HOWELL TOWNSHIP

ENGINEERING STANDARDS

April 2025

Accepted by Township Board: April 14, 2025

Howell Township Hall
3525 Byron Road
Howell, MI 48855

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Site and Infrastructure Subgroup

Process Equipment Subgroup

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GENERAL PLAN SUBMITTAL REQUIREMENTS AND PROCEDURES

PURPOSE

It is the purpose of this Section to specify standards and data requirements, which shall be followed in the preparation of the site plans. It is also the purpose of this Section to ensure that:

1. The proposed use will not be injurious to the surrounding neighborhood and protects the general health, safety, welfare, and character of the Township.
2. Natural resources will be preserved to the maximum extent possible in the site design by developing in a manner which will not detrimentally affect or destroy natural features such as lakes, ponds, streams, wetlands, steep slopes, soils, ground water, and woodlands; and
3. Landscaping, including grass, trees, shrubs, and other vegetation is provided to maintain and improve the aesthetic quality of the site and area.

DEFINITIONS

AASHTO - The American Association of State Highway and Transportation Officials is a standard setting body which publishes specifications, test protocols, and guidelines that are used in highway design and construction throughout the United States.

Frontage - The distance between the two side lot lines of a lot or parcel of land, as measured between the two points at which the two side lot lines each intersect the right-of-way, dedicated easement or minimum building setback line.

HDPE – High Density Polyethylene

Manning's Equation – An empirical formula estimating the average velocity of a liquid flowing in a conduit with open channel flow.

NAD83 – A unified horizontal or geometric datum and successor to NAD27 providing a spatial reference for Canada and the United States.

NGVD88 - The vertical datum for orthometric heights established for vertical control surveying in the United States of America.

PVC - Polyvinyl chloride

RCP – Reinforced Concrete Pipe

Setbacks – The minimum distance which a building or structure must be set back from a property line, road, river, shore, floodplain, or any other place which is deemed to need protection.

Siphons - A tube bent to form two legs of unequal length by which a liquid can be transferred to a lower level over an intermediate elevation by the pressure of the atmosphere in forcing the liquid up the shorter branch of the tube immersed in it while the excess of weight of the liquid in the longer branch when once filled causes a continuous flow

CONSTRUCTION PLAN SUBMITTAL PROCEDURES

1. Following approval of the preliminary and final site plans by the Township, the applicant shall submit to the Zoning Administrator two (2) copies of construction plans and a PDF file of the construction plans, as well as any other data and exhibits hereinafter required, the review fee, and a completed application form. After the initial submittal, subsequent revisions can be sent directly to the Township Engineer.
2. The construction plans shall address the same concerns as the final site plan but shall include much greater detail in accordance with the adopted Howell Township Engineering Standards. Approval of the construction plans is required prior to beginning construction.
3. As part of the review process, the Township Engineer may contact the Township, Fire Department, or other regulatory agencies for comments and feedback. If other agencies (MDOT, EGLE, LCRC, LCDC, etc.) have not completed their reviews, the Township Engineer may request that their comments be supplied to the Township Engineer prior to final approvals. In general, the following agencies shall have review authority over the type of improvement:
    a) Howell Township
        i. Sanitary sewer and appurtenances
        ii. Public and Private water distribution system and appurtenances
        iii. Private storm sewer and appurtenances
        iv. Stormwater management (detention, retention, etc.)
        v. Private roads and paved areas
        vi. Pathways and sidewalks
        vii. Grading and restoration
        viii. Any other improvements not regulated by another agency
    b) Livingston County Road Commission (LCRC)
        i. Public roads, streets, and right-of-ways
    c) Livingston County Drain Commissioner (LCDC)
        i. Public and private storm sewer and appurtenances
        ii. Stormwater management (detention, retention, etc.)
        iii. Soil Erosion Control
    d) Livingston County Department of Public Health
        i. Private septic fields
        ii. Private water wells
    e) Marion Howell Oceola Genoa Water Authority (MHOG)
        i. Public water distribution system and appurtenances
4. When plans are complete and ready for approval the Township Engineer will request additional sets of plans be submitted for distribution to EGLE for sanitary sewer permitting (see item 7 in this Section).

5. The applicant shall be responsible for submitting directly to the LCRC, LCDC, MHOG, and other separate regulatory agencies (MDOT, EGLE for wetland permitting, etc.). Any such approvals shall be forwarded to the Township Zoning Administrator and the Township Engineer prior to beginning construction.
6. All public improvement plans submitted for permits must carry the seal and signature of the Design Engineer licensed in the State of Michigan. Note that the amount and type of sanitary and/or water main pipe must be summarized on the cover sheet when EGLE permitting is required.
7. Sanitary sewer plans along with a completed Basis of Design and EGLE Sanitary Sewer Permit Part 41 Application, shall be provided to the Township Engineer. The Township Engineer will then submit the application and plans to EGLE for permitting via the MiEnviro Portal.
8. **Modification of Plan During Construction** - All improvements shall conform to the final site plan. It shall be the responsibility of the applicant to notify the Zoning Administrator of any such changes prior to such change being made. Any changes which result in a material alteration of the approved final site plan shall require resubmittal of a site plan, which shows the proposed changes, to the Planning Commission including any fees determined by the Township Board of Trustees. The Planning Commission or Township Board of Trustees may require the applicant to correct the changes so as to conform to the approved final site plan.
9. **Phasing of Development** - The applicant may, at their discretion, divide the proposed development into two (2) or more phases. In such case, the preliminary site plan shall cover the entire property involved and shall clearly indicate the location, size, and character of each phase. A site plan for each phase shall be submitted in accordance with the procedure herein for a final site plan including any fees required.
10. **Appeals -** No decision or condition related to a construction plan approval shall be taken to the Zoning Board of Appeals.
11. **Fees -** The Howell Township Board shall establish by resolution a fee schedule to defray costs, which may include but not be limited to plan review, administration, inspection, and enforcement of this section. Before final approval, any costs incurred by the Township shall be paid by the applicant. Please refer to the Howell Township Wastewater Ordinance for more information regarding applicable fees.

INSURANCE

1. Prior to construction, the Contractor shall procure and maintain, during the term of the project, public liability and property damage insurance with a responsible insurance company which meets the approval of Howell Township, in such amounts as will be adequate to protect the public, Howell Township interests, and shall not be less than the limits set forth herein.

TYPE OF INSURANCE:

a. Workmen's Compensation Insurance and Employer's Liability Limit: As required by laws of State of Michigan

Public Liability & Property Damage:

Bodily Injury:	Each Occurrence:	$1,000,000
Aggregate:	$2,000,000	
Property Damage:	Each Occurrence:	$1,000,000
Aggregate:	$2,000,000	

b. Owner’s and Contractor’s Protective Liability & Property Damage:

Bodily Injury:	Each Occurrence:	$1,000,000
Aggregate:	$2,000,000	
Property Damage:	Each Occurrence:	$1,000,000
Aggregate:	$2,000,000	
Motor Vehicle (including Owner, Hired and Non-Owned Vehicles):		
Bodily Injury:	Each Occurrence:	$1,000,000
Property Damage:	Each Occurrence:	$1,000,000
Combined Single Limit:		$2,000,000

2. Policies shall be made available to Howell Township and the Township Engineer for examination as to their validity and any undesirable exclusions deemed improper by legal opinion rendered to the Township regarding same. Underground construction, where applicable, shall be specified in the coverage. Certificates of coverage signed by the insurance carriers shall include a guarantee that 30 days written notice shall be given by the insurance carrier to Howell Township prior to cancellation of, or any change in the respective policies. In the event that the insurance is canceled, operations shall cease prior to the cancellation date and shall not resume until evidence is provided that proper insurance is again in effect. Additional Named Insured under Owners and Contractors Protective Public Liability and Property Damage Insurance shall include Howell Township, the Township Engineer (specifically by name) and members of staff, employees and agents for the Township.
3. The name of the proposed development must be included on the insurance documents.

CONSTRUCTION OBSERVATION PROCEDURES

Howell Township or their designated representative will provide observation on all proposed public utilities and improvements, as well as limited construction observation of private improvements. Any facilities installed without Township provided observation may not be accepted by the Township, and therefore may be required to be re-installed. The requirements and procedures for Construction Observation and final project closure shall be as follows.

1. Pre-Construction Meeting
    a) Upon construction plan approval and receipt of all permits, but prior to commencing construction, a pre-construction meeting shall be held. The Developer or the Developer's Authorized Representative shall contact the Township Engineer to schedule the pre-construction meeting.
    b) Attendees shall include: Township representatives, Township Engineer, Marion Howell Oceola and Genoa (MHOG) Water Authority representative, Developer or Developer's Authorized Representative, Design Engineer, Underground and Paving Contractors, and any interested regulatory agency.
    c) At the pre-construction meeting, the following information shall be provided:
        i. Proof of insurance naming Howell Township and its Engineer as additionally insured.
        ii. All permits from other agencies (MDOT, EGLE, LCRC, MHOG, etc.).
        iii. Approximate schedule for construction.

d) Prior to the pre-construction meeting, the contractor shall provide the inspection escrow to the Township. Proof of payment should be forwarded to the Township Engineer. The final approval letter from the Township Engineer will detail the amounts and basis of the escrow based upon industry standard production rates.
    i. Unused observation and administration escrow funds will be eligible for return as described in the final approval letter.
    ii. The Township Engineer shall monitor the observation escrow and may require additional deposits. This shall be dependent on the contractor's rate of progress and the difficulty in completing the project.
    iii. Failure to keep the observation escrow current may result in withholding construction observation, and therefore possibly delaying construction.

2. Notice of Construction
    a. The Township Engineer shall have a minimum 72-hour notice (not including weekends or holidays) prior to the start of any construction requiring observation.
3. Construction Inspection
    a. The Township's Engineer shall observe all public and private sanitary improvements. Full time inspection will be provided by the Township's Engineer. The Township's Engineer may inspect all other operations requested by the Township.
4. Sanitary Sewer Testing
    a. Sanitary sewer will be required to undergo testing 30 days after the completion of construction. Developer/contractor are responsible for arranging and paying for all tests seen below. Township Engineer must witness all tests.
        i. Pressure Testing
            1. The contractor shall conduct a sanitary air test with the Township Engineer witnessing. Air tests shall comply with current testing standards and requirements. Air testing should not be used if the groundwater level is 2 feet or more above the top-of-pipe at the upstream end (reference ASTM F1417)
        ii. Deflection Testing
            1. The contactor shall conduct a deflection test with the Township Engineer witnessing. The test shall take place a minimum of 30 days after backfill has been installed, but not longer than 12 months after installation. Deflection tests shall comply with current testing standards and requirements.
        iii. TV Testing
            1. Conducted after cleaning and demonstrating the flow of clean water.
        iv. Manhole Vacuum Testing
    b. If the sanitary sewer fails to pass any of the above test, the failed portion must be repaired or replaced at the discretion of the Township Engineer.
5. Acceptance of final project:
    a) After the project is substantially complete, including paving, the Township Engineer will perform a site walkthrough and generate a punch list. Once the items have been addressed, the Township and the Township's Engineer will conduct a final site inspection.
    b) All punch list items must be addressed.
    c) All fees and escrows must be paid in full.
    d) Record drawings and related documents must be provided to the Township:
        i. Upon acceptance of field improvements, the Township Engineer will provide the Developer's Engineer with a copy of Inspector's Daily Reports and any applicable lead reports. The Developer's Engineer will update the drawings

using these materials and any of their own notes and submit these to the Township's Engineer for review and approval.

ii. A grading certificate will be required at this time. This form (provided by the Township's Engineer with IDR's) will also need to be signed and sealed by the Developer's Engineer licensed in the State of Michigan and then submitted to the Township's Engineer along with the record drawings.

iii. Easements for public utilities based on "As-Built" conditions requires a sketch and legal description to be submitted by the Developer's Engineer to the Township's Engineer for review and approval along with the record drawings. Once easements documents are approved, the Township's Engineer will mail the Developer/Township the easements to be recorded with the County Register of Deeds. Once the easements are recorded with liber and page number, recorded copies will need to be forwarded to the Township and the Township's Engineer.

iv. Once the record drawings are approved by the Township's Engineer, the Developer's Engineer will be instructed as to what is required for final distribution (i.e. CAD files, mylars, etc)

e) Performance guarantee will be released after all the above items have been completed.

CONSTRUCTION PLAN REQUIREMENTS

The following is a list of requirements that shall be used to assist in Construction Drawing and Record Drawing preparation. Items or criteria not specifically on this list or contained within the Howell Township Zoning Ordinance shall be subject to Township approval, based solely on the Township's discretion as to appropriate standards, regulations, or local impact.

