provisions of this and other sections, so as to provide consistency and logical coordination between activities. Provide close coordination of the progress schedule, listing of subcontracts, schedule of submittals, progress reports, and payment requests.

1.3 PROGRESS SCHEDULE

- A. The CONTRACTOR shall submit a bar-chart type preliminary progress schedule with their bid.
- B. Within seven (7) days after the Contract Award the CONTRACTOR shall submit an updated progress schedule. On the schedule, indicate a time bar for each major category or unit of work to be performed.
 - 1. Submittal Tabulation: With the bar-chart submittal, submit a tabulation, by date, of the submittals required during the Construction Time. At the CONTRACTOR's option, submittal dates may be shown on the bar-chart schedule, in lieu of being tabulated.
- C. The first Payment Request shall not be submitted prior to submittal of a progress schedule acceptable to the OWNER and ENGINEER.
- D. The CONTRACTOR shall update the progress schedule and submit it to the OWNER and ENGINEER every time the substantial completion date changes by more than seven (7) days.

1.4 PROGRESS MEETINGS, REPORTING

- A. General: In addition to an initial progress meeting, and other regular project meetings held for other purposes, a general progress meeting with the OWNER and ENGINEER will be held each week to:

1. Review each entity's present and future needs including interface requirements, time, sequences, deliveries, access, site utilization, temporary facilities and services, hours of work, hazards and risks, housekeeping, change orders, and documentation of information for payment requests.
 2. Discuss whether each element of current work is ahead of schedule, on time, or behind schedule in relation with updated progress schedule.
 3. Determine how behind-schedule work will be expedited, and secure commitments from entities involved in doing so.
 4. Discuss whether schedule revisions are required to ensure that current work and subsequent work will be completed within Contract Time.
 5. Review everything of significance which could affect progress of the work.
- B. Initial Progress Meeting: Schedule initial progress meeting, recognized as "Pre-Construction Meeting", for a date not more than 10 days before date of commencement of the work. Use it as an organizational meeting, and review responsibilities and personnel assignments.
- C. Reporting: Within 5 days after each progress meeting date, distribute copies of minutes-of-the-meeting to each entity present and to others who should have been present. Include brief summary (in narrative form) of progress of the work since previous meeting and report.
- D. Schedule Updating: Immediately following each progress meeting, where revisions to progress schedule have been made or recognized, revise progress schedule. Reissue revised schedule concurrently with report of each meeting.
- E. Daily Reports: Prepare a daily report, recording the following information concerning events at the site; and submit duplicate copies to OWNER at regular intervals not exceeding weekly intervals:
1. List of subcontractors at the site.
 2. Approximate count of personnel at the site.
 3. High/low temperatures, general weather conditions.
 4. Accidents (refer to accident reports).
 5. Meetings and significant decisions.
 6. Unusual events (refer to special reports).
 7. Stoppages, delays, shortages, losses.
 8. Emergency procedures, field orders.
 9. Orders/requests by governing authorities.
 10. Change orders received, implemented.
 11. Substantial completions authorized.

1.5 PAYMENT REQUESTS

- A. General: Except as otherwise indicated, the progress payment cycle is to be regular. Each application must be consistent with previous applications and payments. Certain

applications for payment, such as the initial application, the application at substantial completion, and the final payment application involve additional requirements.

1. **Waivers of Lien:** For each payment application, submit waivers of lien from every entity (including CONTRACTOR) who could lawfully and possibly file a lien in excess of \$1000 arising out of the Contract, and related to work covered by the payment. Submit partial waivers for the amount requested, prior to deduction or retainage, on each item. When the application shows completion of an item, submit final or full waivers. The OWNER reserves the right to designate which entities involved in the work must submit waivers.
 2. **Waiver Delays:** Each progress payment must be submitted with CONTRACTOR's waiver for the period of construction covered by the application. At the CONTRACTOR's option, each progress payment may be submitted with waivers from the subcontractors or sub-subcontractors and suppliers for the previous period of construction covered by the previous application. The final payment application must be submitted together with or preceded by final or complete waivers from every entity involved with performance of the work covered by the payment request.
 3. **Waiver Forms:** Submit waivers on forms, and executed in a manner, acceptable to OWNER.
 4. **Sworn Statements:** Each progress payment must be submitted with a sworn statement showing subcontractors and material suppliers and the payment status of each. Form or the sworn statement shall be subjected to approval of owner.
- B. **Payment Application Times:** The "date" for each progress "payment" is as indicated in OWNER-CONTRACTOR Agreement or, if none is indicated therein, it is the 15th day of each month. The period of construction work covered by each payment request is period indicated in OWNER-CONTRACTOR Agreement or, if none is indicated therein, it is period ending 15 days prior to date for each progress payment, and starting day following end of preceding period.
- C. **Application Preparation:** Except as otherwise indicated, complete every entry provided for on the form, including notarization and execution by authorized persons. Incomplete applications will be returned by OWNER without action. Listing must include amounts of change orders issued prior to last day of the "period of construction" covered by application.
- D. **Initial Payment Application:** The principal administrative actions and submittals which must precede or coincide with submittal of contractor's first payment application can be summarized as follows, but not necessarily by way of limitation:
1. Listing of subcontractors and principal suppliers and fabricators.

2. Progress schedule (preliminary if not final).
 3. Schedule of principal products.
 4. Schedule of submittals (preliminary if not final).
 5. Listing of CONTRACTOR's staff assignments and principal consultants.
 6. Copies of acquired permits and similar authorizations and licenses from governing authorities for current performance of the work.
 7. Data needed to acquire OWNER's insurance coverages.
 8. Initial progress report, including report of pre-construction meeting.
 9. Same forms for Waiver of Lien and Sworn Statement.
- E. Application at Time of Final Completion: Following issuance of ENGINEER's final "certificate of substantial completion", and also in part as applicable to prior certificates on portions of completed work as designated, a "special" payment application may be prepared and submitted by CONTRACTOR. The principal administrative actions and submittals which must proceed or coincide with such special applications can be summarized as follows, but not necessarily by way of limitation:
1. Warranties (guarantees), maintenance agreements and similar provisions of contract documents.
 2. Cost inventory of all purchased items.
 3. Test records, maintenance instructions, start-up performance reports, and similar change-over information germane to OWNER's occupancy, use, operation and maintenance of completed work.
 4. Final cleaning of the work.
 5. Application for reduction (if any) of retainage, and consent of surety.
 6. Advice to OWNER on coordination of shifting insurance coverages, including proof of extended coverages as required.
 7. Final progress photographs, where required.
 8. Listing of CONTRACTOR's incomplete work, recognized as exceptions to ENGINEER's certificate of substantial completion.

- F. Final Payment Application: The administrative actions and submittals which must precede or coincide with submittal of contractor's final payment application can be summarized as follows, but not necessarily by way of limitation:
1. Completion of project closeout requirements.
 2. Completion of items specified for completion beyond time of substantial completion (regardless of whether special payment application was previously made).
 9. Assurance, satisfactory to OWNER, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
 4. Transmittal of required project construction records to OWNER.
 5. Proof, satisfactory to OWNER, that taxes, fees and similar obligations of CONTRACTOR have been paid.
 6. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
 7. Consent of surety for final payment.
- G. Application Transmittal: Submit 3 executed copies of each payment application, one copy of which is completed with waivers of lien and similar attachments. Transmit each copy with a transmittal form listing those attachments, and recording appropriate information related to application in a manner acceptable to ENGINEER. Transmit to ENGINEER by means ensuring receipt within 24 hours.

END OF SECTION

SECTION 01335

PRE-CONDITION SURVEY

PART 1 – GENERAL

1.1. SCOPE OF WORK

- A. The CONTRACTOR shall conduct a thorough pre-construction site condition survey of the entire job. Site Condition Survey shall consist of photographs, digital video recordings, and a survey log and report, describing and thoroughly documenting the survey with location maps and detailed comments as needed. Sufficient photographs supplemented by digital video shall be provided by the CONTRACTOR and submitted to the ENGINEER to resolve any damage claims from third party, which may arise due to the construction of this project.
- B. Digital video and photograph survey shall be completed of existing facilities that may be impacted by the Work, and shall include, but not be limited to, residential buildings, commercial properties, government buildings, streets, curbs, catch basins, sidewalks, driveways, bridges, railroad tracks, ditches, culverts, trees, landscaping, headwalls, retaining walls, fences, visible utilities, and access roads used to transport material or equipment to and from the project site.

1.2. RELATED WORK

- A. Section 01505 – Mobilization and Demobilization
- B. Section 02100 – Site Preparation

1.3. QUALITY ASSURANCE AND CONTROL

- A. The CONTRACTOR shall retain the services of an independent third-party professional or company who will conduct detailed pre-construction survey documenting the condition of all private, commercial and public property that may be impacted by the Work. The third party professional or company shall have performed similar pre-construction survey services on at least three projects of similar scope and complexity.

1.4. SUBMITTALS

- A. Submit to the ENGINEER the following a minimum of eight weeks before the scheduled start of the applicable activity:
 - 1. Name and qualifications of a person responsible for pre-construction site condition survey in accordance with Paragraph 1.3 herein.

2. Schedule delineating all tasks to be performed including but not limited to:

- a. Preparing submittals
- b. Notifications to the ENGINEER
- c. Conducting pre-condition survey
- d. Preparation of Reports

B. Photographs shall be placed in plastic photo-sheets and bound along with the related survey log and reports. Digital video shall be placed on a DVD and be formatted correctly to view on a DVD player. The data obtained from the survey shall be delivered to the ENGINEER within 7 days of the date of survey. Two copies of the DVD, photographs and report shall be provided.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01340

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-Administrative Submittals
- B. Operation and Maintenance Manuals

1.2 DESCRIPTION OF REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Specification Sections, apply to work of this Section.
- B. Non-Administrative Submittals
 - 1. This Section specifies procedural requirements for non-administrative submittals including shop drawings, product data, and other miscellaneous work-related submittals. Shop drawings, product data, and other work-related submittals are required to amplify, expand and coordinate the information contained in the Contract Documents.
 - 2. Refer to other Division 1 Sections and other contract documents for specifications on administrative, non-work-related submittals. Such submittals include, but are not limited to the following items:
 - a. Permits.
 - b. Payment applications.
 - c. Performance and payment bonds.
 - d. Insurance certificates.
 - e. Inspection and test reports.
 - f. Progress reports.
 - g. Listing of subcontractors.
 - 3. Shop drawings are technical drawings and data that have been specially prepared for this project, including but not limited to the following items:
 - a. Fabrication and installation drawings.
 - b. Schedules.
 - c. Design mix formulas.
 - 4. Standard information prepared without specific reference to a project is not considered to be shop drawings.

5. Product data includes standard printed information on manufactured products that has not been specially-prepared for this project, including but not limited to the following items:
 - a. Manufacturer's product specifications and installation instructions.
 - b. Catalog cuts.
 - c. Standard product operating and maintenance manuals.
6. Miscellaneous submittals are work-related, non-administrative submittals that do not fit in the three previous categories, including, but not limited to the following:
 - a. Specially-prepared and standard printed warranties.
 - b. Survey data and reports.
 - c. Testing and certification reports.
 - d. Record drawings.
 - e. Field measurement data.

C. Operation and Maintenance Manuals

1. The CONTRACTOR shall be responsible for obtaining installation, operation, and maintenance manuals from manufacturers and suppliers for each item of equipment furnished under the Contract. Submit three copies of each complete manual to the OWNER within 90 days after approval of shop drawings, product data, and samples and not later than the date of shipment of each item of equipment to the project site.
2. Manuals shall be provided for each piece of equipment including individual components and subsystems of complete assemblies. The Section of the manual on operation shall describe the function of each component and its relationship to the system of which it is a part. Where several models, options, or styles are described, the manual shall identify the items actually provided. The manual shall be updated to show as built and designed conditions
3. The manual shall contain the following:
 - a. An 8-1/2 x 11 inch typewritten sheet listing the manufacturer's identification, including order number, model, and serial number and location of parts and service centers.
 - b. A separate 8-1/2 x 11 inch typewritten list of recommended stock of parts, including part number and quantity.
 - c. Complete replacement parts list and drawings.
 - d. Performance data and rating tables.
 - e. Specific instructions for installation, operation, adjustment, and maintenance.
4. Each manual shall be bound in a folder and labeled to identify the contents and project to which it applies.

5. Operation and maintenance manuals specified herein are in addition to any operation, maintenance, or installation instructions required by the CONTRACTOR to install, test, and start up equipment.

1.3 SUBMITTAL PROCEDURES

A. General

1. Refer to the General Conditions for basic procedures for submittal handling.

B. Coordination

1. Coordinate the preparation and processing of submittals with the performance of the work. Coordinate each separate submittal with other submittals and related activities such as testing, purchasing, fabrication, delivery and similar activities that require sequential activity.
2. Coordinate the submittal of different units of interrelated work so that one submittal will not be delayed by the ENGINEER's need to review a related submittal. The ENGINEER reserves the right to withhold action on any submittal requiring coordination with other submittals until related submittals are forthcoming.
3. Scheduling: In each appropriate administrative submittal, such as the progress schedule, show the principal work-related submittals and time requirements for coordination of submittal activity with related work.

C. Coordination of Submittal Times: Prepare and transmit each submittal to the ENGINEER sufficiently in advance of the scheduled performance of related work and other applicable activities. Transmit different kinds of submittals for the same unit of work so that processing will not be delayed by the ENGINEER's need to review submittals concurrently for coordination.

D. Review Time: Allow sufficient time so that the installation will not be delayed as a result of the time required to properly process submittals, including time for resubmittal, if necessary. Advise the ENGINEER on each submittal as to whether processing time is critical to the progress of the work, and if the work would be expedited if processing time could be shortened.

1. Allow two weeks for the ENGINEER's processing of each submittal. Allow a longer time period where processing must be delayed for coordination with subsequent submittals. The ENGINEER will advise the CONTRACTOR promptly when it is determined that a submittal being processed must be delayed for coordination.
2. No extension of time will be authorized because of the CONTRACTOR's failure to transmit submittals to the ENGINEER sufficiently in advance of the work.

- E. Submittal Preparation: Mark each submittal with a permanent label for identification. Provide the following information on the label for proper processing and recording of action taken.
1. Project name.
 2. Date.
 3. Name and address of Engineer.
 4. Name and address of Contractor.
 5. Name and address of supplier.
 6. Name of manufacturer.
 7. Number and title of appropriate specification Section.
 8. Drawing number and detail references, as appropriate.
 9. Similar definitive information as necessary.
 10. Provide a space on the label for the CONTRACTOR's review and approval markings, and a space for the ENGINEER's "Action" marking.
- F. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the CONTRACTOR to the Engineer by use of a transmittal form. Submittals received from sources other than the CONTRACTOR will be returned to the sender "without action".
- G. Transmittal Form: Provide on the form places for the following information:
1. Project name.
 2. Date.
 3. To:
 4. From:
 5. Names of subcontractor, manufacturer and supplier.
 6. References.
 7. Category and type of submittal.
 8. Submittal purpose and description.
 9. Submittal and transmittal distribution record.
 10. Signature of transmitter.
 11. CONTRACTOR's certification stating that the information submitted complies with the requirements of the Contract Documents, with a place for the CONTRACTOR's signature.
 12. Record relevant information and requests for data on the transmittal form. On the transmittal form, or on a separate sheet attached to the form, record deviations from the requirements of the Contract Documents, if any, including minor variations and limitations.

1.4 SPECIFIC SUBMITTAL REQUIREMENTS

- A. General: Specific submittal requirements for individual units of work are specified in the applicable specification Section. Except as otherwise indicated in the individual specification Sections, comply with the requirements specified herein for each type of submittal.

1. Where it is necessary to provide intermediate submittals between the initial and final submittals, provide and process intermediate submittals in the same manner as for initial submittals.
- B. Shop Drawings: Information required on shop drawings includes, dimensions, identification of specific products and materials which are included in the work, compliance with specified standards and notations of coordination requirements with other work. Provide special notation of dimensions that have been established by field measurement. Highlight, encircle or otherwise indicate deviations from the contract documents on the shop drawings.
 1. Do not permit shop drawing copies without an appropriate final "Action" marking by the ENGINEER to be used in connection with the work.
- C. Preparation: Submit newly prepared information, drawn to accurate scale on sheets not less than 8-1/2" x 11"; except for actual pattern or template type drawings, the maximum sheet size shall not exceed 24" x 36". Indicate the name of the firm that prepared each shop drawing and provide appropriate project identification in the title block. Provide a space not less than 12 sq. in. beside the title block for marking the record of the review process and the ENGINEER's "Action" marking.
 1. Do not reproduce contract documents or copy standard printed information as the basis of shop drawings.
- D. Submittal: Provide a minimum of seven (7) copies of all information, unless directed otherwise by the CONTRACTOR. Clark Dietz, Inc. is to keep a max of four (4) copies.
- E. Product Data: General information required specifically as product data includes manufacturer's standard printed recommendations for application and use, compliance with recognized standards of trade associations and testing agencies, and the application of their labels and seals (if any), special notation of dimensions which have been verified by way of field measurement, and special coordination requirements for interfacing the material, product or system with other work.
- F. Preparation: Collect required product data into a single submittal for each unit of work or system. Mark each copy to show which choices and options are applicable to the project. Where product data has been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark the copies to show clearly that such information is not applicable.
 1. Where product data must be specially prepared for required products, materials or systems, because standard printed data is not suitable for use, submit data as "shop drawings" and not as "product data".
- G. Submittals: Product data submittal is required for information and record and to determine that the products, materials and systems comply with the provisions of the contract documents. Therefore, the initial submittal is also the final submittal, except where the ENGINEER observes that there is non-compliance with the provisions of the

contract documents and returns the submittal promptly to the CONTRACTOR marked with the appropriate "Action".

H. Miscellaneous Submittals

1. Inspection and Test Reports: Classify each inspection and test report as being either "shop drawings" or "product data" depending on whether the report is specially prepared for the project, or a standard publication of workmanship control testing at the point of production. Process inspection and test reports accordingly.
2. Warranties: Refer to Sections 00700 and 01600 for specific general requirements on warranties, product bonds, workmanship bonds and maintenance agreements. In addition to copies desired for the CONTRACTOR's use, furnish 2 executed copies of such warranties, bonds or agreements.
3. Survey Data: Refer to Section 01040 for specific general requirements on field measurements, quantitative records of actual work, damage surveys and similar data required by the individual Sections of these specifications. None of the specified copies will be returned.
4. Standards: Where submittal of a copy of standards is indicated, and except where copies of standards are specified as an integral part of a "Product Data" submittal, submit a single copy of standards for the ENGINEER's use. Where workmanship, whether at the project site or elsewhere is governed by a standard, furnish additional copies of the standard to fabricators, installers and others involved in the performance of the work.
5. Closeout Submittals: Refer to Section 01700 and to individual Sections of these specifications for specific submittal requirements of project closeout information, materials, tools, and similar items.
6. Record Documents: Furnish at least one set of original documents to be maintained on the project site for the purpose of recording as-built information.
7. General Distribution: Provide additional distribution of submittals to subcontractors, suppliers, fabricators, installers, governing authorities, and others as necessary for the proper performance of the work. Include such additional copies of submittals in the transmittal to the ENGINEER where the submittals are required to receive "Action" marking before final distribution. Record distributions on transmittal forms.

1.5 ENGINEER'S ACTION

- A. General: Except for submittals for the record and similar purposes, where action and return on submittals is required or requested, the ENGINEER will review each

submittal, mark with appropriate "Action", and where possible return within 2 weeks of receipt. Where the submittal must be held for coordination the ENGINEER will so advise the CONTRACTOR without delay.

- B. Action Stamp: The ENGINEER will stamp each submittal to be returned with a uniform, self explanatory action stamp, appropriately marked and executed to indicate whether the submittal returned is for unrestricted use, final-but-restricted use (as marked), must be revised and resubmitted (use not permitted) or without action (as explained on the transmittal form).
- C. Final Unrestricted Release: Where the submittals are marked as follows, the work covered by the submittal may proceed provided it complies with the requirements of the contract documents; acceptance of the work will depend upon that compliance.
 - 1. Marking: "No Exception Taken".
- D. Final-But-Restricted Release: When the submittals are marked as follows, the work covered by the submittal may proceed provided it complies with both the ENGINEER's notations or corrections on the submittal and with the requirements of the contract documents; acceptance of the work will depend on that compliance.
 - 1. Marking: "Make Corrections Noted".
- E. Returned for Resubmittal: When the submittal is marked as follows, do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise the submittal or prepare a new submittal in accordance with the ENGINEER's notations stating the reasons for returning the submittal; resubmit the submittal without delay. Repeat if necessary to obtain a different action marking. Do not permit submittals with the following marking to be used at the project site, or elsewhere where work is in progress.
 - 1. Marking: "Rejected".
"Revise and Resubmit".
"Submit Specified Item".

END OF SECTION

SECTION 01341

REQUESTS FOR INFORMATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Requests for Information (RFIs)

1.2 DESCRIPTION OF REQUIREMENTS

- A. General provisions of Contract, including General and Supplementary Conditions and other Specification Sections, apply to work of this Section.
- B. The CONTRACTOR shall use an RFI when requesting an interpretation or clarification of a requirement of the Contract Documents. The CONTRACTOR shall clearly and concisely set forth the issue for which they seek interpretation or clarification and why a written response is needed from the ENGINEER. The CONTRACTOR shall, in the written RFI, set forth their interpretation or understanding of the Contract Documents along with the reason they have reached such an understanding. The CONTRACTOR shall also set forth their proposed solution to the issue raised in the RFI. If the CONTRACTOR's proposed solution potentially involves a change in the contract's cost or time, it shall be noted in the original RFI along with an estimate of those changes.
- C. The ENGINEER's response to the RFI will not change any requirements of the Contract Documents unless so noted in the response. In the event the CONTRACTOR believes that a response to an RFI will cause a change to the requirements of the Contract Documents, the CONTRACTOR shall within five (5) days give written notice to the ENGINEER. Failure to give such written notice within five (5) days shall waive the CONTRACTOR's right to seek additional time or cost.
- D. RFIs shall not be used for routine project communications, submittals, proposals, or for substitution or "or equal" requests. The ENGINEER will review all RFIs to determine whether they meet the above criteria. If the ENGINEER determines that the document is not an RFI, it will be returned to the CONTRACTOR, unviewed as to content, for resubmittal in the proper manner. Consequences of resulting delays shall be the responsibility of the CONTRACTOR.
- E. If an expedited review of the RFI is needed, the CONTRACTOR shall include on the RFI an explanation of the need to expedite, including the identification of activities in the Project Schedule potentially impacted by the RFI. For all RFIs, when an activity that is or may be impacted by the RFI is in progress or has an early start date within thirty (30) days of the submittal of the RFI, that activity shall be identified on the RFI.

The ENGINEER will expedite when possible. Expedited review requests shall not exceed ten percent (10%) of the total RFIs.

1.3 RFI SUBMITTAL PROCEDURES

A. RFI Preparation:

1. The CONTRACTOR shall submit typed copies of RFIs to the Engineering. Handwritten copies will not be accepted.
2. Each RFI shall be sequentially numbered. Each RFI shall be submitted on its own form.
3. The CONTRACTOR shall use a standard RFI form that includes
 - a. Project name
 - b. Date
 - c. Name and address of Engineer
 - d. Name and address of Contractor
 - e. Number and title of appropriate specification Section or Drawing number
 - f. Information Requested
 - g. Potential Cost Impact
 - h. Potential Schedule Impact
 - i. Request for Expedited Response
 - j. Provide a space on the RFI form for the ENGINEER's response.

- #### B. RFI Transmittal:
- The original RFI shall be delivered to the Resident Engineer at the project site. The Resident Engineer may not be at the project site each day. Electronic copies shall also be sent to the ENGINEER.

1.4 ENGINEER'S ACTION

- #### A.
- The ENGINEER's response time will begin on the date that either the Resident Engineer is on site and receives the original RFI or the date that the electronic copy is sent to the ENGINEER.
- #### B.
- The ENGINEER shall have a minimum of 10 working days to respond to such requests.

END OF SECTION

SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Providing a draft complete Schedule of Values (SOV) for review by the ENGINEER.
- B. Providing a final complete SOV after receipt of comments from the ENGINEER regarding the draft complete SOV.

1.2 SUBMITTAL

- A. The CONTRACTOR shall submit a draft complete Schedule of Values, as specified herein, to the ENGINEER within seven (7) days after Contract Award.
- B. The CONTRACTOR shall submit a final Complete Schedule of Values, as specified herein, to the ENGINEER at least ten (10) days prior to submitting the first payment estimate. **Failure by the CONTRACTOR to submit a final complete Schedule of Values within the allotted time may delay approval and payment of the initial payment request.**
- C. Provide information as requested by the ENGINEER to substantiate price included in the Schedule of Values.
- D. The BID-3 forms submitted with the CONTRACTOR's Bid shall be considered to meet the requirements of General Conditions 2.7.3 for providing a preliminary SOV.

1.3 SCHEDULE OF VALUES

- A. The complete Schedule of Values shall follow the general outline yet significantly expand on the work items listed on the BID-3 forms submitted with the CONTRACTOR's Bid.
- B. The total of all items in the Schedule of Values shall equal the Bid Price.
- C. The Schedule of Values shall be provided both digitally and by hard-copy in a format approved by the ENGINEER.
- D. The Schedule of Values shall be used to determine the value of work completed for payment purposes.
- E. For each item which has an installed value of over \$50,000 break down cost to list major products or operations under each item. Round off figures to the nearest hundred

(100) dollars. The sum total of all items in the Schedule shall equal to Total Contract Price.

- F. Mobilization and Demobilization shall include acquiring bonds and insurance, completing pre-condition survey, establishing temporary facilities, acquiring permits, providing and installing erosion control and project signs, and any other tasks required to initiate the Work, move on to the work sites, and leave the work sites at the end of the Work. Mobilization shall be limited to 75% of the total for Mobilization and Demobilization. The total for Mobilization and Demobilization items SHALL NOT EXCEED 3% OF THE TOTAL LUMP SUM VALUE.
- G. Construction Engineering shall include providing temporary traffic control when required, maintaining erosion control and construction survey points, scheduling, compiling and submitting shop drawings, maintaining and providing record drawings, compiling and submitting O&M data, managing the project, and any other tasks required to insure compliance with the Contract Documents. The total for Construction Engineering items SHALL NOT EXCEED 3% OF THE TOTAL LUMP SUM VALUE.
- H. The CONTRACTOR shall be paid as provided for in the General Conditions, Article 13.

END OF SECTION

SECTION 01500

TEMPORARY CONSTRUCTION FACILITIES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Temporary utilities and services.
- B. Construction aids.
- C. Security.
- D. Access roads and parking areas.
- E. Temporary controls.
- F. Field offices and storage sheds.

1.2 RESPONSIBILITY

- A. All construction facilities and temporary controls remain the property of the CONTRACTOR establishing them and shall be maintained in a safe and useful condition until removed from the construction site.
- B. Access to dumpsters by OWNER personnel and refuse haulers must be maintained throughout construction.

1.3 TEMPORARY UTILITIES AND SERVICES

- A. Applicable Utilities
 - 1. The CONTRACTOR is to provide and pay for the following temporary utility services as required and as needed for the Work. No OWNER facilities are to be utilized by the CONTRACTOR.
- B. Temporary Electric Service
 - 1. CONTRACTOR shall furnish and maintain a complete temporary lighting and power system of the phase and voltage required. Extend to the point of usage for the work of all trades and pay for all power used. The CONTRACTOR shall make modifications to CONTRACTOR's equipment if needed to accept available power.

2. Include in the Bid all costs for providing temporary electrical service to the site including but not limited to the following:
 - a) Utility company charges for extending temporary service to the site.
 - b) Utility company charges for installing and removing primary switches and fuses, lightning arrestors, transformers, metering and meter rental, poles, lines, etc.
3. Temporary service shall include protective enclosures, branch wiring, outlets, lamps, and grounding as required by NEC and Local Electrical Codes.
4. If temporary wiring interferes with construction, it shall be relocated. Maintain service during all work hours and one-half hour before and after working hours.
5. When temporary service is no longer needed, remove all temporary electrical facilities from the site.

C. Temporary Heating

1. If required for the Work, the CONTRACTOR shall furnish fuel or power and provide and operate all temporary heating units. Heat shall be provided as necessary to thaw or heat materials, to control humidity, to protect all water-bearing materials against injury by frost or freezing, and to provide heat required for operations. Temporary heating units shall be adequately vented and approved devices which will not damage finished areas. The CONTRACTOR shall also furnish all tarpaulins and temporary enclosures necessary to provide this protection.
2. The CONTRACTOR shall provide heat to a minimum of 55 degrees F. in enclosed and existing buildings or as required or recommended for the normal operation of the existing facilities or construction operations.

D. Temporary Ventilation

1. If required for the Work, the CONTRACTOR shall provide, operate, and furnish power for temporary ventilation required for the proper installation and curing of materials and safety of workmen.

E. Temporary Telephone

1. The CONTRACTOR shall provide and maintain a modern wireless telephone for the ENGINEER in the temporary field office. The CONTRACTOR shall pay for all local calls; toll calls shall be paid for by persons making such calls.

F. Temporary Water

1. The CONTRACTOR shall furnish potable drinking water in suitable dispensers and with cups for use of all employees at the job.
2. If required for the Work, the CONTRACTOR shall coordinate with the local water utility for water supply for construction purposes. The CONTRACTOR shall pay the local water utility directly for all water usage.
3. The CONTRACTOR shall provide all temporary piping, hoses, etc., required to transport water to the point of usage.
4. Large quantities of water for testing pipelines and tanks shall be drawn only at night or as directed by the OWNER.

G. Temporary Sanitary Facilities

1. Provide temporary toilet facilities and maintain these during the entire period of construction under this Contract for the use of all construction personnel and the OWNER's representative on the job. Enough chemical toilets shall be provided to conveniently serve the needs of all personnel and OWNER's representative.
2. Chemical toilets and their maintenance shall meet the requirements of State and local health regulations and ordinances. Any facilities or maintenance methods failing to meet these requirements shall be corrected immediately.
3. Local commercial or any other OWNER toilet facilities shall not be used by construction personnel.

H. Temporary Pumping and Site Drainage

1. The CONTRACTOR shall keep the site free from water at all times to permit continuous access and to prevent damage to the work.

1.4 CONSTRUCTION AIDS

A. Material Hoists and Cranes

1. Provide material hoists required for normal use by all trades and employ skilled hoist operators. Provide all necessary guards, signals, safety devices, etc., required for safe hoist operation. The construction and operation of material hoists shall be in accordance with the applicable ANSI Standards, the "Manual Code of Accident Prevention in

Construction" of the Associated General Contractors of America, OSHA, and of other Federal, State, and municipal codes or ordinances. The CONTRACTOR shall prohibit the use of hoists for transporting personnel. Hoists shall be located to avoid risk of damage to completed work.

- B. Special rigging and hoisting facilities shall be provided by each trade requiring their use.

1.5 SECURITY

- A. Full time watchmen will NOT be specifically required as a part of the Contract, but the CONTRACTOR shall provide inspection of work area daily and shall take whatever measures necessary to protect the safety of the public, workmen, and materials, and provide for the security of the site, both day and night. CONTRACTOR shall install temporary barriers as needed around all open excavations as a minimum safety measure.

1.6 ACCESS ROADS AND PARKING AREAS

- A. Construct temporary roadways and parking areas within the site as required to provide proper access to site for delivery of material and equipment of all trades. Roadways and parking areas shall be constructed and maintained to keep the surface free from mud and standing water and to keep mud from being picked up and deposited on adjacent streets and roadways. Location of the temporary roads and parking areas shall be approved by the ENGINEER.
- B. At completion of the work or when directed by the ENGINEER, material used for temporary road and parking areas shall be removed, unless otherwise approved by the ENGINEER.

1.7 TEMPORARY CONTROLS

- A. Dust and Mud Control
 - 1. Take all necessary precautions, to the maximum extent reasonable, to control dust and mud associated with the work of this Contract, subject to the approval of the ENGINEER. In dry weather, spray dusty areas daily with water or weekly with oil in order to control dust. Take necessary steps to prevent the tracking of mud onto adjacent streets and highways.
 - 2. Provide street cleaning as needed at the direction of the ENGINEER.

1.8 TEMPORARY STORAGE SHEDS

A. Storage Sheds

1. The CONTRACTOR shall provide storage sheds as required for the performance of the Work and protection of materials and equipment. Locate storage areas with approval of the ENGINEER.

1.9 REMOVAL OF TEMPORARY CONSTRUCTION

- A. Remove the various temporary facilities, services, and controls and legally dispose of them as soon as the ENGINEER deems permissible. Sites used for temporary facilities shall be properly reconditioned and restored to a condition acceptable to the ENGINEER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01505

MOBILIZATION AND DEMOBILIZATION

PART 1 -- GENERAL

1.1 GENERAL

- A. Mobilization and Demobilization shall include the obtaining of all permits; moving onto the site of all equipment; furnishing and erecting construction facilities; implementing security requirements; and removal of same from the site; all as required for the proper performance and completion of the WORK. Mobilization and Demobilization shall include the following principal items:

1. Moving on to the site of all CONTRACTOR's equipment required for first month operations.
2. Installing temporary construction utilities, including power, wiring, and lighting facilities.
3. Establishing fire protection system.
4. Developing construction water supply.
5. Providing and siting field office trailer(s) and/or securing local office and storage space for the CONTRACTOR and the ENGINEER, complete with all furnishings and utility services including telephones, telephone appurtenances, and copying machine.
6. Providing all on-site communication facilities, including telephones, and radio pagers.
7. Providing on-site sanitary facilities and potable water facilities.
8. Arranging for and erection of CONTRACTOR's work and storage yard.
9. Constructing and implementing security features and requirements.
10. Obtaining all required permits.
11. Having all OSHA required notices and establishment of safety programs.
12. Submitting initial submittals.
13. Removing all temporary utilities, field office trailer(s) and furnishings away from project site at project completion as directed by ENGINEER.

14. Restoration of surfaces damaged as a result of construction activities, including mobilization and demobilization, that are not included under other Items and as directed by ENGINEER.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01520

SECURITY

PART 1 – GENERAL

1.1 SECURITY PROGRAM

A. The CONTRACTOR shall:

1. Protect WORK from theft, vandalism, and unauthorized entry.
2. Initiate program at mobilization.
3. Maintain program throughout construction period until Substantial Completion.

1.2 ENTRY CONTROL

A. The CONTRACTOR shall:

1. Restrict entry of persons and vehicles into Site.
2. Allow entry only to authorized persons with proper identification.
3. Maintain log of workmen and visitors and make log available to OWNER on request.
4. Coordinate access of OWNER'S personnel to Site.

1.3 RESTRICTIONS

- A. The CONTRACTOR shall not allow cameras on site or photographs taken except by written approval of OWNER.

END OF SECTION

SECTION 01620

PRODUCT DELIVERY, STORAGE AND PROTECTION

PART 1 - GENERAL

1.1 APPLICABILITY

- A. This section applies to all products furnished under this Contract and equipment purchased by the OWNER for use as a part of the project. Shipments of equipment or materials to be used by the CONTRACTOR or its subcontractors shall be delivered to the site only during regular working hours. All shipping papers and shipments shall be addressed and consigned to the CONTRACTOR. Under no circumstances will the OWNER accept shipments directed to it or the ENGINEER unless otherwise specified.

1.2 DELIVERY

- A. Products shall not be delivered to the project site until related shop drawings have been reviewed and approved by the Design Engineer and until appropriate storage facilities are in place and approved by the ENGINEER.
- B. Products shall be delivered to the site in manufacturer's original, unopened, labeled containers.
- C. The CONTRACTOR shall not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.3 STORAGE AND PROTECTION

A. GENERAL

- 1. The CONTRACTOR shall store and protect products in accordance with the manufacturer's recommendations and the requirements specified herein. Some on-site existing storage facilities are available for use by the CONTRACTOR within the existing building. Storage within the existing building shall be coordinated with the OWNER and ENGINEER. CONTRACTOR use of the existing building shall not interfere with the OWNER'S use of the building or the operation of the treatment equipment within the building.
- 2. The CONTRACTOR shall not block or restrict the use of Public Right of Way, access roads or private property with stored materials, except where indicated on the Contract Documents.
- 3. The CONTRACTOR shall not store products where they will interfere with operations of the OWNER or other contractors.
- 4. The CONTRACTOR shall protect all products from damage or

deterioration by weather.

5. The CONTRACTOR shall not store any products directly on the ground.

B. UNCOVERED STORAGE

1. Materials not subject to deterioration or contamination by weather may be stored uncovered at the project site. Such materials may include concrete masonry units, reinforcing steel, piping, precast concrete, and castings. All such material shall be stored on wood blocking where practical. Aggregates and sand may be stored uncovered provided that they are protected from contamination by other materials.

C. COVERED STORAGE

1. The following types of material may be stored out-of-doors if covered with material impervious to water:
 - a. Rough Lumber
 - b. Equipment as specifically allowed by the ENGINEER
2. The CONTRACTOR shall tie down covers with rope and slope to prevent accumulation of water on covers. All materials shall be stored on wood blocking or pallets.

D. FULLY PROTECTED STORAGE

1. The CONTRACTOR shall store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof; and fully closed walls on all sides.
2. The CONTRACTOR shall provide heated storage space for materials which would be damaged by freezing.
3. The CONTRACTOR shall protect mechanical and electrical equipment from being contaminated by dust and dirt.
4. The CONTRACTOR shall maintain temperature and humidity at levels recommended by manufacturer(s) for electrical and electronic equipment.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01660

TESTING AND ADJUSTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping system testing.
- B. Leakage tests for tanks.
- C. Testing and adjusting equipment and systems.

PART 2 PRODUCTS

2.1 GENERAL

Provide all necessary equipment, temporary pumps, temporary piping, instrumentation, and other items required for proper completion of testing. Plant water for system testing is available from the OWNER.

2.2 SUBMITTALS

- A. Submit shop drawings and product data in compliance with Section 01340.
- B. At minimum, testing plans are required for the following:
 - 1. Buried and above ground pipe testing
 - 2. Receiving tank testing
 - 3. Treatment train testing
- C. Testing plan submittals shall include the following information:
 - 1. A schedule showing when the testing will be performed in relation to other work
 - 2. Anticipated test pressure and durations as applicable.

PART 3 EXECUTION

3.1 PIPING SYSTEM TESTING

- A. General Requirements

1. Test procedures and method of disposal of water shall be approved by the ENGINEER. All tests shall be made in the presence of the ENGINEER, unless directed otherwise. Preliminary tests made by the CONTRACTOR without being observed by the ENGINEER will not be accepted. Notify the ENGINEER at least 48 hours before any work is to be inspected or tested.
2. All defects in piping systems shall be repaired and/or replaced and retested until acceptable. Repairs shall be made to the standard of quality specified. All repair methods shall be subject to approval by the ENGINEER.
3. Sections of the system may be tested separately, but any defect which may develop in a section previously tested and accepted shall be promptly corrected and retested. Pressure tests shall be made between valves to demonstrate ability of valves to sustain pressure. Valves connecting new and existing systems shall only be operated by OWNER's personnel or by CONTRACTOR with specific approval from OWNER for each operation.
4. All piping shall be tested in accordance with the following test methods, in addition to any test required by local and state codes or building authorities.
5. Testing shall be performed after backfill but prior to improvements to be constructed over the pipe such as floors, base slabs, pavement, etc. CONTRACTOR shall coordinate pipe testing with other work.

B. Flushing

Prior to testing, flush all piping systems with water to remove construction debris.

C. Underground Gravity Pipe Testing, General

1. All pipe subject to less than 5 psig pressure shall be tested as gravity pipe.
2. After backfill has been placed, the ENGINEER will visually inspect all gravity flow lines to check alignment and grade. All obstructions shall be removed. Any sewer in which the direct light of a lamp cannot be viewed in either direction between adjacent manholes shall be considered unsatisfactory, unless the line is designed with horizontal deflections, and shall be repaired by the CONTRACTOR without additional compensation.
3. When leakage occurs in excess of the specified limits, defective pipe or joints shall be located and repaired. The CONTRACTOR, at his/her own expense, shall remove and reconstruct as much of the work as necessary to obtain a sewer test within the allowable leakage limits.
4. All tests shall be performed by the CONTRACTOR.

D. Underground Gravity Piping, Exfiltration Tests

1. Testing for acceptability of the gravity pipe shall be conducted by Low Pressure Air Test (Exfiltration) and Deflection Test.
2. Low Pressure Air Testing (Exfiltration)
 - a. Manholes shall be air tested in accordance with ASTM C1244-93, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.
 - b. Test each section of gravity pipeline between manholes and/or structures after backfilling, separately with equipment and methods as outlined below.
 - i) Furnish facilities required including necessary piping, connections, test pumping equipment, pressure gauges, bulkheads, regulators (to avoid over-pressurization), and miscellaneous items required.
 - ii) Air Testing Method Procedures: The section of sewer to be tested shall have been trench backfilled and cleared. Pneumatic plugs (having a sealing length equal to or greater than the diameter of the pipe to be tested) placed in both ends of the pipe to be tested shall be inflated to twenty-five (25 psig). The sealed sewer pipe shall then be pressurized to four (4) psig above the average back pressure of ground water over the sewer pipe and the air pressure allowed to stabilize for at least two minutes.
 - iii) After the stabilization period the line shall be pressurized to 3.5 psig and the time in minutes measured for pressure to drop to 2.5 psig. If ground water is present, the air pressure within shall be increased to 3.5 psig above the level of the ground water and the drop of one (1) psig of air pressure measured in minutes.
 - iv) Air testing techniques shall be in accordance with the latest ASTM standard practice for testing sewer lines by low-pressure air test method for the appropriate pipe material, except that the time shall not be less than that shown in the following Air Test Table.