PLAN REQUIREMENTS

GENERAL

1. Plan paper shall be 24" x 36".
2. Plan scale shall be a maximum horizontal scale of 1"=50' and vertical scale of 1"=5'.
3. Plan cover sheet shall include the following: project name, name of Howell Township, Livingston County, Michigan, proprietor's, engineer's, architect's and landscape architect's name, address, phone and fax number, a location map (1" = 2000' scale) with north arrow, parcel ID number(s), agency approvals required, plan sheet index, and professional architect's or engineer's seal Licensed in the State of Michigan.
4. A title block shall be present on each plan sheet.
5. The legal description for the property shall be included, must also be represented by bearing angles and distances in plan view, and shall have a ratio of closure no greater than 1 part in 5000.
6. Zoning information including zoning designation, land use, minimum lot area, frontage, and setbacks; and maximum lot coverage and building height requirements for the site's zoning designation.
7. A topographic survey plan sheet shall be included; additional requirements are outlined in Section II, Topographical Survey, of this document.
8. A general area plan shall be included at 1" =100' or 1" =200' when size of the site prohibits a single sheet. The general plan shall show existing and proposed roadways, site location, dimensions, utilities, building structures, landscaping, and topography.
9. A landscaping plan with tree survey information shall be included.
10. Location of wetlands, drainage courses, and floodplain areas shall be shown on the plans.
11. On and offsite permanent and temporary easements shall be shown on the plans.
12. Private and public roadways, road right-of-way, and road easements shall be shown on the plans.
13. Dimensions for existing and proposed road right-of-way and/or easements, roadways, parking areas, driveways, sidewalks, and pathways shall be shown on the plans and shall be in accordance with the Howell Township Zoning Ordinance and the requirements outlined herein.

TOPOGRAPHICAL SURVEY

GENERAL

1. A complete topographical survey is required for all sites. Existing offsite elevations must be given at a minimum of 100' abutting the entire perimeter of the site. Onsite contours are required to establish the existing site drainage. Contours shall be at the following spacing:
    a) 1-foot contours if scale of plan is less than or equal to 1" = 50'
    b) 2-foot contours if scale of plan is greater than 1" = 50'
2. A minimum of two (2) benchmarks based on NAD83 or NGVD88 must be included. The datum shall be clearly referenced.
3. Property lines shall be indicated by bearing and distance.

4. All existing conditions shall be shown, including but not limited to the following items (location and elevation):
    a) All utilities including sanitary, water main, gas, telephone, cable, and electrical (including rim and invert elevations).
    b) Property lines.
    c) The building finished floor.
    d) Sidewalks and pathways.
    e) Retaining walls.
    f) Finished grades of all adjacent buildings.
    g) All easements.
    h) 100-year flood plain.
    i) Existing drainage courses and wetlands.
    j) Upstream and downstream culverts.
    k) Adjoining road right-of-way.
5. Road Topography shall extend across the entire site with grades shown on both sides of the street for:
    a) Property line.
    b) Ditch centerline and top of bank.
    c) Edge of shoulder.
    d) Edge of pavement or top of curb.
    e) Crown or centerline.

UTILITIES (GENERAL)

GENERAL

1. The location, size, and type of pipe of all existing and proposed utilities shall be shown in plan view.
2. Proposed sanitary sewer shall extend across the property frontage(s) or to a property line, as directed by the Township.
3. No new utilities shall be placed below or within a 1:1 influence of a building footprint. The limits of all removals and/or abandonments shall be shown on the plans. The following criteria shall apply for all existing utilities within the influence of a building foundation:
    a) Utilities within five (5) or less below a footing shall be removed.
    b) Utilities greater than five (5) feet below a footing shall be grouted full using a standpipe to prevent air voids.
    c) Utilities that are to be abandoned and are not within the influence of a footing shall be bulkhead unless the utility is determined to be a hazard, nuisance or potential maintenance problem by the Township.
4. A minimum ten (10) feet wide horizontal separation shall be required between water main and sewers.
5. No sanitary sewer shall be within five (5) feet (measured horizontally) from the high-water elevation of a detention, retention, and/or forebay basin.
6. All utility crossings, including sanitary sewer leads, shall specify top and bottom of pipe elevations in both plan and profile view. An 18” minimum vertical clearance between water main and sanitary sewer is required.
7. Sewer and storm mains shall maintain at least 18” minimum vertical clearance. If this cannot be achieved the contractor shall install a full length of pipe centered on the crossing to ensure the joints are as far from the crossing as possible.
8. A casing pipe shall be provided when utilities must cross retaining walls or when a bore is proposed under a roadway. The casing pipe must extend beyond the angle of repose of the

retaining wall or roadway. The size, length and invert of the casing pipe shall be indicated. All bores under roadways shall meet the requirements of the Livingston County Road Commission Requirements.

SANITARY SEWER

GENERAL

1. Follow Howell Township Standard Sanitary Details and Howell Township Sewer Ordinance 21 – Wastewater Collection and Treatment System.
2. Follow Recommended Standards for Wastewater Facilities (10 States Standards).
3. The following must be shown in plan view for sanitary and storm sewer:
    a) Length, size, type, and class of pipe between structures.
    b) Top of casting elevation at structures.
    c) Easement width. Minimum width for sanitary sewer is 25', however a wider easement maybe required based on the depth of the sewer.
    d) Progressive numbering system for all structures.
4. The following must be shown in profile view for sanitary and storm sewer:
    a) Length, size, type, class, and slope of pipe between structures.
    b) Size and type of structure.
    c) Top of casting and sewer invert elevations at structures.
    d) Existing and proposed ground elevations.
    e) Utility crossings, including top and bottom of pipe elevations.
    f) Special backfill areas under or within pavement areas.
    g) Progressive numbering system for all structures.
5. A quantity list and design data (on the cover sheet or first sheet of the plans) shall be provided and be in accordance with the current 10 States Standards.
6. Lift stations will not be permitted unless there is no other alternative for sewer service. If a lift station is required, the Design Engineer shall provide the Township with all design details and calculations within flow range, which shall be in accordance with all current Township, County and State requirements.
7. Siphons shall only be allowed when specifically approved by the Township and Township Engineer.
8. A sanitary sewer Basis of Design shall be submitted alongside the construction plans for approval by the Township Engineer. It must include all areas to be served, including any off-site areas. The design calculations shall follow the Equivalent User Table outlined in the Howell Township Wastewater Collection and Treatment System Ordinance to determine the number of Residential Equivalent Units.

SEWER

1. Sanitary sewer size, grade, and structure spacing table:

Size	Min. Grade (%)	Max. Grade (%)	Max Spacing (ft)
8”*	0.40	10	400
10”	0.28	6.2	400
12”	0.22	6.0	400
15”	0.15	3.6	400
18”	0.12	2.8	400
21” & greater	0.10	2.2	400

*minimum allowable sanitary sewer size is 8”

2. Where Manning’s equation is used to compute flow, a minimum value for “n”, roughness coefficient shall be 0.013.
3. A minimum cover of 5’ is required over all sanitary sewers, including leads.
4. A minimum 25' wide easement is required for all public sanitary sewer. Wider easements will be required for deeper sewer to maintain a 1:1 excavated side slope within the easement. The sanitary sewer shall be centered within the public easement. No buildings should be located within the easement.

MANHOLES

General

1. All pipe connections at structures shall be separated by a minimum of one (1) foot between pipe walls and 40% of the structure circumference must remain intact. The design engineer shall provide details for all structures with multiple pipe connections not meeting the requirements below:

Structure Diameter	Max. Pipe Size for Straight Through Installation	Max. Pipe Size for Right Angle Installation
48”	24”	18”
60”	36”	24”
72”	42”	36”
96”	60”	42”

2. The Township Engineer will inspect all sanitary taps into existing Township structures.
3. Manholes shall generally be placed at intervals not to exceed 400 feet; at every change of grade, direction, and pipe size: and at each junction of sewers.
4. When there is a change in direction in a sewer at a manhole, an allowance of 0.10 feet in grade shall be made for a loss of head through the manhole.
5. Whenever there is a change in pipe size, the inverts of both sewers shall be set at a grade so that both sewers maintain the same energy gradient.
6. Interior manhole coating will be required for forcemain discharge into proposed or existing manholes.

Drop Connections

1. External drop connections are required when there is an 18” vertical difference between inverts on the outlet and inlet pipes and shall be constructed according to Standard Details.
2. The Township must approval internal drop connections. The connection shall be based on field conditions an in accordance with standard details.

SERVICE LEADS

General

1. The Township will own sanitary lead within the ROW or easement. The property owner will own the lead outside the ROW or easement and will be responsible for maintenance of this portion of the lead.
2. A cleanout should be provided at the ROW and at every change of direction of the lead.
3. The building lead location, size, type, and slope (minimum 6” diameter and 1% per Ordinance 21, Section 5) shall be provided. In order to verify the slope of the lead, invert elevations shall be provided at the finished grade of the building and at the connection to the mainline sanitary sewer. The 6” lead shall extend all the way to the building.
4. In sanitary sewers where construction of building leads to the property line is not required, a wye branch shall be installed for sewer for 14’ or shallower and a tee installed for sewer that is deeper than 14’ for each lot or potential building site.
5. Leads shall not be connected to manholes unless specifically approved by the Township for connection to the last manhole or connection to deep sewer. An exterior drop connection will be required at connections to manholes.

Grinder Pump Connections

1. Grinder pump connection should connect to manhole where possible.
2. Grinder pumps may be connected to gravity sewer directly with a gravity lead with a cleanout located at the Right-of-Way line.
3. Manholes with grinder pump connection must be lined with interior corrosion protection.

Grease Interceptor

1. Grease interceptor shall be provided for all food service facilities and any facilities with a commercial kitchen, as required by the Planning Commission.
2. Grease interceptor shall be connected to all food service drains which include mop sinks, dishwashers, food prop sinks, and floor drains. Non-food wastewater shall not pass through the grease interceptor and be connected downstream of the grease interceptor.
3. A cleanout shall be provided after the grease interceptor.
4. Grease interceptors shall be located outside the building, outside of the ROW or easement, and underground.
5. The minimum size for grease interceptors is 1,000 gallons.
6. A maintenance schedule shall be provided.

Industrial/Manufacturing Sites

1. Oil water separators should be provided all industrial/manufacturing sites and as required by the Township Engineer.

2. A manhole shall be provided at the ROW instead of cleanout for inspection and sample collection purposes.

PUBLIC PUMP STATIONS

GENERAL

1. Pump stations should be designed in accordance to:
    a. Recommended Standards for Wastewater Facilities (Ten State Standards)
    b. Howell Township Standard Pump Station Drawings and Specifications
    c. Howell Township Sewer Ordinance 21 – Wastewater Collection and Treatment System.
2. Pump stations may be designed by Howell Township Engineer, if requested.
3. Each station's configuration shall be dependent on the proposed flow rate, based on the chart below. Final configuration to be approved by Howell Township.

Peak Flow (GPM)	Pumps	Discharge Piping Size	Valve Vault Configuration
<250	Submersible	2" – 4"	Aboveground controls/ below or above ground Valve Vault
>250	Submersible	4" – 6"	Aboveground Enclosure

4. Wet well shall be appropriately sized for all future flows.
5. Buoyancy calculations and necessary ballast concrete for Wet well and valve vault (where applicable) must be included.
6. Five-year warranty should be supplied from the time of start up.
7. All cabinetry, hatches, and other devices requiring locks shall be locked with a keyed pad lock.
8. Bollards, fences, and concrete pads may be required per discretion of Howell Township, depending on site location, and proximity to road.
9. A bypass connection shall be supplied with connect to match Howell Township pumps.
10. Aboveground shelters facade shall be approved by Howell Township.

CONTROLS

1. Primary Level Control Method: Down Radar Transducer
    a. Measuring Range: Minimum of 60 feet.
    b. Operating Temperature Range: Minus 40 to plus 150 degrees F.
    c. Operating Pressure: Up to 23 psig
    d. Accuracy: Plus or minus 0.4 inch.
2. Backup Level Control Method: Float Switch Array.
    a. High Level Alarm / Pumps Start
    b. Low Level Alarm / Pumps Stop
3. Each pump shall be provided with a Hand-Off-Auto selector switch.
    a. The "Hand" position provides Township personnel to operate each pump manually, regardless of other pump station conditions (sensor failures, alarms, etc.).
    b. The "Off" position prevents starting of pumps due to pump station conditions.
    c. The "Auto" position allows the pumps to operate in Automatic mode, which shall be a lead/lag method.

4. While in “Auto” mode pumps shall operate as follows:
    a. When liquid level in wet well rises to elevation of "lead pump start" setpoint, start lead pump. When lead pump is started, run pump until liquid level in wet well is drawn down to "lead pump stop" setpoint, and then shut down lead pump.
    b. When lead pump cannot keep up with influent flow, liquid level in wet well rises to "lag pump start" setpoint that starts lag pump. When lag pump is started, run pump until liquid level in wet well is pumped down to "lag pump stop" setpoint and shut down lag pump. Lead pump shall continue to run until wet well is drawn down to “lead pump stop” setpoint.
    c. Automatically alternate lead and lag status of pumps after each pumping cycle (lead pump shutdown upon reaching “lead pump stop” setpoint).
5. When liquid level in wet well rises to elevation of the "wet well high level" float switch start lead pump, after an adjustable time delay start the lag pump, energize the "Wet Well High Level" alarm relay and light located on pump control panel, and activate the secondary control method. The secondary controls shall remain active until reset by pressing the “Alarm Reset” button.
6. When liquid level in wet well is pumped down to elevation of "wet well low level" float switch, shut down pumps and energize "Wet Well Low Level" alarm relay and light located on pump control panel.
7. Pumps shall be equipped with high temperature and seal leak detectors that shall shut down the pumps and alert Township personnel.
8. The following information, at a minimum, shall be made available via the township’s current remote monitoring and alarming system. These signals shall be wired to a dedicated terminal strip in the control panel, for wiring to alarming/monitoring device.
    a. Power Failure / Phase Monitor.
    b. Pump No. 1 Motor High Temperature/Seal Failure.
    c. Pump No. 2 Motor High Temperature/Seal Failure.
    d. High Wet Well Level.
    e. Wet Well Low Level.
    f. Pump No. 1 Running.
    g. Pump No. 2 Running.
    h. Wet Well Level.
9. Substituting operator interface devices such as indicator lights, elapsed time meters, pushbuttons, and selector switches with objects on a graphical interface (ie. Touchscreen or computer screen) shall only be allowed when given prior approval by the Township.
10. Wetwell and piping coated in corrosion protection

GENERATOR

1. An onsite Standby Generator shall be required at all pump stations.
    a. A portable generator may be purchased for the Township in leu of an onsite generator, if approved by Howell Township, depending on location of pump station.
2. Generators smaller than and including 100KW shall be natural gas. Generators larger than 100KW may be diesel.
3. Generator engine speed shall be 1800 rpm. High-speed generators will not be acceptable.
4. All generators shall include the following accessories, at a minimum. Additional products may be necessary based on pump station location.
    a. Coolant heater
    b. Battery charger
    c. Batteries
    d. Exhaust silencer, critical type

    e. Battery tray heater
    f. Alternator heater
    g. Convenience receptacle
5. Generator shall be equipped with a weatherproof, insulated, level 2 sound attenuated enclosure.
6. Generator shall be sized according to pump sizes, other electrical loads required per pump station, and must be approved by Howell Township.
7. An Automatic Transfer Switch (ATS) shall be sized to handle the electrical service and generator requirements. ATS shall be from the Generator supplier and approved by the Generator manufacturer for each specific application.

PUMPS

1. Pump shall be sized as to pump peak flow through one pump at any given time.
2. Pumps must be able to pass flushable wipes.
3. Pump discharge piping 3" or larger must be ductile iron. Discharge piping may only be one size larger than the pump discharge, as recommended by the manufacturer.
4. Pump discharge piping less than 3" must be PVC Sch 80.
5. For pump discharge less than 3", grinder pumps are required.
    a. VFDs with a manual backflow option shall be provided for all grinder pumps.

FORCEMAIN

1. Forcemain shall be a minimum of 2" but may not be smaller than the outlet of the pumps.
2. Connect to Howell Township manhole or pump station as approved by Howell Township.
3. Forcemain materials shall be DIP, HDPE or PVC.

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formwork for cast-in-place concrete.
   2. Shoring, bracing, and anchorage.
   3. Form liners and accessories.
   4. Form stripping.

B. Related Requirements:
   1. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel and required supports for cast-in-place concrete.
   2. Section 03 30 00 - Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:
   1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
   2. ACI 301 - Specifications for Structural Concrete.
   3. ACI 318 - Building Code Requirements for Structural Concrete.
   4. ACI 347 - Guide to Formwork for Concrete.

B. American Forest & Paper Association:
   1. AF&PA - National Design Specification (NDS) for Wood Construction.

C. American Society of Mechanical Engineers:
   1. ASME A17.1 - Safety Code for Elevators and Escalators.

D. APA - The Engineered Wood Association:
   1. APA/EWA PS 1 - Voluntary Product Standard - Structural Plywood.

E. ASTM International:
   1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

F. West Coast Lumber Inspection Bureau:
   1. WCLIB - Standard No. 17 Grading Rules for West Coast Lumber.

1.3 COORDINATION

A. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer information on void form materials and installation requirements.

B. Shop Drawings:
   1. Indicate:
      a. Formwork, shoring, and reshoring.
      b. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
      c. Means of leakage prevention for concrete exposed to view in finished construction.
      d. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift, and height of drop during placement.
      e. Vertical, horizontal, and special loads according to ACI 347, and camber diagrams when applicable.
      f. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.
      g. Procedure and schedule for removal of shores and installation and removal of reshores.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Delegated Design Submittals:
   1. Submit signed and sealed Shop Drawings with design calculations and assumptions for formwork, shoring, and reshores.
   2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.
   3. Include structural calculations to support design.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statement:
   1. Submit qualifications for licensed professional.

1.5 QUALITY ASSURANCE

A. Perform Work according to ACI 347, 301, and 318.

B. For wood products furnished for Work of this Section, comply with AF&PA.

C. Perform Work according to Municipal, State, and Federal standards.

1.6 QUALIFICATIONS

A. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept void forms on Site in manufacturer's original packaging and inspect for damage.

B. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318 to conform to design and applicable code requirements to achieve concrete shape, line, and dimension as indicated on Drawings.

B. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96, water method.

2.2 WOOD FORM MATERIALS

A. Form Materials: At discretion of Contractor.

2.3 PREFABRICATED FORMS

A. Manufacturers:
   1. Sonoco Products Co.

B. Preformed Steel Forms:
   1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

C. FRP Forms: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Pan:
   1. Material: Steel.
   2. Configuration: Size and profile as required.

E. Tubular Column:
   1. Description: Round spirally wound laminated fiber.
   2. Surface Treatment: Release agent, non-reusable.
   3. Sizes: varies.

F. Steel Forms:
   1. Description: Sheet steel, suitably reinforced.
   2. Design: varies.

G. Form Liners: Smooth, durable, grainless, and non-staining hardboard.

H. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.

2.4 FORMWORK ACCESSORIES

A. Form Ties:
   1. Type: Removable.
   2. Material: Galvanized.
   3. Length: Adjustable.
   4. Furnish waterproofing washer.
   5. Free of defects capable of leaving holes larger than 1 inch in concrete surface.

B. Spreaders:
   1. Description: Standard, non-corrosive metal-form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch of concrete face.
   2. Wire ties, wood spreaders, or through bolts are not permitted.

C. Form Release Agent:
   1. Description: Colorless mineral oil that will not stain concrete or absorb moisture [or impair natural bonding or color characteristics of coating intended for use on concrete].

D. Corners:
   1. Type: Chamfer.
   2. Size: 3/4 by 3/4 inches.
   3. Lengths: Maximum possible.

E. Dovetail Anchor Slot:
   1. Material: Galvanized steel.
   2. Thickness: 22 gage.
   3. Filling: Foam.
   4. Fasten slot to concrete formwork according to manufacturer instructions, and insert foam filler to prevent concrete from entering slot during pour.

F. Flashing Reglets:
   1. Material: Galvanized steel.
   2. Thickness: 22 gage.
   3. Lengths: Maximum possible.
   4. Furnish alignment splines for joints.
   5. Filling: Foam.
   6. Fasten flashing reglet to concrete formwork according to manufacturer instructions, and insert foam to prevent concrete from entering reglet during pour.

G. Vapor Retarder:
   1. Description: Polyethylene sheet.
   2. Thickness: 8 mils.

H. Bituminous Joint Filler: Comply with ASTM D1751.

I. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

J. Waterstop:
   1. Description: Flexible strip of bentonite waterproofing compound in coil form for joints in concrete construction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork.

B. Verify that dimensions agree with Shop Drawings.

C. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, request instructions from Engineer before proceeding.

3.2 INSTALLATION

A. Earth Forms: Not permitted.

B. Formwork:
1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Camber forms where necessary to produce level finished soffits.
4. Positioning:
   a. Carefully verify horizontal and vertical positions of forms.
   b. Correct misaligned or misplaced forms before placing concrete.
5. Complete wedging and bracing before placing concrete.
6. Erect formwork, shoring, and bracing to achieve design requirements according to ACI 318.
7. Stripping:
   a. Arrange and assemble formwork to permit dismantling and stripping.
   b. Do not damage concrete during stripping.
   c. Permit removal of remaining principal shores.
8. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.
9. Install fillet and chamfer strips on external corners of beams, joists, and columns.
10. Install void forms according to manufacturer instructions.
11. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view.
12. Do not patch formwork.
13. Leave forms in place for minimum number of days according to ACI 347.

C. Form Removal:
1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads, and removal has been approved by Engineer.
2. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
3. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.
4. Discard damaged forms.
5. Form Release Agent:

a. Apply according to manufacturer instructions.
b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
c. Do not apply form release agent if concrete surfaces are indicated to receive special finishes or applied coverings that may be affected by agent.
d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.

6. Form Cleaning:
   a. Clean forms as erection proceeds to remove foreign matter within forms.
   b. Clean formed cavities of debris prior to placing concrete.
   c. Flush with water or use compressed air to remove remaining foreign matter.
   d. Ensure that water and debris drain to exterior through cleanout ports.
   e. Cold Weather:
      1) During cold weather, remove ice and snow from within forms.
      2) Do not use de-icing salts.
      3) Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure; use compressed air or other dry method to remove foreign matter.
7. Reuse and Coating of Forms:
   a. Thoroughly clean forms and reapply form coating before each reuse.
   b. For exposed Work, do not reuse forms with damaged faces or edges.
   c. Apply form coating to forms according to manufacturer instructions.
   d. Do not coat forms for concrete indicated to receive "scored finish."
   e. Apply form coatings before placing reinforcing steel.

D. Forms for Smooth Finish Concrete:
1. Use steel, plywood, or lined-board forms.
2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
3. Install form lining with close-fitting square joints between separate sheets without springing into place.
4. Use full-sized sheets of form liners and plywood wherever possible.
5. Tape joints to prevent protrusions in concrete.
6. Apply forming and strip wood forms in a manner to protect corners and edges.
7. Level and continue horizontal joints.
8. Keep wood forms wet until stripped.

E. Architectural Form Liners:
1. Erect architectural side of formwork first.
2. Attach form liner to forms before installing form ties.
3. Install form liners square, with joints and pattern aligned.
4. Seal form liner joints to prevent grout leaks.
5. Dress joints and edges to match form liner pattern and texture.

F. Forms for Surfaces to Receive Membrane Waterproofing:
1. Use plywood or steel forms.
2. After erection of forms, tape form joints to prevent protrusions in concrete.

G. Framing, Studding, and Bracing:
1. Maximum Spacing of Studs:
   a. Boards: Maximum 16 inches o.c.

b. Plywood: 12 inches o.c.

2. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Construct beam soffits of material minimum 2 inches thick.
4. Distribute bracing loads over base area on which bracing is erected.
5. When placed on ground, protect against undermining, settlement, and accidental impact.

H. Form Anchors and Hangers:
1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

I. Inserts, Embedded Parts, and Openings:
1. Install formed openings for items to be embedded in or passing through concrete Work.
2. Locate and set in place items required to be cast directly into concrete.
3. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.
4. Joints:
   a. Install waterstops continuous without displacing reinforcement.
5. Openings:
   a. Provide temporary ports or openings in formwork as required to facilitate cleaning and inspection.
   b. Locate openings at bottom of forms to allow flushing water to drain.
6. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

J. Form Ties:
1. Provide sufficient strength and quantity to prevent spreading of forms.
2. Place ties at least 1 inch away from finished surface of concrete.
3. Leave inner rods in concrete when forms are stripped.
4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally.

K. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

L. Construction Joints:
1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
3. Appearance:
   a. Show no overlapping of construction joints.
   b. Construct joints to present same appearance as butted plywood joints.
4. Arrange joints in continuous line straight, true, and sharp.

M. Embedded Items:
1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.

3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

N. Openings for Items Passing through Concrete:
1. Frame openings in concrete where indicated on Drawings.
2. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
3. Coordinate Work to avoid cutting and patching of concrete after placement.
4. Perform cutting and repairing of concrete required as result of failure to provide required openings.

O. Screeds:
1. Set screeds and establish levels for tops of and finish on concrete slabs.
2. Slope slabs to drain where required or as indicated on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms; remove freestanding water.

P. Screed Supports:
1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.
2. Staking through membrane is not permitted.

Q. Cleanouts and Access Panels:
1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed.
3. Remove chips, sawdust, and other debris.
4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.