AIR TEST TABLE
 SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP
 FROM 3 ½ TO 2 ½ PSIG
 WHEN TESTING ONE PIPE DIAMETER ONLY
 PIPE DIAMETER, INCHES

Length of Sewer Pipe In Feet	4	6	8	10	12	15	18	21	24
25	0.04	0:10	0.18	0.28	0.40	1.02	1.29	2.01	2:38
50	0.09	0:20	0.35	0.55	1.19	2.04	2.58	4.03	5:17
75	0.13	0:30	0.53	1.23	1.59	3.06	4.27	6.04	7:55
100	0.18	0:40	1.10	1.50	2.38	4.08	5.56	8.05	10:34
125	0.22	0:50	1.28	2.18	3.18	5.09	7.26	9.55	11:20
150	0:26	0.59	1.46	2:45	3:58	6:11	8:30		
175	0.31	1:09	2:03	3:13	4:37	7:05			
200	0:35	1:19	2:21	3:40	5:17				12:60
225	0:40	1:29	2:38	4:08	5:40			10:25	13:36
250	0:44	1:39	2:56	4:35			8:31	11:35	15:07
275	0:48	1:49	3:14	4:43			9:21	12:44	16:38
300	0:53	1:59	3:31				10:12	13:53	18:09
350	1:02	2:19	3:47			8:16	11:54	16:12	21:10
400	1:10	2:38			6:03	9:27	13:36	18:31	24:12
450	1:19	2:50			6:48	10:38	15:19	20:50	27:13
500	1:28			5:14	7:34	11:49	17:01	23:09	30:14

If air test fails to meet above requirements, repeat test as necessary after leaks and defects have been repaired. Prior to acceptance all constructed sewer lines shall satisfactorily pass the low pressure air test.

- v) In areas where groundwater is known to exist, install a one-half (1/2) inch diameter capped pipe nipple, approximately ten (10) inches long, through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, determine ground water level by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertical and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. Divide the height in

feet by 2.3 to establish the pounds of pressure that will be added to all readings:

3. Deflection Test: Polyvinyl chloride pipe shall be tested for deflection as outlined below
 - i) All new polyvinyl chloride sewers shall be tested for deflection.
 - ii) The 5% deflection test for pipe sizes six (6) to fifteen (15) inches in diameter is to be run using a nine-arm mandrel having a diameter equal to 95% of the base diameter of the pipe as established in ASTM D-3034. For pipe sizes eighteen (18) to twenty-seven (27) inches diameter, the nine-arm mandrel size shall be 95% of the inside diameter as determined using the pipe outside diameter and wall thickness dimensions shown in Table 1 of ASTM F-679, latest issue. The test shall be performed without mechanical pulling devices.
 - iii) Individual lines to be tested shall be so tested no sooner than 30 days after they have been installed.
 - iv) Wherever possible and practical, testing shall initiate at the downstream lines and proceed towards the upstream lines.
 - v) No pipe shall exceed a deflection of 5%.
 - vi) Where deflection is found to be in excess of 5% of the original pipe diameter, CONTRACTOR shall excavate to the point of excess deflection and carefully compact around the point where excess deflection was found. The line shall then be retested for deflection. If the deflected pipe fails to return to the original size (inside diameter) the line shall be replaced.

E. Manhole Testing: Infiltration Testing of New Sewer Manholes

1. Manholes shall be observed (tested) by the CONTRACTOR in the presence of the ENGINEER for sources of infiltration.
2. Manholes observed to be actively leaking will not be acceptable and will have failed the test. Manholes failing the test will require rehabilitation by the CONTRACTOR at no additional cost to the OWNER.

F. Pressure Piping Testing, General

1. All pressure piping shall pass hydrostatic pressure test and leakage test.

2. The pressure and leakage test shall be made after all jointing operations are completed and any concrete reaction blocks, and restraints have cured at least 7 days. Lines tested before backfill is in place shall be retested after compacted backfill is placed.
3. Sections of piping between valves and other short sections of line may be isolated for testing. If shorter sections are tested, test plugs or bulkheads required at the ends of the test section shall be furnished and installed by the CONTRACTOR, together with all anchors, braces, and other devices required to withstand the hydrostatic pressure without imposing any thrust on the pipe line. The CONTRACTOR shall be solely responsible for any damage which may result from the failure of test plugs or supports.

G. Hydrostatic Test for Pressure Piping

1. Piping shall be slowly filled with water and all air expelled. Care shall be taken that all air valves are installed and open in the section being filled, and that the rate of filling does not exceed the venting capacity of the air valves.
2. After the section of line to be tested has been filled with water, the specified test pressure shall be applied and maintained for a minimum period of 10 minutes and for such additional period necessary for the ENGINEER to complete the inspection of the line under test. Do not exceed pipe manufacturer's suggested time duration at the test pressure. If defects are noted, repairs shall be made and the test repeated until all parts of the line withstand the test pressure.
3. Hydrostatic test pressure shall be as specified in Section 15060-Piping and Fittings.

H. Leakage Test for Pressure Piping

1. After the specified hydrostatic test has been completed, the line shall be subjected to a leakage test under a hydrostatic pressure as specified in Section 15060-Piping and fittings. The pressure shall be maintained within a maximum variation of 5% during the entire leakage test. The duration of the leakage test shall be four (4) hours minimum, and for such additional time necessary for the ENGINEER to complete inspection of the section of line under test. Leakage measurements shall not be started until a constant test pressure has been established. The line leakage shall be measured by means of a water meter installed on the supply side of the pressure pump.
2. No leakage is allowed in exposed piping, buried piping with flanged, threaded, or welded joints or buried non-potable piping in conflict with plant water lines.

3. Tested sections of buried piping with slip-type or mechanical joints will not be accepted if it has a leakage rate in excess of that rate determined by the formula:

(a) $L = 0.00027 NDp$, in which;

- (i) L = Maximum permissible leakage rate, in gallons per hour, throughout the entire length of line being tested.
- (ii) N = Number of gasketed joints (two for each flexible coupling joint) in the line under test.
- (iii) D = Nominal internal diameter (in inches) of the pipe.
- (iv) p = The square root of the actual pressure in psig on all joints in the tested portion of the line. This actual pressure shall be determined by finding the difference between the average elevation of all tested pipe joints and the elevation of the pressure gauge and adding the difference in elevation head to the authorized test pressure.

4. Where the leakage rate exceeds the permissible maximum, the CONTRACTOR shall locate and repair leaking joints to the extent required to reduce the total leakage to within the prescribed amount.
5. All apparent leaks discovered within one year from the date of final acceptance of the work by the ENGINEER shall be located and repaired by the CONTRACTOR, regardless of the total line leakage rate.

I. Air Pipe Testing

Air piping shall be tested with air pressure as indicated in Section 15060. Allowable leakage for buried piping shall be 5% of test pressure. The test pressure shall be maintained for a minimum period of two (2) hours and for such additional period as necessary for the OWNER to complete inspection of the line under test.

3.2 LEAKAGE TESTS FOR TANKS

- A. When reservoirs, basins, tanks, or concrete structures, which are to hold water, have been completed, except for waterproofing, swept-in toppings, grout fills, and backfilling, they shall be tested at the direction of the ENGINEER by filling with water at a rate that requires at least 24 hours for filling.
- B. The water source for tank testing shall be the OWNER'S plant water supply, unless otherwise approved by the OWNER. All temporary piping, pumping, etc., to convey water to the appropriate tank shall be the CONTRACTOR's responsibility.

- C. Should leakage become evident at any point, or should the water level be lower as a result of leakage by any amount greater than 1/4-inch in 24 hours, exclusive of evaporation and absorption, leaks shall be repaired by methods acceptable to the ENGINEER. The value of loss due to evaporation shall be determined by using a flat metal pan or container of known area and setting in the same conditions (sun, wind, temperature, etc.) and determining the rate of evaporation per square foot. Reservoirs, basins, or tanks shall be retested until satisfactory results are obtained.

3.3 TESTING AND ADJUSTING EQUIPMENT AND SYSTEMS

- A. The CONTRACTOR shall request that the OWNER coordinate GAC media delivery and installation after testing of applicable piping systems has passed Pipe System Testing.
- B. After the installation and startup of the equipment, pumps, and receiving tank is complete, the CONTRACTOR shall test each GAC treatment train as follows. Testing shall be coordinated with the ENGINEER and OWNER:
 - 1. Fill the Receiving Tank (T203) with clean water the OWNER'S plant water supply.
 - 2. Install a temporary plug in the 24" pipe exiting the effluent manhole (MH #9), a pump capable of delivering at least 1,250 gpm to the receiving tank, and temporary piping from the effluent manhole to the receiving tank.
 - 3. Run forward flow through Pump P501 and GAC Adsorbers 501A and 501B at 1,250 gpm continuously for at least 20 minutes, or as directed by the ENGINEER and OWNER, simultaneously pumping water from the effluent manhole back to the receiving tank. Repeat for the other three pumps and treatment trains.
 - 4. Remove the temporary plug, pumps, and piping.
 - 5. Run backwash flow from the backwash pumps through each of the new GAC Adsorbers individually at 1,000 gpm for at least 3 minute and no more than at 5 minutes or as directed by the ENGINEER and OWNER.
- C. Field testing shall be scheduled and coordinated with the ENGINEER and performed in his/her presence. Unless otherwise indicated, the CONTRACTOR shall be responsible for and pay for all water, chemicals, electricity, etc., used in testing equipment and systems.
- D. System Testing: All items including valves and controls shall be given a thorough test. Unless specified otherwise, the entire system shall be operated for two days to prove

compatibility of equipment and to achieve proper adjustment for operation. Continuous-operating motor driven equipment shall be tested for proper levels of operation and output. Valves, pipes, tanks, and other items that are non-operating or occasional-operating shall be tested for ability to meet design criteria.

- E. Adjustments: When an item of equipment is found to be in conflict with the stated design criteria, an adjustment shall be made to the item by experienced personnel of the CONTRACTOR or a Manufacturer's representative.
- F. If adjustments fail to correct the operation of a piece of equipment, remove the equipment from the Project Site and replace it with a workable replacement that will meet the Specification requirements.

END OF SECTION

SECTION 01700

PROJECT CLOSEOUT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF REQUIREMENTS

Definitions: Project closeout is the term used to describe certain collective project requirements, indicating completion of the Work that is to be fulfilled near the end of the Contract time in preparation for final acceptance and occupancy of the Work by the OWNER, as well as final payment to the CONTRACTOR and the normal termination of the Contract.

1. Specific requirements for individual units of work are included in the appropriate Sections herein.
2. Time of closeout is directly related to "Final Completion"; therefore, the time of closeout may be either a single time period for the entire Work or a series of time periods for individual elements of the Work that have been certified as substantially complete at different dates. This time variation, if any, shall be applicable to the other provisions of this section.

1.3 PREREQUISITES TO SUBSTANTIAL COMPLETION

- A. General: Complete the following before requesting the ENGINEER's inspection for certification of substantial completion, either for the entire Work or for portions of the Work. List known exceptions in the request.
- B. In the progress payment request that coincides with, or is the first request following, the date substantial completion is claimed, show either 100% completion for the portion of the Work claimed as "substantially complete", or list incomplete items, the value of incomplete work, and reasons for the Work being incomplete. Include supporting documentation for completion as indicated in these contract documents.
- C. Submit a statement showing an accounting of changes to the Contract Sum.
- D. Submit specific warranties, workmanship/maintenance bonds, final certifications and similar documents.
- E. Obtain and submit releases enabling the OWNER's full, unrestricted use of the Work.

- F. Submit record drawings, maintenance manuals, damage or settlement survey, and similar final record information.
- G. Discontinue and remove temporary facilities and services from the project site, along with construction tools and facilities.
- H. Inspection Procedures: Upon receipt of the CONTRACTOR's request for inspection, the ENGINEER will either proceed with inspection or advise the CONTRACTOR of unfilled prerequisites.
 - 1. Following the initial inspection, the ENGINEER will either prepare the certificate of substantial completion, or will advise the CONTRACTOR of work which must be performed before the certificate will be issued. The ENGINEER will repeat the inspection when requested and when assured that the Work has been substantially completed.
 - 2. Results of the completed inspection will form the initial "punch-list" for final acceptance.

1.4 PREREQUISITES TO FINAL ACCEPTANCE

- A. General: Complete the following before requesting the ENGINEER's final inspection for certification of final acceptance, and final payment as required by the General Conditions. List known exceptions, if any, in the request.
 - 1. Submit the final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 - 2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 - 3. Submit a certified copy of the ENGINEER's final punch-list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and has been endorsed and dated by the ENGINEER.
 - 4. Submit consent of surety.
 - 5. Submit a final liquidated damages settlement statement, acceptable to the OWNER.
- B. Reinspection Procedure: The ENGINEER will reinspect the Work upon receipt of the CONTRACTOR's notice that the work, including punch-list items resulting from earlier inspections, has been completed, except for these items whose completion has been delayed because of circumstances that are acceptable to the ENGINEER.

1. Upon completion of reinspection, the ENGINEER will either prepare a certificate of final acceptance, or will advise the CONTRACTOR of work that is incomplete or of obligations that have not been fulfilled, but are required for final acceptance.
2. If necessary, the reinspection procedure will be repeated.

1.5 RECORD DOCUMENT SUBMITTALS

- A. General: Specific requirements for record documents are indicated in the individual sections of these specifications. Other requirements are indicated in the General Conditions. General submittal requirements are indicated in the various "submittals" sections.
 1. Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the OWNER's and the ENGINEER's reference during normal working hours.
 2. All record documents must be kept up to date on a continuous basis by all contractors and subcontractors. Failure to do so will result in withholding additional money from monthly payment requests.
- B. Record Drawings: Maintain a record set of contract drawings and shop drawings in a clean, undamaged condition. Mark-up the set of record documents to show the actual installation where the installed work varies from the work as originally shown. Mark whichever drawing is most capable of showing the actual "field" condition fully and accurately; however, where shop drawings are used for mark-up, record a cross-reference at the corresponding location on the working drawings.
 1. Mark record sets with red erasable pencil and, where feasible, use other colors to distinguish between variations in separate categories of work.
 2. Mark-up new information which is known to be important to the OWNER and ENGINEER, but for some reason was not shown on either contract drawings or shop drawings.
 3. Note related change-order numbers where applicable.
 4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
 5. For buried piping, electrical, conduits, etc. measure distance to permanent exposed improvements that will enable locations to be determined after backfilling. Provide 2 measurements for all bends, fittings, etc.

- C. Record Specifications: Maintain one complete copy of the Project Manual, including specifications and addenda, and one copy of other written construction documents such as change orders and similar modifications issued in printed form during construction.
- D. Record Product Data: Maintain one copy of each product data submittal. Mark these documents to show significant variations in the actual Work performed in comparison with the submitted information. Include both variations in the products as delivered to the site, and variations from the manufacturer's instructions and recommendations for installation. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily discerned at a later date by direct observation. Note related change orders and mark-up of record drawings and specifications. Upon Completion of mark-up, submit complete set of record product data to the ENGINEER for the OWNER's records.
- E. Miscellaneous Record Submittals: Refer to other sections of these specifications for requirements of miscellaneous record-keeping and submittals in connection with the actual performance of the Work. Immediately prior to the date or dates of substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the ENGINEER for the OWNER's records.

1.6 FINAL CLEANING

- A. General: Special cleaning requirements for specific units of Work are included in the appropriate sections of Divisions 2. General Cleaning during the regular progress of the Work is required by the General Conditions and is included under Section "Temporary Facilities".
- B. Cleaning: Complete the following cleaning operations before requesting the ENGINEER's inspection for certification of substantial completion:

Clean the project site of rubbish, litter and other foreign substances.
- C. Removal of Protection: Except as otherwise indicated or requested by the ENGINEER, remove temporary protection devices and facilities which were installed during the course of the work to protect previously completed work during the remainder of the construction period.
- D. Compliance: Comply with safety standards and governing regulations for cleaning operations. Do not burn waste materials at the site. Do not bury debris or excess materials on the OWNER's property. Remove waste materials from the site and dispose of in a lawful manner.

END OF SECTION

SECTION 02100

SITE PREPARATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The WORK of this Section includes measures required during the CONTRACTOR's initial move onto the Site to protect existing fences, structures and associated improvements, streets, and utilities from damage; clearing, grubbing and stripping; and regrading of certain areas.

1.2 SITE INSPECTION

- A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review the existing site and utility routes and facilities delineating the OWNER's property and right-of-way lines.

PART 2 -- PRODUCTS - NOT USED

PART 3 -- EXECUTION

3.1 PRIMARY SITE ACCESS

- A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.
- B. Utility Interference: Where existing utilities interfere with the WORK, the CONTRACTOR shall notify the OWNER and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

- A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the ENGINEER, unless otherwise specified.

- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. All objectionable material from the clearing and grubbing process shall be removed from the Site and disposal at approved safe locations.
- C. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, at no additional cost to the OWNER.
- D. Clearing Right of Way shall be in accordance with the requirements of Section 201 of the INDOT Standard Specifications except as follows: If it becomes necessary to remove encumbrances or materials that are not indicated in the Contract Documents to be removed, then such removal and disposal of these encumbrances or materials shall be considered as a part of clearing right of way.
- E. Unless otherwise provided, any existing structure or parts thereof, fence, building, or other encumbrance or obstruction upon or within the limits of the right of way which interferes in any way with the new construction shall be removed with no additional payment. Materials belonging to owners of abutting property shall be stockpiled neatly and in an acceptable manner upon their property or otherwise disposed of as required.
- F. Materials not specifically reserved for use by the OWNER shall become the property of the CONTRACTOR, except as set out in the General Conditions Section 4.8. Such materials shall be removed or disposed of as specified or directed. Materials reserved for use by the OWNER shall be removed without damage in sections which can be readily transported. Such materials shall be stockpiled neatly at accessible points. No material shall be disposed of except as provided herein.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

- A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require overexcavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The overexcavated volumes to a level 2.5 feet below the existing ground contours shall be backfilled.

END OF SECTION

SECTION 02140

DEWATERING

PART 1 – GENERAL

1.1 SCOPE

- A. Work described in this Section includes furnishing all labor, equipment, tools and incidentals required for all dewatering. This work includes the installation, operation, and removal of all facilities required to maintain open excavations and trenches in a dewatered condition to permit unrestricted construction operations.
- B. Construct all permanent work in areas free from water. Design, construct and maintain all pumping systems, dikes, levees, cofferdams, diversion and drainage channels as necessary to maintain the areas free from water and to protect the areas to be occupied by permanent work from water damage. Remove temporary works after they have served their purpose.
- C. The CONTRACTOR shall be responsible for the stability of all temporary and permanent slopes, trenches, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and sub-surface, to the lines, grades and conditions existing prior to the damage at no additional cost to the OWNER.
- D. Dewatering wells installed by the CONTRACTOR shall be located within the right-of-way, the OWNER's easements, or areas with specific rights-of-entry granted for this Project.
- E. Water from dewatering activities shall be pumped by the CONTRACTOR to the ICS treatment facility Spring Receiving Sump. In this manner all water from dewatering activities will be treated prior to surface water discharge. Dewatering activities shall not occur during or immediately after significant rain events. The OWNER has the right to request that dewatering activities be stopped if such a rain event has occurred that maximizes the treatment capacity at the ICS facility. Rainfall events of this magnitude are expected several times each year. Weather related work delays caused by the temporary inability to dewater, whether or not requested by the OWNER, will not result in any increase of the Contract Price.
- F. All dewatering activity shall remain in compliance with Rule 5 Stormwater requirements throughout construction.

1.2 QUALITY CONTROL

- A. The CONTRACTOR or subcontractor designing and installing any dewatering

system shall have a minimum of three years of experience in dewatering excavations in similar ground and depths.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents and as specified hereinafter.
- B. Working Drawings
 - 1. Submit complete working drawings and supporting documents showing the type of water control system proposed for each site where required. Obtain ENGINEER's approval prior to installation of the system.
 - 2. Working drawings and supporting documents will show:
 - a. Arrangement and location of the system.
 - b. Complete description of equipment and materials to be used.
 - c. Installation and operation and maintenance procedures.
 - d. Drawdown curves for the range of pumping rates anticipated and estimate of anticipated dewatering system discharge rate in gallons per minute.
 - e. Standby equipment and power supply.
 - f. Location and size of berms, dikes, settling basins, sumps, and discharge items.
 - g. Discharge location.
 - 3. Working drawings and supporting documents will be revised and resubmitted if the system is modified during installation or during operation.
- C. Copies of all permits required to perform dewatering as specified below.
- D. Submit to the ENGINEER during construction within the specified time:
 - 1. Discharge Rates: Measured discharge rates for each discharge point. Submit for each point when discharge is initiated, at changes in discharge rate greater than 50 percent, and at a frequency of weekly. Submittals shall be made within two working days of such initiation, change, and taking of each reading.
- E. Qualifications of persons or subcontractor responsible for the dewatering operation.

1.4 JOB CONDITIONS

- A. Responsibilities

1. Select and install a system to control water as herein specified, and to comply with the requirements of the jurisdictional agencies.
2. Take measures to prevent damage to properties, buildings or structures, sewers and other utility installations, pavements, sidewalks, improvements and work.
3. Do not overload or obstruct existing facilities.
4. Modify the system at no additional cost to the OWNER if after installation and while in operation it causes or threatens to cause damage to existing buildings, structures, utilities, facilities, or other adjoining property.
5. Measure and evaluate if movements are being caused to adjacent buildings, structures, utilities, facilities or other adjoining properties by dewatering operations.
6. Repair damage, disruption, or interference resulting directly or indirectly from dewatering operations at no additional cost to the OWNER and to the ENGINEER's approval.

PART 2 – PRODUCTS - NOT USED

PART 3 – EXECUTION

3.1 CARE OF WATER

- A. Except where the excavated materials are designated as materials for permanent work, material from required excavation may be used for dikes, levees, cofferdams and other temporary backfill.
- B. Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the work and for maintaining the foundation and other parts free from water as required for constructing each part of the work.
- C. Install all drainage ditches, sumps and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables, and to drain impervious surfaces at final excavation elevation.
- D. After they have served their purpose, remove all temporary protective work at a satisfactory time and in a satisfactory manner. All diversion channels and other temporary excavations shall be cleaned out, backfilled and processed under the same Specifications as those governing the compacted fill.

- E. Temporary works and all debris shall be completely removed and the site restored to its original condition after the work is completed.
- F. Intercept and divert surface drainage away from the excavation, by the use of dikes, curb walls, ditches, pipes, sumps, or other means.
- G. Design surface drainage systems so that they do not cause erosion on or off the site or cause unwanted flow of water.

3.2 DEWATERING

- A. By the use of pumps or other approved methods, the CONTRACTOR shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.
- B. All water that is removed by dewatering shall be pumped to the ISC treatment facility Spring Receiving Sump for treatment prior to surface water discharge.
- C. Excavations shall be continuously dewatered, unless required otherwise by the OWNER, to maintain a ground water level no higher than two feet below the lowest point in the excavation unless otherwise specified. Dewatering shall be accomplished well enough in advance of excavation to ensure that groundwater is already lowered prior to completing the final excavation to finish subgrade.
- D. Dewater by means which will insure dry excavations, preserve final lines and grades, and not disturb or displace adjacent soil.
- E. Provide and maintain ditches of adequate size to collect surface water and seepage which may enter the excavations and divert the water into a sump so that it can be drained or pumped into drainage channels and settling basins prior to discharge to storm sewers if approved by the ENGINEER and the jurisdictional agency concerned.
- F. All destabilized subgrade conditions caused by inadequate or untimely dewatering operations shall be undercut and backfilled with suitable backfill material at no additional cost to the OWNER.

END OF SECTION

SECTION 02150

SHORING AND BRACING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Shoring and bracing.

1.2 DESIGN AND SUPERVISION

- A. All shoring and bracing used for the Work shall be designed and certified by a Professional Engineer licensed in the State of Indiana. The certified design shall be submitted as one or more shop drawings to the ENGINEER prior to installation of any shoring or bracing. This is for information only. THE ENGINEER WILL NOT REVIEW OR APPROVE this shop drawing as this is the responsibility of the certifying engineer.
- B. Shoring and bracing shall be designed and installed in such a way as to allow full access and the safe use of the ICS treatment facilities as required elsewhere in these Contract Documents.
- C. Acquiring shoring and/or bracing materials prior to acceptance of the certified shoring and bracing submittal by the ENGINEER shall be at the CONTRACTOR's risk.
- D. The CONTRACTOR shall engage and assign supervision of shoring and bracing installation to a qualified foundation Consultant.

1.3 REGULATIONS

- A. Comply with local codes and ordinances of governing authorities having jurisdiction.

1.4 JOB CONDITIONS

- A. Before starting work, check and verify governing dimensions and elevations. Survey condition of adjoining properties, take photographs, recording existing settlement or cracking of structures, pavements, and other improvements. Prepare list of such damages, verified by dated photographs, and signed by CONTRACTOR and others conducting investigation.
- B. CONTRACTOR shall, at a minimum, comply with the requirements of the General Conditions, Paragraph 6.20, for all excavations.

1.5 EXISTING UTILITIES

- A. Protect existing active utility services and structures from damage during shoring and bracing work. Repair or replace damages to satisfaction of utility owner.

1.6 MATERIALS

- A. Provide suitable shoring and bracing materials which will support loads imposed. Materials and construction shall be as provided in the certified shoring and bracing submittal.

1.7 SHORING

- A. Protect site from caving and unacceptable soil movement. Where shoring is required, locate system to clear permanent construction and to permit forming and finishing of concrete surfaces. Provide shoring system adequately anchored and braced to resist earth and hydrostatic pressures.
- B. Shoring systems retaining earth on which support or stability of existing structures is dependent must be left in place at completion of work. If wood is part of shoring system near existing structures, use pressure preservative treated materials or remove before placement of backfill.
- C. Shoring may be used as falsework for forming reinforced concrete.

1.8 BRACING

- A. Locate bracing to clear permanent work. If necessary to move a brace, install new bracing prior to removal of original brace.
- B. Install internal bracing, if required, to prevent spreading or distortion to braced frames.
- C. Maintain bracing until structural elements are re-braced by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

1.9 REMOVAL

- A. Shoring and/or bracing may be completely or partially removed, at the CONTRACTOR's option. All shoring and/or bracing shall be removed to an elevation at least eight (8) feet below the proposed finish grade above the section of shoring or bracing.

- B. Regardless of whether shoring and/or bracing is fully or partially removed, it shall be removed by the CONTRACTOR in stages to avoid disturbance to underlying soils and damage to structures, pavements, facilities, and utilities.
- C. CONTRACTOR shall repair or replace adjacent work damaged or displaced through installation or removal of shoring and bracing work.

END OF SECTION

SECTION 02210

SITE ROUGH GRADING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Rough grading for site drainage and the site.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Unless otherwise indicated, material for fills shall be surplus excavated soil and borrow material meeting the appropriate requirements for backfill as specified in other sections and shall be subject to approval by the ENGINEER.

PART 3 – EXECUTION

3.1 GENERAL

- A. Provide all rough grading and filling to achieve the lines and grades indicated on the Drawings, with an allowance for the thickness of surfacing or top soil. Material not suitable for the required fills shall be spread uniformly in designated spoil areas and compacted as specified in Section 02250 to achieve a smooth and firm surface. All earthwork shall be done in a manner that provides drainage and prevents surface drainage from entering excavations.

3.2 PREPARATION FOR FILLS

- A. Upon completion of site preparation work, remove any additional organic material or debris where fill is to be placed. Ground surfaces sloped steeper than 1 vertical to 4 horizontal shall be plowed, stepped or benched, or broken up as directed by the OWNER so the fill material will bond with the existing surface. Level surfaces shall be disked, wetted or dried as required, and recompacted. Backfill all holes made by demolition, clearing, grubbing, and other site preparation work.
- B. Lift thicknesses and compaction requirements are specified in Section 02250.
- C. Fill material and the surface to be filled shall be free of any frozen material. If, in the opinion of the ENGINEER, fill already placed has loosened as a result of frost action, the fill shall be recompacted prior to placing additional lifts. Compacted material that has been flooded and no longer meets the density specified shall be removed and replaced.

END OF SECTION

SECTION 02221

UTILITY TRENCHING AND BACKFILLING

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The work of this section includes, but is not necessarily limited to excavation and backfilling for all potable water mains, raw water mains, gravity and storm sewer lines, force mains, power and instrumentation cables and other utilities as shown on the Contract Documents and specified herein.

1.2 QUALITY ASSURANCE

- A. Testing and inspection services as required by this section shall be provided by the CONTRACTOR as part of the project cost. Testing shall be performed by a qualified commercial testing laboratory as chosen by the CONTRACTOR and approved by the ENGINEER. Tests can include hand auger probing, field density tests for verifying the degree of compaction and excavation inspections to determine the limits of unsuitable material to be removed. Certified copies of all test reports shall be submitted to the ENGINEER.
- B. CONTRACTOR shall indicate to the City of Bloomington Utilities Inspector, during his initial visit to the site, the nature and storage place of any and all hazardous substances. This shall be updated as necessary.

1.3 REFERENCES

- A. Indiana Department of Transportation (INDOT) Publication: Latest edition of Standard Specifications.
- B. Occupational Safety and Health Administration (OSHA) Standards 29 CFR Part 1926 including Subparts A,B,C,D and P.
- C. City of Bloomington Utilities: Latest edition of Construction Specifications for Wastewater, Water, and Storm Projects.

1.4 CARE OF EXISTING STRUCTURES AND PROPERTY

- A. All poles, fences, sewer, gas, water, drainage or other pipes, wires, conduits, manholes, buildings, structures and property in the proximity of any excavation shall be supported and protected from damage by the CONTRACTOR during construction.

- B. Wherever sewer, gas, water, drainage or other pipes or conduits cross the excavation, the CONTRACTOR shall support said pipes and conduits without damage to them and without interrupting their use during the progress of the work. The manner of supporting such pipes, etc., shall be subject to review by the ENGINEER.
- C. Any damage to poles, fences, sewer, gas, water, drainage or other pipes, wires, conduits, manholes, buildings, structures and property resulting from the CONTRACTOR's work shall be promptly repaired by the CONTRACTOR. The quality of all such repair work shall be to the satisfaction of the ENGINEER.

1.5 EXISTING UNDERGROUND STRUCTURES AND UTILITIES

- A. The Contract Documents show the location of utilities based upon the best available information, however, the ENGINEER does not accept any responsibility for the accuracy of this information nor does he guarantee that all utilities within the work area are shown.
- B. The CONTRACTOR, prior to the start of construction, shall verify the location of any existing underground utilities and structures within the site limits. It shall be the CONTRACTOR's responsibility to make any and all exploratory investigation which may be necessary to verify or locate the utility pipes, wires, structures and appurtenances of others. The CONTRACTOR shall notify the ENGINEER of any conflicts between the location called for in the information furnished and the actual location of any existing underground utilities or structures. Any conflicts found shall be recorded as directed by the ENGINEER.

PART 2 – PRODUCTS

2.1 BEDDING

- A. The CONTRACTOR shall provide bedding material as noted below and indicated on the plans. Per the requirements of the City of Bloomington, bedding shall conform to ASTM D 2321 and be either No. 11 or No. 12 crushed stone.
- B. All pipe shall be bedded on four inches (4") of either #11 or #12 crushed stone when in soil and on six inches (6") when the pipe is laid in rock or 1/6 pipe O.D. up to eight inches (8") maximum thickness, whichever is thicker. The stone shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between pipe joints. Bedding material shall be removed for bells so the entire length of pipe rests evenly on the bedding. It will be permissible to slightly disturb the finished bedding surface by withdrawal of pipe slings or other lifting tackle. After each pipe has been placed, sufficient pipe embedment material shall be deposited and shovel-sliced beneath the haunches of the pipe up to the spring line to hold the pipe in proper position during subsequent operations. This shall be done uniformly and simultaneously on each side of the pipe to prevent lateral displacement of the pipe before primary backfill.
- C. Bedding beneath structures shall be a minimum of 4" of either #11 or #12 crushed

stone in soil and 6" in rock. All over-excavation shall be filled with either #11 or #12 crushed stone or Class D Concrete, as required by the ENGINEER, to achieve elevations indicated on the plans.

2.2 BACKFILL

- A. Backfill materials shall be placed and compacted in uniform lifts and shall have a moisture content to assure that maximum density will be obtained with compaction.
- B. Primary backfill shall be #11 or #12 crushed stone to a point 12 inches above top of pipe. The stone shall be shovel-sliced beneath the haunches of the pipe.
- C. Secondary backfill above pipe embedment shall conform to the following requirements:
 - 1. Beneath pavements, surfacing, and driveways backfill shall be in accordance with the agency issuing the permit. If no permit is required full-depth #53 stone compacted in six-inch (6") lifts must be used.
 - 2. Under highway shoulders, fills, or embankments backfill shall be in accordance with the agency issuing the permit. If no permit is required full-depth #53 stone backfill is required compacted in six-inch (6") lifts if nearest trench edge is within five feet of pavement.
 - 3. In unimproved areas backfill may be the same materials as excavated, if it is good native material, but may contain no stone larger than six inches (6") in its greatest dimension.
 - 4. Around structures backfill shall be placed and compacted in uniform lifts not to exceed twelve inches (12") in depth.
- D. Backfill around flexible pipe shall be performed in accordance with material and installation the requirements of the pipe manufacturer.
 - 1. Materials should be installed and compacted in 6-inch lifts.
 - 2. Proper haunching provides a major portion of the pipe's strength and stability. CONTRACTOR shall use care in workmanship to avoid excessive pipe deflection and grade alignment problems.
- C. The bell holes shall be excavated for bell and spigot pipe so the entire pipe barrel rests on the bedding. The bedding shall be such that after the pipe has been placed to line and grade, there remains a four (4) inch minimum depth of material below the pipe barrel and a minimum of three (3) inches below the bell.
- D. For all installations, the haunching material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped to the springline (1/2 the outside diameter) to ensure compaction of the haunch area and complete filling of all

voids. The initial backfill shall be added in six (6) inch lifts “walked” in for compaction.

- E. Final backfill requirements are determined by the location of the excavation.
 - 1. For all other installations within five (5) feet of the edge of pavement, curbs, gutters, or similar structures:
 - a. Trenches shall be backfilled with structural “B-Borrow” for structural installations per INDOT Standard Specifications - Section 211.
 - b. Backfill shall be compacted to achieve not less than 95% Standard Proctor Dry Density per INDOT Standard Specifications Section 203.23. The CONTRACTOR shall use in-house or independent testing to verify proper compaction. The OWNER may require independent testing to verify CONTRACTOR results at any time during the duration of the project.
 - 2. Outside five (5) feet of the edge of pavement, curbs, gutters, or similar structures trench shall be backfilled with clean fill material free of rocks larger than three (3) inches in diameter, frozen lumps of soil, wood, or other extraneous material.
- F. Backfill shall be added and compacted in twelve (12) inch balanced lifts by means of mechanical tampers.
- G. Flowable fill may be used as a substitute for structural “B-Borrow.”
- H. Jetting or flooding of the backfill shall not be used to meet the compaction requirements for utility trenching and backfilling.

PART 3 – EXECUTION

3.1 TRENCH INSTALLATION

- A. The minimum width of the trench at and below the top of the gravity sewer, lateral, or force main shall be only as wide as necessary for proper installation and backfilling.
- B. The minimum trench width for gravity sewers, laterals, and force mains shall not be less than the greater of the following:

Minimum Width = Pipe O.D. + 16 inches

or

Minimum Width = (Pipe O.D. x 1.25) + 12 inches

- C. Under no circumstances shall the distance from the trench wall to the outside edge of the pipe be less than six (6) inches for pipes six (6) inches and less, and eight (8) inches for pipes eight (8) inches and larger.

- D. For flexible conduits, the lateral resistance of in-situ soils shall be of sufficient stiffness to provide the required pipe support. Where unstable trench sidewall conditions exist, or where trench depth dictates the use of a moveable trench box, the ENGINEER shall determine the width of compacted bedding and backfill material necessary to provide adequate pipe side support.
- E. The minimum and maximum trench widths above the top of the gravity sewer, lateral, and force main shall be determined by the CONTRACTOR and shall be in conformance with all applicable safety regulations including, but not limited to, those promulgated by OSHA.

3.2 GENERAL TRENCHING REQUIREMENTS

- A. Whenever pipe trenches are inadvertently excavated below the designed bedding bottom, the CONTRACTOR shall fill the over-excavated area with compacted No. 8 crushed stone or No. 8 fractured face aggregate and shaped to form a firm, uniform trench base.
- B. In cases where a firm foundation is not encountered at the required grade, the CONTRACTOR shall remove the unstable material to a sufficient depth not less than six (6) inches and replaced with either No. 2 crushed stone, No. 8 crushed stone, or No. 8 fractured faced aggregate. When compacted and properly shaped, the fill material shall produce a uniform and stable foundation along the entire length of the pipe. If more than one (1) foot of unstable material is encountered, the CONTRACTOR shall take additional measures to ensure that additional stabilization is provided, such as geotextile fabric wrapping of the trench section or as approved by the OWNER. The cost for such stabilization shall be paid for under the applicable provisions of the General Conditions.
- C. All rocks, boulders and stones six (6) inches in diameter and larger shall be removed. Boulders or rocks are not to be used for any portion of the trench backfill.
- D. The pipe trench shall not be excavated more than one hundred (100) feet in advance of pipe laying unless approved by the ENGINEER or OWNER.
- D. In cases where material is deposited along open trenches, the material shall be placed and protected so that no damage will result to the work or adjacent property as a result of rain or surface wash.

3.3 LAYING THE PIPE

- A. Anchors shall be required for stabilization of any pipe having a slope of 20% or greater.
- B. Every precaution shall be taken to prevent foreign material from entering the pipe during installation. If this proves ineffective, the ENGINEER may require that, before lowering the pipe into the trench, a heavy, tightly-woven canvas bag of

suitable size be placed over each pipe end and left there until connection is to be made to the adjacent pipe.

- C. Each length of pipe shall be inspected while suspended above the trench immediately before installation, with special attention being given to pipe ends and gaskets. Defective pipe or fittings shall be laid aside for inspection by the ENGINEER, who will prescribe corrective repairs or rejection.

END OF SECTION

SECTION 02223

STRUCTURAL EXCAVATION AND BACKFILL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavation and backfill for structures.
- B. Structural backfill.
- C. Granular bedding and backfill under concrete slabs.
- D. Disposal of excess excavated material.

1.2 CLASSIFICATION

- A. Excavation will be unclassified regardless of the nature of the materials encountered.

1.3 REFERENCES

- A. City of Bloomington Utilities: Latest edition of Construction Specifications for Wastewater, Water, and Storm Projects.

PART 2 PRODUCTS

2.1 STRUCTURAL BACKFILL

- A. Structural Backfill as indicated on the Contract Documents shall be No. 53 crushed limestone complying with the Indiana Department of Transportation Standard Specification (Section 904.056).
- B. The particle size shall be less than 2" and contain no more than 8% by weight passing a #200 sieve.
- C. The uniformity coefficient shall be greater than 4.
- D. The liquid limit shall not be greater than 25 and the plasticity index not more than 6.
- E. Structural Backfill shall be compacted in accordance with Section 02250.

2.2 GRANULAR BACKFILL

- A. Granular Backfill as indicated on the Contract Documents shall be natural sand or a mixture of sand with gravel, crushed gravel or crushed stone complying with the Indiana Department of Transportation Standard Specifications. Borrow as defined by the Indiana Department of Transportation Standard Specifications may be substituted for Granular Backfill when placed adjacent to buried structures.
- B. Granular Backfill and B Borrow shall be compacted in accordance with Section 02250.

2.3 BACKFILL

- A. Unless approved by the ENGINEER previously excavated materials shall not be used as backfill.

2.4 GRANULAR BEDDING COURSE

- A. Granular Bedding Course as indicated on the Contract Documents shall be No. 12, washed complying with the Indiana Department of Transportation Standard Specification (Section 904.02).

2.5 DRAINAGE FILL

- A. Drainage Fill as indicated on the Contract Documents shall be No. 8, washed complying with the Indiana Department of Transportation Standard Specification (Section 904.02).

2.6 COARSE DRAINAGE FILL

- A. Coarse Drainage Fill as indicated on the Contract Documents shall be No. 2, washed complying with the Indiana Department of Transportation Standard Specification (Section 904.02).

2.5 CHIP AND DUST COURSE

- A. Chip and Dust Course as indicated on the Contract Documents shall be No. 12 complying with the Indiana Department of Transportation Standard Specification (Section 904.02).

PART 3 EXECUTION

3.1 STRUCTURAL EXCAVATION

- A. Excavate to the depth and dimensions necessary for the construction; maintain excavations in good order; and provide barricades and warning lights as required. If underground utilities and/or structures not shown on the Contract Documents are encountered, notify the ENGINEER and do not proceed until instructions are obtained. Notify the ENGINEER if springs or running water are encountered.

- B. The bottom of all excavations shall be undisturbed earth unless otherwise noted, and shall be approved before subsequent work is started. Subgrade shall be proof-rolled with a loaded tandem axle dump truck or similar rubber tired vehicle, weighing at least 20 tons. Proof-rolling, as indicated, will be required only on roadways. Structure subgrades will be evaluated by the ENGINEER as deemed necessary. Soils which are observed to rut or deflect excessively under the moving load shall either be scarified and recompacted or undercut and replaced with properly compacted fill.
- C. Where excavation and backfill below the Limits of Excavation defined on the Contract Documents is ordered in writing by the ENGINEER, such additional excavation and structural backfill will be paid for as extra work. Where the Limit of Excavation is not defined, the limit shall be taken as the base of the footing or mud slab where applicable.
- D. Dewatering and drainage is specified in Section 02140.
- E. Do not excavate for any structure until that structure is scheduled for construction. If the bearing capacity of the foundation soils is reduced because the excavation is allowed to remain open prior to commencing work or dewatering is inadequate, the weathered or unsuitable soil shall be removed and replaced with lean (2000 psi) concrete or compacted structural backfill at the expense of the CONTRACTOR.
- F. Excavations carried below depths indicated on the Contract Documents without the previous approval of the ENGINEER shall be filled with lean (2000 psi) concrete or compacted structural backfill to the correct elevation at the expense of the CONTRACTOR.
- F. Side forms on footings will not be required if the soil is stable and square corners and straight sides are maintained until the concrete is placed; otherwise, excavate outside the foundation lines to allow for installation and removal of formwork and for inspection.