3.4 FIELD QUALITY CONTROL

A. Inspection:
1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
2. Notify Engineer after placement of reinforcing steel in forms but prior to placing concrete.
3. Schedule concrete placement to permit formwork inspection before placing concrete.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bars.
   2. Welded wire fabric.
   3. Reinforcement accessories.

B. Related Requirements:
   1. Section 03 10 00 - Concrete Forming and Accessories.
   2. Section 03 30 00 - Cast-in-Place Concrete.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete.
   2. ACI 318 - Building Code Requirements for Structural Concrete.
   3. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.
   4. ACI SP-66 - ACI Detailing Manual.

B. American Welding Society:
   1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

C. ASTM International:
   1. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.
   2. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   3. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
   4. ASTM A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
   5. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   6. ASTM A775 - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
   7. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
   8. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
   9. ASTM A996 - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
   10. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

D. Concrete Reinforcing Steel Institute:
   1. CRSI 10-MSP - Manual of Standard Practice.

2. CRSI 10PLACE - Placing Reinforcing Bars.

1.3 COORDINATION

A. Coordinate Work of this Section with placement of formwork, formed openings, and other Work.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel.
   2. Indicate bending and cutting schedules.
   3. Indicate supporting and spacing devices.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Submit certified copies of mill test report of reinforcement materials analysis.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement:
   1. Welders: Qualify procedures and personnel according to AWS D1.1.

1.5 QUALITY ASSURANCE

A. Perform Work according to ACI 301 ACI 318.

B. Prepare Shop Drawings according to ACI SP-66.

C. Perform Work according to Municipal, State, and Federal standards.

1.6 QUALIFICATIONS

A. Welders: AWS qualified within previous 12 months for employed weld types.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:
   1. Comply with ASTM A615.
   2. Yield Strength: 60 ksi.
   3. Billet Bars: Deformed.
   4. Finish: Uncoated.

2.2 FABRICATION

A. Fabricate concrete reinforcement according to ACI 318.

B. Form standard hooks for, 90-degree bends, stirrups and tie hooks.

C. Form reinforcement bends with minimum diameters according to ACI 318.

D. Fabricate column reinforcement with offset bends at reinforcement splices.

E. Form ties and stirrups from following:
   1. Bars No. 10 and Smaller: No. 3 deformed bars.
   2. Bars No. 11 and Larger: No. 4 deformed bars.

F. Splicing:
   1. Locate reinforcement splices at point of minimum stress.
   2. Obtain approval of splice locations from Engineer.

2.3 ACCESSORY MATERIALS

A. Tie Wire:
   1. Minimum 16-gauge, annealed type.

B. Chairs, Bolsters, Bar Supports, and Spacers:

C. Size and Shape: To strengthen and support reinforcement during concrete placement conditions.

D. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

2.4 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:

1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Place, support, and secure reinforcement against displacement.

B. Do not deviate from required position beyond specified tolerance.

C. Do not weld crossing reinforcement bars for assembly except as permitted by Engineer.

D. Do not displace or damage vapor retarder.

E. Accommodate placement of formed openings.

F. Spacing:
   1. Space reinforcement bars with minimum clear spacing according to ACI 318.
   2. If bars are indicated in multiple layers, place upper bars directly above lower bars.

G. Maintain minimum concrete cover around reinforcement according to ACI 318 or as shown on the plans.

3.2 TOLERANCES

A. Install reinforcement within following tolerances for flexural members, walls, and compression members:
   1. Reinforcement Depth Greater Than 8 Inches:
      a. Depth Tolerance: Plus or Minus 3/8 inch
      b. Minus 3/8 inch
   2. Reinforcement Depth Less Than or Equal to 8 Inches:
      a. Depth Tolerance: Plus or Minus 1/2 inch
      b. Minus 1/2 inch

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing according to ACI 318.

B. Provide unrestricted access to Work and cooperate with appointed inspection and testing firm.

C. Reinforcement Inspection:
   1. Placement Acceptance: Inspect specified and ACI 318 material requirements and specified placement tolerances.
   2. Welding: Inspect welds according to AWS D1.1.
   3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
   4. Weldability Inspection: Inspect for reinforcement weldability if formed from steel other than ASTM A706.

5. Continuous Weld Inspection: Inspect reinforcement according to ACI 318.
6. Periodic Weld Inspection: Inspect other welded connections.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Cast-in-Place Concrete for Following Items:
   1. Slabs on Grade
   2. Thrust blocks
   3. Concrete Fillets
   4. Equipment Housekeeping Pads

B. Related Requirements:
   1. Section 03 10 00 - Concrete Forming and Accessories.
   2. Section 03 20 00 - Concrete Reinforcing.
   3. Section 31 23 23 - Fill.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete.
   2. ACI 305R - Guide to Hot Weather Concreting.
   3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
   4. ACI 308.1 - Specification for Curing Concrete.
   5. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:
   1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   2. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. ASTM C33 - Standard Specification for Concrete Aggregates.
   4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   5. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
   7. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
   8. ASTM C150 - Standard Specification for Portland Cement.
   9. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
   10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
   11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   13. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   14. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.

15. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
17. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
18. ASTM C685 - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.
19. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
20. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
21. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
22. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
23. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
24. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete.
25. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
26. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
27. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
28. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
29. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
30. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
31. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
32. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
33. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
34. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
35. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.3 COORDINATION

A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

1.4 SUBMITTALS

A. Product Data: Submit data on joint devices, attachment accessories, admixtures, and mix design.

B. Design Data:
   1. Submit concrete mix design for each concrete strength.
   2. Submit separate mix designs if admixtures are required for following:
      a. Hot and cold weather concrete Work.
      b. Air entrained concrete Work.

3. Identify mix ingredients and proportions, including admixtures.
4. Identify chloride content of admixtures and whether or not chlorides were added during manufacture.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit installation procedures and interfacing required with adjacent Work.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 301.

B. Comply with ACI 305R when pouring concrete during hot weather.

C. Comply with ACI 306.1 when pouring concrete during cold weather.

D. Acquire cement and aggregate from one source for Work.

E. Perform Work according to Municipal, State, and Federal standards.

1.7 AMBIENT CONDITIONS

A. Maintain concrete temperature after installation at minimum 50 degrees F for minimum seven days.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96, water method.

2.2 MATERIALS

A. Concrete:
   1. Cement:
      a. Comply with ASTM C150, Type I - Air Entraining. Type II or I/II cement required when concrete is in contact with wastewater.
      b. Type: Portland.
   2. Normal Weight Aggregates:
      a. Comply with ASTM C33.
      b. Coarse Aggregate Maximum Size: According to ACI 301.

3. Water:
    a. Comply with ACI 318.
    b. Potable, without deleterious amounts of chloride ions.

B. Admixtures:
1. Air Entrainment: Comply with ASTM C260.
2. Chemical:
    a. Comply with ASTM C494.
    b. Type A - Water Reducing.
    c. Type B - Retarding.
    d. Type C - Accelerating.
    e. Type D - Water Reducing and Retarding.
    f. Type E - Water Reducing and Accelerating.
    g. Type F - Water Reducing, High Range.
    h. Type G - Water Reducing, High Range, and Retarding.
3. Fly Ash: Comply with ASTM C618, Class F or C.
4. Silica Fume: Comply with ASTM C1240.
5. Slag:
    a. Description: Ground-granulated blast-furnace slag.
    b. Comply with ASTM C989.
    c. Grade 100 or 120.
6. Plasticizing:
    a. Comply with ASTM C1017.
    b. Type II, plasticizing and retarding.

C. Joint Devices and Filler:
1. Joint Filler, Type A:
    a. Description: Asphalt-impregnated fiberboard or felt.
    b. Comply with ASTM D1751.
    c. Thickness: 1/4 inch.
    d. Profile: Tongue-and-groove.

D. Curing:
1. Membrane Curing Compound:
    a. Comply with ASTM C309, Type 1, Class A.
2. Water: Potable; not detrimental to concrete.

2.3 CONCRETE MIX

A. Select proportions for normal weight concrete according to ACI 301, Method 1.

B. Class A – Structural or Foundation Concrete:
1. Minimum Compressive Strength: 2600 psi at 7 days.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Slump Limit: 0-3 inch without MR, 0-6 inch with MR.

C. Class B – Thrust blocking, electrical equipment slabs:
1. Minimum Compressive Strength: 2450 psi at 7 days.
2. Minimum Compressive Strength: 3500 psi at 28 days.
3. Slump Limit: 5-2 inches

D. Class C – Fence post bases, pipe cradles:
   1. Minimum Compressive Strength: 1950 psi at 7 days.
   2. Minimum Compressive Strength: 3000 psi at 28 days.
   3. Slump Limit: 5-2 inches

E. Class D – Fill or Superstructure Concrete
   1. Minimum Compressive Strength: 1300 psi at 7 days.
   2. Minimum Compressive Strength: 2000 psi at 28 days.
   3. Slump: 6-3 inches

F. Concrete mixtures, general
   1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both.
   2. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
      a. Fly Ash: 25%
      b. Ground Granulated Blast-Furnace Slag: 50%
      c. Combined Fly Ash and Ground Granulated Blast-Furnace Slag: 50%
      d. Portland cement minimum, with fly ash not exceeding 25%
   3. Limit water-soluble, chloride-ion content in hardened concrete to 0.15% by weight of cement.
   4. Admixtures: Use admixtures according to manufacturer's written instructions.
      a. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
      b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
      c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
      d. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having a total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
         1) Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure: 5.0 percent.
         2) Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent.

G. Admixtures:
   1. Include admixture types and quantities indicated in concrete mix designs only if approved by Engineer.
   2. Cold Weather:
      a. Use accelerating admixtures in cold weather.
      b. Use of admixtures will not relax cold-weather placement requirements.
   3. Hot Weather: Use set-retarding admixtures.
   4. Use calcium chloride only if approved by Engineer.
   5. Add air entrainment admixture to concrete mix for Work exposed to freezing and thawing or deicing chemicals.
   6. For concrete exposed to deicing chemicals, limit fly ash, pozzolans, silica fumes, and slag content as required.

H. Average Compressive Strength Reduction: Not permitted.

I. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C685.

J. Site-Mixed Concrete: Mix concrete according to ACI 318.

2.4 ACCESSORIES

A. Bonding Agent:
   1. Description: Two-component modified epoxy resin.

B. Vapor Retarder:
   1. Description: Clear polyethylene film.
   2. Comply with ASTM E1745, Class A.
   3. Thickness: 6 mils.
   4. Type: As recommended for below-grade application.
   5. Joint Tape: As recommended by manufacturer.

C. Non-shrink Grout
   1. Description: Premixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents.
   2. Comply with ASTM C1107.
   3. Minimum Compressive Strength: 2,400 psi.

D. Bentonite Waterstops
   1. Continuous 1 inch x ¾ inch strips, containing 75% bentonite by weight. Proper care and construction procedures shall be used to avoid damaging or displacing the strip while placing concrete. If the material exhibits considerable swelling prior to confinement in the joint, it must be replaced as directed by the Engineer. Joint shall be cleaned from debris and dry prior to replacement. Install per manufacturer's instructions as approved by the Engineer.
   2. Waterstop-RX manufactured by American Colloid Environmental Technologies Company or equal.

E. Wall Sleeves
   1. HDPE thermoplastic sleeves, "CS" model, used for non-concrete pipe penetrations requiring "Link-seals".
   2. Manufactured by Thunderline Corporation 1-800-288-0404, or equal.

F. Expansion Joints
   1. ANSI/ASTM D1751, fiber type; 1/4 inch to 1 inch thick, manufactured by A.C.D. International W.R. Meadows, or equal.

G. Form Release Agent
   1. Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.

H. Corners
   1. Chamfered, wood strip type 3/4" x 3/4" size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

A. Previously Placed Concrete:
   1. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
   2. Remove laitance, coatings, and unsound materials.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels, and pack solid with non-shrink grout.

C. Remove debris and ice from formwork, reinforcement, and concrete substrates.

D. Remove water from areas receiving concrete before concrete is placed.

3.3 INSTALLATION

A. Placing Concrete:
   1. Place concrete according to ACI 301R.
   2. Place concrete for floor slabs in accordance with ACI 302.1R.
   3. Notify testing laboratory and Engineer minimum 48 hours prior to commencement of operations.
   4. Ensure that reinforcement, inserts, embedded parts, formed expansion and contraction joints, and existing utilities are not disturbed during concrete placement.
   5. Install vapor retarder under interior slabs on grade according to ASTM E1643.
   6. Lap joints minimum 6 inches and seal watertight by taping edges and ends.
   7. Repairs:
      a. Repair vapor retarder damaged during placement of concrete reinforcement.
      b. Using vapor retarder material, lap over damaged areas minimum 6 inches and seal watertight.
   8. Joint Filler:
      a. Separate slabs on grade from vertical surfaces with joint filler.
      b. Place joint filler in floor slab pattern placement sequence; set top to required elevations; secure to resist movement by wet concrete.
      c. Extend joint filler from bottom of slab to within 1/2 inch of finished slab surface.
   9. Joint Devices:
      a. Coordination: Install construction joint devices in coordination with floor slab pattern placement sequence; set top to required elevations; secure to resist movement by wet concrete.
      b. Install joint device anchors, maintaining correct position to allow joint cover to be flush with floor and wall finish.
      c. Install joint covers in longest practical length when adjacent construction activity is complete.

10. Deposit concrete at final position, preventing segregation of mix.
11. Place concrete in continuous operation for each panel or section as determined by predetermined joints.
12. Consolidate concrete.
13. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
14. Place concrete continuously between predetermined expansion, control, and construction joints.
15. Do not interrupt successive placement and do not permit cold joints to occur.
16. Place floor slabs in indicated checkerboard or saw-cut pattern.
17. Saw-Cut Joints:
    a. Saw-cut joints within 12 hours after placing.
    b. Use 3/16 inch thick blade.
    c. Cut into 1/4 depth of slab thickness.
18. Screeding:
    a. Screed floors and slabs on grade level.
    b. Surface Flatness: maximum 1/4 inch in 10 feet.
19. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
    a. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand- spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
    b. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.
20. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.
    a. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items, and into corners.
    b. Bring slab surfaces to correct level with a straightedge and strike off. Use bull flats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
    c. Maintain reinforcing in proper position on chairs during concrete placement.
21. Cold-Weather Placement: Comply with provisions of ACI 306R - Cold Weather Concreting; American Concrete Institute International; 1988 (Reapproved 2002), and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
    a. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F and not more than 80°F at point of placement.
    b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

22. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305R - Hot Weather Concreting; American Concrete Institute International; 1999, and as specified.
    a. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90°F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
    b. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
    c. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
    d. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.
23. Screed floors and slabs on grade level, maintaining surface flatness of maximum 1/4 inch in 10 ft, but not more than an 1" maximum.
24. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

B. Separate Floor Toppings:
    1. Prior to placing floor topping, remove deleterious material, roughen substrate concrete surface, and broom and vacuum clean.
    2. Place required dividers and reinforcement and other items to be cast in concrete.
    3. Apply bonding agent to substrate.

C. Slab Jointing
    1. Indicated joint locations on the drawings.
    2. Anchor joint fillers and devices to prevent movement during concrete placement.
    3. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
        a. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
    4. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
    5. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

D. Floor Flatness and Levelness Tolerances
    1. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
        a. Exposed to View and Foot Traffic: F(F) of 20; F(L) of 15.
        b. Areas of Modular Steel Cell installation: F(F) of 35; F(L) of 25.
        c. Under Thick-Bed Tile: F(F) of 35; F(L) of 25.
        d. Under Carpeting: F(F) of 25; F(L) of 20.
        e. Under Thin Resilient Flooring and Thinset Tile: F(F) of 35; F(L) of 25.
    2. Measure F(F) and F(L) in accordance with ASTM E1155, within 48 hours after slab installation; report both composite overall values and local values for each measured section.
    3. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

4. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

E. Concrete Finishing:
   1. Repair surface defects, including tie holes, immediately after removing formwork.
   2. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
   3. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
      a. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
      b. Grout Cleaned Finish: Wet areas to be cleaned and apply grout mixture by brush or spray; scrub immediately to remove excess grout. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.
      c. Exterior Exposed Foundations: Exposed foundations, porches, retaining walls, etc. are to have all fins and projections removed and ground smooth, all voids and holes filled for a smooth finished appearance from finish grade to top of exposed surface. If necessary, due to number of holes and flaws visible, contractor shall skim-coat the surface with an appropriate concrete coating product to produce a smooth finished appearance on all portions of the work visible in the finished construction. Architect shall determine if skim-coating is required.
   4. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
      a. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 302.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, thin set quarry tile, and thin set ceramic tile.
      b. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.
   5. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

F. Concrete Floor Finishes:
   1. High Gloss Clear Sealer: Use in new buildings.
   2. High Gloss Clear Sealer for Non-Pigmented Concrete: Transparent, non-yellowing, water-based coating.
      a. Composition: Acrylic polymer-based.
      b. Nonvolatile Content: 20 percent, minimum, when measured by volume.
      c. Color: Manufacturer's site-mixed color pack; Grey.
      d. Products:
         1) Dayton Superior Corporation; Cure & Seal 1315 J22WB
         2) L&M Construction Chemicals, Inc; Dress & Seal WB 30
         3) W.R. Meadows, Inc; Decra-Seal W/B
         4) BASF/Sonneborn: Kure-N-Seal W
      e. Installation:
         1) Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
         2) Apply first coat as promptly after floating as allowed by manufacturer's recommendations.
         3) Apply second coat just prior to Substantial Completion, once most construction is complete.

4) Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.
5) Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
6) Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

G. Curing and Protection:
1. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Protect concrete footings from freezing for minimum of five days.
3. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
a. Normal concrete: Not less than 7 days.
4. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
5. Surfaces Not in Contact with Forms:
a. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
b. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
1) Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 4 days.
2) Spraying: Spray water over floor slab areas and maintain wet.
3) Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.
c. Final Curing: Begin after initial curing but before surface is dry.
1) Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.
6. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing: Performed by Owner's testing laboratory according to ACI 318.

B. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.

D. Concrete Inspections:
1. Continuous Placement Inspection: Inspect for proper installation procedures.
2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.

E. Strength Test Samples:
1. Sampling Procedures: Comply with ASTM C172.
2. Cylinder Molding and Curing Procedures:

a. Comply with ASTM C31.
b. Cylinder Specimens: Field cured.

3. Sample concrete and make one set of three cylinders for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area for slabs and walls.
4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch if less than five batches are used.
5. Make one additional cylinder during cold weather concreting and field cure.

F. Field Testing:
1. Slump Test Method: Comply with ASTM C143.
2. Air Content Test Method: Comply with ASTM C173.
3. Temperature Test Method: Comply with ASTM C1064.
4. Compressive Strength Concrete:
a. Measure slump and temperature for each sample.
b. Measure air content in air-entrained concrete for each sample.

G. Cylinder Compressive Strength Testing:
1. Test Method: Comply with ASTM C39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at seven days.
4. Test one cylinder at 28 days.
5. Retain one cylinder for 30 days for testing when requested by Engineer.
6. Dispose of remaining cylinders if testing is not required.

H. Core Compressive Strength Testing:
1. Sampling and Testing Procedures: Comply with ASTM C42.
2. Test Acceptance: According to ACI 318.
3. Drill three cores for each failed strength test from failed concrete.

I. Patching:
1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. Honeycombing or Embedded Debris in Concrete:
a. Not acceptable.
b. Notify Engineer upon discovery.
3. Patch imperfections according to ACI 301.

J. Defective Concrete:
1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

K. Protection
1. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

SECTION 03 60 00
GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Portland cement grout.
   2. Rapid-curing epoxy grout.
   3. Nonshrink cementitious grout.

B. Related Requirements:
   1. Section 03 10 00 - Concrete Forming and Accessories: Form materials, waterstops, and accessories as required to form cast-in-place concrete and maintain structural integrity until stripping.
   2. Section 03 30 00 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components.

1.2 REFERENCE STANDARDS

A. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete for Buildings.
   2. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:
   1. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
   2. ASTM C40/C40M - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   3. ASTM C150/C150M - Standard Specification for Portland Cement.
   4. ASTM C191 - Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
   5. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   6. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   7. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   8. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

C. U. S. Army Corps of Engineers Concrete Research Division (CRD):
   1. CRD-C621 - Non-Shrink Grout.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer information regarding grout.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.4 QUALITY ASSURANCE

A. Perform Work according to Municipal, State, and Federal standards.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.6 AMBIENT CONDITIONS

A. Maximum Conditions: Do not perform grouting if temperatures exceed 100 degrees F.

B. Minimum Conditions: Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

A. Portland Cement: Comply with ASTM C150, Type I and II.

B. Water:
   1. Potable.
   2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
      a. Corrosion of steel.
      b. Volume change increasing shrinkage cracking.
      c. Efflorescence.
      d. Excess air entraining.

C. Fine Aggregate:
   1. Washed natural sand.
   2. Gradation:
      a. Comply with ASTM C33.

b. Represented by smooth granulometric curve within required limits.
3. Free from injurious amounts of organic impurities according to ASTM C40/C40M.

D. Mix:
1. Portland cement, sand, and water.
2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID-CURING EPOXY GROUT

A. Description:
1. High-strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.
2. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids, and alkalis.

B. Performance and Design Criteria:
1. Compressive Strength:
a. 12,000 psi at seven days.
b. Comply with ASTM C579.
2. Minimum Tensile Strength:
a. 2,000 psi.
b. Comply with ASTM C307.
3. Coefficient of Expansion:
a. 30x10-6 inch per degree F.
b. Comply with ASTM C531.
4. Shrinkage:
a. None.
b. Comply with ASTM C827/C827M.

2.3 NONSHRINK CEMENTITIOUS GROUT

A. Description:
1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, and no chlorides.

B. Performance and Design Criteria:
1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to CRD-C621 for Type D nonshrink grout:
a. Setting Time:
1) Initial: Approximately two hours.
2) Final: Approximately three hours.
3) Comply with ASTM C191.
b. Maximum Expansion: 0.10 to 0.40 percent.
c. Compressive Strength:
1) One-Day: 4,000 psi.
2) Seven-Day: 7,000 psi.
3) 28-Day: 10,000 to 10,800 psi.
4) Comply with CRD-C621.

2.4 FORMWORK

A. As specified in Section 03 10 00 - Concrete Forming and Accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify areas to receive grout.

3.2 PREPARATION

A. Remove defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by brushing, hammering, chipping, or other similar means until sound and clean concrete surface is achieved.

B. Roughen concrete lightly, but not to interfere with placement of grout.

C. Remove foreign materials from metal surfaces in contact with grout.

D. Align, level, and maintain final positioning of components to be grouted.

E. Saturate concrete surfaces with clean water, and then remove excess water.

3.3 INSTALLATION

A. Formwork:
   1. Construct leakproof forms anchored and shored to withstand grout pressures.
   2. Install formwork with clearances to permit proper placement of grout.
   3. As specified in Section 03 10 00 - Concrete Forming and Accessories.

B. Mixing:
   1. Portland Cement Grout:
      a. Use proportions of two parts sand and one part cement, measured by volume.
      b. Prepare grout with water to obtain consistency to permit placing and packing.
      c. Mix water and grout in two steps:
         1) Premix using approximately 2/3 of water.
         2) After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
      d. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
      e. Do not add additional water after grout has been mixed.
      f. Minimum Compressive Strength: 2,400 psi in 48 hours and 7,000 psi in 28 days.
   2. Mix grout components in proximity to Work area and transport mixture quickly and in manner not permitting segregation of materials.

C. Placing of Grout:
   1. Place grout material quickly and continuously.
   2. Do not use pneumatic-pressure or dry-packing methods.
   3. Apply grout from one side only to avoid entrapping air.
   4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
   5. Thoroughly compact final installation and eliminate air pockets.
   6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:
   1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap method.
   2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
   3. After grout has attained its initial set, keep damp for minimum three days.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing:
   1. Comply with ACI 301.
   2. Submit proposed mix design of each class of grout to Engineer of Record for review prior to commencement of Work.
   3. Tests of grout components may be performed to ensure compliance with specified requirements.

END OF SECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fluid-applied elastomeric membrane waterproofing.
   2. Protective covering.

1.2 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
   2. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
   3. ASTM D429 - Standard Test Method for Rubber Property - Adhesion to Rigid Substrates.
   4. ASTM D471 - Standard Test Method for Rubber Property - Effect of Liquids.
   5. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   6. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   7. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
   8. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
   9. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
   10. ASTM D3468 - Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing.
   11. ASTM D5957 - Standard Guide for Flood Testing Horizontal Waterproofing Installations.
   12. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Roofing Contractors Association:
   1. NRCA - The NRCA Waterproofing Manual.

1.3 SUBMITTALS

A. Product Data: Submit data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work according to NRCA Waterproofing Manual.

B. Perform Work according to MDOT standards.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum documented experience no less than longest warranty offered.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.6 AMBIENT CONDITIONS

A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.7 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements of surfaces scheduled for waterproofing prior to installation.

1.8 WARRANTY

A. Furnish 1-year installer's warranty for waterproofing failing to resist penetration of water.

B. Furnish 5-year manufacturer's warranty for waterproofing failing to resist penetration of water.

C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 - PRODUCTS

2.1 FLUID-APPLIED WATERPROOFING

A. Manufacturers:
   1. EPRO Services, ECODAMP Water Protection Membrane
   2. Or equal.

2.2 MATERIALS

A. Cold-applied elastomeric fluid-applied membrane.
   1. Water-based polymer complying with ASTM C836, two component, suitable for installation over concrete substrates.
   2. Applied 60 cured mil thickness.