3.2 FILLING, BEDDING, AND BACKFILLING

- A. General: Obtain the ENGINEER's approval of existing conditions before starting filling operations. Remove all vegetation, formwork, rubbish and other debris. Excavate muddy subgrade. Do not fill on frozen subgrade. The quantity of structural fill or granular fill required beneath concrete slabs and foundations is dependent on the limits of excavation required to install the footings and foundation walls as well as on the extent of any unstable soil requiring removal. Fill limits shall be from undisturbed soil to the necessary lines and grades under all concrete slabs and foundations of buildings, tanks, and miscellaneous structures.
- B. Structural backfill and granular backfill shall be added and compacted in twelve (12) inch balanced lifts. Degree of compaction and methods shall be in accordance with Section 02250.
- C. Structural Backfill: Provide structural backfill to achieve necessary lines and grades

under all structures.

- D. Granular Backfill: Provide granular backfill indicated on the Contract Documents to achieve necessary grades under concrete slabs and elsewhere as indicated.
- E. Provide 8-12 oz per square yard of non-woven geotextile filter fabric.
- F. Backfilling: Do not backfill until new concrete has properly cured and wall coatings have been approved. Leakage tests shall be completed before backfilling.
- G. Exercise care during backfilling operations to avoid any puncture, break, or other damage to waterproofing systems. Backfill adjacent to waterproofing in the presence of the ENGINEER.
- H. Where backfilling is required on both sides of structures, backfill and compact simultaneously on opposite sides in even layers. Other backfilling sequences shall be as specifically indicated.
- I. Flowable fill shall be used for backfill where compaction requirements can not be met due to restricted areas.

3.3 DISPOSAL OF EXCAVATED MATERIAL

- A. Stockpiled excavated material shall be contained within construction work limits. Spoil piles for moving material into dump trucks shall be graded to drain in a controlled manner in compliance with all Rule 5 requirements.
- B. All excess material shall be disposed on off-site at the CONTRACTOR's expense. Disposal of "clean" material off-site shall be the CONTRACTOR's sole responsibility including, but not limited to, hauling, location, grading, and permitting.
- C. All excavated materials containing slag, cinders, foundry sand, debris and rubble shall be removed from the site and legally disposed of properly. Disposal of such materials shall be the CONTRACTOR's sole responsibility including, but not limited to, hauling, location, grading, and permitting.

END OF SECTION

SECTION 02224

ROCK REMOVAL

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Solid rock excavation, removal, and disposal.

1.2 DEFINITIONS

- A. Rock excavation shall include ledge rock, all boulders exceeding one-half (1/2) cubic yards in volume, and concrete or masonry structures or any other material which, in the opinion of the ENGINEER, requires ripping or jack hammering for removal.

1.3 REFERENCES

- A. City of Bloomington Utilities: Latest edition of Construction Specifications for Wastewater, Water, and Storm Projects.

PART 2 – EXECUTION

2.1 ROCK EXCAVATION

- A. If rock is encountered in the excavation, it shall be removed by ripping or jack hammering, or as otherwise approved by the OWNER.
- B. Ledge rock, boulders and large stones shall be removed to provide a clearance of at least six (6) inches below and on each side of all pipe, valves and fittings. Rock shall be excavated at least seven (7) inches from the outside of the pipe bell on each side. Before pipe bedding is started, all trench bottom irregularities shall be filled with approved granular material, well compacted into place, and the bottom of the trench brought to proper grade. Each section of pipe shall be backfilled immediately after laying. The exposed end of the last pipe shall be covered with sandbags to protect it from damage from flying debris.
- C. Rock excavation for structures shall be carried to the bottom of the footing, foundation slab, or lowest point of improvements and on all sides to a width sufficient to allow proper construction procedures.
- D. Excavated rock may be utilized as specified fill provided it meets requirements. All excess rock shall be removed from the site and disposed of by the CONTRACTOR at the CONTRACTOR's expense.

E. Do not excavate until notified by the ENGINEER that the elevations of the top of the rock have been taken, if required.

F. No separate payment will be made for rock excavation and disposal.

2.2 BLASTING

A. Blasting of rock, ledge rock, boulders, or large stones will not be permitted.

END OF SECTION

SECTION 02230

SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract Documents apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, as indicated on Drawings.
- E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius equal to the diameter of the drip line unless otherwise indicated.
- F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain OWNER'S property, cleared materials shall become CONTRACTOR'S property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from OWNER'S and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by OWNER or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining OWNER'S property will be obtained by OWNER before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by ENGINEER.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on OWNER'S premises per OWNER'S direction.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 02223 Structural Excavation and Backfill.
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer.
1. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.
- C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to OWNER.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site with 4' tall orange snow fence stabilized with posts at a maximum of 10' on center. Fence shall be installed at drip edge of existing trees or as indicated on plans.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by ENGINEER.

3.4 EXISTING UTILITIES

- A. OWNER will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by CONTRACTOR.
 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
 1. OWNER will arrange to shut off indicated utilities when requested by CONTRACTOR.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by OWNER or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify ENGINEER not less than seven days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without ENGINEER'S written permission.
- E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 3. Use only hand methods for grubbing within protection zones.
 4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within protection zones.
 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
 4. Stockpile surplus topsoil to allow for resspreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off OWNER'S property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 02240

SOIL STABILIZATION

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. If needed to maintain safe working conditions and protect existing facilities from damage during open-cut excavation the CONTRACTOR may stabilize the soil utilizing chemical grout and the application of air-placed concrete to the face of the excavation in conjunction with other trench support systems.

1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be made in accordance with General Conditions 6.22.
- B. The CONTRACTOR shall submit, for approval by the ENGINEER, detailed sketches of the intended injection techniques and patterns, including necessary data to prove that the chemicals contemplated will meet in all respects the requirements as to properties and qualities required by these Contract Documents. Any test data furnished by the CONTRACTOR substantiating the adequacy of the grout shall be from a certified testing laboratory, as directed by the ENGINEER.

1.3 QUALIFICATIONS

- A. Work required under this Section shall be performed by a CONTRACTOR having at least 5 years' experience in the field of chemical grout soil stabilization and underpinning and having successfully completed at least 5 projects of a similar nature.
- B. The CONTRACTOR shall submit satisfactory documentation that project personnel have the appropriate qualifications.

1.4 WORK COORDINATION

- A. The CONTRACTOR shall fully coordinate the work operations of this Section with that of other trades involved and with the ENGINEER to ensure proper sequence of work, limitation, methods, and time of work so as to minimize or avoid interferences as well as performance of work by other trades.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. "Chemical Grout," as referred to herein, shall be a relatively nonviscous solution, not a slurry, that may be injected into a permeable soil mass, undergo chemical reactions that lead to metathetical precipitation or polymerization, and result in solidification of that injected soil by binding together the soil grains for the purpose of increasing the load bearing capacity of the soil. The solidified soil shall have an unconfined compressive strength of 50 psi at 28 days.
- B. The CONTRACTOR shall be responsible for formulation of the grout. Chemicals used shall be sodium silicate based with catalyst that will provide the required chemical grout. Water used shall be compatible with the chemical system to be used.
- C. Considering the chemistry of the gel and the conditions known at the site, the chemical system used shall produce a stable gel. The chemical system used shall stabilize soil to permit open-cut excavation and the application of air-placed concrete to the face of the excavation without use of any shoring, and shall have a proven record of stability.
- D. The chemicals used shall be so proportioned and mixed as to produce a chemical grout that contains no solids in suspension, may be pumped without difficulty, will penetrate and fill the voids in the soil mass, and will form a gel of the required strength and stability.
- E. Chemicals mixed into primary solutions before final batching may be held only in accordance with the Manufacturer's recommendations and must not be injected if limiting factors imposed by the Manufacturer are exceeded. Any solutions not to be used for injection shall be immediately disposed of to the satisfaction of the ENGINEER. The chemical system shall not be detrimental to the environment. The injected solution and its components shall be nontoxic.

2.2 SITE PREPARATION

- A. The project site consists of various geotechnical characteristics as detailed in the Project Geotechnical Data Report (GDR).
- B. The site clearing, grubbing, and removal shall be in accordance with Section 02100 Site Preparation. After site preparation work is complete, the CONTRACTOR may commence soil stabilization if needed.

2.3 MIXING

- A. All materials shall be accurately measured by weight or volume for mixing. If a variable proportioning pump system is used, positive controls shall be incorporated to ensure accurate proportioning. Care shall be taken not to contaminate mixing vessels with reactive chemical by spillage, splash, etc.
- B. A fast check reaction shall be made with each new primary chemical batch. A test sample shall be made of every injection batch. The CONTRACTOR shall keep records to establish the point of injection for each sample. These data shall be submitted to the ENGINEER on a daily basis.
- C. If any sample fails to show the proper gelation, the potential area of failure shall be reinjected. The CONTRACTOR shall propose method of correction.

PART 3 – EXECUTION

3.1 APPLICATION

- A. The CONTRACTOR shall determine the extent of the soil stabilization required, if any, subject to approval by the ENGINEER.
- B. Care shall be taken in the placing of injection points to secure accurate injection and the proper overlapping of injection cylinders.
- C. Injection rates and pressures shall be closely controlled to prevent blowout, localized "quick" conditions, and to ensure the proper filling of voids to attain the desired stabilized section.
- D. Quantities of chemical grout injected at each point shall be governed by calculated volume, back pressure, or a combination of these two factors. If it appears, at any point, that a large void exists, proper steps shall be taken to ensure permeation of the desired soil section as directed by the ENGINEER.

3.2 CLEANUP

- A. Upon completion of soil stabilization and work specified herein, the CONTRACTOR shall dispose of all excess materials off the jobsite and the jobsite shall be left in a clean and orderly condition ready for subsequent work operations.

END OF SECTION

SECTION 02250

COMPACTION CONTROL AND TESTING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Placement, compaction control, and field density testing requirements for all earthwork, including pavement subgrade. See Section 02221 for requirements specific to Utility Trenching and Backfilling.

1.2 QUALITY ASSURANCE

- A. Testing and inspection services as required by this section shall be provided by the CONTRACTOR as part of the project cost. Testing shall be performed by a qualified commercial testing laboratory as chosen by the CONTRACTOR and approved by the ENGINEER. Tests can include hand auger probing, field density tests for verifying the degree of compaction and excavation inspections to determine the limits of unsuitable material to be removed. Certified copies of all test reports shall be submitted to the ENGINEER.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. All materials and products are specified elsewhere in these Contract Documents.

PART 3 – EXECUTION

3.1 FILL PLACEMENT

- A. If fill already placed has loosened as a result of frost action, the fill shall be recompact prior to placing additional lifts. Compacted material that has been flooded and no longer meets the density specified shall be removed and replaced.
- B. If the in-place surface has dried, sprinkle with water before placing the next lift. The surface of smooth lifts shall be scarified before the next lift is placed.
- C. Where fill is required on both sides of structures, fill and compact simultaneously on opposite sides in even layers. Other filling sequences shall be as specifically indicated on the Drawings.
- D. Fill shall be spread in uniform horizontal lifts. The material shall be thoroughly mixed to insure uniform moisture content slightly wetter than optimum but not greater than 5

percent above optimum water content as determined by the Standard Proctor Test, ASTM D698.

- E. Where cohesive fill is used, the moisture content when compacted shall be within 3 percent of the optimum moisture content. If the fill does not have a natural water content which falls within the acceptable range, the CONTRACTOR shall mix, dry, or moisten as necessary.
- F. Place and compact each lift over an entire area prior to placing successive lifts, unless otherwise approved by the ENGINEER.
- G. All materials shall be placed in loose lift thicknesses indicated hereafter.

3.2 COMPACTION

A. General

- 1. Unless otherwise indicated, the type of equipment and number of passes required to obtain the specified degree of compaction shall be determined at the site, subject to the approval of the ENGINEER.
- 2. Provide mechanical compaction for cohesive material and vibratory compaction for granular materials, unless otherwise approved by the ENGINEER. Jetting, flooding, puddling, or vibroflotation methods will not be allowed.
- 3. Noncohesive soils shall be compacted with vibrating roller or equivalent; cohesive soils shall be compacted with sheeps-foot roller, pneumatic tamping, or approved equivalent, unless otherwise indicated.

B. Granular Backfill

- 1. Granular Backfill and B Borrow, as specified in Section 02223, shall have each lift thoroughly compacted and seated with the subgrade. Compaction methods and procedures shall be subject to approval of the ENGINEER.

C. Topsoil

- 1. Topsoil, as specified in Section 02260, shall be compacted with a "cultipacker", roller, or approved equivalent equipment weighing 100 to 160 pounds per lineal foot of roller width.

3.3 FILL LIFT THICKNESSES AND COMPACTION DENSITIES

- A. Unless otherwise indicated or approved by the ENGINEER, place fills in the loose lift thicknesses indicated hereafter and compact to a dry density not less than the following percentage of maximum dry density, determined by the Standard Proctor Test, ASTM D698, unless otherwise noted.

3.4 TESTING

- A. The CONTRACTOR shall provide to the ENGINEER reports of field density tests to insure required densities are being obtained:
1. One test for each 10,000 square feet or fraction thereof per lift of general backfilling.
 2. Two tests for each 10,000 square feet or fraction thereof per lift of structural fill under slabs, foundations, and pavements.
 3. One test per lift for each other type of fill, if so directed by the ENGINEER.
- B. Tests shall be in accordance with ASTM D698 or other tests suitable for the materials being tested.

<u>Type of Fill</u>	<u>Usage</u>	<u>Lift Thickness</u>	<u>Compaction %</u>	<u>ASTM</u>
Structural Backfill	All locations under major structures	6"	98	D698
	All locations under minor structures (manholes, etc.)	6"	95	D698
	Under walks, concrete curbs, the concrete steps	6"	95	D698
Impermeable Fill	All locations	6"	98	D698
Granular Backfill (and B Borrow)	Below concrete slab bedding, foundations, rigid paving, and excavated areas adjacent to structures.....	8"	95	*D698
	All other uses	12"	95	D698
	Beneath concrete slabs	6"	95	D698
Granular Bedding Course	Fill in other locations not covered herein	12"	95	D698
General Site Grading	Topsoil placement	12"	95	D698
Drainage Fill	Building slabs, pervious pavement, porous unit paving, softile, rain gardens, and retaining walls	6"	98	D698
Coarse Drainage Fill	Decorative porous unit pavers	8"	98	D698
Chip and Dust Course	Playground tile	6"	95	D698

"Influence area" shall be considered the area within lines sloped downward at 45 degrees from the outer edges of paving, foundations, and utility lines.

* See drawings for additional compaction requirements.

END OF SECTION

SECTION 02260

FINISH GRADING

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Topsoil placement.
- B. Final grading of the site.

PART 2 – PRODUCTS

2.1 TOPSOIL

- A. Topsoil shall be fertile, friable, loose and easily pulverized natural topsoil typical of the area, free from subsoil, stones over 1-inch in diameter, plants, roots or other extraneous material which would be detrimental to the proper development of vegetative growth, and shall not be used while muddy or frozen.
- B. Topsoil shall have a pH value of 6.2 to 7.4 and contain not less than 8% organic matter (AASHTO T194). The topsoil shall consist of either natural topsoils typical of the locality and free from coarse stone aggregate or surface soils stripped from the site and enriched with humus at a rate of 8% by volume. The soil mixture prepared by mixing surface soils and humus shall be free of oil, cinders, coarse stone, and woody root material.
- C. The CONTRACTOR shall save all existing project topsoil, if possible, keeping it in a separate pile, and working into at least the top six inches of the subsoil with a power rototiller.
- D. In the event that sufficient topsoil cannot be obtained from common excavation, top soil may be obtained from outside the limits of this project as directed by the ENGINEER and in accordance with Sections 621.04, 621.08 and 914.01 of the Standard Specifications, at no additional cost to the OWNER. No additional compensation shall be allowed for over hauling common excavation suitable for topsoil, stockpiling or placement of topsoil.
- E. When Borrow is required, the CONTRACTOR may elect to preserve the required topsoil from common excavation or furnish borrow suitable for topsoil. No payment will be made for top soil when borrow is required.
- F. Topsoil shall not be incorporated into the work until it is approved.

- G. Topsoil shall be spread to a sufficient depth to produce the thickness specified, after it has been compacted lightly with an approved roller, tamping device or other approved method. The depth of topsoil shall not be greater than 8 inches.

PART 3 – EXECUTION

3.1 GENERAL

Provide all topsoil placement and finish grading and filling to achieve the lines and grades indicated on the Drawings. All earthwork shall be done in a manner that provides drainage.

3.2 TOPSOIL PLACEMENT

- A. Place topsoil in all areas of new grading or where topsoil has been removed. Prior to placing material, the area to be covered shall be free of all rocks or clods over 1.5 inches in diameter, and all sticks or other foreign material, which may prevent the close contact of the topsoil to the existing soil. Areas to be covered with topsoil shall be tilled or disked to a depth of at least three (3) inches before the material is placed. If as a result of a rain, the recently placed special topsoil becomes eroded, or if eroded places, ruts or depressions exist, the soil shall be reworked until it is smooth. Topsoil shall be spread evenly and compacted to a thickness of not less than one (1) inch, and to the proposed elevations and grades. Grade shall be flush with walks and paving.
- B. Topsoil shall be compacted in accordance with Section 02250.

3.3 FINISH GRADING

- A. All areas of the project including all previously grassed areas that have been disturbed, borrow sites, excavated and filled sections and adjacent transition areas shall be uniformly smooth-graded. Depressions from settlement shall be filled and compacted. Tops of embankments and breaks in grade shall be rounded. All surfaces shall be finished to provide adequate drainage. Finished surfaces shall be reasonably smooth, compacted, free from irregular surface changes and comparable to the smoothness obtained by blade-grader operations.
- B. Slope grades to drain away from structures at a minimum of 1/4-inch per foot for ten (10) feet.
- C. Finished surfaces adjacent to paved or surfaced areas and within ten (10) feet of structures shall be within one (1) inch of the proposed grade. All other areas shall be within three (3) inches of the proposed grade.
- D. Newly graded areas shall be protected from traffic and erosion. All settlement or washing away that may occur from any cause prior to seeding or acceptance shall be

repaired and grades re-established to the required elevations and slopes at no additional cost to the OWNER.

- E. Unless otherwise indicated, all surplus material shall be disposed of by the CONTRACTOR.

END OF SECTION

SECTION 02268

EROSION CONTROL BARRIER

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide erosion control barriers, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with General Conditions Section 6.22.
- B. Product Data: Manufacturer's catalog sheets on geotextile fabrics.

PART 2 -- PRODUCTS

2.1 FABRIC

- A. Fabric may be woven or non-woven, made from polypropylene, polyethylene, or polyamid, and shall contain sufficient UV inhibitors so that it will last for 6 months in outdoor exposure.
- B. Fabric shall have the following properties:

Parameter	Standard Method	Value
Grab tensile strength	ASTM D 4632	100 lb
Burst strength	ASTM D 3786	200 psi
Apparent opening size	ASTM D 4751	Between 200 and 70 sieve size

- C. Fabric Manufacturer, or equal
1. Mirafi by TenCate Geosynthetics North America

2.2 POSTS

- A. Posts shall be wood, at least 2 inches by 2 inches, or steel 1 1/2-inch, T-shaped with protective coating, at least 6 feet long with protective coating.

2.3 FENCING

- A. Woven wire fabric fencing shall be galvanized, mesh spacing of 6 inches, maximum 14-gauge, at least 30 inches tall.

2.4 FASTENERS

- A. Fasteners to wood posts shall be steel, at least 1 1/2 inches long.
- B. Fasteners to steel posts shall be galvanized clips.

PART 3 -- EXECUTION

3.1 PREPARATION

- A. Provide erosion control barriers at the indicated locations and as required to prevent erosion and silt loss from the Site.
- B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

3.2 INSTALLATION

- A. Barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
- B. Attach the woven wire fencing to the posts that are spaced a maximum of 8 feet apart and embedded a minimum of 12 inches. Install posts at a slight angle toward the source of the anticipated runoff.
- C. Trench in the toe of the filter fabric barrier with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow. Lay fabric along the edges of the trench. Backfill and compact.
- D. Securely fasten the fabric materials to the woven wire fencing with tie wires.
- E. Reinforced fabric barrier shall have a height of 18 inches.
- F. Provide the filter fabric in continuous rolls and cut to the length of the fence to minimize the use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.

3.3 MAINTENANCE

- A. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until final acceptance; then remove erosion and sediment control systems promptly.

- B. Remove sediment deposits when silt reaches a depth of 1/2 the height of the barrier or when the fabric starts to bulge, whichever is less. Dispose of sediments on the Site, if a location is indicated on the Contract Documents, or at a site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

END OF SECTION

SECTION 02731

YARD PIPING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Work under this section includes, but is not limited to:
 - 1. The installation and testing of gravity sewer pipe.
 - 2. Piping and fittings for the 15" gravity effluent discharge line and the 3" forcemain.

1.2 RELATED WORK

- A. Section 01660 – Testing and Adjusting
- B. Section 02221 - Utility Trenching and Backfilling
- C. Section 02601 - Manholes, Catch Basins, Vaults and Appurtenances

1.3 REFERENCES

- A. City of Bloomington Utilities: Latest edition of Construction Specifications for Wastewater, Water, and Storm Projects.

1.4 QUALITY ASSURANCE

- A. All similar components shall be manufactured and furnished by one manufacturer unless specifically approved by the Engineer in writing.
- B. All pipe shall be made in the U.S.A.
- C. The new effluent discharge line shall pass an air pressure test and a deflection test.

1.5 SUBMITTALS

- A. The Contractor shall submit shop drawings in accordance with the General Conditions for the pipe and pipe fittings furnished herein. Shop Drawing submittals shall include descriptive literature, pressure ratings, certification of all applicable ASTM standards, design calculations, and manufacturer's installation instructions.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01600. Exercise care in transporting and handling pipe and fittings in order to avoid damage to materials or coatings. Lifting shall be by hoist or on skids when hand lifting is not feasible. Dropping shall not be permitted. Unload, handle, and store pipe as recommended by the manufacturer. Damaged pipe and fittings shall be replaced.

PART 2 PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE

- A. This specification includes high-density polyethylene (PE 3408/3608) ductile iron pipe size (O.D.) pressure pipe primarily intended for the transportation of water or sewage either buried or above grade.
- B. Material
 - 1. Pipe shall be manufactured from a PE 3408/3608 resin in accordance with ASTM D 3350-02 with a minimum cell classification of PE345464C. The pipe density shall be greater than 0.941 with no additives. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.
 - 2. Acceptable Manufactures include JM Eagle, ISCO, or Engineer-approved equal.
- C. Fittings
 - 1. All fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are jointed. All fittings shall be molded or fabricated by the manufacturer. No contractor fabricated fittings shall be used.
 - 2. Fittings, accessories, adapters, or special items required to perform the work shall be supplied by the same manufacturer used to supply the HDPE pipe.
 - 3. All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters.
 - 4. All pipe material transitions shall be made per the approval of the Engineer and per the Manufacturer's recommendations and specifications. A molded flange connector adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions.
- D. Fusion
 - 1. Contractor shall understand and follow all equipment manufacturer's fusion recommendations and guidelines.
 - 2. Butt Fusion Fittings. Butt fusion fittings shall be in accordance with ASTM. All fittings shall be pressure rated to provide a working pressure

- rating no less than that of the pipe. The fitting shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.
3. Electrofusion fittings. Electrofusion Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02 and be the same base resin as the pipe. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055.
- E. Field Cutting of Pipe
1. All field-cutting of pipe shall be done in a neat, trim manner using a hand or power saw.
- F. Rejection of Damaged Pipe
1. Pipe possessing the following defects may be rejected for installation: variation from straight centerline; elliptical shape; illegible markings as required; deep or excessive gouges or scratches of the pipe wall; fractures, punctures, or cracks passing through the pipe wall; and damaged ends where such damage would prevent making a satisfactory joint.
- G. Pipe Markings
1. At minimum the following information shall be continuously indented printed on the pipe or spaced at intervals not exceeding 5-ft:
 - a. Name and/or trademark of the pipe manufacturer
 - b. Nominal pipe size and dimension ratio
 - c. The letters PE followed by the polyethylene grade in accordance with ASTM
 - d. A production code from which the date and place of manufacture can be determined.
- H. Tracing Wire
1. Installation shall include tracing wire
 2. Tracer wire shall be #12 THWN single strand electrical cable suitable for direct burial. Tracer wire shall be installed with all pipes on this project. The wire shall be taped or attached to the pipe in an approved manner during installation and prior to backfilling. Two feet of slack shall be provided in all valve boxes and fire hydrants. The slack shall be wrapped around the valve box or fire hydrant at ground level.
 3. Installation shall include marking tape
- I. Certification of Materials
1. The Engineer reserves the right to require material certification from the manufacturer prior to construction to ensure the material supplied conforms to the prescribed requirements.
 2. Upon request, the Contractor shall furnish a certificate of conformance to the required ASTM, AWWA, and/or ANSI Standards, this Manual, and

other conformance certifications in the form of affidavits of conformance, test results, and/or copies of test reports.

3. Provisions for obtaining this certification shall be the responsibility of the Contractor. The Owner and Engineer do not assume the responsibility for the expense of obtaining material certification.

2.2 DUCTILE IRON PIPE

- A. Ductile Iron Pipe shall be centrifugally cast in metal or sand-lined molds and shall conform to ANSI A21.51 with the thickness class as scheduled herein.
- B. Joints: Mechanical and push-on joints for pipe and fittings shall conform to ANSI A21.11. Flanged joints shall conform to ANSI A21.15 with ANSI B16.1, Class 125 flanges. Bolts and nuts shall conform to ASTM A307, Grade B. Restrained retainer gland joints shall be Mega-Lug 1100 series as manufactured by EBAA Iron Works or Ford Uni Flange Series 1400. As an alternate to restrained retainer gland joints, restrained joints using a boltless design, American Cast Iron Pipe "Flex-Ring" or U.S. Pipe "TR-FLEX" may be used. No substitutions other than those listed in this paragraph will be acceptable for use in thrust restraint locations.
- C. Gaskets: Flanged joint gaskets shall be ring type and conform to ANSI B16.21.
- D. Fittings: Fittings for ductile iron pipe shall be of the type shown and shall conform to ANSI A21.10 or A21.53. Joints shall be as specified above.
- E. Grooved pipe type couplings shall be manufactured by Victaulic Company of America or equal. Coupling shall be rigid system conforming to ASTM A536.
- F. Interior Lining: Interior lining for cast iron and ductile iron pipe and fittings shall be as follows:
 1. Cement mortar lining and bituminous seal coat shall conform to ANSI A21.4.
 2. Bituminous lining shall be 1 mil thick.
- G. Exterior Coating: Exterior coating for ductile iron pipe and fittings shall be as follows.
 1. Buried pipe and fittings shall have an ANSI A21.6 or A21.8 bituminous coating.
 2. Exposed pipe and fittings shall have the standard bituminous coating omitted and shall be shop primed in accordance with Section 09900, if applicable.
- H. Corrosion Protection
 1. Ductile iron pipe and fitting and valves shall be encased in polyethylene encasement sleeves which consist of linear low density polyethylene, 8

mil thickness, Class C (black) conformity to the requirements of AWWA C105/ANSI A21.5.

2. Ductile iron pipe and fittings installed to be paralleled or crossed with other mains that have galvanic anode or rectified cathodic protection shall be encased by dual wrap polyethylene encasement sleeves, Class C (black) conforming to the requirements of AWWA C105/ANSI A21.5. The inner wrap shall be linear low density, polyethylene, 8 mil thickness, and the exterior wrap shall be high density cross laminated, polyethylene, 4 mil thickness. The dual wrap shall extend a minimum of 20 feet perpendicular to the crossing or any portion of ductile iron pipe laid within 10 feet parallel to cathodically protected pipelines.

2.3 PVC (POLYVINYL CHLORIDE) PIPE (SCHEDULE 40)

- A. Pipe: Schedule 40 PVC pipe shall be manufactured from PVC 1120 and shall conform to ASTM D1785. Nominal size shall be as indicated on the Drawings. Pipe and fittings shall be NSF approved for the usage to which they will be applied.
- B. Joints: solvent weld.
- C. Fittings:
 1. Manufactured of the same material as the pipe
 2. The same type of joints
 3. Conform to ASTM D2467.
- D. Provide adapters as required to join PVC pipe to pipe, fittings, and equipment of other materials.
- E. Provide unions at all connections to equipment.
- F. Solvent Cement: cleaner and primer shall be as recommended by the pipe manufacturer and shall conform to ASTM standards.

2.4 BLACK AND GALVANIZED STEEL PIPE

- A. Black and galvanized steel pipe shall conform to ASTM A53 and A120. Pipe shall be Scheduled 40 unless otherwise scheduled. All close nipples shall be cut from double extra strong pipe.
- B. Joints for pipe 2-inches and smaller shall be threaded joints, conforming to ANSI B2.1. Couplings shall conform to ASTM A120. Joints for pipe larger than 2-inches shall be welded, conforming to the current AWWA standards.
- C. Fittings shall be screw type 150 pound malleable iron fittings conforming to ANSI B16.3 Fabricated fittings, where required, shall match the pipe.

2.5 POLYPROPYLENE PIPE

- A. This specification includes polypropylene (PP) pipe primarily intended for the conveyance of sewage or stormwater below grade.
- B. Material
 - 1. 12-inch to 30-inch pipe shall have smooth interior and exterior surfaces with annular inner corrugations and meet ASTM F2736.
 - 2. 30-inch to 60-inch pipe shall have smooth interior and exterior surfaces with annular inner corrugations and meet ASTM F2764.
 - 3. Minimum pipe stiffness shall be 46 psi when tested in accordance with ASTM D2412.
 - 4. Pipe shall have a design Mannings n value of 0.012.
 - 5. Pipe shall be manufactured from virgin material.
 - 6. Material shall be impact modified copolymer polypropylene conforming with the requirements of ASTM D4101.
 - 7. Acceptable Manufactures include ADS N-12 HP or Engineer-approved equal.
- C. Fittings
 - 1. 12-inch to 30-inch fittings shall conform to ASTM F2736; 30-inch to 60-inch fittings shall conform to ASTM F2764.
 - 2. Bell and spigot connections shall utilize a spun-on, welded, or integral bell and spigot with gaskets meeting ASTM F477.
 - 3. Fitting joints shall meet the watertight joint performance requirements of ASTM D3212.
 - 4. All fittings shall be fabricated by the pipe manufacturer. No contractor fabricated fittings shall be used.
 - 5. Fittings, accessories, adapters, or special items required to perform the work shall be supplied by the same manufacturer used to supply the PP pipe.
- D. Joints
 - 1. Pipe shall be joined with a gasketed integral bell and spigot joints meeting the requirements of ASTM F2764 or ASTM F2736, as applicable.
 - 2. Joints shall meet the watertight joint performance requirements of ASTM D3212.
 - 3. Spigots shall have two gaskets meeting the requirements of ASTM F477.
 - 4. Gaskets shall be installed by the pipe manufacturer and covered with a removable protective wrap to ensure that the gasket is free of debris.
 - 5. During assembly, a manufacturer-supplied joint lubricant shall be used on the gasket.
 - 6. The bell shall be reinforced with a polymer composite band installed by the manufacturer.
- E. Rejection of Damaged Pipe

1. Pipe possessing the following defects may be rejected for installation: variation from straight centerline; elliptical shape; illegible markings as required; deep or excessive gouges or scratches of the pipe wall; fractures, punctures, or cracks passing through the pipe wall; and damaged ends where such damage would prevent making a satisfactory joint.

F. Pipe Markings

1. At minimum the following information shall be continuously indented printed on the pipe or spaced at intervals not exceeding 5-ft:
 - a. Name and/or trademark of the pipe manufacturer
 - b. Nominal pipe size and dimension ratio
 - c. The letters PE followed by the polyethylene grade in accordance with ASTM
 - d. A production code from which the date and place of manufacture can be determined.

G. Tracing Wire

1. Installation shall include tracing wire
2. Tracer wire shall be #12 THWN single strand electrical cable suitable for direct burial. Tracer wire shall be installed with all pipes on this project. The wire shall be taped or attached to the pipe in an approved manner during installation and prior to backfilling. Two feet of slack shall be provided in all valve boxes and fire hydrants. The slack shall be wrapped around the valve box or fire hydrant at ground level.
3. Installation shall include marking tape

H. Certification of Materials

1. The Engineer reserves the right to require material certification from the manufacturer prior to construction to ensure the material supplied conforms to the prescribed requirements.
2. Upon request, the Contractor shall furnish a certificate of conformance to the required ASTM, AWWA, and/or ANSI Standards, this Manual, and other conformance certifications in the form of affidavits of conformance, test results, and/or copies of test reports.
3. Provisions for obtaining this certification shall be the responsibility of the Contractor. The Owner and Engineer do not assume the responsibility for the expense of obtaining material certification.

2.6 PIPING SCHEDULES

- A. The inside and outside piping schedules at the end of this section enumerate the piping to be used on this project.
- B. Abbreviations used in the schedule are as follows:
 1. Pipe Materials
 - a. DI Ductile Iron
 - b. HDPE High Density Polyethylene

- c. ST Black or Galvanized Steel
- d. PP Polypropylene
- e. PVC Polyvinyl chloride
- 2. Joints
 - a. MJ Mechanical Joint
 - b. PO Push-On Joint
 - c. F Flanged
 - d. RRG Restrained Retainer Gland
 - e. T Threaded
 - f. W Welded
 - g. ERF Electrical resistance fusion
 - h. SW Solvent welded
 - i. BS Bell and spigot
- 3. Coatings and Linings
 - a. B Bituminous
 - b. CL Cement-Mortar Lined
 - c. P Painted
 - d. U Unlined
 - e. BC Bituminous – Cold Application

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor shall furnish and set all line and grade stakes (HUB). A Professional Engineer or Land Surveyor registered in the State of Indiana will be required to set, or oversee the setting of, all bench mark stakes necessary for the installation of any facility being constructed. Bench marks shall be set in strategic locations within the project to facilitate the installation of grade stakes. Horizontal and vertical control will be required to be provided with record drawings to be submitted to the Owner upon completion of the project. The method of establishing and following line and grade in conformance with the approved Contract Documents shall be determined by the Contractor.
- B. Suitable tools and equipment shall be used for the safe and convenient handling of all materials and for the installation of all facilities. All material shall be unloaded with care. Care shall be taken to prevent pipe coatings, encasements or wrappings from being damaged. Each section of pipe shall be carefully examined for cracks and other defects prior to installation. Pipe or fittings found to be cracked, broken, or otherwise defective either before, during, or after installation, shall be removed and replaced with material free from defects. All pipes, gaskets, and other fittings shall be thoroughly cleaned prior to installation and shall be kept clean during construction.
- C. The point of commencement for laying pipe should be the lowest point in the proposed line. Provisions for beginning construction at other than the lowest point

in the proposed line shall be approved by the Engineer. All bell and spigot pipe shall be laid with the bell end, or with the receiving groove end of tongue and groove pipe pointing upgrade or toward the lift station end of force mains. Each pipe shall be laid on an even firm bed throughout its length so that no uneven strain will come to any single portion of the pipe. Particular care shall be taken to prevent the total load from bearing on the pipe sockets. All bells of bell and spigot pipes shall be carefully placed into a receiving hole excavated into the pipe bedding material. All pipes shall be properly joined utilizing the manufacturer's assembly marks. Adequate pressure shall be applied to the center of each tongue and groove pipe to ensure the proper joint seal is achieved.

- D. Before constructing the effluent discharge line, the Contractor shall provide a watertight bulkhead or seal, in the existing sewer immediately downstream of the point of connection or the most practical location as determined by the Engineer. This bulkhead shall be left in place until the new line has been cleaned of all accumulated water and debris and accepted by the Owner. During all work stoppages in construction of the line, the open face of the last pipe laid shall be plugged with a watertight seal to prevent sand, water, earth, or other materials from entering the pipe. Whenever pipe and special castings are required to be cut, the cutting shall be done by skilled workers in such manner as to leave a smooth end at right angles to the axis of the pipe without damage to the pipe casting or lining. CUTTING TORCHES SHALL NOT BE USED.
- E. Until such time as a minimum of four (4) feet of compacted fill material has been placed over the installed effluent discharge line, the Contractor shall not use heavy equipment in such a way as to cause damage to these pipelines or structures.
- F. The Owner reserves the right to order pipe installation discontinued whenever, in their opinion, there is danger of the quality of work being impaired because of cold weather. The Contractor shall be responsible for heating the pipe and jointing material so as to prevent freezing of joints. No flexible or semi-rigid pipe shall be laid when the air temperature is less than 32° F unless proper precautions, per the manufacturer's recommendations, are taken by the Contractor and the method is approved by the Engineer and the Owner. When pipes with rubber gaskets or resilient-type joints are to be laid in cold weather, sufficiently warm the gasket or joint material to facilitate making a proper joint. No portion of a facility shall be installed directly onto frozen ground or backfilled with frozen material.

3.2 TESTING

- A. Pipe pipe testing requirements is specified in Section 01660.
- B. The completed gravity sewer shall be inspected for damage and improper installation, tested for leakage, and repaired if necessary prior to being placed into operation. The Contractor shall retest the gravity sewer subsequent to any repairs required initial testing fails.

- C. The Owner reserves the right to supplement the other required tests with a pressure smoke test if considered necessary or desirable by the Owner or Engineer.
- D. Before final acceptance, all new gravity sewers shall be televised by the City of Bloomington Utilities Department. The Contractor shall arrange with the City for televising. The first televising run shall be conducted after all other testing and cleaning is complete. The Contractor must give at least 72 hours prior notice (not including weekends or holidays) to the Utilities Department when scheduling televising. A second televising run will be conducted 11 months after the date of final acceptance. Both televising runs will be used to determine wye locations, defective joints, and deformed or cracked pipe or fittings. Both runs will be done by the City Utilities without charge to the Contractor. Any additional runs that are considered necessary to reinspect defective pipes or joints shall be charged to the Contractor at a rate to be determined by the City of Bloomington.

3.3 PLUGS

- A. Installed piping systems shall be temporarily plugged at the end of each day's work, or other interruption to progress on a given line. Plugging shall be adequate to prevent entry of small animals or persons into the pipe or the entrance or insertion of deleterious materials.
- B. Standard plugs shall be inserted into all dead-end pipes, tees, or crosses; spigot ends shall be capped; flanged and mechanical joint ends shall have blind flanges of metal.
- C. Plugs installed for pressure testing shall be blind flanges fully secured and blocked to withstand the test pressure.
- D. Where plugging is required because of contract division or phasing for later connection, the ends of such lines shall be equipped with a permanent type plug or blind flange. Installation or removal of such plugging shall be considered incidental to the work.

END OF SECTION

SITE PIPING SCHEDULE

<i>Service</i>	<i>Size (inches)</i>	<i>Material</i>	<i>Ext. Coating</i>	<i>Int. Lining</i>	<i>Joint</i>	<i>Test Pressure (psi)</i>	<i>Design Class</i>
Force main	3	PVC	-	U	SW	120	Sch 40
Gravity sewer	15	PP	-	U	BS	5	-

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SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General formwork.
- B. Forms and coatings.
- C. Form ties and accessories.

1.2 RESPONSIBILITY

- A. The CONTRACTOR shall be solely responsible for the ability of formwork to produce members of the size, shape, and exterior finish required, for the structural adequacy of the forms to carry construction loads without excessive deflection, and for the safe use of forms in connection with completion of the concrete work. The CONTRACTOR shall be responsible for any injury or damage arising from inadequate forms or from premature removal of formwork.
- B. Submittals
 - 1. Samples and Certifications.
 - 2. Samples and Certifications shall be submitted in accordance with Section 01340.
- C. Referenced Standards: Formwork design, construction, and removal shall conform to ACI 301, Standard Specifications for Structural Concrete.

PART 2 PRODUCTS

2.1 FORMWORK

- A. Form Ties: Form ties shall be a water-sealing, snap-in type or tapered thru bolt type. The large end of tapered thru bolt ties shall be on the liquid side of the wall.
- B. Plywood Forms and Liners: Plywood forms and liners shall be minimum grade B-B High Density Overlay Concrete Form Panels, Class I.
- C. Lumber: Formwork lumber shall be straight and clean. All nails shall be withdrawn and surfaces in contact with concrete shall be thoroughly cleaned before reuse.

- D. Metal Forms: Metal forms shall be fabricated from carbon steel sheets conforming to ASTM A569.

PART 3 EXECUTION

3.1 PREPARATIONS

- A. Fastening Devices for Other Work: Coordinate with other trades and properly place and locate in position all necessary dowels, bolts, anchors, anchor slots, inserts, sleeves, openings, hangers, metal ties and other fastening devices required for attachment and support of adjacent work. Securely anchor all embedded items.

3.2 FORMWORK REQUIREMENTS

A. General:

1. Formwork shall comply with ACI 347 and to shape, lines and dimensions of the members as indicated on the Drawings. Joints in forms shall be horizontal or vertical. Forms shall be properly braced or tied to maintain position and shape under all dead and live loads and to prevent leakage. Forms shall be assembled so their removal will not damage the concrete. Tolerances for formed surfaces shall be in compliance with ACI 301.
2. Lumber formwork may be used for surfaces which will not be exposed to view. Use plywood or metal forms for exposed surfaces.
3. Provide temporary openings at the base of forms greater than 4 feet high, if necessary, to facilitate cleaning and inspection immediately before depositing concrete.
4. All external corners of concrete exposed to view shall be chamfered by using 3/4 inch by 3/4 inch by 45 degree wood stripping, except as otherwise indicated on the Drawings.

B. Grade A Forms

1. Unless otherwise indicated, Grade A forms shall be used for all exposed concrete.
2. Grade A forms shall consist of steel forms lined with 3/16 inch thick tempered hardboard or 1/4 inch thick plywood, or by using plywood forms.
3. Full sized sheets shall be used wherever possible. The edges of all sheets shall be straightened to insure tight, close fitting joints. Bulges or depressions more than 1/8 inch in 4 feet will not be permitted. Open joints which would permit leakage shall be sufficient cause for rejection of forms. Other tolerances shall be as allowed by ACI 347.