2.3 ACCESSORIES

A. Surface Primer: Compatible with membrane compound, as recommended by membrane manufacturer.

B. Elastic Flashings: 47 mil thick, neoprene, as recommended by membrane manufacturer.

C. Joint Cover Sheet: 1/4-inch-thick elastic sheet material designated for and compatible with membrane.

D. Cant Strips: Premolded composition material.

E. Drainage Panel: 1/4-inch-thick formed plastic, sheet with non-woven geotextile material.

F. Joint and Crack Sealant:
   1. As recommended by membrane manufacturer.

G. Backup Material: PVC membrane.

H. Reglet Strip Devices

I. Counterflashings: Galvanized steel.

J. Tack-Free Surfacing: Type II, portland cement.

K. Separation Sheet: Sheet polyethylene, 6 mil thick.

L. Protection Board: 1/4-inch-thick biodegradable hardboard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

B. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

C. Verify that items penetrating surfaces to receive waterproofing are securely installed.

D. Verify that substrate surface slopes to drain for horizontal waterproofing applications.

3.2 PREPARATION

A. Ensure cast-in-place concrete has achieved minimum cure time required by waterproofing manufacturer.

B. Clean and prepare surfaces to receive waterproofing.

C. Do not apply waterproofing to surfaces unacceptable to manufacturer.

D. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer.

3.3 INSTALLATION

A. Apply surface conditioner at rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

B. Apply 12-inch-wide strip of joint cover sheet over cracks, expansion joints over 1/16 inch but not exceeding 1/2 inch in width, and non-working joints.

C. At expansion joints from 1/2 to 1 inch in width, loop cover sheet down into joint between 1-1/4 and 1-3/4 inch. Extend sheet 6 inches on both sides of expansion joint.

D. Center cover sheet over crack or joints. Roll sheet into 1/8 inch coating of waterproofing material. Apply second coat over sheet extending minimum of 6 inches beyond sheet edges. Apply this procedure to expansion joints between horizontal and vertical surfaces.

E. Apply and spread waterproofing material to minimum 60-mils cured thickness.

F. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches above horizontal surface for first ply and 6 inches at subsequent plies laid in shingle fashion.

G. Install cant strips at inside corners.

H. Apply extra thickness of waterproofing material at corners, intersections, and angles and over joints.

I. Seal items protruding to or penetrating through membrane, and install counterflashing membrane material.

J. Install membrane flashings and seal into waterproofing material.
   1. After membrane has cured, but before it becomes dusty, apply separation sheet. Lap joints to ensure complete coverage.

3.4 FIELD QUALITY CONTROL

A. If leakage is found, remove water and patch leaking areas with new waterproofing materials as directed by Engineer; repeat flood inspection. Repair damage to building.

B. When area is proven watertight, drain water and remove dam.

3.5 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

B. Protect membrane and protection board from damage.

C. Protect adjacent surfaces not designated to receive waterproofing.

3.6 SCHEDULE

A. Fluid-Applied Waterproofing Schedule:
   1. New Precast Concrete Structures – exposed to earth.

END OF SECTION

SECTION 09 96 00
HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. High-performance coatings and special preparation of exposed interior and exterior surfaces.

1.2 REFERENCE STANDARDS

A. California Department of Public Health:
   1. CA/DHS/EHLB/R-174 - Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

B. Federal Specification Unit:
   1. FS A-A-3054 - Paint, Heat Resisting (204 Degrees C).
   2. FS AA-3120A - Paint: For Swimming Pools.
   3. FS TT-C-555B - Coating, Textured (for Interior and Exterior Masonry Surfaces).
   4. FS TT-P-28H - Paint, Aluminum, Heat Resisting.

C. Master Painters Institute:
   1. MPI - Approved Products List.
   2. MPI - Architectural Painting Manual.

D. Military Standardization Documents:
   1. MIL C-22750D - Coatings: Epoxy Polyamide.

E. SSPC: The Society for Protective Coatings:
   1. SSPC - Painting Manual, Volume 2: Systems and Specifications.
   2. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide Black (or Dark Red).
   3. SSPC-SP1 - Solvent Cleaning
   4. SSPC-SP 2 - Hand Tool Cleaning.
   5. SSPC-SP 3 - Power Tool Cleaning.
   6. SSPC-SP 5 - White Metal Blast Cleaning.
   7. SSPC-SP 6 - Commercial Blast Cleaning.
   8. SSPC-SP 7 - Brush-Off Blast Cleaning.
   9. SSPC-SP 10 - Near-White Metal Blast Cleaning.
   10. SSPC-SP 11 - Power Tool Cleaning to Bare Metal.
   11. SSPC-SP 13 - Surface Preparation of Concrete

F. NACE: National Association of Corrosion Engineers:
   1. NACE 1 – White Metal Blast Cleaning
   2. NACE 2 – Near-White Blast Cleaning
   3. NACE 3 – Commercial Blast Cleaning
   4. NACE 6 – Surface Preparation of Concrete

G. ANSI/NSF: American National Standards Institute / National Safety Foundation:
   1. ANSI/NSF 61 – Drinking Water System components – Health Effects

H. ASTM: American Society for Testing and Materials
   1. ASTM D 16 – Terminology Relating to Paint, Varnish, Lacquer, and Related Products
   2. ASTM D 4263 – Indicating Moisture in Concrete by the Plastic Sheet Method
   3. ASTM F 1869 – Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

I. AWWA: American Water Works Association:
   1. AWWA C 652 – Disinfection of Water Storage Facilities
   2. AWWA D 102 – Painting Steel Water Storage Tanks

J. ICRI: International Concrete Repair Institute:
   1. ICRI Guideline No.03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.3 SUBMITTALS

A. Product Data:
   1. Submit manufacturer’s product information
      a. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
      a. Generic description
      b. Complete technical data
      c. Surface preparation
         1) Cross-reference surface preparation to coating system and locations of application areas. Use designation indicated on Drawings and in schedules.
      d. Application instructions
   2. Include MPI - Approved Products Lists with proposed products highlighted.

B. Samples: Submit manufacturer’s color samples illustrating available colors for selection.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.

E. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.
   2. Submit manufacturer's approval of applicator.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit maintenance and cleaning requirements for coatings, repair and patching techniques.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:

1. Furnish 1 gal. of each color of each type of coating specified, for Owner's maintenance use.
2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.6 QUALITY ASSURANCE

A. MPI Standards:
   1. Comply with indicated MPI standards.
   2. Products: Listed in MPI - Approved Products List.

B. Perform Work according to State of Michigan and Municipality standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years' documented experience.

B. Applicator: Company specializing in performing Work of this Section with minimum 5 years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Container Labeling: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Inspection:
   1. Accept materials on Site in manufacturer's sealed and labeled containers.
   2. Inspect for damage and to verify acceptability.

C. Store materials in ventilated area and otherwise according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are within manufacturer’s requirements.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85%, at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Do not spray coating if wind velocity is above manufacturer’s limit.

D. Provide ventilation during coating evaporation state in confined or enclose areas in accordance with AWWA D102.

E. Schedule coating work to avoid excessive dust and airborne contaminants. Protect work areas from excessive dust and airborne contaminates during coating application and curing.

F. Restrict traffic from area where coating is being applied or is curing.

PART 2 PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS

A. Manufacturers:
   1. Sherwin Williams
   2. Tnemec Company Incorporated.
   3. ICI Devoe.

2.2 COMPONENTS

A. Coatings:
   1. Description:
      a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.
      b. Specified number of coats does not include primer or filler coat.
   2. Lead content: None.
   3. Chromium Content as Zinc Chromate or Strontium Chromate: None.
   4. Maximum VOC Content: As required by applicable regulations.
   5. Colors: As selected from manufacturer's standard colors.

B. Coating Systems for Exterior Concrete
   1. New Construction – buried
      a. See Section 07 14 00 – Fluid Applied Waterproofing
   2. New Construction – exposed, no color
      a. Clear Sealer/Hardener
      b. First Coat:
         1) Series 629 CT Densifyer or Endurpol Clear Hardener.
         2) 300-350 sq.ft./gal.
      c. Second Coat:
         1) Series 629 CT Densifyer or Endurpol Clear Hardener.
         2) 350 – 400 sq.ft./gal
   3. New Construction - exposed, Owner to choose color
      a. Two-component, modified epoxy
      b. Surface Preparation:
         1) Clean, dry and free of oil, grease and other contaminants.
      c. First Coat:
         1) Series 156 Enviro-Crete or ConFlex XL.
         2) DFT 4.0 to 8.0 mils.
      d. Finish Coat:
         1) Series 156 Enviro-Crete or ConFlex XL.
         2) DFT 4.0 to 8.0 mils.
      e. Minimum Total Dry Film Thickness:
         1) 8.0 to 16.0 mils.

4. Existing Painted Surfaces
    a. Two-component, modified epoxy
    b. Surface Preparation:
        1) Remove chalk and old paint not tightly bonded to the surface.
        2) Apply test patch to check adhesion.
    c. First Coat:
        1) Series 156 Enviro-Crete or ConFlex XL.
        2) DFT 4.0 to 8.0 mils.
    d. Finish Coat:
        1) Series 156 Enviro-Crete or ConFlex XL.
        2) DFT 4.0 to 8.0 mils.
    e. Total Minimum Total Dry Film Thickness:
        1) 8.0 to 16.0 mils.

C. Coating Systems for Interior Concrete
1. New Construction
    a. Two-Component, Polyamide-Epoxy
    b. Surface Preparation:
        1) SSPC-SP 13/NACE 6. Abrasive blast.
    c. Primer:
        1) Series 218 MortarClad or Cement-Plex 875 Block Filler.
            a) Patching and filling voids and bugholes
    d. Intermediate Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    e. Finish Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    f. Minimum Total Dry Film Thickness:
        1) 8.0 to 12.0 mils plus filler.
2. Existing Painted Surfaces
    a. Two-Component, Polyamide-Epoxy
    b. Surface Preparation:
        1) Remove chalk and old paint not tightly bonded to the surface.
        2) Clean, dry and free of oil, grease and other contaminants.
    c. Primer:
        1) Series 218 MortarClad or Cement-Plex 875 Block Filler.
            a) Patching and filling voids and bugholes
    d. Intermediate Coat:
        1) 27 F.C. Typoxy or or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    e. Finish Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    f. Minimum Total Dry Film Thickness:
        1) 8.0 to 12.0 mils.

D. Coating Systems for Interior Concrete Floors and Stair Treads
1. New Construction
    a. Clear Sealer/Hardener.
    b. First Coat:

1) Series 629 CT Densifyer or Endurpol Clear Hardener.
2) 300-350 sq.ft./gal.

c. Second Coat:
1) Series 629 CT Densifyer or Endurpol Clear Hardener.
2) 350 – 400 sq.ft./gal

2. Existing Painted Surfaces
a. Two-Component, Polyamide-Epoxy Coating
b. Surface Preparation:
1) SSPC-SP 13/NaCE 6. Shot blast or mechanically abrade.
c. Primer:
1) Series 201 Epoxoprime or Dura-Plate 2300.
2) DFT 6.0 to 8.0 mils.
d. Finish Coat:
1) Series 280 Tneme-Glaze or Macropoxy 646 Epoxy.
2) DFT 6.0 to 8.0 mils.
3) Orange Peel Finish
e. Minimum Total Dry Film Thickness:
1) 12.0 to 16.0 mils.

E. Coating Systems for Submerged or Intermittently Submerged Concrete
1. New Construction
a. Two-Component, Polyamide-Epoxy, Coal Tar
b. Surface Preparation:
1) SSPC-SP 13/NACE 6. Brush-off blast.
c. Primer:
1) Series 218 MortarClad or Cement-Plex 875 Block Filler.
a) Patching and filling voids and bugholes
d. Intermediate Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hi-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
e. Finish Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hi-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
f. Minimum Total Dry Film Thickness:
1) 28.0 to 40.0 mils plus filler.
2. New Construction (Modified Polyurethane)
a. Surface Preparation:
1) SSPC-SP 13/NACE 6. Brush-off blast.
b. Primer:
1) Series 218 MortarClad or Cement-Plex 875 Block Filler
a) Patching and filling voids and bugholes
c. Intermediate Coat:
1) Series 66 Hi-Build Epoxoline or Cement-Plex 875 Block Filler.
2) DFT 4.0 to 6.0 mils.
d. Finish Coat:
1) Series 262 Elasto-Shield or Sher-Glass Glass Flake Reinforced Epoxy
2) DFT 50.0 mils. minimum
e. Minimum Total Dry Film Thickness:
1) 54.0 mils plus filler.
3. Existing Painted Surfaces
a. Two-Component, Polyamide-Epoxy, Coal Tar

b. Surface Preparation:
    1) SSPC-SP 13/NACE 6. Abrasive blast.
    2) Completely remove existing coatings.
c. Primer:
    1) Series 218 MortarClad or Cement-Plex 875 Block Filler
        a) Patching and filling voids and bugholes
d. Intermediate Coat:
    1) 46H-413 Hi-Build Tneme-Tar or Hi-Mil Sher-Tar Epoxy Black.
    2) DFT 14.0 to 20.0 mils.
e. Finish Coat:
    1) 46H-413 Hi-Build Tneme-Tar or Hi-Mil Sher-Tar Epoxy Black.
    2) DFT 14.0 to 20.0 mils.
f. Minimum Total Dry Film Thickness:
    1) 28.0 to 40.0 mils plus filler.