C. Grade B Forms

1. Use lumber, plywood or metal forms. All joints shall be solidly backed, aligned and made leak proof.
 2. Unless otherwise indicated, Grade B Forms are intended for use where concrete will not be exposed to view, such as below grade, below normal liquid levels in water-retaining structures, or inside manholes, boxes, vaults, etc.
- D. Surface Treatment of Formwork: The inside surface of lumber forms shall be soaked with clean water prior to placing concrete. All other forms shall be treated with an approved form oil or lacquer. If oil is used, all excess oil shall be wiped off.
- E. Inspection of Formwork: Concrete shall not be placed until the forms have been inspected by the OWNER to assure surfaces in conformance with the Drawings and Specifications.
- F. Removal of Forms: Forms shall be removed in accordance with requirements of ACI 318, without damaging the concrete. Leave shoring in place until concrete will safely support its own weight plus any live loads that may be placed upon it.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Provision of all reinforcement.

1.2 SUBMITTALS

- A. Certifications: Certifications for reinforcement shall be submitted in accordance with Section 01340.
- B. Shop Drawings: Submit checked reinforcement steel shop drawings in accordance with Section 01340. Shop drawings shall be prepared in accordance with ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures. Drawings shall indicate bending diagrams, shapes, dimensions, clearances, splicing and lap lengths, accessories, and installation notes.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcement Bars: Reinforcement bars shall be ASTM A615, Grade 60 deformed bars, except as otherwise indicated.
- B. Smooth Dowels: Smooth dowels shall be ASTM A615, Grade 60 plain bars.
- C. Threaded Dowels: Threaded dowels shall be ASTM A36.
- D. Welded Wire Fabric: Welded wire fabric shall conform to ASTM A185. Where welded wire fabric is shown but not sized on Drawings, use 6" x 6" x W2.9 x W2.9 WWF.
- E. Accessories: Accessories for proper installation of reinforcement shall conform to CRSI "Manual of Standard Practice for Reinforced Concrete Construction". All bar supports at exposed surfaces shall be Class 1- Plastic Protected.
- F. Reinforcement Fabrication: Reinforcement fabrication shall conform to ACI 315 and ACI 318, and approved shop drawings.
- G. Mechanical Splices: Splices shall develop 125% of the specified yield strength of the reinforcing bar.

PART 3 EXECUTION

3.1 PREPARATIONS

- A. Vapor Barrier: On porous subgrade or beddings, provide vapor barrier as specified in Section 03300.
- B. Fastening Devices for Other Work: Coordinate with other trades and properly place and locate in position all necessary reinforcement, dowels, bolts, anchors, anchor slots, inserts, hangers, metal ties, and other fastening devices required for attachment and support to adjacent work. Securely anchor all fixtures and embedded items.

3.2 REINFORCEMENT

- A. General:
 - 1. The placement of reinforcing steel shall conform to "Placing Reinforcing Bars", as published by the Concrete Reinforcing Steel Institute except as noted.
 - 2. Reinforcement shall be inspected and approved by the ENGINEER before enclosing forms are erected and shall be rechecked immediately prior to depositing concrete.
- B. Splices, Laps, and Dowels:
 - 1. Provide continuous reinforcement or dowels through construction joints. The use of inserts in lieu of dowels shall be subject to the ENGINEER'S approval. All reinforcement shall be discontinued across expansion joints, except for sleeved or greased dowels, if indicated.
 - 2. Splice laps shall be as indicated on the Drawings. Dowels shall be of the same size as the largest bar to which they lap, unless otherwise indicated.
 - 3. Clean all concrete, dirt, and foreign substances from reinforcing bars by sand blasting or by other methods as approved by the ENGINEER prior to making a mechanical splice. Manufacturer's representative shall provide on-site instruction to CONTRACTOR's personnel and OWNER's representative on proper installation procedures. Manufacturer's representative shall observe initial splices made by the CONTRACTOR to insure proper technique and performance of the product. HE shall make additional visits to the site as may be requested by the OWNER to inspect completed work. The CONTRACTOR shall only use personnel who have received instructions from manufacturer's representative to perform the work.

C. Fabric Reinforcement for Slabs

1. Fabric reinforcement for slabs shall be overlapped at splices not less than the spacing of the cross wires plus 2 inches. Fabric shall extend to within 2 inches of concrete edges.
2. Unless otherwise shown, place reinforcement 2 inches below the top of the finished slab. Mesh shall either be sandwiched between two layers of fresh concrete or supported on mesh supports. Supports that may puncture the vapor barrier, if any, shall not be used.

D. Reinforcement for Formed Concrete

1. Secure steel reinforcement to maintain proper position during concrete placement. Concrete protection for reinforcement shall conform to ACI 318, except as otherwise indicated on the Drawings.
2. Provide Z bars and bar supports at 4-foot on centers each way in wall, columns, etc. pours to maintain proper position.

END OF SECTION

SECTION 03250

CONCRETE ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Construction joints.
- B. Chemical anchoring.
- C. Waterstop.

1.2 SUBMITTALS

- A. Samples and Certifications: Samples and certifications for all materials herein shall be submitted in accordance with Section 01340.

PART 2 PRODUCTS

2.1 JOINT FILLERS

- A. Joint fillers shall be products of the following manufacturers, or equal:
 - 1. W. R. Meadows, Inc., Elgin, Illinois.
 - 2. W. R. Grace and Co., Cambridge, Massachusetts.
- B. Preformed Sponge Rubber Joint Filler: Preformed sponge rubber joint filler shall conform to ASTM D1752, Type I.
- C. Preformed Cork Joint Filler: Preformed cork joint filler shall conform to ASTM D1752, Type II.
- D. Preformed Bituminous Fiber Joint Filler: Preformed bituminous fiber joint filler shall be non-extruding type conforming to ASTM D1751.
- E. Control Joint Strips: Control joint strips shall have a minimum depth of 25 percent of slab thickness and a minimum thickness of 1/4 inch.

2.2 JOINT SEALANTS

- A. Sealants for joints shall be as indicated under Execution and in accordance with Section 07900.

B. PVC Waterstop:

1. Waterstop shall be virgin polyvinyl chloride (PVC) and shall be dense, homogeneous and uniform. Holes and imperfections shall be cause for rejection.
2. Waterstops for construction joints shall be 6 inch by 3/16 inch minimum split waterstop or 6 inch by 3/16 inch minimum with hollow center bulb. Multiple rib type of waterstop is required. Where size and type of waterstop are not indicated, 6 inch by 3/16 inch minimum with hollow center bulb shall be used.

2.3 CHEMICAL ANCHORING

- A. Chemical Adhesive: The chemical adhesive used for each type of load application shall be in accordance with the manufacturer's recommendations and product limitations. Chemical adhesives for bonding reinforcement dowel bars, and threaded anchors shall be one of the following:

Adhesives Technologies: Ultrabond Glass Capsules, method 2; Ultrabond Speedset 2, Ultrabond A1; Ultrabond 365

Hilti Inc: HVA or HVU method 2; HIT HY-150, HIT HY-150 MAX

ITW Ramset/Red Head: Epcon A7; Epcon C6; Epcon G5

Kelken Construction: Keligrout 101P

MKT Fastening: LiquidRoc 300; LiquidRod 700

SIKA Corp: Sikadur Anchor Fix-2, Anchor Fix-3, Anchor Fix-4

Simpson Strong-Tie Co: VGC; Acrylic-Tie

Power Fasteners: AC100+Gold; Hammer Capsule, method 1

Unitex: Pro-Poxy 400

W.R. Meadows: Sealtight Poly-Grip

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove existing concrete and provide openings for installation of new work as indicated on Drawings. Repair all damage to existing work caused by concrete removal.

3.2 CONSTRUCTION JOINTS

- A. General

1. Arrange construction joint bulkheads to allow concrete to be placed between construction joints in one continuous operation.
 2. Provide construction joints with shear transfer keyways and waterstops as indicated. Unless otherwise indicated on the Drawings, spacing of construction joints for walls shall not exceed 40 feet.
 3. Erect bulkheads where shown on the Drawings. Bulkheads shall be at right angles to the main reinforcement and shall produce a tongue and grooved joint of the configuration indicated on the Drawings. Install waterstop as indicated.
 4. Obtain the ENGINEER'S approval if it becomes necessary to eliminate or relocate construction joints shown on the Drawings.
 5. Tops of edge forms, bulkheads and screeds shall be set to the finished elevations and to provide uniform pitch to drains as indicated on Drawings.
- B. Horizontal Joints: Provide methods of achieving a leakproof joint. No horizontal construction joints will be permitted in slabs, beams, or girders.
- C. Vertical Joints: Joints in reinforced slabs, beams, and girders shall be perpendicular to the axis or plane of the members joined.
- D. Expansion Joints: General: Provide expansion joints and waterstops where indicated. Joint fillers shall be placed on each side of waterstops.
- E. Interior Horizontal Joints: Unless otherwise indicated, provide preformed sponge rubber or preformed cork filler. Allow for installation of two component traffic grade polyurethane sealant in compliance with Section 07900.
- F. Exterior Horizontal Joints: For drives, pavements, parking areas, walks and slabs on grade, provide preformed non-extruding asphalt strip or bituminous fiber joint filler set 1/8-inch below finished surface unless otherwise indicated. Tool concrete edges on each side of joint. No sealant is required.
- G. Interior and Exterior Vertical Joints: Unless otherwise indicated, provide preformed sponge rubber or cork filler with allowance for installation of two-component polysulfide sealant in compliance with Section 07900.
- H. Submerged Horizontal and Vertical Joints: Unless otherwise indicated, provide preformed sponge rubber or cork filler with allowance for installation of two component polyurethane or two-part polysulfide sealant as required in compliance with Section 07900. CONTRACTOR shall submit sealant manufacturers recommendation that his product is suitable for this application.

3.3 WATERSTOPS

- A. Provide continuous waterstops.
- B. Embed approximately half of the waterstop on each side of the joint. Field splice and join PVC waterstop with heat sealing butt joints.
- C. All splices and joints shall be in accordance with the manufacturer's recommendations to produce a water-tight joint. Lap splices will not be permitted. Support and protect the waterstop during construction. Repair or replace all damaged waterstop.

3.4 CHEMICAL ANCHORING

- A. Drill and prepare hole and place bar in accordance with the manufacturer's installation instructions.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete mixtures.
- B. Mixing.
- C. Transporting.
- D. Placement schedule.
- E. Depositing and consolidating.
- F. Slab finishing.
- G. Curing.
- H. Formed surface finishing.

1.2 SUBMITTALS

- A. Samples and Certifications: Samples and certifications shall be submitted in accordance with Section 01340. Unless otherwise indicated, submit certifications for all products and samples as may be specifically requested by the ENGINEER.
- B. Product Data: Submit manufacturer's literature for all admixtures proposed for the work.
- C. Delivery Tickets: Submit delivery tickets in accordance with ASTM C94 for each batch of ready-mixed concrete. Information on the ticket shall include class of concrete, water content, time of loading, truck number, admixtures, and quantity.
- D. Mix Design
 - 1. At least 35 days prior to placing of concrete, the Contractor shall submit proposed mix proportions and samples of proposed materials to the testing laboratory retained by the OWNER. The laboratory will prepare a detailed report of the 7-day and 28-day compressive strength, slump, and air-entrainment of the concrete mix submitted. The strength determination for each class of concrete will be based on not less than three concrete specimens of each age.

2. The laboratory will employ techniques to adjust for mechanical vibrators and any special devices or equipment to be used for the work. The Contractor shall inform the OWNER and the Testing Laboratory of proposed techniques and devices.
 3. As an alternate to items 1 and 2 above, the mix design may be based upon field experience. Contractor shall submit all data and calculations necessary to show compliance with Section 5.3 of ACI 318.
- E. Placement Schedule: Submit a concrete placement schedule showing the pouring sequence and location of construction and contraction joints not indicated on the Drawings to the maximum extents possible.

1.3 QUALITY CONTROL

- A. Materials and Methods: Materials and methods of mixing and placing concrete shall conform to ACI 318, Building Code Requirements for Reinforced Concrete.
- B. Laboratory Tests
1. The CONTRACTOR will retain the services of testing laboratory and pay all laboratory costs to make tests and submit reports.
 2. The Contractor shall provide all necessary labor and devices to obtain samples and provide field curing.
 3. As directed by the ENGINEER, the testing laboratory will provide for inspection of the concrete batch plant to see that the concrete is properly mixed and that the consistency of mix is being controlled.
 4. The laboratory will immediately submit two copies of laboratory reports on all strength tests to the ENGINEER, the local building authority, if required, the concrete contractor, and the supplier. Reports will be made on a form acceptable to the ENGINEER and will indicate delivery ticket numbers, strength, slump, air entrainment, admixtures, concrete temperature, pour location, date, age, and remarks on properties changes.
- C. Compressive Strength Tests: Sample specimens for strength tests of Class A concrete shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete placed, nor less than once for each 5000 square feet of surface area for slabs and/or walls. Five specimens shall be secured in accordance with ASTM C172. Three specimens will be laboratory-cured in accordance with ASTM C31. The other two shall be cured entirely under field conditions. Compressive strength tests will be made at the age of 7 days on one field-cured and one laboratory-cured specimen. Compressive strength tests will be made at the age of 28 days on one field-cured and two laboratory-cured specimens. All tests will be in compliance with ASTM C39.

D. Enforcement of Strength Requirements:

1. For Class A Concrete, the average of any five consecutive compressive strength test results on laboratory-cured specimens shall be greater than the specified strength. Not more than one of the five test results shall be less than the specified strength. No individual laboratory cured strength test result shall fall below the specified strength by more than 400 psi. Each strength test result will be the average of two laboratory cured cylinders from the same sample test at 28 days.
2. If more than one of the laboratory-cured specimens is below the specified strength, or if the strengths of field-cured specimens are more than 10% below the strength of the corresponding laboratory- cured specimens, the ENGINEER will determine the appropriate corrective measures to be provided at the Contractor's expense.

E. Slump Tests: Tests for slump will be made when directed by the ENGINEER in accordance with ASTM C143. Excessive slump is cause for rejection of concrete prior to placement.

F. Air Entrainment Tests: At least two air content tests will be made each day, and when change in consistency of the concrete mix is noted. The air content tests will be made in accordance with ASTM C138, C173, C231, or AASHTO T152.

G. Adverse Weather Conditions:

1. Comply with ACI 305 or 306 for hot or cold weather concreting.
2. Do not mix salt, chemicals, or other foreign materials with the concrete to prevent freezing without approval of the ENGINEER. Maintain the temperature of concrete above 50 degrees F for 5 days after placement. When high early strength portland cement concrete is used, the temperature shall not be less than 70 degrees F for 2 days or 50 degrees F for 3 days. Transition the concrete to the outside temperature at a rate of 1 degree F each hour for the first 24 hours and 2 degrees F each hour thereafter.
3. In no case shall the temperature of concrete exceed 90 degrees F at the time of placement. If insulated forms are used, the temperature of the concrete mixture shall not exceed 80°F at time of placement.
4. If the ENGINEER determines that heat of hydration may cause excessive concrete temperatures and subsequent detrimental effects, the concrete mixture shall not exceed 60°F at time of placement for critical pours.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Water: Water shall be clean and potable.
- B. Cement: Portland cement shall be ASTM C150 Type I.
- C. Pozzolon: Pozzolons shall conform to ASTM C618 and shall have a loss of ignition less than three percent.
- D. Aggregate:
 - 1. Fine and coarse aggregate shall be clean, hard, natural, or manufactured material conforming to ASTM C33.
 - 2. The nominal maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars or bundles of bars or pretensioning tendons. Coordinate with maximum aggregate sizes specified hereafter for classes of concrete. These limitations may be waived if, in the judgement of the ENGINEER, workability and methods of consolidation are such that the concrete can be placed without honeycomb or void.
- E. Admixtures:
 - 1. Admixtures shall conform to ASTM C260 (air entrainment) or C494 (chemical admixtures) and shall be products of one of the following manufacturers, or equivalent.
 - (a) W. R. Grace and Co.
 - (b) Euclid Chemical Co.
 - (c) Master Builders Co.
 - (d) Sika Chemical Corp.
 - (e) Axim Italcementi Group, Inc.

2.2 MISCELLANEOUS MATERIALS

- A. Vapor Barrier: Vapor barrier shall be polyethylene film 0.006 inches (6 mils) thick and shall conform to Product Standard PS-17.
- B. Curing and Sealing Compound: Curing compound shall be a colorless liquid acrylic formulated to comply with ASTM C309, Type 1, Class B. All interior floor slabs shall be cured and sealed with a colorless liquid acrylic formulated to comply with ASTM C309, Type 1, Class B and with ASTM C1315, Type 1, Class B.

- C. Membrane Curing Compound: Membrane curing compound shall conform to ASTM C309, Type 1 or Type 1-D. Type 1-D compound shall only be used for P.C.C. pavement.
- D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- E. Moisture Retaining Cover: One of the following, complying with ASTM C 171.
 - 1. Waterproof paper.
 - 2. Polyethylene film.
 - 3. Polyethylene-coated burlap.
- F. Silicon Water Repellent: Silicon water repellent shall be a 5% Silicon Solution complying with Fed. Spec. SS-W-110 and manufactured by W. R. Grace, W. R. Meadows, Euclid Chemical Co., or equivalent.
- G. Hardener: Hardener shall be a colorless fluosilicate-base solution of chemically active hardening agents.

2.3 BONDING COMPOUND, GROUT, AND MORTAR MIXTURES

- A. Epoxy Bonding Compound: Epoxy bonding compound for joining new to existing concrete shall be Sikadur Hi-Mod by Sika Chemical Co., Thiopoxy by W. R. Grace and Co., Euco Epoxy 452 or 620 by Euclid Chemical Co., or equivalent.
- B. Non-Epoxy Bonding Compound: Non-epoxy bonding compound for joining new to existing concrete where bonding compound cannot be placed immediately prior to pouring of new concrete shall be Weld-crete by Larsen Products Corp., Euco Weld by Euclid Chemical Co., or equal. Rewettable bonding compound shall be protected from all sources of moisture prior to pouring new concrete.
- C. Cement Grout: Mix 1 part cement and 1 part sand with water to a thick paint consistency. Add white cement to match color of adjacent concrete. Sand shall pass a No. 18 sieve.
- D. Non-Shrink Grout: Non-shrink grout shall be a premixed, nonferrous, cementitious mixture with a 28-day strength of at least 6000 psi. Grout shall not shrink. Mixtures to be placed in excess of 1-inch thickness may include 3/8-inch pea gravel.
- E. Expansive Grout: Expansive grout shall be a premixed, nonferrous, cementitious mixture with a minimum 28-day strength of 3500 psi. Air entraining content shall be as recommended by the manufacturer. Grout shall expand no more than .10% nor less than .03%.

F. Epoxy Grout:

1. The two components of epoxy bonding compound shall be mixed in compliance with the manufacturer's instructions. If permitted by the manufacturer the epoxy bonding compound may be combined with approximately 1-1/2 parts of oven-dry sand to 1 part of the bonding compound, by volume. Mixing of trial batches may be necessary to determine the best proportions.
2. The sand for epoxy grout shall meet the following gradation and shall be oven-dry:

<u>Sieve Size</u>	<u>No. 8</u>	<u>No. 50</u>	<u>No. 100</u>
% Passing	100	30±15	5±5

G. Patching Mortar:

1. Mix 1 part portland cement to 3 parts fine aggregate. Add white cement to match color of adjacent surface. Provide test patch for approval by OWNER prior to patching on exposed concrete. Mix with minimum amount of water necessary.

2.4 CONCRETE MIXTURES

A. General:

1. Concrete not indicated otherwise shall be Class A concrete.
2. The proportions of cement, aggregate, and water shall be selected by the Contractor in accordance with ACI 318 to provide a plastic and workable mix. Coarse aggregate shall be limited to prevent harshness and honeycombing. Coarse aggregate size shall not be greater than the maxima listed for the various classes of concrete and as previously specified under aggregate.

- B. Class A Concrete: Class A structural concrete shall have a 28-day strength of 4000 psi, shall contain not less than 564 pounds cementitious material per cubic yard, shall have a water-cement plus pozzolon ratio of not more than 0.45, and shall contain 4 percent to 6 percent entrained air, by volume, except interior slabs subject to abrasion shall not contain more than 3 percent entrained air. If a pozzolon is used, it shall not exceed 140 pounds per cubic yard of concrete. In addition, Class A concrete shall contain a water-reducing, densifying admixture and have a maximum slump of 4 inches. The maximum aggregate size for concrete for columns, beams, and formed slabs shall be 1 inch. The maximum aggregate size for other concrete construction shall be 1-1/2 inches.

- C. Class B Concrete: Class B lean concrete shall have a 28-day strength of 2500 psi, it shall contain not less than 420 pounds of cementitious material per cubic yard of concrete, shall have a water-cement plus pozzolon ratio of not more than 0.71, and shall have a 5-inch maximum slump. The maximum aggregate size shall be 2 inches. If a pozzolon is used, it shall not exceed 100 pounds per cubic yard of concrete.
- D. Class C Concrete: Class C concrete shall have a 28-day strength of 3,000 psi and shall contain 4-6% of entrained air by volume. The mixture shall contain not less than 470 pounds of cementitious material per cubic yard of concrete and shall have a water-cement plus pozzolon ratio of not more than 0.55 (6-1/4 gallons per bag of cement). Maximum aggregate size shall be 2 inches, and the maximum slump shall be 4 inches. If a pozzolon is used, it shall not exceed 115 pounds per cubic yard of concrete.
- E. Admixtures:
 - 1. Water-reducing densifying admixture added to Class A concrete shall reduce the water-cement ratio while maintaining slump and compressive strength. Use as manufacturer recommends.
 - 2. Other admixtures may be proposed by the Contractor or requested by the ENGINEER and shall be provided at no additional cost to the OWNER. Subject to approval, admixtures may be used for the following:
 - (a) To increase slump up to 50% while maintaining compressive strength and water-cement ratio.
 - (b) To retard set during hot weather.
 - (c) To retard set at the surface to expose aggregate.
- F. Calcium chloride, admixtures containing calcium chloride, or admixtures not approved in writing by the ENGINEER are prohibited.

PART 3 EXECUTION

3.1 PREPARATIONS

- A. Subgrade Preparation: The subgrade and/or bedding shall be compacted and free of frost. If placement is allowed at temperatures below freezing, provide temporary heat and protection as required to remove all frost. Saturate the subgrade approximately 8 hours before placement and sprinkle ahead of the placement of concrete in areas where vapor barrier is not used. Remove all standing water, ice, mud, and foreign matter before concrete is deposited. Mud slabs shall be provided where necessary to obtain a dry and stable working platform for placement of slabs.
- B. Vapor Barrier: On porous subgrade or beddings, or where indicated on the Drawings, provide vapor barrier. Lay vapor barrier sheets with 6 inch edge laps and tape or seal with mastic. Stretch and weight edges and laps to maintain their positions until

concrete is placed. Coordinate with placement of reinforcement specified in Section 03200.

C. Batching:

1. Materials for concrete shall be proportioned according to the approved design mix and batched using either automatic or manually operated batching equipment. If manual operation is employed, fine and coarse aggregates and bulk cement shall be measured separately by weight. Proportioning aggregates for fractional bags of cement will not be permitted unless the cement is weighed for each batch. Weighing equipment shall be arranged to permit compensation for changes in weight of moisture contained in the aggregate and shall be accurate to within 1 percent of the net load being weighed. The scale beam shall indicate at least the last 100 pounds of each aggregate required for the batch.
2. Water shall be measured to within 1 pint of the total amount required per batch. Admixtures shall be measured by weight or volume to an accuracy of 3 percent.

D. Mixing and Transporting Concrete:

1. Concrete shall be ready-mixed or job-mixed at the Contractor's option. Ready-mixed concrete shall be mixed and delivered to the project in accordance with ASTM C94. Job-mixed concrete shall be in accordance with the requirements of ACI 318.
2. Concrete shall be in its final position within one hour after the water and aggregate have been added to the cement, except that in cool weather (50°F or less), the ENGINEER may authorize a lapsed time of up to one and one half hours.
3. Concrete shall be transported from the mixer to place of final deposit in such manner to prevent separation or loss of ingredients.
4. General Concrete and Grout Placement Schedule:

All structural concrete.....	Class A Concrete
Mud slabs, thrust blocks, etc.....	Class B Concrete
Flow channels in manholes and structures, steep slopes, and massive fill configurations	Class C Concrete
Bedding under structural steel bearing plates	Non-Shrink Grout
Equipment installation and leveling.....	Non-Shrink Grout or Expansive Grout
Heavy vibrating equipment.....	Epoxy Grout
Post installation	Epoxy Grout

3.2 DEPOSITING CONCRETE

A. General:

1. Concrete shall be placed in accordance with the requirements of ACI 318 and within 10 feet of its final position. Place concrete only during normal working hours unless the ENGINEER is notified at least 24 hours in advance. Concrete shall not be placed until the ENGINEER has approved the formwork, reinforcement, and embedded items and debris has been removed.
2. Whenever new concrete is to be placed against existing surfaces, roughen and clean the surface to improve bond and apply bonding compound in accordance with the manufacturer's recommendations.
3. Maximum height of free-fall during placement of concrete shall not exceed 4 feet. Where free-fall would exceed allowed maximum height, use "elephant trunks", tremies, chutes, belt conveyors or similar aids to place concrete.

B. Depositing Formed Concrete:

1. Except for beams, columns, or other deep structural monolithic members, place concrete in level layers no more than 24 inches deep. To prevent cold joints between layers, each successive layer shall be placed and consolidated before the preceding layer has taken its initial set. Place concrete in a continuous operation until the section is complete.
2. Concrete shall be directly placed in its final position, shall not be spaded, moved with vibrators, or permitted to fall over rods, spacers, reinforcement, or other embedded items. Any mortar coating which is more than two hours old shall be removed from items to be embedded. Hoppers with trunks, tremies, and/or other means of placement shall be used as necessary.

C. Stopping and Resuming

1. Whenever a wall pour is stopped at an intermediate height, the exposed surfaces of the joint shall be made straight and level.
2. Before depositing new concrete against concrete that has hardened, retighten forms and remove foreign matter and laitance. Previously cast surfaces shall be coated with bonding compound.

D. Depositing Slabs and Flatwork

1. Provide runways and chutes to discharge concrete close to final position to minimize spreading and segregation.

2. Slabs-on-grade for buildings shall be placed in a checkerboard or lane fashion. Unless otherwise shown on the drawings crack control joints consisting of either construction or contraction joints shall be placed such that the area bounded by the joints does not exceed 600 square feet. The aspect ratio (length to width) of the slab units formed by the joint layout shall not exceed 1.25 to 1. Re-entrant corners are not permitted. Allow 24 hours between pours of adjacent slabs. For slab work where joints are not shown on the plans, submit layout of joint location in accordance with Section 1.2E.
3. Structural concrete slabs shall be of one course monolithic construction.

E. Consolidating Formed Concrete

1. Thoroughly compact all concrete with internal vibrators having a minimum frequency of 8000 vibrations per minute and sufficient amplitude and/or hand spading or rodding immediately after depositing, taking care to prevent any movement of the forms or reinforcement. Vibrate adjacent to waterstops and bulkheads to obtain a continuous bond and eliminate surface defects.
2. Vertically insert and withdraw vibrators to consolidate each lift, partially penetrating the previous lift. Do not drag the vibrator nor allow it to come in contact with reinforcement or formwork. Do not attempt to laterally move concrete with the vibrators.

3.3 FINISHING SLABS AND FLATWORK

A. Finish Schedule

1. Unless otherwise indicated, provide the following slab finishes:

<u>Description</u>	<u>Concrete Finish</u>
Depressed setting beds for tile.....	Float
Class B and Class C concrete surfaces.....	Float
Submerged slabs and tank slab toppings.....	1 troweling
Resilient tile or carpet floor covering.....	2 trowelings
Seamless flooring 3 trowelings	
Painted floors.....	3 trowelings
Exposed slabs.....	3 trowelings & sealer
Steps, stair landings.....	Non-slip aggregate
Ramps, walks, and pavement.....	Float & broom finish

B. Concrete Tolerances:

1. Concrete shall be within 1/4-inch of a 10-foot straightedge in all directions except where slabs are dished for drains. Deviations from the elevation indicated shall not exceed 1/4-inch.
2. Slabs sloped for drainage shall not have depressions which retain water.

C. Screeding:

1. Immediately after placement, screed concrete with straightedges or power strikeoffs. Do not use roller screeds or vibrating screeds.
2. Stakes for wet screeds shall be driven down flush with subgrade or pulled out as work progresses to avoid disturbing screeded concrete.
3. For drains in level slabs, form a 5-foot diameter depression approximately 1/2-inch below the adjacent slab surface.
4. Unless otherwise indicated on the Drawings, slabs sloped for drainage shall be uniformly pitched toward the drains at 1/8-inch per foot. Form a dished depression at drains unless otherwise indicated.

D. Darbying: Immediately after screeding, darby surface with wood or magnesium darby to eliminate ridges and to fill in voids left by screeding.

E. Float Finish

1. Float concrete using magnesium or aluminum hand floats or power floats after the concrete has stiffened to a point where only a 1/4-inch indentation can be imparted by normal foot pressure.
2. Float finish shall result in a uniform, smooth, granular texture. After floating, check slab tolerances with 10-foot straightedge. Fill low spots with fresh concrete; do not sprinkle with dry cement.

F. Trowel Finish

1. Where scheduled, or indicated, trowel with steel trowels after floating.
2. Initial troweling shall be done either by power or by hand with the trowel blade kept as flat as possible against concrete surface to prevent washboard or chatter effect.
3. Second troweling may be done by power if three trowelings are scheduled. If two trowelings are specified, second troweling shall be done by hand.

4. Third troweling shall be done by hand and shall continue until the concrete is consolidated to a uniform, smooth, dense surface free of trowel marks and irregularities.
 5. Allow sufficient time between successive trowelings to allow the concrete to become harder. Each successive troweling shall be done with trowels that are progressively smaller and are tipped more to increase compaction of the concrete surface.
- G. Broom Finish: Broom at right angles to direction of traffic to give a non-skid finish. Use a fine, soft-bristled broom for pedestrian ramps and walks, and a coarse, hard-bristled broom for vehicular pavement.
- H. Hardened Finish: Where indicated, apply 3 coats of floor hardener in accordance with manufacturer's printed directions. Use the quantity recommended by the manufacturer. The surface shall be clean and dry before the hardener is applied. Upon completion, leave concrete surfaces clean and without discoloration or traces of excess hardener. Concrete surfaces to be hardened shall be wet cured with an absorptive or moisture retaining cover.
- I. Non-Slip Finish: Incorporate non-slip aggregate in the surface of flatwork in accordance with the manufacturer's directions and at a uniform rate of not less than 50 pounds per 100 square feet. Aggregate shall be applied immediately after floating the surface and embedded flush with the surface. The surface shall be given at least two trowelings.
- J. Control Joints: Control joints for non-structural slabs shall consist of partial depth plastic strips set flush with finished surface or 1/8-inch wide joints cut with a diamond saw. Control joints shall be one-quarter to one-third the depth of the slab unless otherwise indicated.
- K. Saw joints as soon as concrete has hardened sufficiently so aggregate will not be dislodged but before shrinkage stresses develop cracks. Sawn joints shall be filled with joint sealant in accordance with Section 07900.

3.4 PROTECTION AND CURING

- A. General: Comply with ACI 305 and 306 for protecting and curing concrete in hot and cold weather. Fresh concrete shall be protected from rain. Cure all concrete for a minimum period of 7 days (3 days for high early strength concrete) after placing. Provide coverings or curing compound for conventional concrete that is less than 7 days old when forms are removed.

B. Flatwork

1. Immediately after finishing, begin curing by covering with constantly saturated moisture retaining fabrics, impervious sheeting, or membrane curing compounds. Surfaces shall be thoroughly wetted with a fine spray before they are covered with sheeting.
2. Sheeting shall provide complete surface coverage with all joints lapped at least 4 inches, and shall be placed and secured in a manner that will not mar or damage the concrete surface.

C. Membrane Curing Compounds:

1. Apply compound in accordance with manufacturer's recommendations. Apply by spraying in a two-coat continuous operation. Apply the coats at right angles to each other with a coverage of 200 square feet per gallon per coat. Begin application not later than 4 hours after finishing of the surface. The application shall result in an uninterrupted adherent film free of defects.
2. On surfaces scheduled to receive sealants, paint, seamless flooring, or other adhesive bonded finishes, either the membrane curing compound shall be compatible with the bonding agent or the curing compound shall be removed by sandblasting, acid etching or grinding, to the satisfaction of the installer of the finish surfacing. Bonded surfaces that fail to adhere to the concrete shall be removed and replaced at no additional cost to the OWNER.

3.5 DEFECTIVE CONCRETE

- A. All concrete not formed as indicated on the Drawings within tolerances specified in ACI 347 shall be removed and replaced.
- B. Concrete requiring structural repairs shall either be replaced or, with prior written approval of the ENGINEER regarding materials, methods and procedures, may be repaired with epoxy grout.
- C. Concrete that has a defective surface shall be patched or replaced. If patching does not restore the quality and appearance of the surface, the defective concrete shall be replaced.
- D. Temperature and shrinkage cracks which develop prior to final acceptance of the work shall be repaired. Contractor shall propose repair methods to be approved by ENGINEER.

3.6 FINISHING FORMED CONCRETE

A. Patching:

1. After inspection by the OWNER, patch tie holes and defective areas. Where necessary, chip out defective areas to a minimum depth of 1 inch. Wet the area to be patched and the surrounding 6 inches to prevent absorption of water from the patching mortar and/or apply a brush coat of bonding compound or cement grout immediately prior to patching with mortar.
2. Thoroughly compact patching mortar into place and screed, leaving the patch slightly higher than the surrounding surface. For holes passing entirely through the wall use a plunger grout gun to force the mortar through the wall, starting at the back face. Leave undisturbed for a period of one to two hours to permit initial shrinkage before final finishing. The patch shall be finished to match the texture and appearance of the adjoining surface.
3. If form ties are removed completely from wall, place rubber seal in center at wall and epoxy grout under pressure from both sides.
4. All patching shall be cured for three days and then inspected for shrinkage cracks. Excessive cracking shall warrant complete removal and replacement of the patch.

B. Ordinary Finish: The finish resulting directly from formwork shall be used for all surfaces which will be hidden from view by earth, submergence in water, or hidden by subsequent construction or coatings, except as otherwise indicated. Patch as specified.

C. Smooth Finish:

1. Unless otherwise indicated on the Drawings, smooth finish shall be provided for all interior and exterior cast-in-place concrete surfaces permanently exposed to view. Smooth finish shall be produced by using Grade A formwork and the following finish operations:
2. After patching as specified, grind joint marks and fins smooth using a fine carborundum or abrasive stone with clean water. Remove all oil stains by scrubbing the surface with stiff bristle brushes and a 5 to 10 percent muriatic acid solution. After the stains are removed, rinse the surface thoroughly with clean water.

D. Rubbed Finish:

1. Where specifically indicated on the Drawings, produce a rubbed finish on exterior and interior cast-in-place concrete surfaces permanently exposed to view. Do not provide rubbed finish where waterproofing coating is required.
2. Rubbed finish shall be produced by using Grade A formwork and the following finishing operations. As soon as possible after casting and immediately after

patching, wet surfaces and grind with a No. 16 carborundum stone or a mechanical finisher to produce a smooth dense surface free from stains, pits, fins, and irregularities. After grinding, dampen the concrete and paint the entire surface with cement grout. Vigorously work the cement grout into the surface with a cork float or other suitable float. When the grout has set to the point that it will not be pulled out of holes or depressions, the entire surface shall be finished with a sponge rubber float to remove all excess grout.

3. After thorough drying remove all loose grout by scrubbing the surface with a dry burlap or carpet float. Complete the entire rubbed finish for any one area the day it is started. The rubbing operation for any one area shall proceed continuously in an irregular patchwork fashion to eliminate linear horizontal or vertical overlaps.
4. After all rubbed areas are finished once, allow at least 24 hours for the grout to set and perform the rubbing operation, without grinding, a second time.

E. Silicone Water Repellent:

1. Silicone water repellent shall be provided on all permanently exposed concrete surfaces of water retaining structures and where indicated elsewhere. Do not provide silicone water repellent where waterproofing coating is required.
2. Clean all surfaces as required to remove all dirt or stains before applying the water repellent. Apply by spray at the rate of not less than 1 gallon per 125 square feet per coat and in accordance with the manufacturer's recommendations. Apply only to dry surfaces and at temperatures above 40 degrees F. Protect adjacent work from spatter by masking or other suitable methods. Immediately remove any misplaced material from glass and other work using cloths and the proper solvent.

3.7 MISCELLANEOUS CONCRETE WORK

- A. Concrete Stairs and Steps: Use Class A concrete. Provide non-slip nosings for treads and landings, as specified in Division 5. Remove the forms as soon as the concrete develops sufficient strength. Provide non-slip aggregate treads and landings and rubbed finish on exposed vertical surfaces.
- B. Equipment Pads and Supports: Provide concrete equipment pads and supports as indicated and conforming to approved shop drawings. Fastening devices and accessories shall be located by templates or setting diagrams furnished by the manufacturer. Use Class A concrete with rubbed finish on exposed vertical surfaces.
- C. Correcting Slab Tolerances: Slabs exceeding specified tolerances shall have high spots ground down and low spots filled with epoxy resin floor leveler. Epoxy resin shall be applied in strict accordance with the manufacturer's printed instruction.

- D. Watertightness of Concrete Structures: All concrete structures which will contain liquid or are located below groundwater level shall be leak-tested in accordance with Section 01660 and made watertight. Repair all cracks and defects that allow leakage during the guarantee period.

3.8 CLEAN-UP

- A. All concrete floor construction shall have the surfaces thoroughly scrubbed and cleaned with clear water. Cleaning shall be done immediately before application of finish flooring or coating. After cleaning, the slabs shall be protected until they are accepted for floor finishing work.
- B. Clean all surfaces affected by the Concrete Work. No extraneous concrete or discoloration shall be left on any construction.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparing substrate surfaces.
- B. Sealant(s) and joint backing.

1.2 SUBMITTALS

- A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, color available, as per Division 1 and compliance with ASTM C920.

1.3 QUALITY ASSURANCE

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.
- B. Acceptable Manufacturers: All materials shall be products of one of the following manufacturers, or equal:
 - 1. W.R. Meadows, Inc.
 - 2. W.R. Grace and Co.
 - 3. Sika Chemical Corp.
 - 4. Dow-Corning Corp.

PART 2 PRODUCTS

2.1 SEALANTS

- A. Sealants shall be as follows:

	Acrylic Emulsion (Type A-1)	Acrylic (Type A-2)	Polysulfide (Type P5)	Polyurethane (Type PV-1)	Polyurethane (Type PV-2)	Silicone (Type S-1)	Silicone (Type S-2)
Type	S	S	S or M	S or M	S or M	S or M	S or M
Grade	NS	NS	P or NS	P	NS	P	NS
Class	12-1/2	12-1/2	25	25	25	25	25
Use	NT	NT	T or NT	T	NT	T	NT
Hardness	15-50	15-50	25-50	25-50	15-50	25-50	15-50
Elongation	2-5%	5-10	15-25	15-25	15-25	15-25	15-25
Service Temp	0 - 160	0 - 160	-20 - 160	-20 - 160	-20 - 160	-20 - 160	-20 - 160

All as per ASTM C920

All non-staining

All to be non-staining

Color(s) to be selected

Legend

Type: S - single component sealant
M - multi component sealant

Grade: P - pourable or self leveling sealant
NS - non-sag or gunable sealant

Class: 25 - withstand 25% increase/decrease in joint width
12-1/2 - withstand 12-1/2 increase in joint width

Use: T - Use in traffic areas (vehicular and pedestrian)
NT - Use in non-traffic areas (15-50 hardness reading)
M - Use with masonry/mortar
G - Use on glass
A - Use on aluminum
O - Use on other materials

Hardware: T - Traffic 25-50 hardness reading.
NT - Non Traffic 15-50 hardness reading.

Peel Adhesion: As per ASTM A920.

2.2 SCHEDULE

<u>Feature</u>	<u>Sealant Type</u>
Control joints in masonry	Polysulfide.
Sawed control joints in concrete slabs.....	Polysulfide.
Expansion joints in concrete and masonry, interior	Polysulfide or Polyurethane.
Expansion joints in concrete and masonry, exterior.....	Polysulfide.
Submerged joints in concrete	Polysulfide, 2-component.
Around frames and louvers in exterior walls	Silicone or polyurethane.
Joints in sills and thresholds	Silicone or polysulfide.
Precast Concrete Panels.....	Polysulfide or polyurethane or silicone.
Ceiling joints in precast concrete deck units	Polysulfide or polyurethane or silicone.

Sealants shall be compatible with adjacent materials.

2.3 POLYSULFIDE AND POLYURETHANE SEALANT

- A. Polysulfide and polyurethane sealants shall be Grade P or NS. Sealants used for submerged concrete joints shall be approved for use by the manufacturer in waste water.

2.4 SILICONE

- A. One part non-acid curing silicone: "Dow Corning 790" or approved equal.

2.5 EPOXY

- A. All interior non-metallic floor slab sawed control joints shall be filled with Sikadur 51 by Sika Chemical Corp., or equal.

2.6 BACK-UPS AND FILLERS

- A. Back-ups and fillers shall be non-absorbent and non-staining, compatible with sealant and primer. Do not use materials impregnated with oil or bitumen.
- B. Resilient fillers shall be closed-cell resilient urethane foam, polyvinyl chloride foam, polyethylene foam, vinyl or sponge rubber, or polychloroprene tubes or rods. Fillers shall be approximately 25 percent to 50 percent wider than the joint. Braiding hose or rod stock to obtain sufficient size not permitted.
- C. Supporting type fillers shall be closed-cell rigid foam, cork or non-impregnated fiber board of the size and shape indicated and as required for proper installation of sealant.

2.7 BOND BREAKERS

- A. Bond Breakers shall be polyethylene tape with pressure-sensitive adhesive, aluminum foil or wax paper.

2.8 PRIMERS

- A. Primers shall be non-staining type, as recommended by manufacturer of sealant for the material in contact.

2.9 COLORS

- A. All sealant and caulking compounds shall be non-staining and color fast. Colors shall be selected by the Engineer but, in general, shall match the adjacent surfaces. At least four appropriate colors shall be available from which selections can be made.

PART 3 EXECUTION

3.1 INSPECTION OF SURFACES

- A. Examine all surfaces to be sealed or caulked and correct all conditions preventing proper installation. Application of sealant or caulking shall constitute acceptance of the surface.

3.2 PREPARATION OF SURFACES

- A. Prepare surfaces to receive sealant or caulking in strict compliance with the manufacturer's recommendations. Joints shall be raked out and cleaned to full width and depth required to accommodate back-up and sealant materials. Remove dirt, oil, grease, and all loose materials that would inhibit bond.
- B. Metal and non-porous surfaces shall be solvent cleaned and wiped dry to remove residue.

- C. Concrete and masonry surfaces shall be sound and fully cured. Remove form oils, curing compounds, water repellents, and laitance. Test for sealant adhesion; if required the surfaces shall be completely cleaned by chemical or mechanical means.

3.3 APPLICATION OF SEALANT

- A. Apply primer in accordance with manufacturer's instructions.
- B. Oakum or rope yarn packing may be used to fill voids more than 3/4" deep. Compact to a dense, solid mass. Completely fill the joint with caulking applying sufficient pressure to force out all air.
- C. Sealant shall be struck smooth and finished with a general appearance of mortar. Take care to avoid over-filling, fins, overlapping on adjacent surfaces, or applying where sealant is liable to curl, loosen or trap moisture. Caulking shall be uniformly finished and free of wrinkles.

3.4 APPLICATION OF SEALANTS

- A. Follow manufacturer's instructions regarding mixing, surface preparation, primer, application and curing of sealants. Apply sealants in strict accordance with the manufacturer's timing and temperature requirements.
- B. Install suitable back-up material to provide sealant dimensions as detailed. When using back-up of hose or rod stock, roll the material into the joint to avoid lengthwise stretching.
- C. Use bond breaker strip where required between sealant and supporting type back-up material and in all joints where sufficient room for back-up does not exist.
- D. Protect adjacent porous surfaces by applying masking tape in continuous strips in alignment with joint edges. Remove tape immediately after sealant has been tooled.
- E. The depth of sealant shall be equal to joint width in joints up to 1/2 inch wide, 1/2 inch deep for joints 1/2 inch to 1 inch wide and a depth of 1/2 the width for joints over 1 inch wide.
- F. Point or tool joint surface slightly concave. When tooling white or light colored sealants, follow recommendations of the sealant manufacturer to avoid staining.

3.5 PROTECTION AND CLEANING

- A. Temporarily cover or protect joints from injury until the compound has set and protective surface films have formed.

- B. Clean sealant from adjacent surfaces. Use solvent or cleaning agent as recommended by the sealant manufacturer. All finished work shall be left in a neat, clean condition. Stained or damaged adjacent work shall be repaired or replaced.

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Painting

1.2 BASIS OF BID

- A. A schedule of coating colors will be furnished by the Contractor after award. Colors other than those shown in the manufacturer's standard color charts may be required. Deep tone colors may be selected for piping, equipment, and miscellaneous features.

1.3 SUBMITTALS

- A. Painting Schedule: Within 30 days after award of the Contract, the Contractor shall notify the OWNER in writing, the name of the paint manufacturer for the Project.
- B. Prior to submitting shop drawings for any item requiring shop or field applied primer or finish coatings, submit to the ENGINEER a Painting Schedule, indicating major items to be painted, preparation, paint manufacturer, product designation, and dry mill thickness.
- C. Samples: Submit three 8-1/2 inch x 11 inch samples of each scheduled color for approval by the OWNER.

1.4 DELIVERY AND STORAGE

- A. All materials shall be delivered to the job in original sealed and labeled containers of the paint manufacturer, and shall be subject to inspection by the OWNER. Labels shall show name of manufacturer, type of coating, formulation, color and instructions for reducing.

1.5 ABBREVIATIONS

- A. The term "coating", as used herein, includes emulsions, enamels, paints, stains, varnishes, sealers, and other coatings, whether used as prime, intermediate, or finish coats.
- B. SPC – Society of Protective Coatings.

1.6 QUALITY ASSURANCE

- A. Acceptable Manufacturers: It is the intent of this Specification that the Contractor use one paint manufacturer throughout, unless otherwise approved by the OWNER.
- B. Products shall be manufactured by ICI Paints – Devoe Coatings, Strongsville, OH or equal.

PART 2 PRODUCTS

2.1 MISCELLANEOUS MATERIALS

- A. All materials used in the work except oils, thinners and driers, shall be of the brands and qualities specified.
- B. All cleaners, thinners, driers and other additives and surface pretreatment materials shall only be those approved for use by the manufacturer of the coatings.
- C. Do not dilute paints except as recommended by the paint manufacturer.

2.2 COATING SCHEDULE

- A. The following coating systems are required for this project:

System Number

Ferrous Metal Fabrication & Equipment, Non-Galvanized:

Exterior and Interior, Non-Immersion	1
Immersion or Subject to Splashing	7

Ferrous Metal Fabrications & Equipment, Galvanized:

Exterior and Interior, Non-Immersion	2
Immersion or Subject to Splashing	8

Piping, Exterior and Interior, Exposed, Non-Immersion

Non-Galvanized	1
Galvanized	2

Piping, Immersion or Subject to Splashing

Non-Galvanized	7
Galvanized	8

2.3 COATING SYSTEMS

A. System No. 1

1. System No. 1 shall be used for exterior and interior non-galvanized ferrous metals which are not subject to immersion or frequent splashing of water or wastewater, including but not limited to the following:
 - (a) Exposed exterior and interior piping and valves, including piping in vaults and tanks.
 - (b) Pipe supports.
 - (c) All exposed structural steel including equipment supports.
 - (d) Gate and valve operators, floor stands, etc.
 - (e) Exterior mechanical equipment, control panels, miscellaneous metal, etc. without a factory-applied final finish.
 - (f) All other ferrous metals not specifically identified herein for non-immersion service.
2. Surface Preparation: SP 6.
3. Shop Primer: One coat of the following, or equal:
 - (a) Devran 201 Universal Epoxy Primer 2.0-3.0 mils dry film thickness.
4. Field Touch-Up: Same material as Shop Primer.
5. Finish: One (1) coat of Devran 224HS High Build Epoxy Coating 3.0-4.0 mils dry film thickness and one (1) coat of Devthane 379UVA Acrylic Aliphatic Urethane 2.0-3.0 mils dry film thickness per coat.

B. System No. 2

1. System No. 2 shall be used for exterior and interior galvanized ferrous metals which are not subject to immersion or frequent splashing of water or wastewater, including but not limited to the following:
 - (a) Exposed galvanized piping and supports.
 - (b) All structural steel within the buildings including equipment supports.

- (c) Exposed galvanized conduit, equipment, miscellaneous metal and ductwork, etc. without a factory-applied final finish.
 2. Surface Preparation: SP 7 or pretreat with Oakite 747 LTS.
 3. Field Clean-Up: Remove all grease, oil and contaminants with rags soaked in Toluol or Xylol.
 4. Primer: One coat of the following, or equal:
 - (a) Devran 201 Universal Epoxy Primer 2.0-3.0 mils dry film thickness.
 5. Finish: One (1) coat of Devran 224HS High Build Epoxy Coating 3.0-4.0 mils dry film thickness and one (1) coat of Devthane 379UVA Acrylic Aliphatic Urethane 2.0-3.0 mils dry film thickness per coat.
- C. System No. 7
1. System No. 7 shall be used for non-galvanized, ferrous metals subject to immersion or frequent splashing, including but not limited to the following:
 - (a) Submerged piping and piping subject to splashing.
 - (b) Submersible pumps.
 - (c) Submerged miscellaneous metal, equipment, etc. without a factory-applied final finish.
 2. Surface Preparation: SP 10.
 3. Shop Primer: One coat of Devran 201 Universal Epoxy Primer 2.0-3.0 mils dry film thickness.
 4. Finish: Two (2) coats of the following, or equal:
 - (a) Devran 224HS High Build Epoxy Coating 4.0 -6.0 mils dry film thickness per coat.
- D. System No. 8
1. System No. 8 shall be used for galvanized, ferrous metals subject to immersion or frequent splashing, including but not limited to the following:
 - (a) Submerged galvanized piping and piping subject to splashing.

- (b) Submerged galvanized conduit, miscellaneous metal, equipment, etc. without a factory-applied final finish.
- 2. Surface Preparation: SP 7.
- 3. Field Clean-Up: Remove all grease, oil and contaminants with rags soaked in Toluol or Xylol.
- 4. Primer: One coat of the following, or equal:
 - (a) Devran 201 Universal Epoxy Primer 2.0-3.0 mils dry film thickness.
- 5. Finish: Two (2) coats of the following, or equal:
 - (a) Devran 224HS High Build Epoxy Coating 4.0-6.0 mils dry film thickness per coat.

PART 3 EXECUTION

3.1 MIXING

- A. Exercise care to keep fire hazards to a minimum. Provide an approved hand fire extinguisher near each paint storage and mixing area. No oily waste, rags, or painting equipment shall be left scattered throughout the premises.
- B. Mix coatings in accordance with manufacturer's instructions. Colors shall be thoroughly mixed with no streaks or separation of color. Do not add thinners, driers or other additives except as recommended by the coating manufacturer. Do not incorporate in the coating any thinners or solvents used for cleaning brushes or equipment.
- C. Protect all adjacent areas against damage and leave storage and mixing areas clean at the completion of painting.

3.2 ACCEPTANCE OF SURFACES

- A. Inspect all surfaces and adjoining work and report to the OWNER in writing any existing unsatisfactory conditions. No painting work shall be started until the unsatisfactory conditions are remedied.
- B. Commencement of surface preparation and painting shall constitute the acceptance of existing conditions and any defects appearing in the painting work thereafter shall be corrected by the Contractor at no additional cost to the Owner.

3.3 PROTECTION OF ADJACENT SURFACES

- A. Provide necessary protection for completed work and all adjoining surfaces. Provide temporary closures as required to prevent circulation of dust from adjacent areas where other work is in progress. Where it is necessary to remove existing protection of work of others, such protection shall be fully replaced.

3.4 VENTILATION

- A. Provide adequate ventilation for safe application and for proper drying of coatings on interior surfaces.

3.5 SURFACE PREPARATION

A. General

1. Prepare all surfaces in accordance with the coating manufacturer's instructions and as specified. Surfaces shall be uniform texture, dry, and free from dust, grit, oil, grease, or any material which will adversely affect adhesion or appearance of the coating. Rough edges of metal, weld seams and sharp edges from scaffold lugs shall be ground to a curve.
2. Surfaces that have been cleaned, pretreated, and/or otherwise prepared for painting shall be given a coat of the first-coat material as soon as practicable prior to any deterioration of the prepared surface.
3. Hardware, accessories, plates, fixtures, and similar items in contact with coated surfaces shall be removed, masked, or otherwise protected prior to surface preparation and painting operations.
4. Exposed nails and other ferrous metals on surfaces to be coated shall be spot-primed with a metal primer compatible with the finish.

B. Surface Preparation SP 5 – White Metal Blast Cleaning

1. Steel surfaces shall be dry and clean. Remove all grease, oils and contamination with rags soaked in toluol or xylol.
2. Remove all weld spatter. Grind all rough edges to a smooth rounded contour. Blast clean the surface to a White Metal Finish, removing all visible oil, grease, dirt, dust, mill scale, rust, paint oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheel or other specified method.
3. Blasting should be done with an abrasive suitable to get the steel cleanliness specified as well as the 3.0 mil minimum surface profile specified.

4. The blast cleaned surface shall be primed as soon as possible before any rusting occurs.

C. Surface Preparation SP 6 - Commercial Blast Cleaning

1. Remove all oil and grease from the surface. Blast clean surface to a Commercial Finish, removing mill scale, dirt, rust, and foreign matter by the methods outlined in SSPC SP 6. Two thirds of each square inch of surface area shall be free of all visible residues.
2. Blasting shall be done with centrifugal wheel or compressed air blast using either steel grit or flint silica sand. Abrasive should provide a profile depth of 1.0 to 2.0 mils. Steel Grit #G-80 or flint silica sand 20-50 mesh is recommended to obtain proper profile depth. Remove all dust and sand by vacuuming.
3. The blast cleaned surface shall be primed as soon as possible and before any rusting of the surface occurs.

D. Surface Preparation SP 7 - Brush-Off Blast: Prepare metal as outlined in SSPC SP 7 to provide for proper adhesion of coating.

E. Surface Preparation SP 10 - Near White Blast Cleaning

1. Steel surfaces shall be dry and clean. Remove all grease, oils and contaminants with rags soaked in toluol or xylol.
2. Remove all weld spatter. Grind all rough welds and sharp edges to a smooth rounded contour. Blast clean the surface to a Near White Metal finish, removing nearly all mill scale, rust, rust-scale, paint or foreign matter by the recommended methods outlined in SSPC SP 10. At least 95 percent of each square inch shall be free of all visible residues.
3. Blasting shall be done with centrifugal wheel or compressed air blast nozzles using either steel grit or flint silica sand. Abrasive should provide profile depth of 1.0 to 2.0 mils. Steel Grit #G-80 or flint silica sand 20-50 mesh is recommended to obtain proper profile depth. Remove all dust and sand by vacuuming.
4. The blast cleaned surface should be primed as soon as possible and before any rusting of the surface occurs.

3.6 APPLICATION

- A. All work shall be performed by skilled painters. Surfaces shall be free of drops, ridges, waves, laps and brush marks. Edges of paint adjoining other colors or materials shall be sharp and true.

- B. Do not apply coatings in temperatures below 50 degrees F. (60 degrees F for Vinester) except where the manufacturer allows lower temperatures. No exterior painting shall be done during inclement weather when relative humidity exceeds 85%, or under conditions identified by the manufacturer as unsuitable.
- C. The average rate of application shall not exceed the theoretical rate of coverage recommended by the coating manufacturer for the type of surface involved, less an allowance for losses. Average dry film thickness shall not be less than thickness set forth under Painting Systems. Not more than 10-20% of points inspected may be less than 90% of the specified thickness. Deficiencies shall be corrected by application of additional coating.
- D. Each coat shall be uniform in coverage and color. Successive coats shall perceptibly vary in color. Each coat shall be carefully examined and faulty material, poor workmanship, holidays, damaged areas and other imperfections shall be touched up prior to applying succeeding coats. Comply with coating manufacturer's recommendations for drying time between coats.
- E. In the event that the finished surfaces are not acceptable, completely refinish entire unit areas or sections as necessary in order to eliminate visible laps or other indications of repairs.
- F. All areas not accessible after installation shall be painted prior to installation. Contractor shall coordinate installation of equipment and material with painting requirements. Portions of some equipment, such as the final clarifier mechanism, will require finish painting prior to erection. Any area damaged during installation shall be repainted.
- G. In existing buildings that have a minimal amount of work, such as the Filter Building, Administration Building, etc., paint systems for new work shall match existing.
- H. All piping shall be color coded. Colors shall be selected by OWNER.

3.7 CLEAN-UP

- A. At completion of the painting work, clean off all paint spots and other paint materials from surfaces where they are not intended to be. Remove from the premises all rubbish and accumulated material and leave the work in clean orderly condition, acceptable to the OWNER.

END OF SECTION

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing, and operation of all equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All codes, as referenced herein.
- B. Commercial Standards: All equipment, products, and their installation shall be in accordance with the following standards, as applicable, and as specified in each Section of these specifications:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. American Public Health Association (APHA).
 - 3. American National Standards Institute (ANSI)
 - 4. American Society of Mechanical Engineers (ASME).
 - 5. American Water Works Association (AWWA).
 - 6. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
 - 7. American Welding Society (AWS).
 - 8. National Fire Protection Association (NFPA).
 - 9. Federal Specifications (FS).
 - 10. National Electrical Manufacturers Association (NEMA).
 - 11. Manufacturer's published recommendations and specifications.
 - 12. General Industry Safety Orders (OSHA).
- C. The following standards have been referred to in this Section of the specifications:
 - 1. ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
 - 2. ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys
 - 3. ANSI B46.1 Surface Texture
 - 4. ANSI S12.6 Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors

5. ANSI/ASME B1.20.1 General Purpose Pipe Threads (Inch)
6. ANSI/ASME B31.1 Power Piping
7. ANSI/AWWA D100 Welded Steel Tanks for Water Storage
8. AWWA C206 Field Welding of Steel Water Pipe
9. ASTM A 48 Specification for Gray Iron Castings
10. ASTM A 108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall furnish complete shop drawings for all equipment specified in the various Sections, together with all piping, valves, and controls for review by the ENGINEER
- B. Tools: The CONTRACTOR shall supply one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. All tools shall be of best quality hardened steel forgings with bright, finish wrench heads shall have work faces dressed to fit nuts. All tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled tool box of suitable design provided with a hinged cover.
- C. Spare Parts: The CONTRACTOR shall obtain and submit from the manufacturer a list of suggested spare parts for each piece of equipment. After approval, CONTRACTOR shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER, only, after expiration of the guaranty period.
- D. Torsional Analysis:
 1. The CONTRACTOR shall submit to the ENGINEER a torsional and lateral vibration analysis of the following equipment. The analysis has to be performed by a specialist experienced in this type of work and approved by the ENGINEER.
 - a. All engine drives.
 - b. All blowers and compressors with drives of 100 horsepower and over.
 - c. All vertical pumps with universal joints and extended shafts.
 - d. All other equipment where specified.
 2. The torsional natural frequency of the drive train must be avoided by + 25 percent by any exciting frequency of the equipment, throughout the entire operating range.
- E. Vibration Analysis: In his bid price the CONTRACTOR shall include at least two site visits of the abovementioned specialist, during construction and testing of the equipment, to analyze and measure the amount of equipment vibration and make his written recommendation for keeping the vibration at a safe limit.

1.4 QUALITY ASSURANCE

- A. Inspection, Startup, and Field Adjustment: The CONTRACTOR shall demonstrate that all equipment meets the specified performance requirements. CONTRACTOR shall provide the services of an experienced, competent, and authorized service representative of the manufacturer of each item of major equipment who shall visit the site of Work to perform the following tasks:
1. Assist the CONTRACTOR in the installation of the equipment.
 2. To inspect, check, adjust if necessary and approve the equipment installation.
 3. To start-up and field-test the equipment for proper operation, efficiency, and capacity.
 4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the ENGINEER.
 5. To instruct the OWNER's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.
- B. Costs: The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the CONTRACTOR. The OWNER will pay for costs of power and water. When available, the OWNER's operating personnel will provide assistance in the field testing.
- C. Public Inspection: It shall be the responsibility of the CONTRACTOR to inform the local authorities, such as building and plumbing inspectors, Fire Marshall, OSHA inspectors, and others, to witness all required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, etc., to obtain all required permits and certificates, and pay all fees.
- D. Tolerances: Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30 feet or less in length, and not greater than 1/8-inch for members over 30 feet in length.
- E. Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
1. Surface roughness not greater than 63 micro-inches shall be required for all surfaces in sliding contact.
 2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
 4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.
- F. Manufacturer's Experience; Unless otherwise directed by the ENGINEER, all equipment furnished shall have a record of at least 5 years of successful, troublefree operation in similar applications, from the same manufacturer.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. High Noise Level Location: The CONTRACTOR shall provide personal hearing protection, as specified herein, at each high noise level location. Said locations are defined as follows:
1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise level requirements for a 2-hour exposure. Where such equipment is separated by a distance of more than 20 feet, measured between edges of footings, each group of equipment shall be provided with a separate hearing protection station.
 2. Indoor Location:
 - a. Any single equipment item, or any group of equipment items, located within a single room not normally occupied, that produces noise exceeding OSHA noise level requirements for a 2-hour exposure.
 - b. Any single equipment item, or any group of equipment items, located within a single room normally occupied by workers, that produces noise exceeding OSHA noise level requirements for an 8-hour exposure.
- B. Personal Hearing Protection: The CONTRACTOR shall supply, in their original unopened packaging, three pairs of high attenuation hearing protectors. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the CONTRACTOR and mounted in an approved location near the noise producing equipment.
- C. Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Unless otherwise specified, the following load classifications shall apply in determining service factors:

Type of Equipment

Load Classification

Blower:

Centrifugal or vane Lobe	Uniform Moderate Shock
Reciprocating Air Compressor:	
Multi-Cylinder	Moderate Shock
Single-Cylinder	Heavy Shock
Pump:	
Centrifugal or Rotary	Uniform
Reciprocating	Moderate Shock
Mixer:	
Constant Density	Uniform
Variable Density	Moderate Shock
Flocculator or Clarifier	Uniform
Sludge Thickener	Moderate Shock
Grit Handling Equipment	Moderate Shock
Trash Rack Rake	Moderate Shock
Crane or Hoist	Moderate Shock

D. Welding: Unless otherwise specified or shown, all welding shall conform to the following:

1. Latest revision of ANSI/AWWA D100, if applicable.
2. Latest revision of AWWA C206.
3. All composite fabricated steel assemblies which are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
4. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.
5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

- E. Protective Coating: All equipment shall be painted or coated in accordance with Section 09900, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- F. Protection of Equipment: All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. All equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided, to prevent accumulation of condensate in gears and bearings. While in storage, CONTRACTOR shall rotate the drive shaft to ensure proper lubrication of bearings or other practice recommended by the manufacturer.
- G. Identification of Equipment Items: Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number shown or specified for the particular item.
- H. Vibration Level: All equipment subject to vibration shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations.
- I. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the ENGINEER-approved shop drawings.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Equipment Supports: All equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports must bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise directed.
- B. Equipment Foundations: Equipment foundations will be designed by the ENGINEER per manufacturer's written information and recommendations. All mechanical equipment, tanks, control cabinets, etc., shall be mounted on minimum 3.5-inch high concrete bases, as shown on standard structural details, unless otherwise shown or specified.
- C. Shop Drawings: Shop drawings shall be submitted to the ENGINEER for review in accordance with the requirements of Section 00900. Shop drawings will be considered incomplete unless clear, concise calculations are presented showing equipment

anchorage forces and the capacities of the anchorage elements provided by the CONTRACTOR.

2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment.

2.4 FLANGES AND PIPE THREADS

- A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125; or B16.5, Class 150, unless otherwise shown. All pipe threads shall be in accordance with ANSI/ASME B1.20.1, and with requirements of Section 15060.

2.5 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, 3-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.
- D. Where universal type couplings are shown, they shall be of the needle bearing type construction, equipped with commercial type grease fittings.

2.6 SHAFTING

- A. General: All shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. All shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.
- B. Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as shown or specified unless furnished as part of an equipment assembly.
 - 1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
 - 2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- C. Differential Settlement: Where differential settlement between the driver and the driven equipment may be expected, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

2.7 BEARINGS

- A. General: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).
- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and other important factors shall be considered in bearing selection.
- C. All re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
- D. All lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.
- E. Bearing Life: Except where otherwise specified or shown, all bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so specified, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

<u>Type of Service</u>	<u>Design Life (yrs)</u>	<u>L-10 Design Life (hr)</u>
	(whichever comes first)	
1. 8-hour shift	10	20,000
2. 16-hour shift	10	40,000
3. Continuous	10	60,000

- F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.
- G. Sleeve-type bearings shall have a Babbitt or bronze liner.

2.8 GEARS AND GEAR DRIVES

- A. Unless otherwise specified, gears shall be of the helical or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a minimum service factor of 1.7, a minimum L-10 bearing life of 60,000 hours and a minimum efficiency of 94 percent. Worm gears shall not be used, unless specifically approved by the ENGINEER.
- B. All gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, arranged for easy reading.
- C. Gears and gear drives as part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.
- E. Oil level and drain location relative to the mounting arrangement shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be furnished when necessary.
- F. Where gear drive input or output shafts have to connect to couplings or sprockets supplied by others, the CONTRACTOR shall have the gear drive manufacturer supply matching key taped to the shaft for shipment.

2.9 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains and meet ANSI Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.
- C. A minimum of one connecting or coupler link shall be provided with each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and suitable for the process fluid.

2.10 SPROCKETS

- A. General: Sprockets shall be used in conjunction with all chain drives and chain-type material handling equipment.

- B. Materials: Unless otherwise specified, materials shall be as follows:
 - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
 - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
 - 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.
- C. All sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
- E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with taper-lock bushings as required.
- F. Idler sprockets shall be furnished with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving. Steel collars with set screws may be provided in both sides of the hub.

2.11 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, MPTA, and RMA Standards.
- B. Unless otherwise specified, sheaves shall be machined from the finest quality gray cast iron.
- C. All sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
- D. To facilitate installation and disassembly, sheaves shall be furnished complete with taper-lock or QD bushings as required.
- E. Finish bored sheaves shall be furnished complete with keyseat and set screws.
- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.12 DRIVE GUARDS

- A. All power transmission, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform with the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10 gage expanded,

flattened steel with smooth edges and corners, galvanized after fabrication and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.13 FLEXIBLE CONNECTORS

- A. General: Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems.

2.14 INSULATING CONNECTIONS

- A. General: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the Sections 15060.

2.15 GASKETS AND PACKINGS

- A. Gaskets shall be in accordance with the requirements of Sections 15060.
- B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal," or equal.
- C. Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 11100.

2.16 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.17 SAFETY REQUIREMENTS

- A. Where work areas are located within a flammable or toxic gas environment, suitable gas detection, ventilating, and oxygen deficiency equipment shall be provided. Workers shall be equipped with approved breathing apparatus.

PART 3 EXECUTION

3.1 COUPLINGS

- A. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application; installation shall be per equipment manufacturer's printed recommendations.

3.2 INSULATING CONNECTIONS

- A. All insulating connections shall be installed in accordance with the manufacturer's printed instructions.

3.3 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. Hangers, supports, and guides shall be spaced in accordance with ANSI/ASME B.31.1 standard.

3.4 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with his subcontractors, to avoid later change orders.
- B. If the packaged system has any additional features (as safety interlocks, etc.), other than specified, the CONTRACTOR shall coordinate such features with the ENGINEER and furnish all material and labor necessary for a complete installation as required by the manufacturer, at no additional cost to the OWNER.

END OF SECTION

SECTION 11100

PUMPS, GENERAL

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.
- C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.
- D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01340.
- B. Shop Drawings: Shop Drawings shall contain the following information:
 - 1. Pump name, identification number, and specification Section number.
 - 2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable speed drive.
 - 3. The CONTRACTOR shall require the Manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.

4. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
 5. Data, in accordance with Section 16150 for the electric motor proposed for each pump.
 6. Elevation of Local Control Panel, if specified with pumps, showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel. Product data on all components.
 7. Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
 8. Complete electrical schematic diagram.
- E. O&M Manual: The O&M Manual shall contain the required information for each pump Section. Include appurtenances and electrical equipment.
- F. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.
- G. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.
- H. Certifications:
1. Manufacturer's certification of proper installation.
 2. Manufacturer's certification of factory tests.
 3. CONTRACTOR's certification of satisfactory field testing.

PART 2 PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.
- B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

- C. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.2 MATERIALS

- A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:
 - 1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 Class 30, - Specification for Gray Iron Castings, or equal.
 - 2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
 - 3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
 - 4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 05025.

2.3 PUMP COMPONENTS - GENERAL

- A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings dimensions.
- B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for sewage, sludge, and other process fluids shall be lubricated as specified.
- C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.
- D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

- E. Drains: All gland seals, air valves, cooling water drains, and drains from variable speed drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.
- F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the CONTRACTOR shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.
- G. Stuffing Boxes: Where stuffing boxes are specified for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For sewage, sludge, drainage, and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.
 - 1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
 - a. Shaft speeds - up to 2500 fpm
 - b. Temperature - up to 500 degrees F
 - c. pH range - 0-14
 - 2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.
- H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:
 - 1. Sewage, Sludge, or Wastewater Pumps - Double seals:
John Crane Type I Double;
Borg-Warner Type L Double
 - 2. Abrasives, Grit, or Lime Slurry Pumps - Double seals:
John Crane Type I (hard faces);
Borg-Warner Type L (hard faces)
 - 3. Chemicals or Corrosive Liquid - Pumps - Single seals:
John Crane Type 8-1, 9;
Borg-Warner Type Q, QB
 - 4. Water Pumps Hot and Cold - Single seals:
John Crane, Type I, 21;
Borg-Warner Type L

- I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.
- J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

- A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number.
- B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.
- C. Gauges:
 - 1. All pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gages and isolation valves installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.
 - 2. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
 - 3. Gauges shall be 4½ inches in diameter and comply with ANSI B40.1, Grade 2A. Gauges shall have open or solid front with rear or side blowout relief, pressure tight, stem mounted, hermetically sealed, with 270 degree arc with adjustable pointer. Gauges shall have stainless steel bourdon tube, ring and stem. Gauges shall be manufactured by Ashcroft, Crosby, or equal.
 - 4. Isolation valves shall be stainless steel ball valves. Pipe nipples and fittings shall be stainless steel.

2.5 FACTORY TESTING

- A. The following tests shall be conducted on each indicated pump system:
 - 1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 -

Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.

2. Pump Systems: All centrifugal pump systems 10 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc. Tests shall be performed using the complete pump system to be furnished, including the motor. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:
 - (a) Hydrostatic test data
 - (b) A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
 - (c) Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
 - (d) Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.
3. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the OWNER and ENGINEER. The CONTRACTOR shall give the ENGINEER a minimum of 2 weeks notification prior to the test. All costs for OWNER and ENGINEER expenses shall be borne by the CONTRACTOR and shall be included in the bid price. Such costs shall include travel and subsistence for two people excluding salaries. Test results shall be submitted to the ENGINEER and no equipment shall be shipped until the test data have been approved by the ENGINEER. Where three or more identical pumps are supplied, witness tests will only be required for two pumps, unless deficiencies are noted. Certified tests will be acceptable on other pumps.
4. Acceptance: In the event of failure of any pump to meet any of the specified requirements, the CONTRACTOR shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be re-tested at no additional cost to the OWNER until found satisfactory.

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation. Additional time is required to correct manufacturer related deficiencies shall not be included in the days indicated.

1. Installation of the equipment
2. Inspection, checking, and adjusting the equipment
3. Startup and field testing for proper operation
4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements

B. Instruction of the Owner's Personnel:

1. Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
2. The representative shall have at least two year's experience in training. A resume for the representative shall be submitted.
3. Training shall be scheduled a minimum of three weeks in advance of the first session.
4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.
5. The training materials shall remain with the trainees.
6. The OWNER may videotape the training for later use with the OWNER's personnel.

3.2 INSTALLATION

- A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations, including anchor bolt plans and details.
- B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.
- C. Lubricants: The CONTRACTOR shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

- A. Materials and equipment shall be coated as required in Section 09900.

3.4 FIELD TESTS

- A. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.
- B. The following field testing shall be conducted:
 - 1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
 - 2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
 - 3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
 - 4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is specified.
- C. Field testing will be witnessed by the ENGINEER. The CONTRACTOR shall furnish three days advance notice of field testing.
- D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.
- E. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have

been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

- F. The CONTRACTOR shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the OWNER will bear. If available, the OWNER's operating personnel will provide assistance in field testing.

END OF SECTION

SECTION 11310

VERTICAL CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Furnish and install two (2) vertical centrifugal thermoplastic pumps in a prepackaged sump collection and pump station.

1.2 RELATED SECTIONS

- A. Equipment General Provisions: Section 11000.
- B. Pumps, General: Section 11100.
- C. Motors: Section 16150.

1.3 QUALITY ASSURANCE

- A. The pumps shall be heavy duty; electrical end suction, centrifugal units designed for water and shall be fully guaranteed for this use. The pumps provided shall be capable of operating in an ambient liquid temperature of 104°F. Since the high temperature of 104°F is specified by National Electrical Manufacturers Association (NEMA) and Factory Mutual (FM). Motors with a maximum ambient temperature rating below 104°F shall not be acceptable.
- B. The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is totally non-submerged. The use of shower systems, secondary pumps or cooling fans to cool the motor shall not be acceptable.
- C. Qualifications: The pumps, mechanical seals, pump protection system, and motor specified under this Section shall be furnished by a single supplier who shall be responsible for the complete system. The equipment components offered shall be standard products of manufacturers normally engaged in manufacture of the various components for the service intended as described hereinafter. Naming of a specific manufacturer does not preclude the equipment from meeting all aspects of the specifications.
- D. Manufacturers: The equipment specified in this section shall be manufactured by:
 - 1. Vanton SG
 - 2. Or Equal.

1.4 REFERENCE STANDARDS

A. The work in this section is subject to the requirements of applicable portions of the following standards:

1. Hydraulic Institute Standards
2. IEEE Standards
3. NEMA Standards
4. OSHA Rules and Regulations

1.5 SUBMITTALS

A. Shop Drawings and Product Data: Submit as per the General Conditions the copies of the following information:

1. Pump performance curve, pump outline dimension drawing indicating support frame, elbow and anchor bolt locations, electric motor data, parts list, warranty, installation guide, certified factory performance tests, quality assurance record, and manufacturer's start-up report form. Pump performance curves shall indicate head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.
2. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of 100 rpm from minimum speed to maximum speed shall be provided.
3. The Manufacturer shall indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.
4. Provide certification that the motor is inverter duty rated and meets the requirements of NEMA MG-1, Part 31.
5. The submittal information shall also include bearing calculations at the duty point as well as at the maximum and minimum operating heads shown in the specification. These calculations shall verify the specified minimum bearing life shown elsewhere in this specification.
6. The supplier shall also demonstrate that they have a service facility located within one hundred miles of the facility that has a minimum of three trained service technicians certified to work on these pumps as well as the hoisting capabilities in the shop to work on the specified pumps.

- B. Electrical Shop Drawing and Product Data: Submit panel layout drawings indicating front elevation and interior component layout, and project specific wiring diagrams. Submit product data on all control panel electrical components and Control and Monitoring Panels. The pump manufacturer shall also submit a motor chart for the motors to be supplied. The motor chart shall include amp draw, power consumed, and output power versus speed for the induction motor.
- C. Operating Instructions: Copies of an operating and maintenance manual for the pump and motor shall be furnished as per the Contract Documents. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment.
- D. A service representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the OWNER on proper operation and maintenance. If there are difficulties in operation of the equipment, due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the OWNER.

PART 2 PRODUCTS

2.1 GENERAL

- A. The equipment covered by these specifications is intended to be standard pumping equipment of proven ability as manufactured by a reputable firm having at least 5 years of experience in the production of such equipment. The equipment furnished shall be designed and constructed in accordance with the best practices and methods, and shall operate satisfactorily when installed as shown on the Drawings.
- B. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done.
- C. Complete set of spare parts for two (2) pumps.

2.2 OPERATING CONDITIONS

- A. The following are the operating conditions for the GAC feed pump and motor:

1.	Design Flow, per pump (GPM)	118
2.	Design Head (FT)	65
3.	Horsepower	7.5
4.	Speed, maximum (RPM)	3,600
5.	Voltage, Phase, Hertz,	460,3,60
6.	Impeller Diameter (IN)	4.6
7.	Discharge Size (IN)	2
8.	Model	Vanton SG-800

2.3 PUMP CONSTRUCTION

- A. Pump constructed with all wetted components of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP) or polyvinylidene fluoride (PVDF) thermoplastic materials.

2.4 CASING AND CASING COVER

- A. Injection molded homogenous thermoplastic material selected for compatibility with the fluids being pumped.

2.5 IMPELLER

- A. Thermoplastic material injection molded with an embedded dynamically balanced stainless steel insert with radial vanes. It shall be closed or semi open vane design and have a keyway for mounting on the shaft to assure positive drive.

2.6 THERMAL FLUCTUATION MODIFICATION (TFM)

- A. Casing, impeller and suction nozzle designed to accommodate temperature fluctuation without change in pump performance.

2.7 SUCTION STRAINER

- A. Strainer basket to be provided where required in the same material as the hydraulic head.

2.8 SHAFT

- A. Stainless steel shaft sleeved with thermoplastic material to isolate it from the fluid, and machined at the drive end to fit a flexible coupling. Immersed portion of the shaft to be guided by sleeve bearings consisting of ultra pure alumina ceramic inner sleeve and Vanite (siliconized graphite) outer sleeve. Bearings to be lubricated by pumped fluid or flushed and lubricated by external water.

2.9 VERTICAL SUPPORT COLUMN AND DISCHARGE PIPE

- A. Fabricated of heavy-sectioned thermoplastic. Upper portion of the column to be fitted with a nonmetallic vapor seal to protect motor and ball bearings in mounting bracket.

2.10 COVER PLATE

- A. To be sized and shaped to fit the sump, and furnished in the same or compatible thermoplastic material as the pump. All hardware below the coverplate to be nonmetallic.

2.11 MOTOR MOUNTING BRACKET

- A. To have precision-machined mounting surfaced for a rabbet fit to automatically align pump and motor coupling. The assembly to be designed to house regreasable ball bearing(s) for positioning and locking the shaft into position and to allow adjustable impeller clearance without removing the pump from installation. The cast iron motor mounting bracket to be painted with a two-part chemical resistant epoxy resin or similar resistant coating material.

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. Testing performed upon each pump shall include the following inspections:
 - 1. Impeller, motor rating and electrical connections shall be checked for compliance with this specification.
 - 2. Each pump shall be run submerged in water.
 - 3. All motors shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.
- B. A written quality assurance record confirming the above testing/inspections shall be supplied with each pump at the time of shipment.
- C. Each pump shall be tested in accordance with the latest test code of the Hydraulic Institute at the manufacturer to determine capacity vs. head, brake horsepower, pump efficiency, and kilowatt draw required at a minimum of five operating points plus shut off head.

3.2 START-UP SERVICE

- A. The equipment Manufacturer shall furnish the services of a qualified factory trained field service engineer for three, 8-hour working days at the site to inspect and certify in writing that the equipment have been properly installed, aligned, lubricated, adjusted and readied for operation. After the pumps have been completely installed and wired, the Manufacturer shall do the following:
 - 1. Megger stator and power cables.

2. Check seal lubrication.
 3. Check for proper rotation.
 4. Check power supply voltage.
 5. Measure motor operating load and no load current.
 6. Field test to demonstrate satisfactory pump performance. Obtain flow rate and head for individual pumps and pumps in combination at full and reduced speeds.
- B. During this initial inspection, the manufacturer's service representative shall also provide one, 8 hour working day to review recommended operation and maintenance procedures including step-by-step troubleshooting with necessary test equipment with the OWNER's personnel. The representative shall have a minimum of two years experience in training.

3.4 WARRANTY

- A. The pump manufacturer shall furnish the OWNER with a written warranty to cover the pump(s) and motor(s) against defects in design, workmanship, and material for a period of one (1) year from date of startup.

3.5 EQUIPMENT SUPPLIER

- A. The equipment shall be supplied by a local representative of the Manufacturer. The local representative must offer in-house service capabilities as a normal scope of his business. As a minimum, the representative must have at his local facility a complete equipment service shop arranged and equipped to provide in-house factory authorized service for any equipment supplied. The representative must offer 24 hour emergency field service capabilities year round by factory trained and authorized technicians.

3.6 SPARE PARTS

- A. A spare parts kit shall be provided to the OWNER for two (2) pumps. It shall consist of a mechanical seal, shaft sleeve, spacer sleeve, all necessary gaskets, all necessary O-rings, and an impeller bolt. In addition, provide one (1) spare impeller. Parts shall be properly marked, packaged and delivered to the maintenance personnel.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUBMITTALS

- A. Submit Product Data for electrical identification.
- B. Submit record documents in compliance with Division 1. During the progress of work, record all changes or deviations from the original drawings and layout of the work and record critical dimensions of buried or concealed work.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 DESCRIPTION OF WORK

- A. The work to be performed under this Division shall include all labor, materials, equipment, transportation, construction plans and facilities necessary to provide a complete and satisfactory systems ready to use. Wherever the words "the CONTRACTOR" or "this CONTRACTOR" appear in this Division, they refer to the CONTRACTOR for the Work specified in that Section. The CONTRACTOR shall examine all Drawings and all Sections of the Specifications and shall be responsible for ascertaining to what extent other Drawings and Sections affect the Work herein specified.
- B. The CONTRACTOR will provide all necessary line voltage wiring, final connections, disconnect switches, manual and magnetic motor starters as required to complete the electrical system. However, all electrical conduit, wire and necessary connections relating to mechanical equipment controls and all wiring associated with starter holding coils shall be the responsibility of the Mechanical Contractor unless indicated otherwise on the Drawings. This CONTRACTOR shall furnish all required information, relative to electrical characteristics to the Mechanical Contractor.

1.4 SUBMITTALS

- A. The CONTRACTOR shall submit for approval detailed shop drawings of all equipment and all material required to complete the project. No material or equipment shall be delivered to the job site or installed until the CONTRACTOR has in his possession the approved shop drawings for that particular material or equipment. The shop drawings shall be completed as described herein. The CONTRACTOR shall furnish the number of copies

required by the General and Special Conditions of the Contract, but in no case less than six (6) copies.

- B. Prior to delivery of any material to the job site, and sufficiently in advance of requirements to allow ENGINEER ample time for checking, submit for approval detailed, dimensioned drawings or cuts, showing construction, size, arrangement, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be a standard catalog product of an established manufacturer and of equal quality, finish and durability to that specified.
- C. Samples, drawings, specifications and catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of Specifications governing, CONTRACTOR's name and name of job.
- D. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.
- E. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the CONTRACTOR from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications.
- F. Failure of the CONTRACTOR to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

1.5 QUALITY ASSURANCE

- A. All materials and equipment furnished shall be new and to the extent possible, standard products of the various manufacturers except where special construction or performance features are called for. Where more than one of any specific item is required, all shall be of the same type and manufacturer.
- B. The product of specified acceptable manufacturers shall be acceptable only when that product complies with, or is modified as necessary to comply with, all specified and indicated requirements.
- C. Materials and equipment not herein specified or indicated as to manufacturer but necessary for complete functioning systems, shall be provided from sources conforming to the quality levels and functional requirements for corresponding materials and equipment set forth herein.

1.6 INTENT

- A. It is the intent of the Electrical Division of these Specifications that all electrical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and the Drawings so that all installations shall operate as designed. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the OWNER's Representative before acceptance by the OWNER.
- B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the Work, the same as if herein specified or shown.