4. Existing Painted Surfaces (Modified Polyurethane)
a. Surface Preparation:
    1) SSPC-SP 13/NACE 6. Abrasive blast.
    2) Completely remove existing coatings.
b. Primer:
    1) Series 218 MortarClad or Cement-Plex 875 Block Filler
        a) Patching and filling voids and bugholes
c. Intermediate Coat:
    1) Series 66 Hi-Build Epoxoline or Cement-Plex 875 Block Filler.
    2) DFT 14.0 to 20.0 mils.
d. Finish Coat:
    1) Series 262 Elasto-Shield or Sher-Glass Glass Flake Reinforced Epoxy.
    2) DFT 50.0 mils. minimum.
e. Minimum Total Dry Film Thickness:
f. 54.0 mils plus filler.

F. Coating Systems for Interior Concrete Masonry
1. New Construction
a. Two-Component, Polyamide-Epoxy.
b. Surface Preparation:
    1) SSPC-SP 13/NACE 6. Clean and Dry.
c. Primer:
    1) Series 130 Envirofill or Cement-Plex 875 Block Filler
    2) Spreading rate 60 to 80 sq.ft./gal.
d. Intermediate Coat:
    1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
    2) DFT 4.0 to 6.0 mils.
e. Finish Coat:
    1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
    2) DFT 4.0 to 6.0 mils.
f. Minimum Total Dry Film Thickness:
    1) 8.0 to 12.0 mils plus filler
2. Existing Painted Surfaces
a. Two Component, Polyamide-Epoxy.
b. Surface Preparation:
    1) Clean, dry and free of oil, grease and other contaminants.
    2) Remove chalk and old paint not tightly bonded to the surface.

c. Finish Coat:
    1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
    2) DFT 4.0 to 6.0 mils.
d. Minimum Total Dry Film Thickness:
    1) 8.0 to 12.0 mils.

G. Coating System for Exterior Ferrous Metal
1. New Construction
    a. Two-component, pigmented, aliphatic, polyurethane
    b. Surface Preparation:
        1) SSPC-SP 6.
    c. Primer:
        1) Tneme-Zinc Series 90-97 or Corothane I-GalvaPak Zinc Primer.
        2) DFT 2.5 to 3.5 mils.
    d. Intermediate Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 2.0 to 3.0 mils.
    e. Finish Coat:
        1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
        2) DFT 2.0 to 5.0 mils.
    f. Minimum Total Dry Film Thickness:
        1) 6.5 to 11.5 mils.
2. Existing Painted Surfaces
    a. Two-component, pigmented, aliphatic, polyurethane
    b. Surface Preparation:
        1) In accordance with manufacturer's instructions.
        2) Remove chalk and old paint not tightly bonded to the surface.
    c. Primer:
        1) 27 F.C. Typoxy or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    d. Intermediate Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 2.0 to 3.0 mils.
    e. Finish Coat:
        1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
        2) DFT 2.0 to 5.0 mils.
    f. Minimum Total Dry Film Thickness:
        1) 8.0 to 14.0 mils.

H. Coating Systems for Interior Ferrous Metal
1. New Construction
    a. Two-component, polyamide-epoxy
    b. Surface Preparation:
        1) SSPC-SP 13/NACE 6. Clean and dry.
    c. Primer:
        1) Tneme-Zinc Series 90-97 or Corothane I-GalvaPak Zinc Primer.
        2) DFT 2 to 3 mils.
    d. Intermediate Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    e. Finish Coat:

1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.

f. Minimum Total Dry Film Thickness:
1) 10 to 15 mils.

2. Existing Painted Surfaces
a. Two-component, polyamide-epoxy
b. Surface Preparation:
1) Clean, dry and free of oil, grease and other contaminants.
2) Remove chalk and old paint not tightly bonded to the surface.

c. Finish Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.

d. Minimum Total Dry Film Thickness:
1) 8.0 to 12.0 mils.

I. Coating Systems for Submerged or Intermittently Submerged Ferrous Metal
1. New Construction
a. Two-Component, Polyamide-Epoxy Coal Tar
b. Surface Preparation:
1) SSPC-SP 6 Commercial Blast Cleaning.

c. Primer:
1) Tneme-Zinc Series 90-97 or Corothane I-GalvaPak Zinc Primer.
2) DFT 2.5 to 3.5 mils.

d. Intermediate Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.

e. Finish Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.

f. Minimum Total Dry Film Thickness:
1) 30.5 to 43.5 mils.

2. Existing Painted Surfaces
a. Two-Component, Polyamide-Epoxy Coal Tar
b. Surface Preparation:
1) SSPC-SP 6 Commercial Blast Cleaning.

c. Primer:
1) Tneme-Zinc Series 90-97 or Corothane I-GalvaPak Zinc Primer.
2) DFT 2.5 to 3.5 mils.

d. Intermediate Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.

e. Finish Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.

f. Minimum Total Dry Film Thickness:
1) 30.5 to 43.5 mils.

J. Coating Systems for Exterior Exposed Cast or Ductile Iron Pipe and Fittings
1. New Construction
a. Two-Component, pigmented, aliphatic, polyurethane
b. Surface Preparation:

1) In accordance with manufacturer's instructions.
c. Primer:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 3.0 to 5.0 mils.
d. Intermediate Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.
e. Finish Coat:
1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
2) DFT 2.0 to 3.0 mils.
f. Minimum Total Dry Film Thickness:
1) 9.0 to 14.0 mils.
2. Existing Exposed Painted Surfaces
a. Two-Component, pigmented, aliphatic, polyurethane
b. Surface Preparation:
1) In accordance with manufacturer's instructions.
c. Primer:
1) 27 F.C. Typoxy or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.
d. Intermediate Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 2.0 to 3.0 mils.
e. Finish Coat:
1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
2) DFT 2.0 to 5.0 mils.
f. Minimum Total Dry Film Thickness:
g. 8.0 to 14.0 mils.

K. Coating Systems for Interior Cast or Ductile Iron Pipe and Fittings
1. New Construction
a. Two-Component, Polyamide-Epoxy
b. Surface Preparation:
1) In accordance with manufacturer's instructions.
c. Primer:
1) Series 37H Chem-Prime HS or Kem Kromik Universal Primer.
2) DFT 2.0 to 3.0 mils.
d. Intermediate Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.
e. Finish Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.
f. Minimum Total Dry Film Thickness:
1) 10.0 to 15.0 mils.
2. Existing Painted Surfaces
a. Two-Component, Polyamide-Epoxy
b. Surface Preparation:
1) Clean, dry and free of oil, grease and other contaminants.
2) Remove chalk and old paint not tightly bonded to the surface.
c. Primer:
1) 27 F.C. Typoxy or Macropoxy 646 Epoxy.

2) DFT 4.0 to 6.0 mils.
d. Finish Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.
e. Minimum Total Dry Film Thickness:
f. 8.0 to 12.0 mils.

L. Coating Systems for Submerged or Intermittently Submerged Cast or Ductile Iron Pipe and Fittings
1. New Construction
a. Two-Component, Polyamide-Epoxy Coal Tar
b. Surface Preparation:
1) In accordance with manufacturer's instructions
c. Primer:
1) Series 37H Chem-Prime HS or Kem Kromik Universal Primer.
2) DFT 2.0 to 3.0 mils.
d. Intermediate Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
e. Finish Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
f. Minimum Total Dry Film Thickness:
1) 30 to 43 mils.
2. Existing Painted Surfaces
a. Two-Component, Polyamide-Epoxy Coal Tar
b. Surface Preparation:
1) In accordance with manufacturer's instructions.
c. Primer:
1) Series 37H Chem-Prime HS or Kem Kromik Universal Primer.
2) DFT 2.0 to 3.0 mils.
d. Intermediate Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
e. Finish Coat:
1) 46H-413 Hi-Build Tneme-Tar or Hil-Mil Sher-Tar Epoxy Black.
2) DFT 14.0 to 20.0 mils.
f. Minimum Total Dry Film Thickness:
1) 30.5 to 43.5 mils.

M. Coating System for Plaster and Gypsum Board
1. New Construction
a. Two-Component, Polyamide-Epoxy
b. Surface Preparation:
1) Clean and dry.
c. Primer/Sealer:
1) Series 115 Uni-Bond DF or Loxon Concrete & Masonry Primer.
2) DFT 1.0 to 2.0 mils.
d. Intermediate Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 4.0 to 6.0 mils.

e. Finish Coat:
    1) Series 73 Endura-Shield or Macropoxy 646 Epoxy.
    2) DFT 4.0 to 6.0 mils.
f. Minimum Total Dry Film Thickness:
    1) 5.0 to 8.0 mils.

2. Existing Painted Surfaces
    a. Two-Component, Polyamide-Epoxy
    b. Surface Preparation:
        1) Clean and dry.
        2) Remove chalk and old paint not tightly bonded to the surface.
    c. Primer:
        1) 27 F.C. Typoxy or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    d. Finish Coat:
        1) Series 66 Hi-Build Epoxyline or Macropoxy 646 Epoxy.
        2) DFT 4.0 to 6.0 mils.
    e. Minimum Total Dry Film Thickness:
        1) 8.0 to 12.0 mils.

N. Coating Systems for Galvanized Steel, Nonferrous Metals, Insulated Pipe and PVC
1. Exterior Exposed
    a. Two-Component, Pigmented, Aliphatic, Polyurethane
    b. Surface Preparation:
        1) In accordance with manufacturer's instructions.
    c. Primer:
        1) Series 66 Hi-Build Epoxoline or or Macropoxy 646 Epoxy.
        2) DFT 2.0 to 3.0 mils.
    d. Finish Coat:
        1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
        2) DFT 2.0 to 3.0 mils
    e. Minimum Total Dry Film Thickness:
        1) 4.0 to 6.0 mils
2. Interior Exposed
    a. Two-Component, Polyamide-Epoxy
    b. Surface Preparation:
        1) In accordance with manufacturer's instructions.
    c. Primer:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 2.0 to 3.0 mils.
    d. Finish Coat:
        1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
        2) DFT 2.0 to 3.0 mils
    e. Minimum Total Dry Film Thickness:
        1) 4.0 to 6.0 mils.

O. Coating Systems for Wood
1. Exterior Exposed
    a. Two-Component, Pigmented, Aliphatic, Polyurethane
    b. Surface Preparation:
        1) In accordance with manufacturer's instructions.
    c. Primer:

1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 2.0 to 3.0 mils.

d. Finish Coat:
1) Series 73 Endura-Shield or Acrolon 218 HS Polyurethane.
2) DFT 2.0 to 3.0 mils

e. Minimum Total Dry Film Thickness:
1) 4.0 to 6.0 mils

2. Interior Exposed
a. Two-Component, Polyamide-Epoxy
b. Surface Preparation:
1) In accordance with manufacturer's instructions.
c. Primer:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy.
2) DFT 2.0 to 3.0 mils.

d. Finish Coat:
1) Series 66 Hi-Build Epoxoline or Macropoxy 646 Epoxy
2) DFT 2.0 to 3.0 mils

e. Minimum Total Dry Film Thickness:
1) 4.0 to 6.0 mils.

PART 3 EXECUTION

3.1 EXAMINATION

A. Substrates:
1. Verify that substrate surfaces are ready to receive Work of this Section as indicated by coating manufacturer.
2. Obtain and follow manufacturer instructions for examination and testing of substrates.
3. Cementitious Substrates: Do not begin application until substrate has cured minimum 28 days and measured moisture content is not greater than 16 percent.

B. Masonry: Verify that masonry joints are struck flush.

C. Wood: Do not begin application if substrate has moisture content greater than 12 percent.

3.2 PREPARATION

A. Clean surfaces of loose foreign matter.

B. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.

C. Remove finish hardware, fixture covers, and accessories and store.

3.3 APPLICATION

A. Comply with MPI - Architectural Painting Manual.

B. Apply primer to each surface, unless specifically not required by coating manufacturer.

C. Wood: Prior to priming patch with filler to produce smooth, even surface.

D. Concrete: Prior to priming, patch with masonry filler to produce smooth surface.

E. Concrete Masonry and Concrete:
   1. Apply masonry filler to thickness required to fill holes and produce smooth surface.