1.7 REGULATORY AGENCIES, CODES AND STANDARDS

- A. Governing federal, state, local governmental laws, ordinances, referenced codes and standards constitute the minimum requirements of the Contract Documents.
- B. The CONTRACTOR shall include in the Work, without extra cost to the OWNER, any labor, materials, services, apparatus, drawings, in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on the drawings and/or specified.
- C. Portions or all certain recognized industry or association standards referred to herein as being a requirement of these Specifications shall be considered as binding as though reproduced in full herein. Unless otherwise stated the referenced standard shall be the standard which is current as of the date of issuance of these Specifications. Reference may be made to standards either by full name or for the sake of brevity by letter designation as follows:

ANSI	American National Standards Institute
ASTM	American Society for Testing of Materials
BOCA	Building Officials & Code Administrators
FM	Factory Mutual Engineering Corporation
NBS	National Bureau of Standards
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories, Inc.

1.8 PERMITS AND INSPECTIONS

- A. The CONTRACTOR shall give all necessary notices, obtain all permits, and pay all government sales taxes, fees and other costs, including utility connections or extensions, in connection with his work unless noted elsewhere in these specifications; file all necessary plans,

prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates of inspection for his work and deliver same to the ENGINEER before request for acceptance and final payment for work.

1.9 SPACE PREFERENCE

- A. Each Division 16 Contractor shall carefully check and coordinate the location and level of all equipment, conduit, and wiring. Each Division 16 Contractor shall check with all other contractors so that conflict in location may be avoided.
- B. If conflicts occur, the following preference shall be followed:
 - 1. Sanitary drainage
 - 2. Recessed Light Fixtures
 - 3. Ductwork
 - 4. Sprinkler piping
 - 5. Domestic water, storm sewer, & vent lines
 - 6. Electrical conduits
- C. No other work shall have preference over plumbing lines below fixtures.
- D. No mechanical equipment shall be installed in dedicated space above switchgear and panels as defined in the latest version of NFPA 70.
- E. No piping conveying fluids shall be installed directly over electrical equipment.

1.10 INTERRUPTION OF SERVICES

- A. If existing buildings are to be occupied and maintained in normal use by the OWNER during the progress of these contracts, each Division 16 Contractor shall arrange his work to reduce to the minimum the period of interruption or outages in various services.
- B. If it is necessary to do this work after hours to avoid undue inconvenience to the OWNER, no extra payment will be made.
- C. No less than 24 hours before any system is to be put out of service, each Division 16 Contractor shall notify the OWNER and/or the ENGINEER, indicating the extent of the work to be done during the outage, the probable length of time required for that phase of the work and the desired time at which the outage is to begin. The OWNER will make all arrangements with the departments affected and where necessary he will dictate and specify the time of beginning and other regulations governing each particular outage, so that inconveniences to the occupants will not be intolerable.

1.11 DRAWINGS

- A. The layout shown on the Drawings is necessarily diagrammatic but shall be followed as closely as actual construction and as other work will permit. Changes from these Drawings required to make this Work conform to the building construction or other Work of other trades shall be made by this CONTRACTOR without additional cost to the OWNER, but only with the prior approval of the ENGINEER. All major changes shall be shown on Shop Drawings and noted as such to be submitted before the changes are made.

1.12 CORRECTED DRAWINGS

- A. The CONTRACTOR shall, during the progress of the Work, record any and all changes or deviations from the original Drawings and layout of the Work and record critical dimensions of buried or concealed Work. At the Completion of the project the CONTRACTOR shall deliver to the ENGINEER two blueline marked up sets of "As-built" Drawings.

1.13 EQUIPMENT DEVIATIONS

- A. Where the CONTRACTOR proposes to use an item of equipment other than that specified or detailed on the Drawing which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required shall be prepared by the CONTRACTOR at his own expense and approved by the ENGINEER.
- B. Where such approved deviation requires a different quantity and arrangement of ductwork, piping, wiring, conduit and equipment from that specified or indicated on the Drawings, the CONTRACTOR shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit and any other additional equipment required by the system at no additional cost to the OWNER.

1.14 QUIET OPERATION AND VIBRATION

- A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the ENGINEER. In the case of moving machinery, sound or vibration noticeable outside of the room in which it is installed, or annoyingly noticeable inside its own room will be considered objectionable. Also objectionable will be excessive vibration which puts, in the opinion of the ENGINEER, undue stress on piping or other appurtenances connected to the machinery. Sound or vibration conditions considered objectionable by the ENGINEER shall be corrected in an approved manner by the CONTRACTOR at his expense. Vibration control shall be by means of approved vibration eliminators in a manner as recommended by the manufacturer of the eliminators.

1.15 GUARANTEE

- A. This CONTRACTOR shall guarantee all of his work including labor, material and equipment for this project for the period of not less than one (1) year from the date of acceptance by the ENGINEER and agrees to make good at his own expense, repair or replace any part of his installation which may show defect during that period provided that such defect, in the opinion of the ENGINEER is due to imperfections in the material or workmanship and is not caused by carelessness or improper operation.

1.16 VISITING THE SITE

- A. The CONTRACTOR shall visit the site and determine all existing local condition affecting work in his contract. He shall examine the Drawings and Specifications to familiarize himself with the type of construction to be used for all new work and how it will affect the installation of work in his contract.
- B. Failure to visit the site, or to determine existing conditions or the nature of new construction will not be considered a basis for the granting of additional compensation.

1.17 LISTING AND LABELING

- A. Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

PART 2 PRODUCTS

2.1 SUPPORTING DEVICES

- A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.
 - 1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.
 - 2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.
- B. Steel channel supports have 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Fittings and accessories mate and match with channels and are from the same manufacturer.
 - C. Sheet-Metal Sleeves: 0.0276-inch or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.
 - D. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
 - E. Expansion Anchors: Carbon-steel wedge or sleeve type.
 - F. Toggle Bolts: All-steel springhead type.
 - G. Powder-Driven Threaded Studs: Heat-treated steel.
- 2.2 PADS, BASES AND ANCHORS
- A. Provide bases, pads and anchors required for electrical work. Unless otherwise indicated on the Drawings, provide 4 inch thick concrete pads for floor mounted motor control centers, VFD's, control panels and switchboards.
 - B. Set anchor bolts from templates or actual measurements.
- 2.3 ELECTRICAL IDENTIFICATION
- A. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch wide.
 - B. Underground Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 1. Size: Not less than 4 mils thick by 6 inches wide.
 - a. Compounded for permanent direct-burial service.
 - C. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
 - D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
 - E. Interior Warning and Caution Signs: Preprinted, aluminum, baked-enamel finish signs, punched for fasteners, with colors, legend, and size appropriate to the application.

- F. Exterior Warning and Caution Signs: Weather-resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396-inch, galvanized steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
- G. Fasteners for Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- H. Equipment and Compartment Identification: Engraved laminated plastic nameplates (white with black letters) mounted with corrosion resistant screws. Letters shall be 1/4" high with designations as indicated on drawings for the following:
 - 1. Disconnect switches.
 - 2. Motor control center - all spaces & main.
 - 3. Control panel - as noted for exterior & interior.
 - 4. Variable Frequency Drives.
 - 5. Switchboards – all circuit breakers & main.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.
- B. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Give right of way to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING METHODS

- A. Damp Locations and Outdoors Supports: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations Supports: Steel materials.
- C. Support Clamps for PVC Raceways Supports: Click-type clamp system.
- D. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200-lb-minimum design load.

3.3 INSTALLATION

- 3
- A. Conductor splices: Keep to minimum and comply with the following:
 - 1. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 2. Use splice and tap connectors that are compatible with conductor material.
 - B. Wiring at Outlets: Install with at least 12 inches (300 mm) of slack conductor at each outlet.
 - C. Connect outlets and components to wiring systems to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
 - D. Install devices to securely and permanently fasten and support electrical components.
 - E. Raceway Supports: Comply with NFPA 70 and the following requirements:
 - 1. Install individual supports not longer than 12" from top of conduit to the supporting structure, for all conduits 2-1/2" diameter or larger.
 - 2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 3. Support parallel runs of horizontal raceways less than 2-1/2" diameter, together on trapeze- or bracket-type hangers.
 - 4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.
 - 5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.
 - 6. Hanger Rods: 1/4-inch diameter or larger threaded steel, except as otherwise indicated.
 - F. Cable supports: All concealed cables above suspended ceilings shall be bundled with tie wraps and supported per manufacturer's recommendations. Cables shall not lie on suspended ceilings.

- G. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.
- H. In open overhead spaces, cast boxes threaded to raceways need not be separately supported, except where used for fixture support; support sheet-metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- I. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- J. Firestopping: Apply to cable and raceway penetrations of fire-rated floor and wall assemblies. Perform firestopping as required to reestablish the original fire-resistance rating of the assembly at the penetration.
- K. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:
 - 1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.
 - 2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.
 - 3. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.
 - 4. In partitions of light steel construction use sheet-metal screws.
 - 5. Drill holes in concrete beams so holes more than 1-1/2 inches deep do not cut main reinforcing bars.
 - 6. Drill holes in concrete so holes more than 3/4 inch deep do not cut main reinforcing bars.
 - 7. Fill and seal holes drilled in concrete and not used.
 - 8. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

L. If required, install concrete pads and bases according to requirements of Division 3 Section "Cast-in-Place Concrete."

M. Install identification devices where required.

1. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
2. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated on the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.
3. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
4. Tag or label power circuits for future connection and circuits in raceways and enclosures with other circuits. Identify source and circuit numbers in each cabinet, pull box, junction box, and outlet box. Color coding may be used for voltage and phase indication.
5. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above power and communication lines. Locate 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, use a single line marker.
6. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.4 TESTING

- A. After wires and cables are in place, test the electrical system for shorts, open circuits, and unintentional grounds. Correct all shorts, open circuits and unintentional grounds.

3.5 DEMOLITION

- A. Demolition: If required, where electrical work to remain is damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work Indicated to Be Demolished: Remove exposed electrical installation in its entirety.

- C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- D. Removal: Remove demolished material from the Project site.
- E. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- F. Temporary Wiring: Provide wiring and connections to maintain existing systems in service during construction.
- G. Housekeeping Pads: Remove all concrete pads associated with equipment indicated to be removed and patch floor to match existing surfaces.

3.6 EXCAVATION AND BACKFILLING

- A. Comply with Division 2.

3.7 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved. Repair disturbed surfaces to match adjacent undisturbed surfaces.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Building wires and cables.
- B. Connectors and splices.

1.2 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are UL listed and labeled.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified.
- B. Rubber Insulation Material: Comply with NEMA WC 3.
- C. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- F. Conductor Material: Copper.
- G. Stranding: All conductors shall be stranded, except for drops to outlets and switches which may be solid. Minimum size of #12 AWG shall be used for power wiring, minimum size of #14 AWG shall be used for control wiring.

2.2 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated.
- B. High pressure crimp connectors shall be used for #6 AWG and larger conductors. Split bolt type connectors will not be acceptable.

PART 3 EXECUTION

3.1 WIRE AND INSULATION APPLICATIONS

- A. Service Entrance: Type THWN or XHHN, in raceway.
- B. Feeders: Type THHN/THWN, in raceway.
- C. Branch Circuits: Type THHN/THWN, in raceway.
- D. Class 1 Control Circuits: Type THHN/THWN, in raceway.
- E. Class 2 Control Circuits: Type THHN/THWN, in raceway.
- F. Control Panel internal control wiring: Type MTW.

3.2 INSTALLATION

- A. Install wires and cables according to NECA's "Standard of Installation."
- B. Run all wire in conduit, unless otherwise indicated in the Contract Documents.
 - 1. All analog wiring must be installed in a separate conduit system.
 - 2. All control wiring must be installed in a separate conduit system.
 - 3. All power and lighting wiring must be installed in a separate conduit system.
- C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means that will not damage cables or raceway.
- E. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- G. Seal around cables penetrating fire-rated elements.

H. Wire and Cable Identification: Color code wire size No. 10 and smaller as follows:

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

- I. Cables over size 10 shall have each phase labeled using around- the-wire labels at each access point.
- J. Identify control wires at terminations with numbers indicated on the shop drawings.
- K. Identify lighting and receptacle branch circuits with around-the-wire markers designating circuit numbers.

3.3 CONNECTORS

- A. Conductor Splices: Keep to minimum.
- B. Use splice and tap connectors compatible with conductor material.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Visual and Mechanical Inspection:
 - 1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
 - 2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
 - 3. Check cable color coding complies with wire and cable identification in this specification.

C. Electrical Tests:

1. Perform insulation resistance test on each feeder on the power one-line diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
 2. Perform continuity test to ensure proper cable connection.
- D. Correct malfunctioning conductors and cables at project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

SECTION 16121

CONTROL/SIGNAL/COMMUNICATION TRANSMISSION MEDIA

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. PLC Data Highway and Remote I/O cable.
- B. 2-conductor shielded cable for site wiring.
- C. 2-conductor shielded cable for internal panel wiring.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Section 01340.
 - 1. Product data for control/signal/communication transmission media.
 - 2. Product certificates signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in Quality Assurance below.

1.3 QUALITY ASSURANCE

- A. Connected Equipment Manufacturer Approval: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications or for systems furnished under other contracts, obtain review of the cable characteristics and approval for use with the connected system equipment by the connected equipment manufacturers.
- B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code."
- C. Toxicity: Comply with applicable codes and regulations regarding toxicity of combustion products of materials used in control/signal transmission media.
- D. Electronic Industries Association Compliance: Comply with EIA Standards EIA-230, "Color Marking of Thermoplastic Wire" and EIA-258, "Semi-Flexible Air Dielectric Coaxial Cables and Connectors, 50 Ohms."

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cable factory-packaged in containers or reels. Store in clean dry space and protect products from damaging fumes and traffic. Handle wire and cable carefully to avoid damage.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide control/signal transmission media of manufacturer's standard materials as indicated by published product information, designed and constructed as recommended by manufacturer, for a complete installation and for applications indicated.

2.2 PLC DATA HIGHWAY AND REMOTE I/O CABLE

- A. PLC Data Highway and Remote I/O Cable: Provide 1-twisted pair, #20 AWG tinned copper - (7x28) stranding cable with Polyethylene insulation color coded Blue & Clear. Cable shall have Beldfoil shield + 55% tinned copper braid, 100% shield coverage. Cable shall have blue PVC jacket with nominal diameter of 0.243 inch. Cable shall be Belden #9463, or approved equal.

2.3 2-CONDUCTOR SHIELDED CABLE

- A. 2-Conductor Shielded Cable: Provide 1-twisted pair, #18 AWG tinned copper - (16x30) stranding cable with Polyethylene insulation color coded Blue & Clear. Cable shall have Beldfoil shield + 55% tinned copper braid, 100% shield coverage. Cable shall have chrome PVC jacket with nominal diameter of 0.222 inch. Cable shall be Belden #9460, or approved equal.

2.4 MULTI CONDUCTOR SHIELDED CABLE

- A. Same classification and rating as Belden # 9460, except for different quantity of pairs and size of wire as indicated on drawing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present for compliance with requirements for installation and other conditions affecting signal/control transmission media performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONTROL/SIGNAL TRANSMISSION MEDIA

- A. General: Install control/signal transmission media in accordance with manufacturer's written instructions and in compliance with NEC.
- B. Coordinate installation of transmission media with other Work.
- C. Install transmission media without damaging conductors, shield, or jacket. Do not either in handling or installation bend cable to smaller radii than minimum recommended by manufacturer. Ensure that medium manufacturer's recommended pulling tensions are not exceeded. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.
- D. No splices are allowed except at indicated splice points.
- E. Use splice and tap connectors that are compatible with media material.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published instructions or torque tightening values.

3.3 FIELD QUALITY CONTROL

- A. Prior to usage, test control/signal transmission media for electrical continuity and for short circuits. In addition, test the cable installation with a time domain reflectometer with strip chart recording capability and anomaly resolution to within one foot in runs up to 1,000 feet in length. Test all cable segments for faulty connectors, splices, terminations, and the integrity of the cable and its component parts. Replace malfunctioning transmission media with new materials, then retest until satisfactory performance is achieved.

3.4 COMMISSIONING

- A. Subsequent to hookups of control/signal transmission media, operate control/signal systems to demonstrate proper functioning. Replace malfunctioning media with new materials, and then retest until satisfactory performance is achieved.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Raceways and fittings.
- B. Boxes and enclosures.

1.2 SUBMITTALS

- A. Product Data for wireways and fittings, hinged-cover enclosures, and cabinets.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are UL listed and labeled.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- C. Liquidtight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.
- D. Fittings: NEMA FB 1; compatible with conduit/tubing materials.
- E. Rigid Nonmetallic Tubing: NEMA TC 2, Schedule 40 or 80 PVC.
- F. Electrical Nonmetallic Tubing and Rigid Nonmetallic Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

2.2 METAL WIREWAYS

- A. Materials: Sheet metal sized and shaped as indicated.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Screw-on type.
- E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES AND ENCLOSURES

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, Type FD, malleable iron cast box with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast malleable iron with gasketed cover.
- E. Cast-Metal Conduit Outlet Bodies: NEMA FB 1, cast malleable iron with gasketed cover.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3 EXECUTION

3.1 WIRING METHODS

- A. Conduit type as indicated on drawings.

3.2 RACEWAY INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 3/4-inch trade size, except for switch legs which may be 1/2-inch.
- C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.
- D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Complete raceway installation before starting conductor installation.
- G. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- H. Use temporary closures to prevent foreign matter from entering raceways.
- I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- M. Underground Raceways: First 10' of below grade conduit leaving building, structure, manhole or handhole shall be rigid galvanized steel. All underground elbows shall be rigid galvanized steel. All direct buried conduits shall have warning tape buried above conduit.

All conduit threads shall be coated with an approved electrically conductive, corrosion-resistant compound. All PVC conduit connections shall be primed and solvent welded.

- N. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
- O. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- P. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings to protect conductors.
- Q. Tighten set screws of threadless fittings with suitable tools.
- R. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- S. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- T. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

- U. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- V. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- W. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- X. Do not install aluminum conduits embedded in or in contact with concrete.
- Y. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.3 OUTLET BOX INSTALLATION

- A. Cast conduit type outlet boxes shall be used for connection to threaded rigid conduit. Sheet metal boxes with stamped knockouts shall be used for connection to EMT.
- B. Boxes for outdoor areas and areas subject to washdown shall be cast weatherproof boxes with cast covers and spring lids.
- C. Hazardous areas shall have outlet boxes approved for particular atmosphere.
- D. Set floor boxes level and trim after installation to fit flush to finished floor surface.
- E. Set box square and true with building surfaces.
- F. Secure boxes firmly to building structure.
- G. In centering outlets and locating boxes, allow for: overhead pipes, ducts, and mechanical equipment; variations in fireproofing and plastering, windows, etc.; and correct any inaccuracy from failure to do so without extra expense to the OWNER.
- H. Maintain symmetry of all outlets as closely as possible within the Architectural Section contained. For example, center a light fixture over a doorway, or a receptacle in a section of masonry wall, if shown in that approximate position. If the receptacle is shown in the

same location as a counter or bench, determine the counter's top height and set the receptacle to clear the top and trim of the counter and render the outlet easily accessible.

- I. Locate light switches on the latch side of the door. Verify door hinge location in the field prior to the switch outlet installation.
- J. Protect devices on outlets in locations where outlets are subject to injury, by means of wire guards or other approved means of protection.
- K. Cap all outlets not used under this Contract with blank outlet covers.
- L. The OWNER, or his representative, reserve the right to change location of any outlet up to a distance of 10 feet at no extra charge providing necessary instructions are given prior to roughing in of the outlet.
- M. Install weatherproof outlet boxes, covers, and trim as designated on the Drawings.

3.4 HEIGHTS OF OUTLETS

- A. Generally, outlet heights shall be as follows (measured from center of outlet); unless otherwise indicated.
 - 1. Wall outlets for fixtures: 6'-10".
 - 2. Receptacles, general: 1'-6".
 - 3. Wall switches, general: 4'-0".
 - 4. Wall Pushbuttons: 4'-2".
 - 5. Motor controllers: 4'-2".
- B. Exceptions to the above are as follows:
 - 1. At junction of different materials in wall finishes.
 - 2. Where outlets would occur in moldings, break in wall surface, or unsuitable location in tile, wood, or similar finish.
 - 3. Where outlets would conflict with locations of wall mounted equipment, such as radiators, convectors, unit heaters, etc.

3.5 JUNCTION BOX, PULL BOX AND FITTINGS INSTALLATION

- A. Provide junction and pull boxes where required by the NEC whether or not indicated on the Drawings. Install boxes in accessible location. Size boxes in accordance with the NEC.
- B. Cast junction and pull boxes shall be used for connection to threaded rigid conduit. NEMA 1 boxes shall be used only for connection to EMT or as indicated otherwise.
- C. Boxes for use outdoors and in areas as shown on drawings shall be NEMA 3R, NEMA 4X cast aluminum or stainless steel as indicated on drawings.
- D. Provide pull boxes wherever necessary to facilitate pulling of wire and as indicated.
- E. Locate junction and pull boxes as approved and not exposed in a finished space, unless otherwise indicated. Where necessary, reroute conduit or make other arrangements for concealments as approved.
- F. Covers shall be accessible.
- G. Splicing boxes for fixtures recessed in hung ceilings shall be accessible through openings created by removal of fixtures.

3.6 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

SECTION 16150

MOTORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Motors.

1.2 QUALITY ASSURANCE

- A. Furnish to the OWNER standard published test data for all motors where available for motors of similar manufacture and size.
- B. Provide an individual motor test for all motors 15 HP and larger. Test shall be standard NEMA production test consisting of the following:
 - 1. Locked rotor current.
 - 2. High potential test.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data: Submit shop drawings and product data for the products of this Section in compliance with Section 01340.
- B. Operation and Maintenance Manuals: Submit operation and maintenance manuals for the products of this Section.
- C. Test Reports and Certifications: Submit test reports and certifications specified herein to the OWNER.

1.4 COORDINATION AND FIELD CONDITIONS

- A. In general, motors shall be furnished as part of the equipment item and shall comply with the requirements of this Section.
- B. Equipment actually furnished may vary from the equipment which is indicated on the Drawings or specified. The CONTRACTOR is responsible for verifying in the field the equipment that has been provided and shall properly wire the equipment in strict compliance with the NEC.

PART 2 PRODUCTS

2.1 MOTOR CHARACTERISTICS

A. Motor Electrical Characteristics

1. Unless otherwise indicated on the Drawings or specified elsewhere, motors shall have the following electrical characteristics:
 - (a) 1/3 HP and less shall be 120 Vac, 1 phase, 60 Hz.
 - (b) 1/2 HP and above shall be 460 Vac, 3 phase, 60 Hz.

B. Service Factor and Loading

1. Unless otherwise specified, motors shall have a service factor of 1.15.
2. No motor shall have a shaft loading exceeding 90% of full load rating under worst condition of load, unless specifically permitted by equipment specifications.

C. Motor Speed:

1. Motor speed shall be as specified for the equipment. Unless specifically noted otherwise, motor speed shall not exceed 1800 RPM.

D. Torque:

1. Breakdown torque shall be 200% or more of the maximum torque load placed on the motor shaft. Provide necessary WK² curves for all special loads to coordinate with motors. Provide special motors where load requirements exceed standard design.

E. Motor Efficiencies

1. Motors shall be premium efficiency type with the following minimum efficiencies at full load.

<u>HP</u>	<u>Efficiency</u>
1	82.5
2	86.5
3	89.5
5	90.2
7-1/2	91.0
10	91.7
15	92.4
20	93.0

25	93.6
50	94.5
75	94.5
100	95.4
150	95.4
200	95.8
250	95.8
300	95.8

2.2 GENERAL MOTOR CONSTRUCTION REQUIREMENTS

- A. Motor Enclosures shall be of the following types, unless otherwise specified:
 - 1. Standard duty outdoor motors shall be weather protected NEMA I.
 - 2. Outdoor motors over open tanks shall be TEFC corrosion resistant.
- B. Submersible duty motors shall be waterproof, with two (2) extra dip and bake cycles. Provide with moisture detectors on seals and with thermistors.
- C. Standard duty indoor motors shall be dripproof.
- D. Indoor motors in areas subject to washdown shall be splashproof.
- E. Motors in locations classified as hazardous as defined by Article 500 of the National Electric Code, shall meet the requirements of Articles 501 and 502 respectively for use in the class and group of atmosphere involved.
- F. Motors in explosive areas shall be Class I, Group D motors.
- G. Insulation: Insulation shall be Class B, unless otherwise indicated.
- H. Windings: Windings shall be copper.
- I. Bearings: Except as otherwise specified herein, bearings shall either be ball or roller type having a B-10 life rating of at least AGFMA 100,000 hours. Bearings shall adequately support side thrust loadings when encountered. Bearings shall be grease lubricated.
- J. Heaters: Provide heaters for all outdoor mounted motors 20 HP and above. Heating, ventilating, and air conditioning equipment specified in Division 15 is excluded from this requirement, unless otherwise specified.
- K. Heaters shall be supplied from a separate 120 Vac circuit and controlled by the motor control circuit to be "off" during running time and "on" when motor is not running.

- L. Slide Rails and Sole Plates: Provide slide rails and sole plates as required for the application.
- M. Motor Protection: All fractional horsepower motors shall be capacitor start. Temperature rise shall not exceed 50 degrees C over 40 degrees C ambient temperature at full load. Shaft load shall not exceed 80% of full load.
- N. Motors fed from Variable Frequency Drives shall comply with NEMA MG1, Part 31, Definite Purpose Inverter-Fed Motors.
- O. Provide oversize conduit boxes as required for field terminations.

2.3 INDUCTION MOTORS

- A. Provide horizontal or vertical induction motors for standard duty. Provide multi-speed motors where indicated on the Drawings or specified. Motor design shall be in compliance with load application.
- B. Starting requirements shall be across-the-line, unless specifically noted otherwise.

2.4 SPECIAL DUTY MOTORS

- A. Provide special duty motors where required. Design of special duty motors shall be submitted to the OWNER for review. Special duty motors shall be designed to comply with these Specifications, and all exceptions shall be listed on the submittal.
- B. In all cases, special duty motors shall be derated to not more than 85% full load and shall be designed for long life and ease of maintenance, and shall be fully protected.

PART 3 EXECUTION

3.1 GENERAL

- A. Install motors properly and in compliance with the manufacturer's instructions. Securely mount and anchor motors as required.
- B. Check motors for correct rotation before connecting to driven load. Repair or replace, at the OWNER'S option, motors and equipment damaged because of incorrect motor rotation.
- C. Properly lubricate motors before placing in service. Motors operated without lubrication shall be replaced.

3.2 MOTOR FEEDERS

- A. Provide proper feeders for all motors in compliance with the NEC and motor nameplate ratings. The CONTRACTOR shall be responsible for verifying the ratings of all motors and installing proper feeders.

3.3 MOTOR PROTECTION

- A. All motors shall have overcurrent protection in compliance with the NEC and these Specifications.

3.4 ALIGNMENT AND BALANCE

- A. Check alignment and balance of all motors prior to startup, using test equipment specifically designed for this purpose. Motors shall be free from excessive vibration.

3.5 MOTOR CONNECTION

- A. Make all motor connections by indent compression type connectors, using proper tools and fittings to assure good electrical continuity and a low resistance joint. Provide insulation to meet temperature, voltage, and atmosphere encountered.

3.6 FIELD QUALITY CONTROL

- A. Startup service shall include the following:
 - 1. Check alignment.
 - 2. Check couplings.
 - 3. Record running balance.
 - 4. Check electrical installation.
 - 5. Examine overall installation.
- B. Meggar test at startup or within 2 weeks prior or after.
- C. The Service Engineer shall submit copies of the start service report directly to the OWNER. The Service Engineer shall certify in writing that the motor has been fully checked, installation is complete and satisfactory, and that motor has been started and operated under his supervision.

END OF SECTION

SECTION 16452

GROUNDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding.

1.2 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with UL 467.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

- A. Where types, sizes, ratings, and quantities indicated differ from National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.2 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Wire and Cable Grounding Conductors: Comply with Division 16 Section "Wires and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
 - 1. Material: Copper
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode Conductors: Bare stranded cable.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

2.3 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.4 CONNECTOR PRODUCTS

- A. Pressure Connectors: High-conductivity-plated units.
- B. Bolted Clamps: Heavy-duty type.
- C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.5 GROUNDING ELECTRODES

- A. Grounding Rods: Copper-clad steel.
 1. Minimum Size: 3/4 inch by 120 inches.
- B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch thick, size as indicated.

PART 3 EXECUTION

3.1 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
 1. Install a separate equipment grounding conductor with circuit conductors in all conduit.

2. Busway Supply Circuits: Install separate equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding-bar terminal on busway.
 3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- B. Separately Derived Systems: Where NEC requires grounding, ground according to NEC.

3.2 INSTALLATION

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
1. Drive until tops are 2 inches below finished floor or final grade, except as otherwise indicated.
 2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- C. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches below grade.
- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond grounding-conductor conduit to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.3 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 6. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
 7. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
 8. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
 9. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
 10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 11. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 FIELD QUALITY CONTROL

- A. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding

terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.

B. Maximum grounding to resistance values are as follows:

1. Equipment Rated 500 kVA and Less: 10 ohms.
2. Equipment Rated 500 to 1000 kVA: 5 ohms.
3. Equipment Rated More than 1000 kVA: 3 ohms.
4. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
5. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify OWNER promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Lighting and Appliance Branch – Circuit Panelboards.
- B. Distribution panelboards.
- C. Overcurrent protective devices.

1.2 SUBMITTALS

- A. Product Data: For each type of panelboard, accessory item, and component specified.
- B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
 - 1. Enclosure type with details for types other than NEMA 250, Type 1.
 - 2. Bus configuration and current ratings.
 - 3. Short-circuit current rating of panelboard.
 - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
- C. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer's written instructions for testing circuit breakers.

1.3 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
- B. Comply with NFPA 70.
- C. Comply with NEMA PB 1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance requirements, provide products by the following:
 - 1. Square D.

2. General Electric.
3. Cutler-Hammer.

2.2 PANEL FABRICATION

- A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
 1. Outdoor Locations: NEMA 250, Type 3R.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
- B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98 percent conductivity.
- E. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- F. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect switch.
- G. Special Features: Include the following features for panelboards as indicated:
 1. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.
 2. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and floor.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Circuit Breakers for Switching Lights at Panelboards: Indicated as Type SWD.
- B. Circuit Breakers for Equipment Marked Type HACR: Indicated as Type HACR.
- C. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.4 DISTRIBUTION PANELBOARDS

- A. Doors: In panelboard front, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
 - 5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
 - 6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
 - 7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
 - 8. Shunt Trip: Where indicated.
- B. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses, handle lockable.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessory items according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
- E. Install filler plates in unused spaces.

- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."
- B. Panelboard Nameplates: Label each panelboard as specified in Division 16 Section "Basic Electrical Materials and Methods."

3.3 GROUNDING

- A. Make equipment grounding connections for panelboards as indicated.
- B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Perform acceptance tests as follows:
 - 1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
 - 2. Make continuity tests of each circuit.
 - 3. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

3.6 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges as indicated in Coordination Study.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish.

END SECTION

SECTION 16476

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disconnect switches.

1.2 SUBMITTALS

- A. Submit Product Data for disconnect switches, circuit breakers, and accessories according to the Conditions of the Contract and Division 1 Specification Sections.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are UL listed and labeled.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance requirements, provide products by the following:
 - 1. Square D.
 - 2. Cutler-Hammer.
 - 3. General Electric.

2.2 DISCONNECT SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
 - 1. Outdoor Locations: Type 4X stainless steel, unless otherwise indicated on drawings.

2. Other Wet or Damp Indoor Locations: Type 4.
3. Hazardous Areas Indicated on Drawings: Type 7C.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches in locations as indicated, according to manufacturer's written instructions.
- B. Install disconnect switches level and plumb.
- C. Install wiring between disconnect switches, control, and indication devices.
- D. Connect disconnect switches and components to wiring system and to ground as indicated and instructed by manufacturer.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 IDENTIFICATION

- A. Identify each disconnect switch and circuit breaker according to requirements specified in Division 16 Section "Basic Electrical Materials and Methods."

END OF SECTION

SECTION 16481
MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Motor starters.
- B. Starter controls.

1.2 SUBMITTALS

- A. Shop Drawings and Product Data: Submit shop drawings and product data for the products of this Section in compliance with Section 01340.
- B. Operation and Maintenance Manuals: Submit operation and maintenance manuals for the products of this Section.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 GENERAL

- A. Combination magnetic starters for automatic starting of single or three phase motors shall be Allen-Bradley Bulletin 500 Series, Cutler Hammer Freedom Series or Square D.
- B. For manual start of single phase motors less than ½ HP, provide manual start switches with thermal overload protection. Switch operating handle shall be capable of being locked in the OFF position. Manual start switches shall be Allen-Bradley Bulletin 600 Series, Cutler Hammer, or Square D.

2.2 TYPES OF STARTERS

- A. Provide full-voltage, across-the-line, NEMA type starters for all motors, unless otherwise indicated on drawings. Provide motor running protection as specified. IEC type starters are not acceptable.

2.3 STARTER SIZE

- A. Motor starters shall be rated in compliance with NEMA sizes and HP ratings. No starter smaller than size one (1) shall be used. All starters shall be gravity dropout. Timing relays shall be solid state type and shall be adjustable to provide for delayed starting of motor.

2.4 CONTACTS

- A. Furnish fail contact in all starters.
- B. Furnish 1 set of NO and 1 set of NC auxiliary contacts in all starters.
- C. All starters shall have double break silver alloy contacts. All contacts shall be capable of being inspected and shall be removable without removing line or load wiring.

2.5 ENCLOSURES

- A. Starters shall be provided with enclosures as required for the environment. Enclosures shall be as follows:
 - 1. Indoor starters shall have NEMA 12 enclosures.
 - 2. Starters in corrosive area shall have NEMA 4X enclosures.
 - 3. Outdoor starters shall have NEMA 3R enclosures.

2.6 COILS

- A. Coils on starters and on timing relays shall be molded construction.

2.7 OVERLOAD RELAYS AND THERMAL UNITS

- A. Overload relays shall be bimetallic or eutectic alloy type. Overload units shall be of one-piece construction and interchangeable. Starters shall be inoperative unless overload units are installed.

2.8 CONTROL CIRCUITS

- A. Control circuit voltage shall not exceed 120 Vac.
- B. Control circuits shall comply with the following:
 - 1. One side of the secondary of transformers shall be grounded. Transformer shall be 100VA minimum size with primary and secondary protection.
 - 2. One side of all operating coils of control devices shall be connected to ground side of the control circuit.

3. Provide auxiliary contacts as required to serve all remote accessories, equipment, instrumentation, and control systems.
 4. Provide each motor starter with an adjustable solid state time delay relay for delayed start. Delayed start shall be automatically activated when ATS is sourced to the generator as described in Section 16950. Time delay relays shall be Dayton 6A855 or approved equal
- C. Manufacturer shall inform ENGINEER of any obviously incorrect or unsafe conditions arising in control circuit or arrangement.

2.9 SELECTOR SWITCHES

- A. Selector switches shall be heavy duty, 30mm size units with continuous contact rating of 120-volts. The switches shall be of the rotary type with enclosed, positive, quick-acting contacts which are not dependent upon springs. The switches shall be provided with as many states as necessary to perform the functions indicated.

2.10 INDICATING LIGHTS

- A. Indicating lights shall be heavy duty, 30mm size, oil tight transformer type, with glass lenses. Suitable for 120-volt, 60 Hertz operation. Push to test feature shall be provided when indicated on the drawings.

2.11 PUSHBUTTONS

- A. Pushbuttons shall be heavy duty, 30mm size, oil tight type, with removable contact blocks. Contact rating shall be 10-ampere, continuous current at 120-volt alternating current.

2.12 ELAPSED TIME METERS

- A. Elapsed time meters shall be heavy duty, non-resettable with digital readout in hours.

2.13 REMOTE MONITORING SIGNALS

- A. Furnish dry contact closures, either control relay contacts or switch contacts wired to enclosure terminal block as applicable for remote monitoring.
- B. Provide dry contact as required for control interface indicated on drawings.

PART 3 EXECUTION

3.1 MOUNTING

- A. Mount starters on walls five (5) feet above finished floor (top of starter) or match existing mounting height.
- B. Mount pushbuttons four (4) feet above finished floor.
- C. Install enclosed controllers plumb. Provide supports in accordance with Section 16190.

3.2 OVERLOAD PROTECTION

- A. Install overload heaters and verify that protection corresponds to installed motor full load current and that motors will start and operate immediately.

3.3 CONTROL CIRCUITS

- A. Install control circuits and perform continuity tests. Check control and interlock wiring for proper operation.

3.4 LABELS

- A. When starter interlocks with other starters or controls, provide a label on the inside of the cover stating nature of interlock system. (Example: Interlocked with 120 Vac circuit from exhaust fan.)
- B. Provide engraved plastic nameplates according to the requirements specified in Section 16050 "Basic Electrical Materials and Methods".

3.5 STARTUP

- A. Starter manufacturer shall be responsible for startup of solid-state, reduced voltage controllers and demonstrate proper operation in presence of OWNER's representative.

3.6 TRAINING

- A. Provide one day of training for solid-state, reduced voltage controller by manufacturer representative.

END OF SECTION

APPENDIX C

CONSTRUCTION DRAWINGS

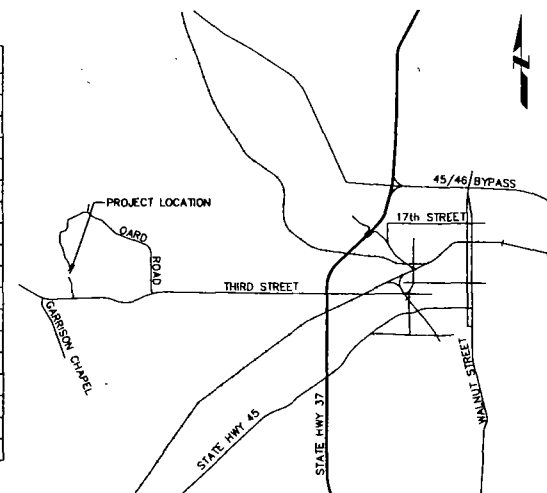
NEAL'S LANDFILL SPRING TREATMENT FACILITY BLOOMINGTON, INDIANA NEAL'S LANDFILL IMPROVEMENTS 2011

APRIL 2011
50% DESIGN PLANS



GENERAL LOCATION MAP

DRAWING INDEX	
DRAWING NUMBER	DRAWING TITLE
G-1	COVER DRAWING
G-2	GENERAL NOTES AND OVERALL SITE MAP
PR-1	DESIGN CRITERIA AND CONSTRUCTION SEQUENCE
PR-2	PROCESS FLOW DIAGRAM
PR-3	PLAN AND PROFILE FORCEMAIN
PR-4	PLAN AND PROFILE FORCEMAIN
PR-5	PLAN AND PROFILE EFFLUENT DISCHARGE LINE
PR-6	PLAN AND PROFILE EFFLUENT DISCHARGE LINE
PR-7	DOWNSTREAM SEEP PUMP STATION SITE PLAN
PR-8	DOWNSTREAM SEEP PUMP STATION SECTION AND DETAILS
PR-9	DETAILS
PR-10	DETAILS
E-1	ELECTRICAL GENERAL NOTES AND SYMBOLS
E-2	ELECTRICAL SITE PLAN
E-3	ELECTRICAL PLANS
E-4	ELECTRICAL PLAN
E-5	ELECTRICAL DETAILS



PROJECT LOCATION MAP



125 WEST CHURCH STREET
CHAMPAIGN, IL 61820
PHONE 217.373.8908
FAX 217.373.8923

PROJECT TITLE
NEAL'S LANDFILL
SPRING TREATMENT FACILITY
BLOOMINGTON, INDIANA
NEAL'S LANDFILL
IMPROVEMENTS 2011

DESIGNED BY: A.W.B.
DRAWN BY: D.L.E.
CHECKED BY:
DATE CHECKED:
NOTE: DIMENSIONS, DATA
IS NOT TO BE OBTAINED BY
SCALING ANY PORTION OF
THIS DRAWING

DATE REVISION

DRAWING TITLE
COVER DRAWING

PROJECT NO.
C0850040

DRAWING NO.
G-1

DRAWING 1 OF 17 DRAWINGS

CONTACT INFORMATION

(SEE SPECIFICATIONS FOR ADDITIONAL CONTACTS)

OWNER
CBS CORPORATION
RUSS CEPKO
11 STANWYX STREET
PITTSBURGH, PA. 15222
PHONE (412) 642-2569
Russ.Cepko@cbs.com

ENVIRONMENTAL CONSULTANT

PSARA TECHNOLOGIES, INC.
PAT KNEIP
PRINCIPAL ENGINEER
202 WEST VERNAL PIKE
BLOOMINGTON, IN 47404
PHONE (218) 335-0424
mkneip@psara.com

ENGINEER
CLARK DIETZ, INC.
125 WEST CHURCH STREET
CHAMPAIGN, IL 61820
PHONE (217) 373-6900
TERRY BOYER
DESIGN ENGINEER
PHONE (217) 373-8938
terrence.boyer@clarkdietz.com

PLANT OPERATOR
PSARA TECHNOLOGIES, INC.
STEVE WADE
ICS PLANT OPERATOR
ILLINOIS CENTRAL SPRINGS
1550 WEST THIRD STREET
BLOOMINGTON, IN 47404
efsbloomington@sbglobal.net

CITY OF BLOOMINGTON UTILITIES
CITY OF BLOOMINGTON UTILITIES
BYRON REINHOLD, JR.
SENIOR PROJECT COORDINATOR
CITY OF BLOOMINGTON, UTILITIES DEPARTMENT
600 EAST MILLER DRIVE
BLOOMINGTON, IN 47401
PHONE (812) 349-3624
reinhold@bloomington.in.gov



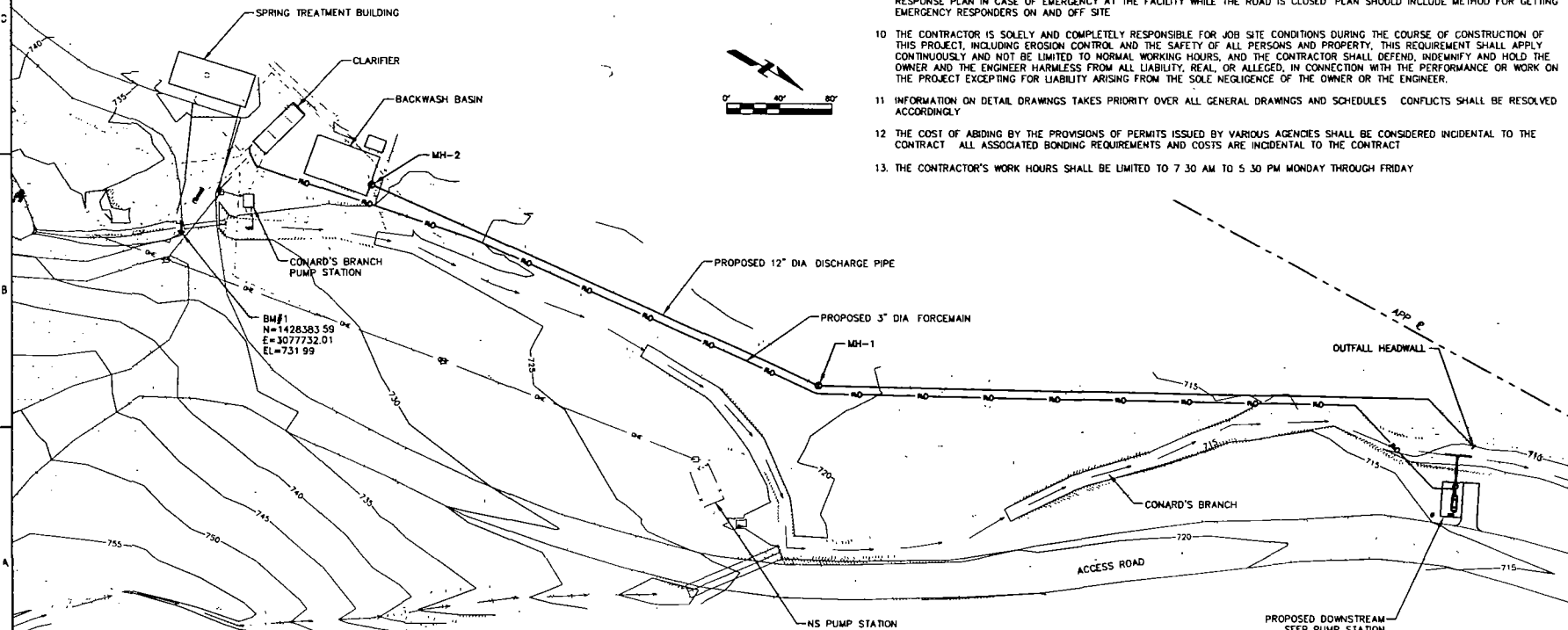
Know what's below.
Call before you dig.

BENCHMARK

BM #1 PK NAIL IN EAST WINGWALL
ELEVATION 731.99

GENERAL NOTES

- NOT ALL OF THE GAS, POWER, TELEPHONE LINES, OR PLANT PIPING WHETHER ABOVE OR BELOW GROUND, HAVE BEEN SHOWN ON THE DRAWINGS. THE CONTRACTOR MUST REALIZE THAT THE ACTUAL LOCATIONS OF THE UTILITIES SHOWN ON THE DRAWINGS MAY BE DIFFERENT FROM THE LOCATIONS INDICATED.
- THE LOCATIONS OF THE EXISTING YARD PIPING, SUCH AS RAW SEWAGE LINES, DRAIN LINES, NON-POTABLE WATER LINES, ETC., AS SHOWN ON THE DRAWINGS, HAVE BEEN DETERMINED FROM 1999 AS-BUILT PLANS FOR THE EXISTING FACILITIES PREPARED BY THE US EPA AND ARE GIVEN FOR THE CONVENIENCE OF THE CONTRACTOR. THE CONTRACTOR MUST ASSUME RESPONSIBILITY FOR ALL PIPING AND MUST REALIZE THAT THE ACTUAL LOCATIONS MAY BE DIFFERENT FROM THOSE INDICATED ON THE DRAWINGS.
- IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO MAINTAIN IN SERVICE THE EXISTING TREATMENT FACILITY, ALL EXISTING PROCESS PIPING, AND ALL EXISTING UTILITIES ENCOUNTERED DURING CONSTRUCTION UNLESS OTHERWISE INDICATED IN THE DRAWINGS. ANY PIPING WHICH CAN BE REMOVED DURING CONSTRUCTION WITHOUT UNDUE INTERRUPTION OF SERVICE MAY BE REMOVED AND REPLACED BY THE CONTRACTOR WITH THE PERMISSION OF THE OWNER.
- BEFORE WORKING WITH OR AROUND EXISTING UTILITIES, THE APPLICABLE UTILITY COMPANY SHALL BE CONTACTED BY THE CONTRACTOR.
- THE CONTRACTOR SHALL PRESERVE AND PROTECT PROPERTY MARKERS, SECTION CORNERS, SURVEY MARKS AND CITY BENCH MARKS, SUCH AS STONES, PIPES, OR OTHER MONUMENTS ENCOUNTERED. IF THE CONTRACTOR MUST RELOCATE THE PROPERTY MARKERS OR MONUMENTS, THEIR LOCATION SHALL BE REFERENCED BY A REGISTERED LAND SURVEYOR AND THE OWNER NOTIFIED BEFORE MOVING ALL PROPERTY MARKERS AND MONUMENTS RELOCATED DURING CONSTRUCTION SHALL BE RE-ESTABLISHED BY A REGISTERED LAND SURVEYOR AT THE CONTRACTOR'S EXPENSE.
- THE CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH THE AREA AND NO EXTRA COMPENSATION CONNECTED WITH OVERHEAD UTILITIES WILL BE ALLOWED.
- THE CONTRACTOR IS RESPONSIBLE FOR DUST AND MUD CONTROL.
- ROADWAY SURFACING AND BASE MATERIALS, OR ANY OTHER PROPERTY REMOVED OR DAMAGED, SHALL BE REPLACED OR REPAIRED AS PROVIDED FOR IN THE SPECIFICATIONS OR OTHER CONTRACT DOCUMENTS.
- THE CONTRACTOR IS RESPONSIBLE FOR ALL CONSTRUCTION TRAFFIC CONTROL. THE CONTRACTOR SHALL PROVIDE AN EMERGENCY RESPONSE PLAN IN CASE OF EMERGENCY AT THE FACILITY WHILE THE ROAD IS CLOSED. PLAN SHOULD INCLUDE METHOD FOR GETTING EMERGENCY RESPONDERS ON AND OFF SITE.
- THE CONTRACTOR IS SOLELY AND COMPLETELY RESPONSIBLE FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING EROSION CONTROL AND THE SAFETY OF ALL PERSONS AND PROPERTY. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS, AND THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE OWNER AND THE ENGINEER HARMLESS FROM ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OR WORK ON THE PROJECT EXCEPTING FOR LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE OWNER OR THE ENGINEER.
- INFORMATION ON DETAIL DRAWINGS TAKES PRIORITY OVER ALL GENERAL DRAWINGS AND SCHEDULES. CONFLICTS SHALL BE RESOLVED ACCORDINGLY.
- THE COST OF ABIDING BY THE PROVISIONS OF PERMITS ISSUED BY VARIOUS AGENCIES SHALL BE CONSIDERED INCIDENTAL TO THE CONTRACT. ALL ASSOCIATED BONDING REQUIREMENTS AND COSTS ARE INCIDENTAL TO THE CONTRACT.
- THE CONTRACTOR'S WORK HOURS SHALL BE LIMITED TO 7:30 AM TO 5:30 PM MONDAY THROUGH FRIDAY.



OVERALL SITE



125 WEST CHURCH STREET
CHAMPAIGN, IL 61820
PHONE 217 373 6900
FAX 217 373 8923

PROJECT TITLE
NEAL'S LANDFILL
SPRING TREATMENT FACILITY
BLOOMINGTON, INDIANA
NEAL'S LANDFILL
IMPROVEMENTS 2011

DESIGNED BY A.P.B.
CHECKED BY S.T.B.
DATE CHECKED

NOTE: DIMENSIONAL DATA
IS NOT TO BE OBTAINED BY
SCALING ANY PORTION OF
THIS DRAWING

DATE	REVISION

DRAWING TITLE
GENERAL NOTES AND
OVERALL SITE MAP

PROJECT NO
C0850040

DRAWING NO
G-2

FIGURE 2 OF 14 FIGURES



125 WEST CHURCH STREET
CHICAGO, IL 60602
PHONE 312.373.8800
FAX 312.373.8822

PROJECT TITLE
NEAL'S LANDFILL
SPRING TREATMENT FACILITY
BLOOMINGTON, INDIANA
NEAL'S LANDFILL
IMPROVEMENTS 2011

DESIGNED BY A.S.B.
DRAWN BY G.L.B.
CHECKED BY
DATE CHECKED
NOTE: DIMENSIONAL DATA
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DATE REVISION

DRAWING TITLE
DESIGN CRITERIA AND
CONSTRUCTION SEQUENCE

PROJECT NO.
C0850040

DRAWING NO.
PR-1

COMPUTED 3 OF 17 SHEETS

DESIGN CRITERIA

DRAINAGE FLOWS

NO DRAINAGE FLOW IN EFFLUENT DISCHARGE PIPE

TREATMENT CAPACITIES

NEAL'S LANDFILL SPRING TREATMENT FACILITY CAPACITY 450 GPM

EXISTING GRAVITY FLOW EFFLUENT DISCHARGE PIPE

MATERIAL PVC
DIAMETER 12-INCH
MANNING'S N 0.016
SLOPE (MIN) 0.005 FT/FT
PIPE CAPACITY 1,470 GPM

NEW GRAVITY FLOW EFFLUENT DISCHARGE PIPE

MATERIAL N-12 HP
DIAMETER 12-INCH
MANNING'S N 0.012
SLOPE (MIN) 0.005 FT/FT
PIPE CAPACITY 1,225 GPM

CONSTRUCTION SEQUENCE NOTES:

1 REFER TO THE AGREEMENT IN THE PROJECT MANUAL FOR ADDITIONAL REQUIREMENTS

2 THE OWNER REQUIRES ADHERENCE TO THE FOLLOWING INTERNAL MILESTONES IN THE STIPULATED TIME AS PART OF THE WORK. FAILURE BY THE CONTRACTOR TO COMPLETE MILESTONES WITHIN THE STIPULATED TIME WILL RESULT IN THE CONTRACTOR PAYING THE OWNER LIQUIDATED DAMAGES OF \$1,000 PER CALENDAR DAY, INCLUDING SUNDAYS AND HOLIDAYS, THAT THE WORK SHALL REMAIN UNCOMPLETED UNLESS THE CONTRACT TIME IS EXTENDED BY THE OWNER

CONSTRUCTION SEQUENCE

CONTRACTOR SHALL SUBMIT PIPING, MANHOLES, CONCRETE AND ALL OTHER RELEVANT SHOP DRAWINGS FOR EFFLUENT DISCHARGE LINE TO ENGINEER

ENGINEER WILL RETURN SUBMITTALS TO CONTRACTOR

CONTRACTOR SHALL, IN THE FOLLOWING ORDER

- COMPLETE THE NEW 15" EFFLUENT DISCHARGE LINE, AND INSTALLATION OF PIPE HEADWALLS AND RIPRAP.
- COMPLETE AND PASS ALL TESTING REQUIREMENTS ON 15" EFFLUENT DISCHARGE LINE.

CONTRACTOR SHALL ACHIEVE SUBSTANTIAL COMPLETION

- COMPLETE AND PASS ALL REMAINING TESTING.

- COMPLETE ALL ROADWAY & SEEDING AREA RESTORATION.

CONTRACTOR SHALL ACHIEVE FINAL COMPLETION

STIPULATED TIME

WITHIN 14 DAYS AFTER ISSUANCE OF A NOTICE TO PROCEED

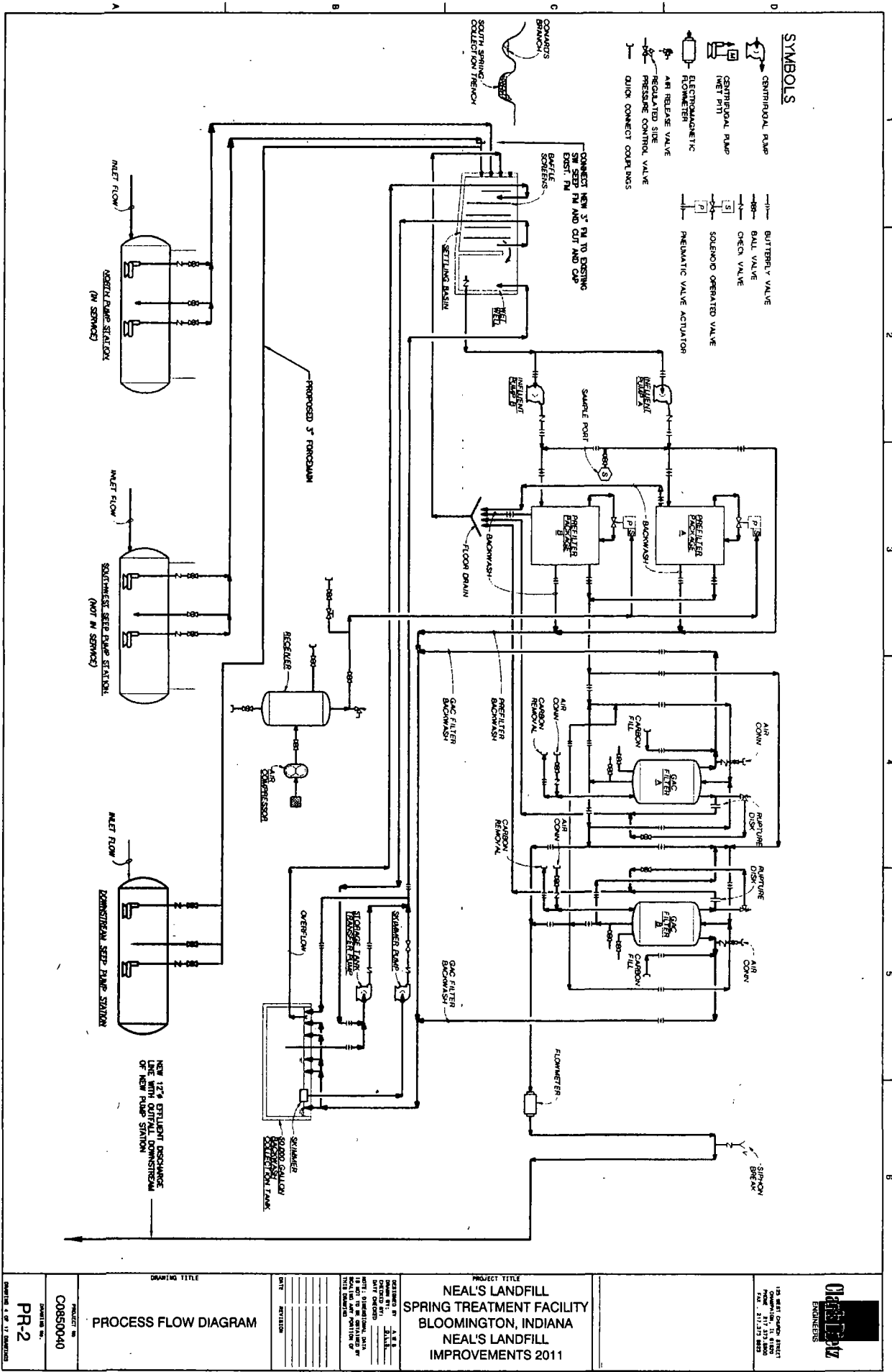
SUBMITTAL RETURN IS ANTICIPATED WITHIN 7 DAYS OF SUBMITTAL RECEIPT

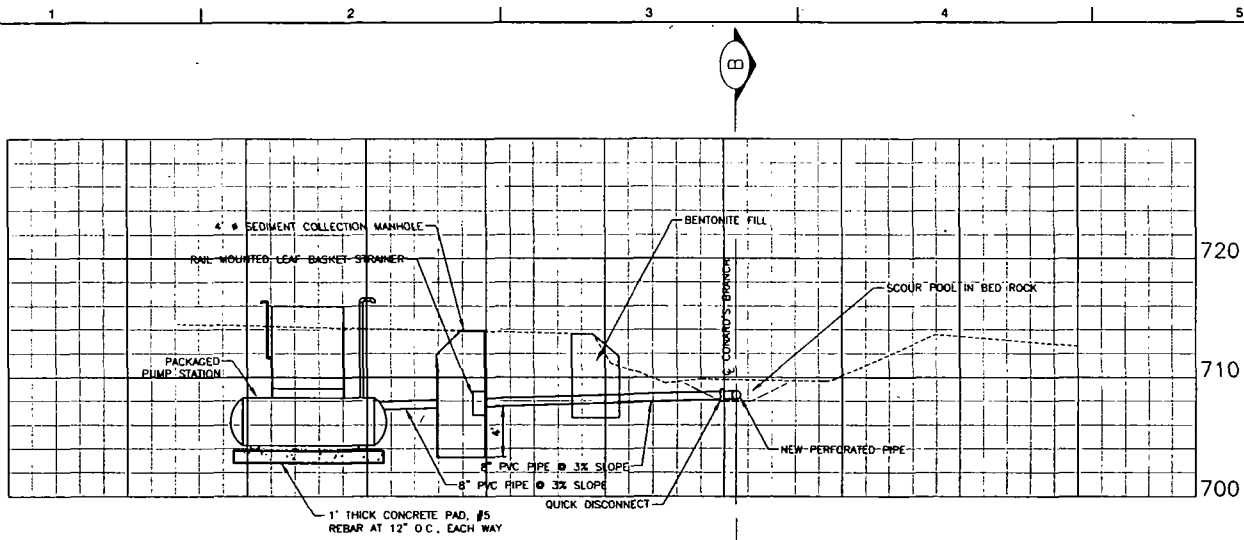
WITHIN 28 CALENDAR DAYS OF APPROVED SHOP DRAWINGS

AFTER 28 CALENDAR DAY TIME FRAME

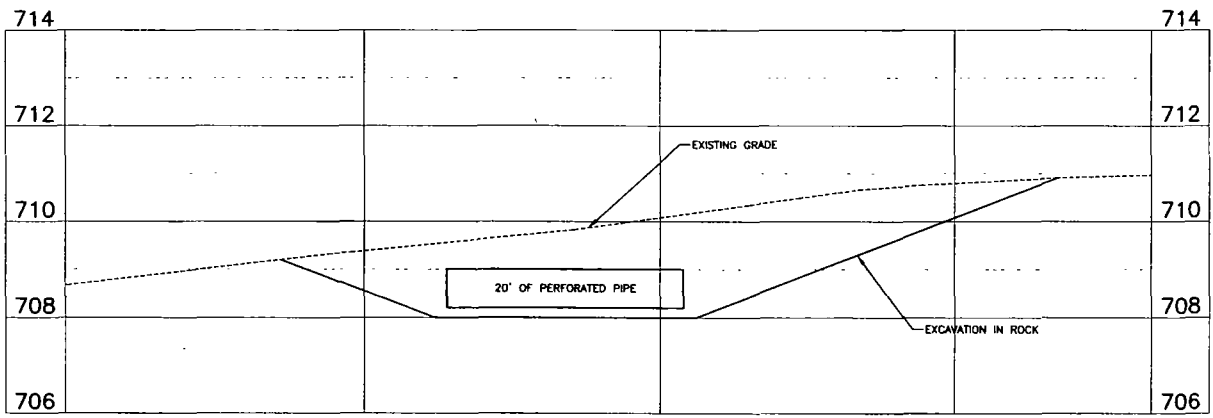
WITHIN 80 CALENDAR DAYS OF THE ISSUANCE OF THE NOTICE TO PROCEED

WITHIN 110 CALENDAR DAYS OF THE ISSUANCE OF THE NOTICE TO PROCEED





SECTION A-A
SCALE 1"=5'



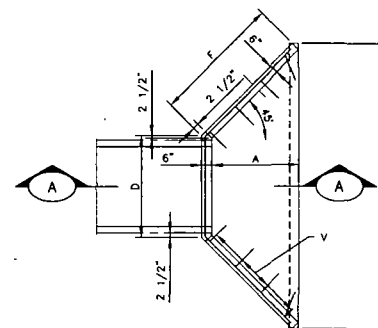
SECTION B-B
SCALE: 1"=5' Horiz
1"=2' Vert

Clark & Dotz
ENGINEERS
125 WEST CHURCH STREET
CHAMPAIGN, IL 61820
PHONE: 317.372.8800
FAX: 317.372.8822

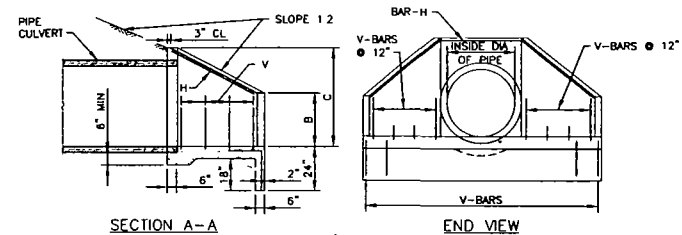
PROJECT TITLE
NEAL'S LANDFILL
SPRING TREATMENT FACILITY
BLOOMINGTON, INDIANA
NEAL'S LANDFILL
IMPROVEMENTS 2011

DESIGNED BY: A.S.S.
DRAWN BY: S.L.B.
CHECKED BY:
DATE CHECKED:
NOTE: DIMENSIONAL DATA
IS NOT TO BE DETAINED BY
SCALING ANY PORTION OF
THEY DRAWINGS.

DRAWING TITLE
DOWNSTREAM SEEP PUMP
STATION SECTION AND
DETAILS
PROJECT NO.
C0850040
DRAWING NO.
PR-8
DRAWING 10 OF 17 DRAWINGS

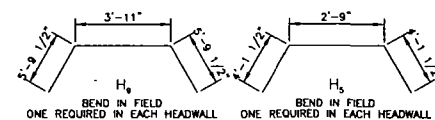


PLAN



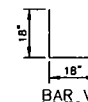
SECTION A-A

END VIEW



BEND IN FIELD
ONE REQUIRED IN EACH HEADWALL

BEND IN FIELD
ONE REQUIRED IN EACH HEADWALL



BAR_V

DIMENSIONS AND QUANTITIES

HEADWALL NO	NOMINAL INSIDE DIA. OF PIPE	SLOPE OF WING WALLS	DIMENSIONS						REINFORCEMENT BAR			
									NO 4	V-BAR NO		
			A	B	C	D	E	F	BAR LENGTH			
1	15	12	2'-10"	16	2'-9"	2'-11"	8'-10"	1/2"	4'-2 1/2"	H 11	11'-0"	28

CONCRETE HEADWALL DETAILS

SCALE NONE



125 WEST CHURCH STREET
CHAMPAIGN, IL 61820
PHONE 217.373.8800
FAX 217.373.8923

PROJECT TITLE
NEAL'S LANDFILL
SPRING TREATMENT FACILITY
BLOOMINGTON, INDIANA
NEAL'S LANDFILL
IMPROVEMENTS 2011

DESIGNED BY	A.W.B.
DRAWN BY	G.L.S.
CHECKED BY	
DATE CHECKED	

NOTE: DIMENSIONAL DATA
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6/17/10	SLO REVISION
11/22/10	RECORD DRAINING

DATE	REVISION

1. *Journal of the American Medical Association*, 2000; 283: 2689-2693.

S. 21

TAIL

DET

9

PROJECT NO
C0850040

000000-10

000000-10

PR-10

DRAWING 12 OF 17 DRAWINGS

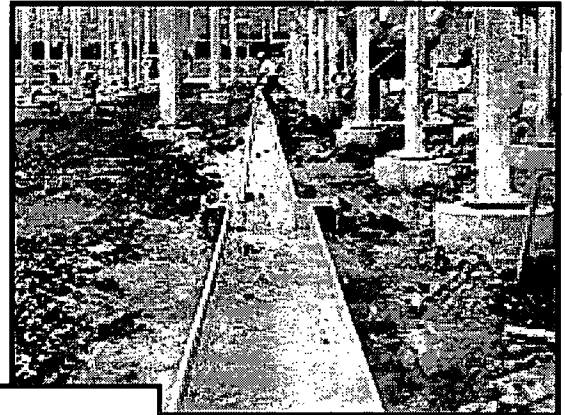
APPENDIX D VENDOR INFORMATION

TRENCH SYSTEM-OVERVIEW

Fibercrete®

REDUCE INSTALLATION COST WITH CONCAST FIBERCRETE® TRENCH

IN-PLACE COST IS LESS than site cast concrete, conventional precast concrete, plastic mortars, or fiberglass plastics.



BENEFITS:

- **HANDLING IS EASY.** One or two men can install without using hoisting equipment.
- **NON-SKID WALKWAY.** Fibercrete® covers provide for a skid-proof walkway.
- **INSTALLATION IS SIMPLE.** The Concast system has fewer parts to handle. No special brackets or lintels are required at corners or tees. One universal channel will form a tee, ell, or cross. Interlocking male-female ends eliminate the need for special tools, nuts, or bolts.
- **LESS ASSEMBLY PARTS.** Less time is spent searching the yard for "Specials." No special lintels, sidewall lengths, or adaptor blocks at tees, crosses, ells, or reducers are required.
- **LESS EXCAVATION REQUIRED.** Fibercrete® trench is a compact system. Its outside dimensions are much less than that of other trench systems. As a result, less room is required around control houses, tower footings, and equipment foundations.
- **SUBSTATION EXPANSION.** Manual installation negates the use of cranes in stations where overhead towers and power lines exist. Fibercrete® trench is ideal for substation expansion since it can adapt to existing trench systems. A universal channel can be strategically placed in trench runs with two end plates for side wall closures, providing for future expansion. This results in significant labor savings when substation expansion requires additional trench.
- **IMMEDIATE USE.** Precast sections of road crossing allow for fast installation and traffic use immediately after installing.



FEATURES:

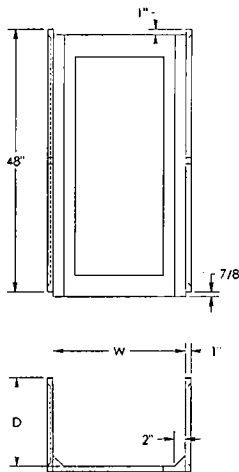
- **OPEN BOTTOM DESIGN.** The Fibercrete® trench system is designed with an open bottom to allow for conduit exits, and drainage. A solid bottom is also available.
- **ABOVE OR BELOW GRADE.** Fibercrete® trench can be installed above ground. No special brackets or bolts are required.



PEDESTRIAN RATED TRENCH

Fibercrete®

STANDARD PEDESTRIAN CHANNELS



PART#	W	D	WEIGHT
8010	10"	12"	80 LBS.
8020	20"	12"	90 LBS.
8024	24"	12"	95 LBS.
8030	30"	12"	100 LBS.
8040	40"	12"	125 LBS.
8050	50"	12"	140 LBS.
801016	10"	16"	90 LBS.
802016	20"	16"	100 LBS.
802416	24"	16"	105 LBS.
803016	30"	16"	110 LBS.
804016	40"	16"	135 LBS.
805016	50"	16"	150 LBS.

Pedestrian channels are rated for 200 lbs./ft²

Our standard and flush channels can be customized per job specifications. Some common options include.

Solid Bottom: These channels are ideal for special applications. For part#, add a "SB". Ex: 8024SB.

Unistrut: Channels can have Unistrut imbedded into the side wall for attaching different hardware. For part#, add a "U". Ex: 8024U

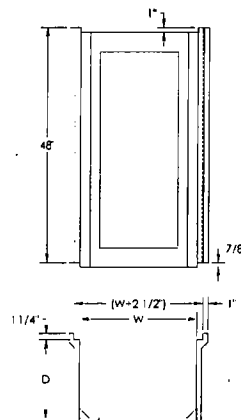
8 FOOT LENGTHS

Channels can be ordered in 4' or 8' lengths. 4' sections are shown, so to specify 8' pieces replace the prefix "80" in the Part# with an "88". Ex: 882416.

SPECIAL LENGTHS

Any length between 6" and 96" can be made add the length in inches to the end of the part#. Ex: 802416 36". (Note: Covers made to fit)

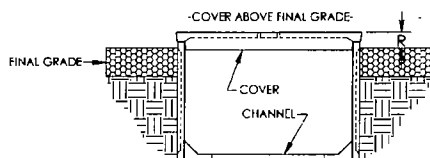
FLUSH SERIES PEDESTRIAN CHANNELS



PART#	W	D	WEIGHT
8010F	10"	10.75"	87 LBS.
8020F	20"	10.75"	97 LBS.
8024F	24"	10.75"	102 LBS.
8030F	30"	10.75"	107 LBS.
8040F	40"	10.75"	132 LBS.
8050F	50"	10.75"	147 LBS.
801016F	10"	14.75"	97 LBS.
802016F	20"	14.75"	107 LBS.
802416F	24"	14.75"	112 LBS.
803016F	30"	14.75"	117 LBS.
804016F	40"	14.75"	142 LBS.
805016F	50"	14.75"	157 LBS.

Pedestrian channels are rated for 200 lbs./ft²

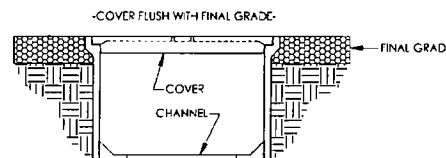
SIDE BY SIDE COMPARISON



STANDARD CHANNEL

THE STANDARD CHANNEL WILL WORK FOR APPLICATIONS NOT REQUIRING COVERS FLUSH WITH GRADE.

VS.

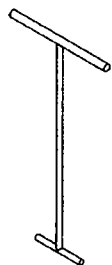


FLUSH CHANNEL

FOR USE WHERE SURROUNDING ROCK, ASPHALT, OR CONCRETE NEED TO BE FLUSH WITH COVERS. CAN BE PURCHASED WITH SOLID BOTTOM AND GRATED COVERS FOR DRAINAGE TRENCH

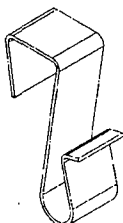
R=2 1/4" (CONCASTS MINIMUM RECOMMENDATION-WITH COVER)

CONCAST



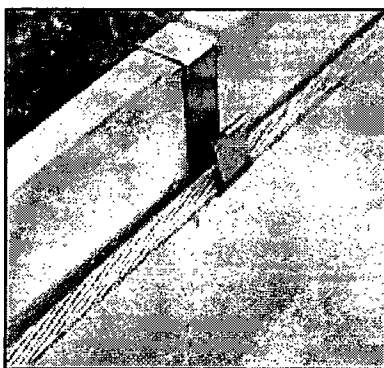
LIFTING DEVICE

Part #8000 Lifting tools are provided with all orders for pedestrian type or steel galvanized covers. Lifting slots are cast into all covers to accommodate a lifting tool.



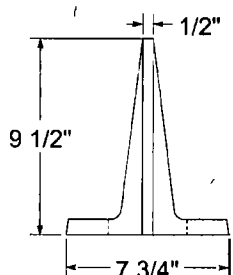
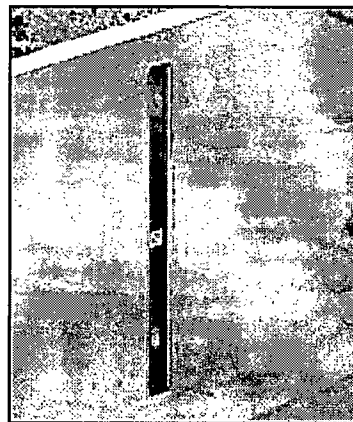
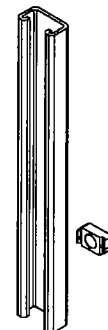
CABLE CLIP

Part #8002 All trench is designed ready for cable clips. Pedestrian channels are notched and Heavy Traffic channels have cast-in inserts. These clips are used to hold grounding wires on trench walls.



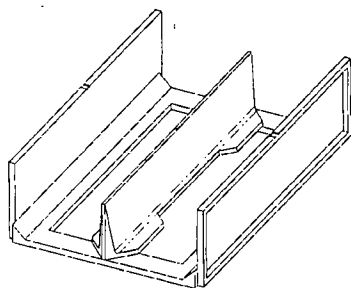
UNISTRUT

Unistrut is an effective way for attaching supports to the trench walls. Unistrut can be cast into all trench on the side walls, bottom, or both. Typical Part # would be 8040U But Part #'s can vary.



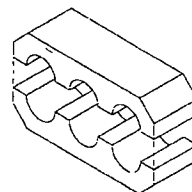
PARTITION BOARDS

Part #8001 We can supply partition boards which provide for physical separation of cables in all trench widths. With a wide base, these dividers will not tip over. Standard length is 47 7/8", but shorter lengths can be produced depending on job need.

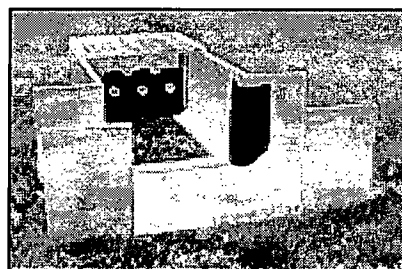


CABLE SUPPORT BLOCKS

Part #'s vary. Support blocks can be made to your special needs. We understand that every job possesses different challenges, and we will work with you to produce a support block to your specifications. Any number of sizes and hole locations can be done.



HDPE PRODUCTS

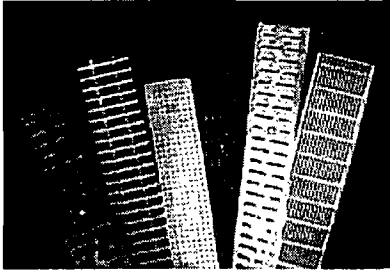


Also shown:
Part #8006 Corner Cable Protector

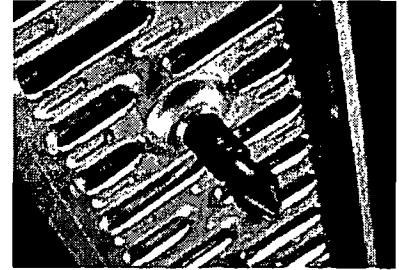
CONCRETE PIPE SUPPORTS



KlassikDrain Features



Wide choice of grates in various materials and styles (including ADA compliant) for applications from Load Class A to Load Class E.

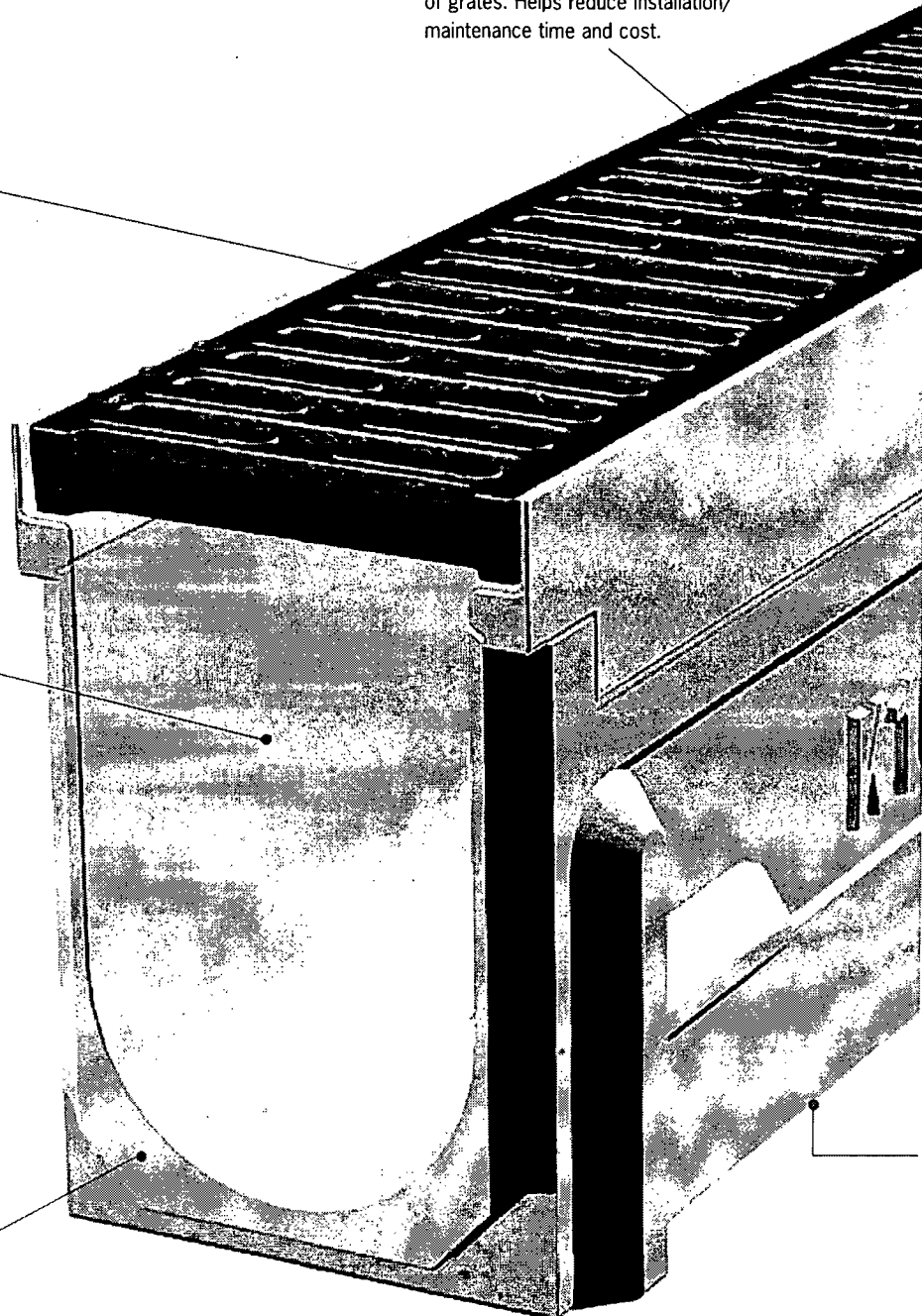


QuickLok - patented, boltless locking system provides quick fitting and removal of grates. Helps reduce installation/maintenance time and cost.

4" internal width trench system - meter (39.37") and half meter (19.69") channel. 'U' shaped bottom improves flow hydraulics.



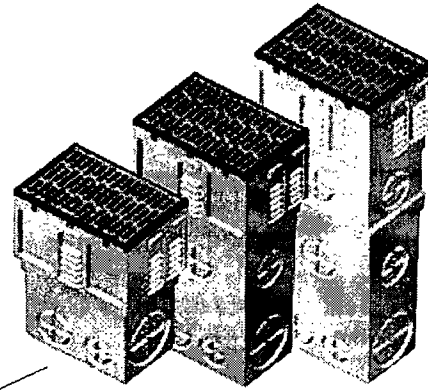
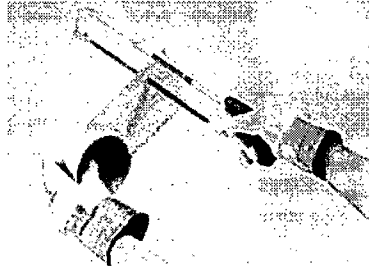
Interconnecting end profiles allow easy and effective joining of channels. Appropriate sealant can be used to create a sealed joint.



Closing/4" inlet/outlet cap

Fits all channels. Manufactured from gray ABS to complement edge rail. Guides aid cutting to correct height. 4" bell end connection to Schedule 40 pipe. Seal using PVC-ABS cement.

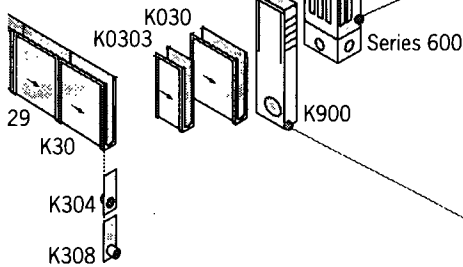
Note: For depth 1-10 channels ACO recommends removal of unused sections of bell end to ensure adequate pavement material coverage.



Series 600 catch basins

Catch basins with 4", 6" and 8" drill-outs for pipe connection. Supplied complete with grate. Available with plastic trash bucket or filter bag. Riser unit fits between top and bottom unit. Options include a choice of deep or short bases.

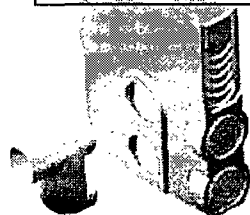
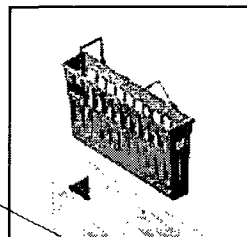
Any channel can be connected into the catch basin by removing the end wall to the correct height. Drill-outs guide connection to channels 5, 10, 15, 20, 25 and 30. See page 52 for details.



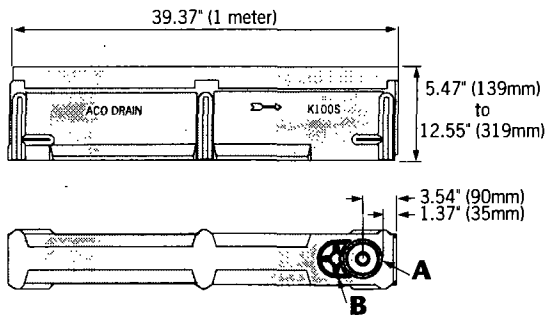
K900 catch basin

In-line catch basin with 4" and 6" drill-outs for pipe connection. Available with plastic trash bucket. Options include in-line or side foul air trap.

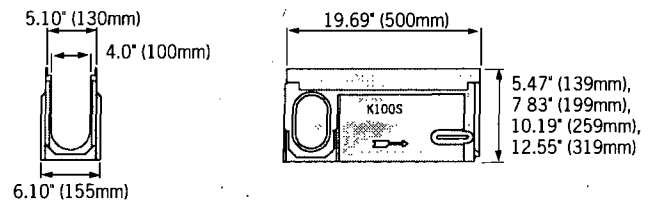
Any channel can be connected into the catch basin by removing the end wall to the correct height. Drill-outs guide connection to channels 5, 10, 15, 20, 25 and 30.



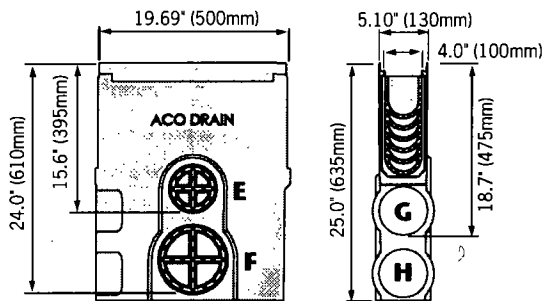
One meter channel



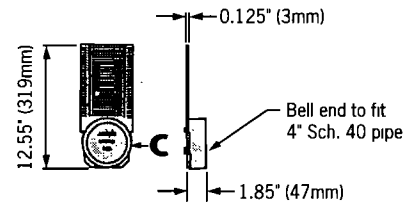
Half meter channel



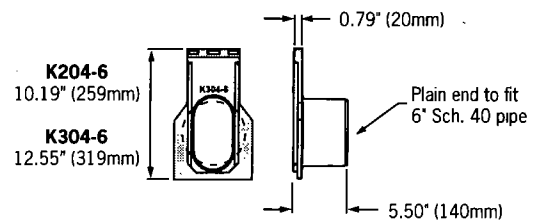
In-line catch basin



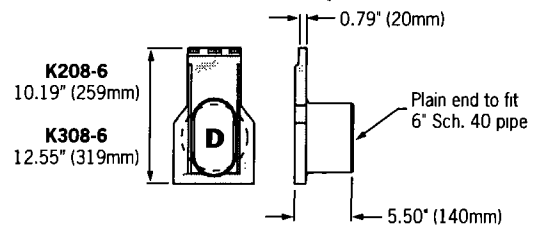
Closing/inlet/outlet cap



6 inch Oval inlet cap



6 inch Oval outlet cap



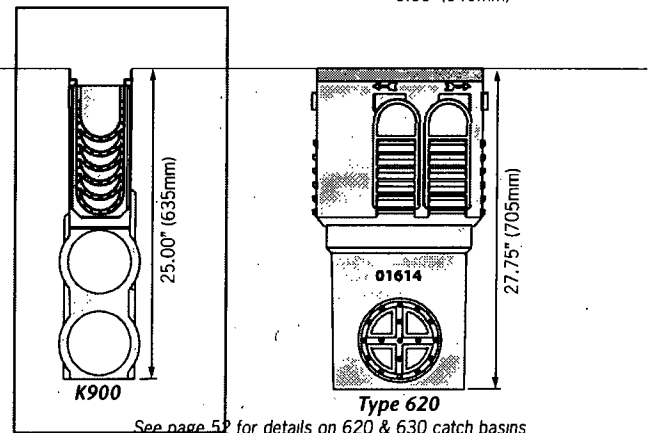
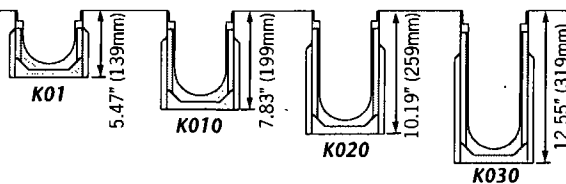
Outlet flow rates

Outlet	Product	Outlet Size (Sch 40)	Invert Depth	GPM	CFS
A	K01 channel	4" round	4.60	117	0.26
A	K030 channel	4" round	11.69	185	0.41
B	K01 channel	6" oval	4.60	183	0.40
B	K030 channel	6" oval	11.69	288	0.64
C	K010 channel	4" round	6.96	119	0.27
C	K030 channel	4" round	11.69	168	0.39
D	K020 channel	6" oval	9.33	220	0.50
D	K030 channel	6" oval	11.69	255	0.59
E	K900*	4" round	15.60	200	0.45
F	K900*	6" round	24.00	561	1.25
G	K900*	4" round	18.70	222	0.49
H	K900*	4" round	24.00	255	0.59

Note: These are the pipe flow rates at the specified outlet, NOT channel flow rates.

* K900 flow rates without trash bucket - using trash bucket reduces flow.

Ground line



See page 52 for details on 620 & 630 catch basins

KlassikDrain Grates

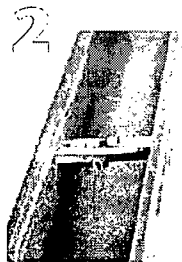
QuickLok - boltless locking system

Comprised of a glass nylon stud, factory fitted to the grating, which allows a snap fit into a stainless steel spring clip in the locking bar. With no loose bolts or bars, QuickLok provides highly secure boltless locking, that is easy to remove/replace for maintenance and cleaning. Saves time and money during installation.

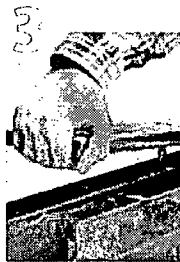


FIT LOCKING BAR

Locate locking bar in channel wall recesses by rotating clockwise.



Use hammer to tap bar into place, so that serrated ends grip in recess.

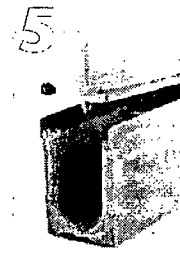


FIT GRATE

To install grate, align QuickLok stud directly over locking bar.



Push down or stand on grate until it clicks into position.



REMOVAL

To remove first grate, insert grate removal tool into slots at end of grate, pull up sharply. Rest of grates can be removed by hand.



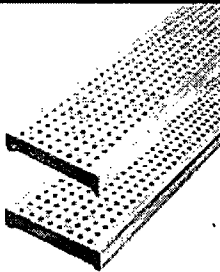
To remove bar, insert screwdriver into hole at end of bar and lever back serrated end, rotate bar free.



PERFORATED STEEL

DIN 19580 Class A - 3,500lbs - 70psi

Pedestrian



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (ins)	Intake area sq. ins	Locking Type
Type 410Q - galvanized steel	98866	39.37" (1.0m)	6.3	0.25 dia.	28.3	QuickLok
Type 412Q - galvanized steel	98879	19.69" (0.5m)	3.2	0.25 dia.	14.1	QuickLok
Type 451Q - stainless steel*	98883	39.37" (1.0m)	6.3	0.25 dia.	28.3	QuickLok
Type 453Q - stainless steel*	98892	19.69" (0.5m)	3.2	0.25 dia.	14.1	QuickLok

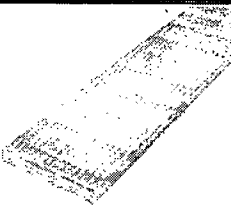
* Grade 304 stainless steel



ADA STAINLESS

DIN 19580 Class A - 3,500lbs - 70psi

Pedestrian



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (ins)	Intake area sq. ins	Locking Type
Type 445Q - stainless steel*	96764	39.37" (1.0m)	8.0	0.16 x 0.82	58.4	QuickLok
Type 446Q - stainless steel*	96882	19.69" (0.5m)	4.0	0.16 x 0.82	29.1	QuickLok

* Grade 304 stainless steel

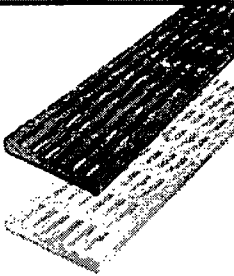
ACO DRAIN



ADA PLASTIC

DIN 19580 Class A - 3,500lbs - 70psi

Pedestrian



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 494Q - black plastic*	97393	19.69" (0.5m)	1.8	0.33 x 1.74	27.4	QuickLok
Type 495Q - gray plastic*	97385	19.69" (0.5m)	1.8	0.33 x 1.74	27.4	QuickLok

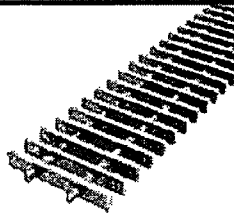
* Polypropylene



BAR FRP

DIN 19580 Class A - 3,500lbs - 70psi

Pedestrian



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 440 - fiberglass*	96935	39.37" (1.0m)	3.0	0.72 x 1.4 avg.	116.8	Bolt/bar**
Type 441 - fiberglass*	96937	19.69" (0.5m)	1.6	0.72 x 1.4 avg.	56.9	Bolt/bar**

* Vinyl ester resin fiberglass

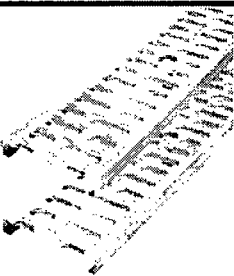
**Type 440/441 grates supplied with locking bolt and bar



SLOTTED STEEL

DIN 19580 Class A - 3,500lbs - 70psi

Pedestrian



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 420Q - galvanized steel	31530	39.37" (1.0m)	5.9	1.46 x 0.38	35.2	QuickLok
Type 421Q - galvanized steel	31531	19.69" (0.5m)	3.0	1.46 x 0.38	17.6	QuickLok
Type 450Q - stainless steel*	31630	39.37" (1.0m)	5.9	1.46 x 0.38	35.2	QuickLok
Type 452Q - stainless steel*	31631	19.69" (0.5m)	3.0	1.46 x 0.38 avg.	17.6	QuickLok

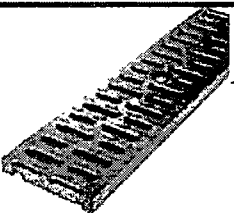
* Grade 304 stainless steel



SLOTTED COMPOSITE

DIN 19580 Class C - 56,000lbs - 1,162psi

Commercial vehicle



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 492Q - resin composite	04780	19.69" (0.5m)	3.5	1.48 x 0.31 avg.	14.5	QuickLok



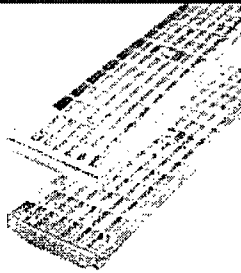
KlassikDrain Grates



MESH STEEL

DIN 19580 Class C - 56,000lbs - 1,162psi

Commercial vehicle



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 405Q - galvanized steel	98707	39.37" (1.0m)	7.8	0.50 x 1.20	121.1	QuickLok
Type 406Q - galvanized steel	98714	19.69" (0.5m)	3.9	0.50 x 1.20	58.0	QuickLok
Type 430Q - stainless steel*	98683	39.37" (1.0m)	8.0	0.57 x 1.20	134.7	QuickLok
Type 431Q - stainless steel*	98695	19.69" (0.5m)	4.0	0.57 x 1.20	63.2	QuickLok

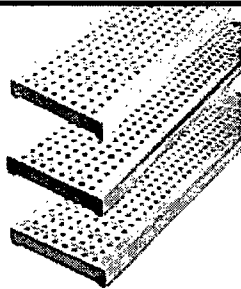
* Grade 304 stainless steel - Stainless version not ADA



PERFORATED STEEL

DIN 19580 Class C - 56,000lbs - 1,162psi

Commercial vehicle



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 411Q - galvanized steel	98905	39.37" (1.0m)	11.3	0.25 dia.	28.3	QuickLok
Type 413Q - galvanized steel	98918	19.69" (0.5m)	5.7	0.25 dia.	14.1	QuickLok
Type 465Q - stainless steel*	98927	39.37" (1.0m)	11.3	0.25 dia.	28.3	QuickLok
Type 466Q - stainless steel*	98934	19.69" (0.5m)	5.7	0.25 dia.	14.1	QuickLok
Type 485Q - brass	98946	39.37" (1.0m)	11.3	0.25 dia.	28.3	QuickLok
Type 486Q - brass	98951	19.69" (0.5m)	5.7	0.25 dia.	14.1	QuickLok

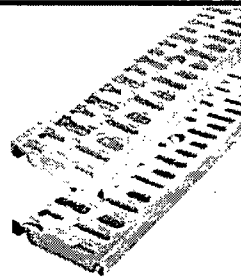
* Grade 304 stainless steel



SLOTTED STEEL

DIN 19580 Class C - 56,000lbs - 1,162psi

Commercial vehicle



Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 425Q - galvanized steel	31540	39.37" (1.0m)	8.8	1.46 x 0.38	35.2	QuickLok
Type 426Q - galvanized steel	31541	19.69" (0.5m)	4.4	1.46 x 0.38	17.6	QuickLok
Type 455Q - stainless steel*	31640	39.37" (1.0m)	8.8	1.46 x 0.38	35.2	QuickLok
Type 457Q - stainless steel*	31641	19.69" (0.5m)	4.4	1.46 x 0.38	17.6	QuickLok

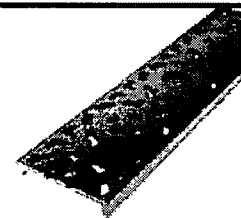
* Grade 304 stainless steel



MOSAIC IRON

DIN 19580 Class C - 56,000lbs - 1,162psi


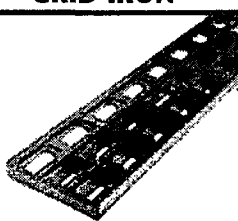
Commercial vehicle




Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
Type 479Q - ductile iron*	97116	19.69" (0.5m)	10.0	0.43 max.	13.0	QuickLok

* Ductile iron to ASTM A 536-84 - grade 65-45-12

ACO DRAIN

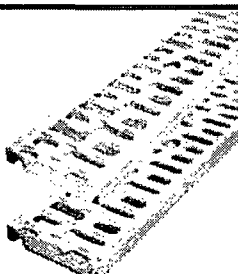
	GRID IRON		DIN 19580 Class D - 90,000lbs - 1,859psi				Light industrial	
	Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type	
	Type 477Q - ductile iron*	98854	19.69" (0.5m)	10.0	1.0 x 1.73	39.7	QuickLok	
	* Ductile iron to ASTM A 536-84 - grade 65-45-12							




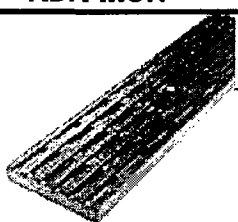



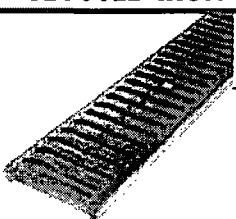
SLOTTED STEEL

DIN 19580 Class E - 135,000lbs - 2,788psi

Medium industrial

Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type	
	Type 435Q - galvanized steel	31550	39.37" (1.0m)	13.7	1.46 x 0.38	35.2	QuickLok
	Type 436Q - galvanized steel	31551	19.69" (0.5m)	6.8	1.46 x 0.38	17.6	QuickLok
	Type 490Q - stainless steel*	31650	39.37" (1.0m)	13.7	1.46 x 0.38	35.2	QuickLok
	Type 493Q - stainless steel*	31651	19.69" (0.5m)	6.8	1.46 x 0.38	17.6	QuickLok
* Grade 304 stainless steel							

  	ADA IRON		DIN 19580 Class E - 135,000lbs - 2,788psi				Medium industrial	
		Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
		Type 478Q - ductile iron*	03314	19.69" (0.5m)	12.8	0.27 x 1.77	22.5	QuickLok
* Ductile iron to ASTM A 536-84 - grade 65-45-12								

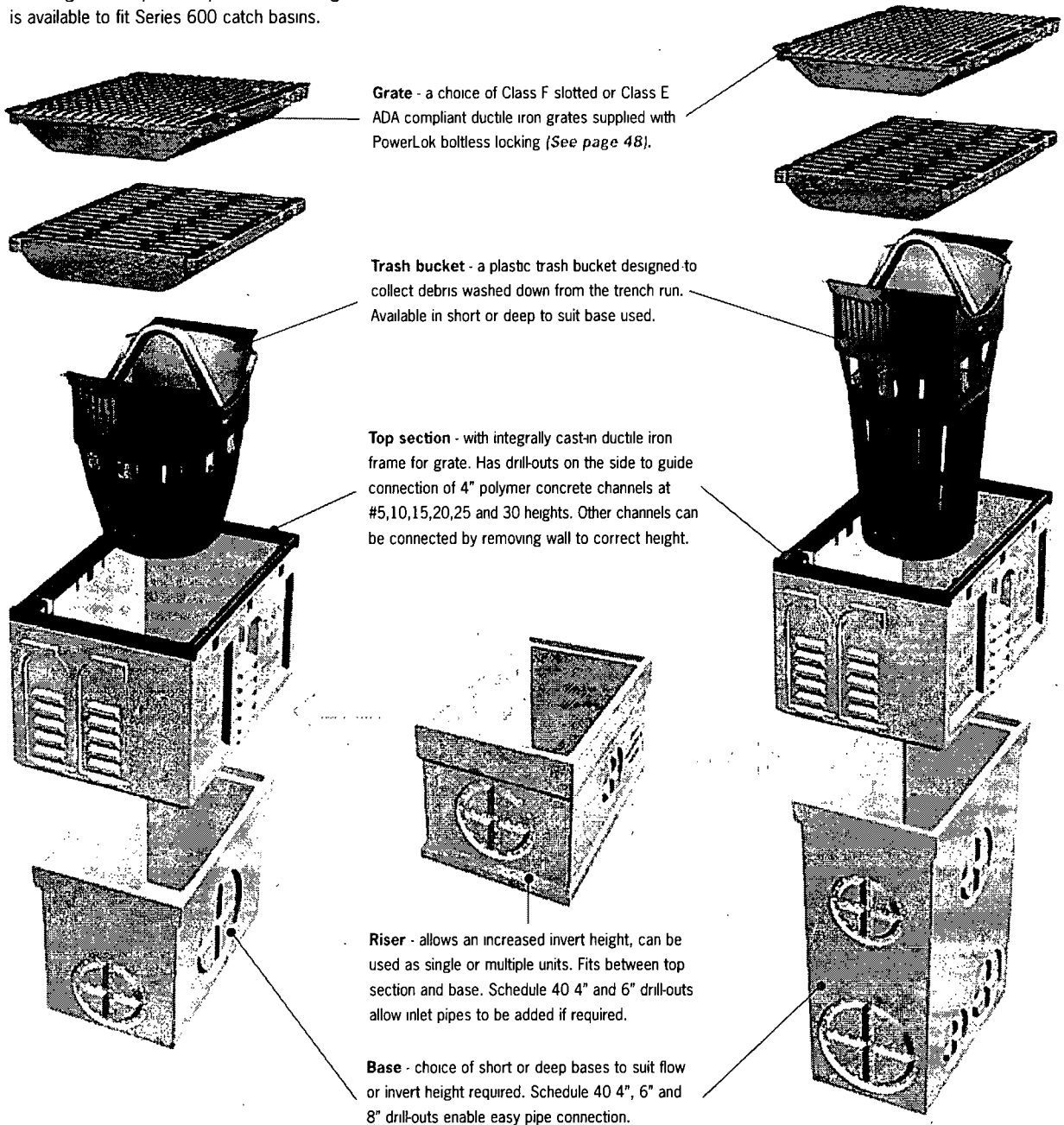
	SLOTTED IRON		DIN 19580 Class E - 135,000lbs - 2,788psi			Medium industrial	
	Description	Part No.	Length Ins (meters)	Weight lbs	Slot size (Ins)	Intake area sq. Ins	Locking Type
	Type 461Q - ductile iron*	96752	19.69" (0.5m)	10.2	3.93 x 0.40	34.1	QuickLok
	* Ductile iron to ASTM A 536-84 - grade 65-45-12						

Series 600 Catch Basins

Polymer concrete catch basins

Series 600 multi-part polymer concrete catch basins are used with KlassikDrain, PowerDrain (S100K) and ChemDrain. The Type 610 top is used with either a short or deep base.

Risers can be inserted between top and base if greater depth is required. A filter bag is available to fit Series 600 catch basins.

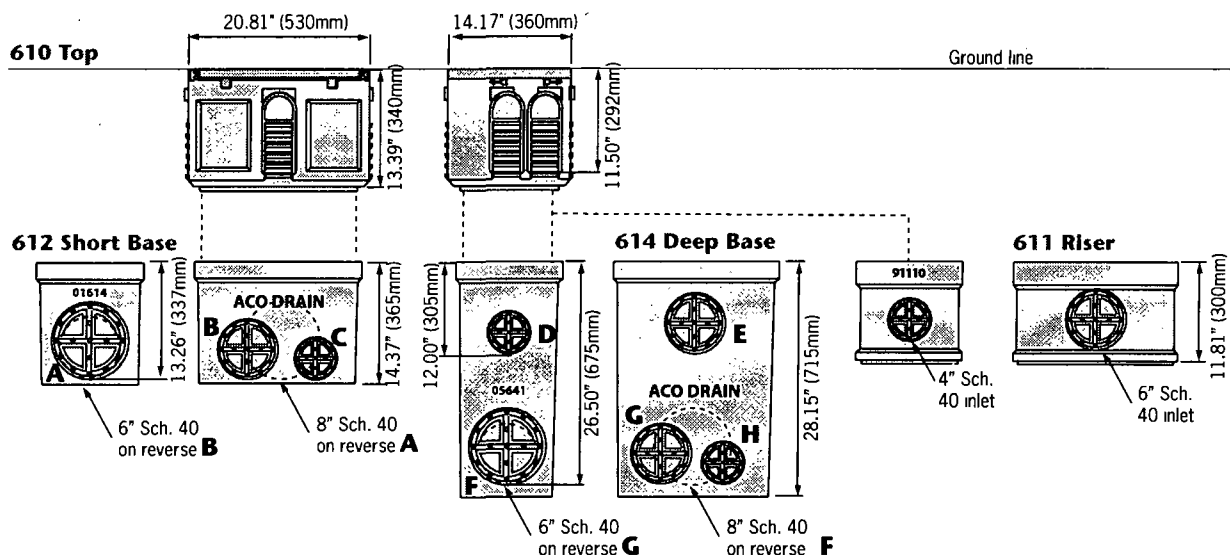


600 series catch basins

Description	Part No		Overall Depth		Weight lbs
	Polyester	Vinyl ester	Inches	mm	
Catch basin assemblies					
Type 620 Catch basin assembly (short) - top, grate, short base & trash bucket	94625	94641	27.75	705	218.6
Type 620ADA Catch basin assembly (short) - top, grate, short base & trash bucket	94626	94643	27.75	705	224.7
Type 630 Catch basin assembly (deep) - top, grate, deep base & trash bucket	94637	94658	41.55	1055	267.2
Type 630ADA Catch basin assembly (deep) - top, grate, deep base & trash bucket	94638	94660	41.55	1055	273.3
Catch basin components					
Type 610 Top section with slotted grate	94666	94674	13.39	340	152.8
Type 610 Top section with ADA grate	94663	94676	13.39	340	158.9
Type 611 Catch basin riser section	91110	91113	11.81	300	48.8
Type 612 Catch basin base - short	01614	06738	14.37	365	63.0
Type 614 Catch basin base - deep	05641	05969	28.15	715	109.6
Series 600 Plastic trash bucket - short	98653	98653	14.46	367	2.8
Series 600 Plastic trash bucket - deep	98665	98665	23.34	593	4.8
Series 600 Filter bag (fits both short and deep bases)	98487	98487	8.00	203	8.0
QuickLok/PowerLok grate removal tool	01318	01318	-	-	0.3

Notes:

1. Filter bag replaces use of trash buckets
2. If foul air trap required please contact ACO
3. Cannot be used with S300K - See page 50 for S300K In-line catch basin



Outlet flow rates

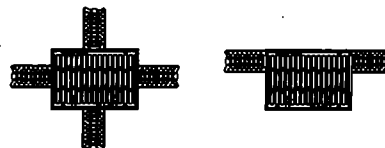
Outlet	Product	Outlet Size (Sch 40)	Invert Depth	GPM	CFS
A	620 basin*	8" round	26.65	1036	2.31
B	620 basin*	6" round	26.65	560	1.25
C	620 basin*	4" round	26.65	270	0.60
D	630 basin*	4" round	25.40	263	0.59
E	630 basin*	6" round	25.40	560	1.25
F	630 basin*	8" round	39.89	1304	2.91
G	630 basin*	6" round	39.89	720	1.61
H	630 basin*	4" round	39.89	310	0.69

Note: These are the pipe flow rates at the specified outlet, **NOT** channel flow rates.

* SK3-900 flow rates without trash bucket - using trash bucket or filter bag reduces flow
Using Type 611 riser will affect flow rates,

Catch basin - channel connection

Channels can be connected to catch basin on all four sides in a variety of different configurations.

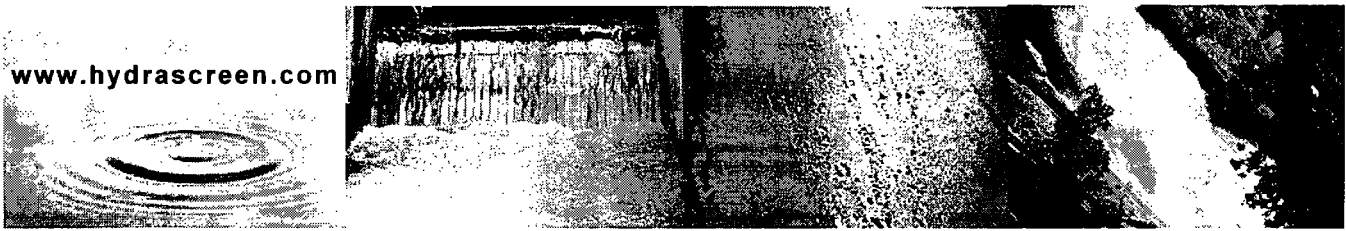




WEDGE-WIRE SCREENING SYSTEMS

Intake Diversions by ENGINEERING FLUID SOLUTIONS, LLC
SAVING TIME, MONEY & RESOURCES

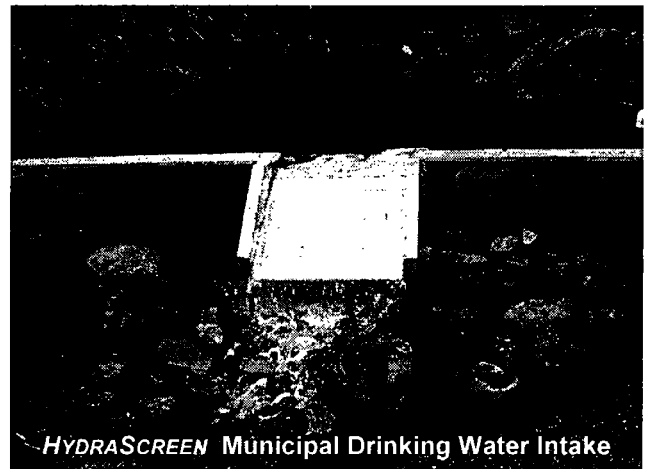
www.hydrascreen.com



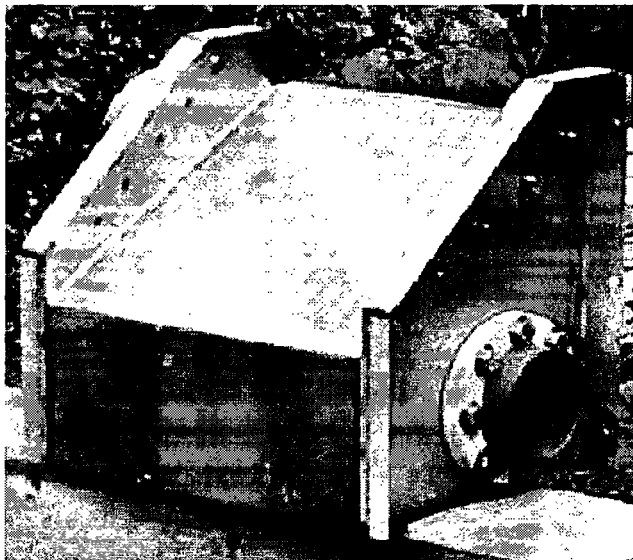
HYDRASCREEN® is a versatile open-channel screening system used in industrial, municipal and commercial applications. The system uses static hillside shearing screens that efficiently separate solids from liquids--these units are constructed in stainless steel or polypropylene. **HYDRASCREEN** is completely self-cleaning, dramatically reducing maintenance costs. There are no electrical controls, only rugged static screens that easily conform to your hydraulic configuration.

HYDRASCREEN has the highest capacity to footprint ratio of any open-channel screening device--it virtually eliminates maintenance associated with intake diversions. **HYDRASCREEN** diversions easily adapt to your process.

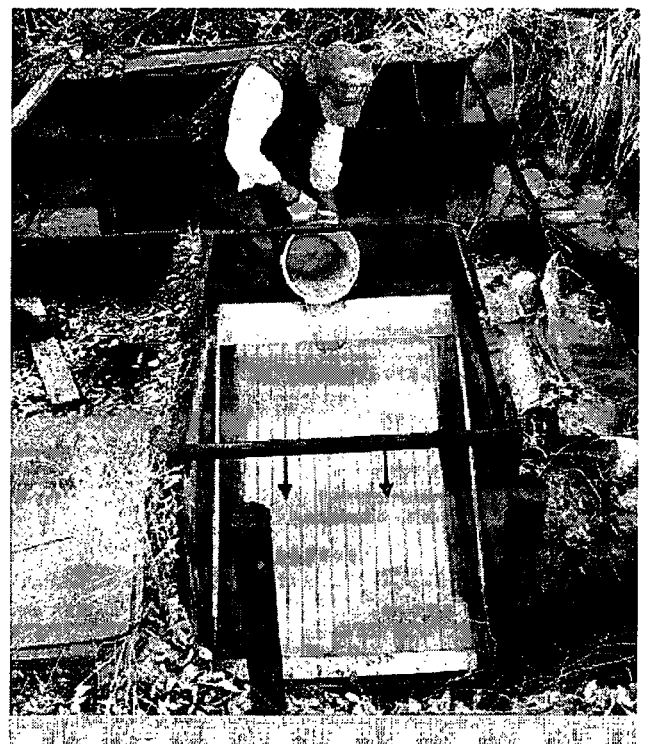
In many applications, **HYDRASCREEN** has replaced conventional drum screens and flat screens.



HYDRASCREEN Municipal Drinking Water Intake



Industry uses **HYDRASCREEN** in process liquid reuse and/or solids reclamation. **Municipal** applications, both drinking water and wastewater, use this versatile technology at headworks for prefiltration and coarse screening to offload downstream processes. **Commercial** applications use the system on raw water supplying irrigation systems for golf courses and agriculture to prevent spray nozzle obstruction.

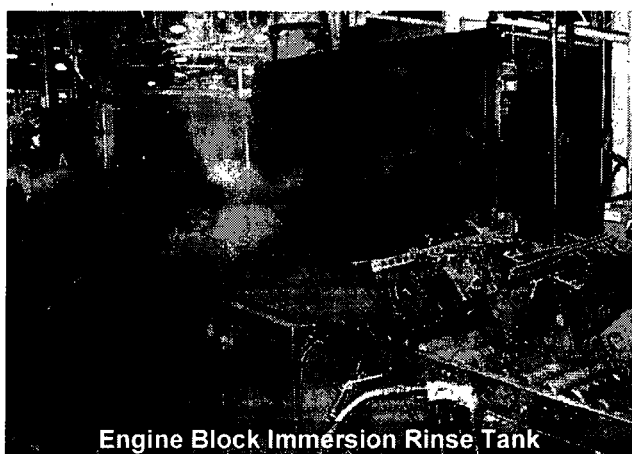
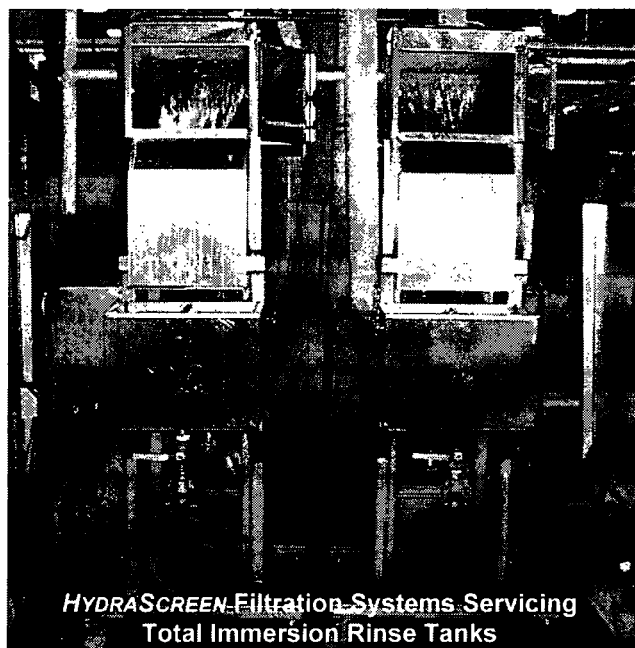


Industrial Installation

Manufacturing: Water and expensive chemical additives are being consumed in industry at an alarming rate--this consumption rate is a universal problem reflecting major costs to manufacturers worldwide. Many conventional industrial filtration and separation systems are characterized by excessive maintenance and high incremental cost.

Historically, to maintain high product quality, a leading engine remanufacturer had to dump and refresh reservoir tanks from washer conveyors and immersion rinse tanks every two days. After installation of the **HYDRASCREEN** system, the plant extended the life of water and chemical additives beyond four weeks, realizing major cost savings. The end result is higher product throughput and greatly improved product quality, all at a much lower cost.

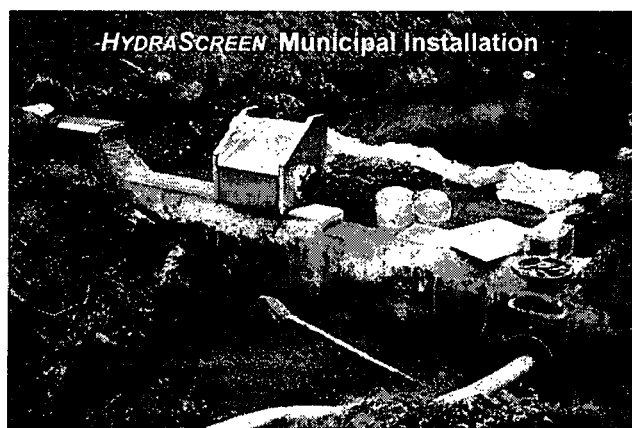
With **HYDRA SCREEN**® systems, manufacturers are now able to reuse water and reclaim solids.



Municipal Installation

Drinking Water Treatment Plant: Naselle Water Company, a small drinking water system in Naselle, Washington, was challenged with their surface water intake on a seasonal mountain creek. The original intake was a bed filter composed of layer upon layer of granular media. During heavy rainfall, pores of the media were quickly plugged off, interrupting supply to the treatment plant. Many nights, the operator was called in to work to restore flow to the plant—an undesirable task at any time, especially on a cold rainy night.

Naselle Water Company contracted **EFS**, seeking design-build services for an alternative intake diversion to significantly reduce maintenance at the intake. After obtaining permit from State of Washington Department of Health and Fish and Wildlife, approval was granted to install a replacement intake. Hydrologic and hydraulic analyses were conducted by **EFS** and a design was engineered--the **HYDRASCREEN** system was quickly installed, turning a high maintenance intake into a very low maintenance intake.



HYDRASCREEN kicked off the New Year right for the townspeople of Naselle, Washington, who now enjoy uninterrupted supplies of drinking water.

Commercial Installation

Golf Course Irrigation: Many golf course irrigation systems rely on raw water supply from seasonal ditches and streams that have high solid load (both organic and inorganic). These solids overload conventional filtration systems and eventually obstruct irrigation spray nozzles. **HYDRASCREEN** efficiently separates solids from liquids, relieving groundskeepers from constantly clearing obstructions at the water intake.

Before installing a **HYDRASCREEN** open-channel diversion, Salida Golf Club groundskeepers cleaned a rudimentary intake drum screen on a daily basis. Under the old arrangement, irrigation heads were disassembled and cleaned every day to clear obstructions from the irrigation spray nozzles.



**Existing High-maintenance
Rudimentary Drum Screen Intake**

After installation of the **HYDRASCREEN** system, Salida Golf Club has not had to perform any maintenance at the intake, and further, groundskeepers have not had to clean out any irrigation spray nozzles.



**New ZERO-maintenance
HYDRASCREEN Intake Diversion**

With the new **HYDRASCREEN** installation, the golf course's existing irrigation pump is no longer starved for water like it was before installation. Moreover, due to the increased flow provided by the intake, the golf course was able to install a higher capacity pump to replace the existing pump. This resulted in greater irrigation coverage, and consequently shorter irrigation cycles.

"My new HYDRASCREEN is the best piece of equipment I've ever bought." --Jim Luchetta,
Salida Golf Course Superintendent

HYDRASCREEN® easily retrofits to existing systems or may be furnished as original equipment. **EFS** is your single source provider of **HYDRASCREEN** systems, handling your entire project from start to finish.

Specifications

- **Footprint:** high capacity to footprint ratio
- **Principle of Operation:** gravity
- **Assembly:** static screen elements, infrastructure & interconnection piping
- **Installation:** typically in one day--no specialty tools required
- **Hydraulic Capacity:** unlimited capacity
- **Particulate Removal:** down to 50-micron
- **Materials:** 304L or 316L stainless steel (alternative materials available--polypropylene)

Features

Operation

- No consumable media
- Greatly reduces total suspended solids (TSS)
- Improves quality and maintains consistent quality

Maintenance

- Easily and quickly installed
- Virtually no maintenance required
- Open design allows easy access
- Easily retrofits or outfits as original equipment
- Design easily adapted and reconfigured
- Easily disassembled and reassembled
- No moving parts

Financial

- High-capacity to footprint ratio
- Short payback period--high ROI
- Increases throughput
- Greatly reduces operation & maintenance costs
- Greatly reduces wastewater treatment costs
- Very low asset depreciation rate

Hydraulic

- Handles extremely heavy solid loading rates
- May be used on other liquids besides water
- Easily conforms to existing configurations
- May be connected hydraulically in-line or in sidestream
- Automatic self-cleaning feature requires no auxiliary mechanical, vibratory or spray systems
- Capable of reclaiming liquids and/or solids
- Excellent prefilter for finer filtration equipment
- Stainless steel filter elements in varying pore size easily removed and exchanged for optimizing hydraulic performance
- No strict physical property requirements of solids in specific gravity, size, shape or character; no strict flow requirements

The scope of Project Engineering services provided with **HYDRASCREEN®** systems include:

- Initial evaluation & recommendation
- Hydrologic & hydraulic analyses
- System design
- Permit approval
- Contracting & specifications
- Fabrication
- Shipping & handling
- Project management
- Installation, start-up, monitoring
- Performance verification & validation

Applications (include but not limited to):

Industrial

- General Manufacturing; Steel; Steel Wire Rope; Bearing Manufacturers; Aerospace; Pots, Pans & Caldrons
- Automotive; Remanufacturing; Parts Washers; Machine Tool Coolants
- Scrubbers; Air Pollution Abatement; Raw Water; Cooling Towers
- Mining; Cement, Concrete & Mortar
- Food & Drug; Canning, Bottling & Packaging; Beverage; Poultry, Dairy & Beef; Animal Feeding Operations; Hog Farms & Washdown Waters
- Plastics & Rubber; Inking; Paper; Textiles

Municipal

- Drinking Water Supply
- Wastewater Treatment
- Stormwater

Commercial

- Golf Course Irrigation
- Farming & Agricultural Irrigation
- Aquaculture; Car Washes
- Pollution Control

ENGINEERING FLUID SOLUTIONS, LLC

1851 East 68th Avenue
Denver, Colorado 80229 USA

Phone: 303.463.5357

Fax: 303.987.1547

Email: info@efsfilter.com

Website: www.efsfilter.com

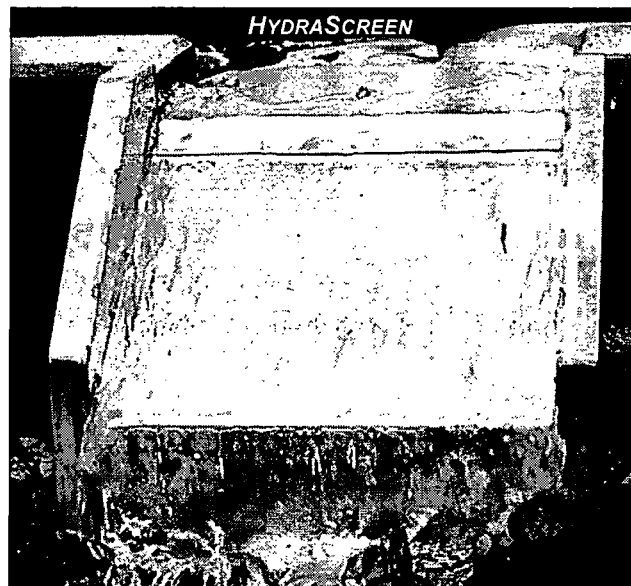
Contact **EFS** and join others who have abandoned their old rudimentary intakes for the revolutionary **HYDRASCREEN** self-cleaning systems. This brochure may be downloaded and printed from the **EFS** website.

Product Warranty:

HYDRASCREEN systems and subsystems are warranted to be free from defects for a period of one (1) year from the date of installation or 18 months after shipment, whichever occurs first.

Performance Guarantee:

All products and services offered by **ENGINEERING FLUID SOLUTIONS, LLC** are guaranteed on quality and performance. Performance guarantees are written to meet owner-driven specifications.



**Cost Saving Equipment & Strategies
in Fluids Management**



ENGINEERING FLUID SOLUTIONS, LLC

Product Registration

The **HYDRASCREEN®** name and logo are registered trademarks owned by **ENGINEERING FLUID SOLUTIONS, LLC**. **HYDRASCREEN** systems and subsystems are the intellectual property of **ENGINEERING FLUID SOLUTIONS, LLC**--**HYDRASCREEN** is a division of **HYDRAKLEEN** registered by **ENGINEERING FLUID SOLUTIONS, LLC** with the U.S. Patent & Trademark Office (US Patent No. 6,986,849).



HYDRASCREEN® is proudly made in the USA

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