F. Wood Items to Receive Transparent Finish:
   1. Remove dust and grit, sealing residue, seal knots, pitch streaks, and sappy sections as indicated by coating manufacturer.
   2. Fill nail holes and cracks with matching tinted filler.

G. Apply coatings to specified thicknesses.

H. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish.

I. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.4 FIELD QUALITY CONTROL

A. Inspecting and Testing: Comply with MPI - Architectural Painting Manual.

3.5 CLEANING

A. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.

B. Clean surfaces immediately of overspray, splatter, and excess material.

C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.6 PROTECTION

A. Protect adjacent surfaces and materials not receiving coating from overspray.

B. Mask when necessary to provide adequate protection and repair damage.

3.7 ATTACHMENTS

A. Coating Application Schedule
   1. Provide the following coating systems for substrates indicated.
      a. Where undercoats or other conditions show through final coat, apply additional coats until the cured film is of uniform coating finish, color, and appearance.
   2. Exterior Concrete - buried
      a. All new construction. See Section 07 14 00 – Fluid Applied Waterproofing
   3. Submerged or Intermittently Submerged Concrete
      a. New construction
   4. Interior ferrous metal
      a. All new construction.
   5. Exterior Ferrous Metal

a. All new construction.

6. Submerged or Intermittently Submerged Ferrous Metal
   a. All new construction
7. Interior Cast or Ductile Iron Pipe and Fittings
   a. All new construction
8. Exterior Cast or Ductile Iron Pipe and Fittings
   a. All new construction
9. Submerged or Intermittently Submerged Cast or Ductile Iron Pipe and Fittings
   a. All new construction
10. Galvanized Steel, Nonferrous Metals
    a. All new construction
11. Wood
    a. All new construction

B. Pipe Color Code
   1. All piping that is not buried shall be color coded in accordance with Section 54.5 of "Recommended Standards for Wastewater Facilities" 2014 Edition and the Owner's existing color code system unless otherwise indicated. Final color selection by Owner.

END OF SECTION

SECTION 13 34 20
FIBERGLASS REINFORCED PLASTIC BUILDINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Freestanding, shop fabricated and assembled fiberglass reinforced plastic (FRP) insulated composite buildings.
   2. Include fasteners, anchors, doors and frames, vents, windows, gasketing, interior and exterior lighting, exterior alarm lights, and HVAC.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Building shall conform to dimensions shown on Drawings.
   2. Building shall be completely waterproof, air and watertight, corrosion and chemical resistant, lightweight, and environmentally aesthetic.
   3. Design to sustain superimposed loads for load combinations in accordance with ASCE 7-98.
      a. Design loads:
         1) Dead load of building, live (snow) load, 35 psf, wind load, 25 psf mechanical equipment.
      b. During installation of the composite FRP structure a concentrated load not exceeding 250 pounds may be placed on any portion of the roof. The concentrated load shall not be applied to the roof if other loads are present.
   4. Stresses produced by specified load conditions shall be determined consistent with recognized methods of analysis.
   5. Average R-value of assembled building shall be minimum of R-7.

1.3 SUBMITTALS

A. Product Data:
   1. Resin and glass manufacturers material specifications.

B. Shop Drawings:
   1. Include plans and elevations, fabrication details indicating laminate thickness and section depths and widths, location of openings and equipment supports, size and location of anchor bolts, and gasketing details.

1.4 QUALITY ASSURANCE

A. Buildings provided shall be end product of one manufacturer to achieve standardization for appearance. Manufacturer Qualifications: Building shall be manufactured and erected by firm with minimum of 5 yrs experience in structures of size and character specified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect on manufacturer's site, project site and during shipment and installation to prevent warping and fracturing.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. EASI-SET WORLDWIDE, 5119 Catlett Road, Midland VA 22728. 800-547-4045, www.easiset.com

2.2 LAMINATE MATERIALS

A. Resins, Gel Coat, Glass Reinforcing, Insulation.
   1. As provided by Manufacturer.

2.3 MISCELLANEOUS MATERIALS

A. Concrete Anchors, Doors, Gasketing
   1. As provided Manufacturer.

B. Permanently fused building assembly yielding a watertight one-piece structure.

2.4 FABRICATION

A. Form individual segments on high gloss molds ensuring consistent dimensions of finished parts. Cast each segment in one piece. Laminate shall consist of chopped roving impregnated with resin. Form panel flanges and perimeter anchoring flanges to the interior of the building.

2.5 ASSEMBLY

A. Shop assemble complete building. Flanges between adjacent panels shall be factory bonded together with structural adhesive. Seal exterior edges of adjacent panels with color matched silicon sealant. Fit and bond appurtenances, formed separately, into openings cut in finished panel or integrally mold to panel. Bond attachments with glass fibers and resin from interior of panel. Resin seal cut or drilled edges.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surface to receive building for acceptable installation conditions. Do not start installation unless acceptable conditions are provided.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved submittals. Field erect panels. Flanges between adjacent panels shall be bolted and gasketed. Use washers to avoid localized stresses. Seal exterior edges of adjacent panels with color matched silicon sealant.

B. Install continuous neoprene gasket between perimeter anchoring flange and where panels rest on supporting structure. Resin seal cut or drilled edges. Repair damaged panels. Minimum spacing and edge distances of concrete anchors shall conform to requirements of manufacturer.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes building wire and cable; nonmetallic-sheathed cable; direct burial cable; service entrance cable; armored cable; metal clad cable; and wiring connectors and connections.

B. Related Sections:
   1. Section 26 05 53 - Identification for Electrical Systems.
   2. Section 31 23 17 - Trenching.
   3. Section 31 23 23 - Fill.

1.2 REFERENCES

A. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
   2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

C. Underwriters Laboratories, Inc.:
   1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:
   1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
   2. Stranded conductors for control circuits.
   3. Conductor not smaller than 12 AWG for power and lighting circuits.
   4. Conductor not smaller than 14 AWG for control circuits.
   5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.

B. Wiring Methods: Provide the following wiring methods:
   1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway, nonmetallic- sheathed cable, armored cable or metal clad cable.
   2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway, nonmetallic-sheathed cable, armored cable or metal clad cable.
   3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway, nonmetallic-sheathed cable, armored cable or metal clad cable.
   4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway, direct burial cable, armored cable or metal clad cable.

5. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway, direct burial cable, service-entrance cable, armored cable or metal clad cable.
6. Underground Locations: Use only building wire, Type THHN/THWN insulation, in raceway, direct burial cable, service-entrance cable, armored cable or metal clad cable.
7. Cable Tray Locations: Use only Tray cable Type TC.

1.4 DESIGN REQUIREMENTS

A. Conductor sizes are based on copper unless indicated as aluminum or "AL".

B. When aluminum conductor is substituted for copper conductor, size to match circuit requirements, terminations, conductor ampacity and voltage drop.

C. Substituting aluminum conductors for copper must be approved by owner and engineer prior to procurement and installation.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit for building wire and each cable assembly type.

C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.

D. Test Reports: Indicate procedures and values obtained.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of components and circuits.

1.7 QUALITY ASSURANCE

A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

B. Perform Work in accordance with all applicable Federal, State, and local Codes and Ordinances.

C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.9 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.10 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

C. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths of an additional 10% or 10 feet, whichever is shorter, of length shown.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation Voltage Rating: 600 volts.

E. Insulation Temperature Rating: 105 degrees C.

F. Insulation Material: Thermoplastic.

2.2 NONMETALLIC-SHEATHED CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

2.3 DIRECT BURIAL CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90 degrees C.

2.4 SERVICE ENTRANCE CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: Type USE, SE, or USE-2, as approved by Utility Company.

2.5 ARMORED CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Aluminum.

G. Armor Design: Interlocked metal tape.

2.6 METAL CLAD CABLE

A. Manufacturers:
   1. Cerro Wire LLC.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.
   4. Substitutions: Section 01 60 00 - Product Requirements.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Aluminum.

G. Armor Design: Interlocked metal tape.

H. Jacket: Where required.

2.7 WIRING CONNECTORS

A. Split Bolt Connectors:
   1. Manufacturers:
      a. Burndy: Part of Hubbell Electrical Systems.
      b. ILSCO.
      c. Thomas & Betts Corporation; A Member of the ABB Group.
      d. Substitutions: Section 01 60 00 - Product Requirements.

B. Solderless Pressure Connectors:
      a. Burndy: Part of Hubbell Electrical Systems.
      b. ILSCO.
      c. Thomas & Betts Corporation; A Member of the ABB Group.
      d. Substitutions: Section 01 60 00 - Product Requirements.

C. Spring Wire Connectors:
   1. Manufacturers:
      a. Burndy: Part of Hubbell Electrical Systems.
      b. ILSCO.
      c. Thomas & Betts Corporation; A Member of the ABB Group.
      d. Substitutions: Section 01 60 00 - Product Requirements.

D. Compression Connectors:
   1. Manufacturers:
      a. Burndy: Part of Hubbell Electrical Systems.
      b. ILSCO.
      c. Thomas & Betts Corporation; A Member of the ABB Group.

d. Substitutions: Section 01 60 00 - Product Requirements.

2.8 TERMINATIONS

A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.

B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify interior of building has been protected from weather.

C. Verify mechanical work likely to damage wire and cable has been completed.

D. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 EXISTING WORK

A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.

B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.

C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing wire and cable remaining or wire and cable to be reinstalled.

3.4 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

D. Special Techniques--Building Wire in Raceway:
   1. Pull conductors into raceway at same time.
   2. Install building wire 4 AWG and larger with pulling equipment.

E. Special Techniques - Cable:
   1. Protect exposed cable from damage.
   2. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
   3. Use suitable cable fittings and connectors.

F. Special Techniques - Direct Burial Cable:
   1. Trench and backfill for direct burial cable installation. Refer to Section 31 23 23 and Section 31 23 17. Install warning tape along entire length of direct burial cable, within 3 inches of grade.
   2. Use suitable direct burial cable fittings and connectors.

G. Special Techniques - Wiring Connections:
   1. Clean conductor surfaces before installing lugs and connectors.
   2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
   3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
   4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
   5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
   6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
   7. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
   8. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

H. Install stranded conductors for branch circuits 10 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

I. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.

J. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

K. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

3.5 WIRE COLOR

A. General:
   1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
      a. Black and red for single phase circuits at 120/240 volts.
      b. Black, red, and blue for circuits at 120/208 volts single or three phase.
      c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
   2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
      a. Black and red for single phase circuits at 120/240 volts.
      b. Black, red, and blue for circuits at 120/208 volts single or three phase.
      c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.

B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:
   1. For 6 AWG and smaller: Green.
   2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements

B. Section 01 70 00 - Execution and Closeout Requirements.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rod electrodes.
2. Active electrodes.
3. Wire.
4. Grounding well components.
5. Mechanical connectors.
6. Exothermic connections.

B. Related Sections:
1. Section 03 20 00 - Concrete Reinforcing: Bonding or welding bars when reinforcing steel is used for electrodes.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
2. NFPA 99 - Standard for Health Care Facilities.

1.3 SYSTEM DESCRIPTION

A. Grounding systems use the following elements as grounding electrodes:
1. Metal underground water pipe.
2. Metal building frame.
3. Concrete-encased electrode.
4. Rod electrode.
5. Plate electrode.

1.4 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms maximum.

1.5 SUBMITTALS

A. Product Data: Submit data on grounding electrodes and connections.

B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

C. Manufacturer's Installation Instructions: Submit for active electrodes.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and grounding electrodes.

1.7 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Perform Work in accordance with all applicable Federal, State, and local Codes and Ordinances.

C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three (3) years documented experience or approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.11 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Manufacturers:
   1. ERICO International Corporation.
   2. Harger Lightning & Grounding.

B. Product Description:
   1. Material: Copper.
   2. Diameter: 3/4 inch
   3. Length: 10 feet

C. Connector: Connector for exothermic welded connection.
   1. U-bolt clamp only allowed upon approval by Engineer.

2.2 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 2 AWG.

C. Grounding Electrode Conductor: Copper conductor, bare.

D. Bonding Conductor: Copper conductor, bare.

2.3 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inches NPS by 24 inches long concrete pipe with belled end.

B. Well Cover: Fiberglass with legend "GROUND" embossed on cover.

2.4 MECHANICAL CONNECTORS

A. Manufacturers:
   1. Burndy: Part of Hubbell Electrical Systems.
   2. ERICO International Corporation.
   3. Harger Lightning & Grounding.

B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.5 EXOTHERMIC CONNECTIONS

A. Manufacturers:
   1. Cadweld.
   2. ERICO International Corporation.
   3. Harger Lightning & Grounding.

B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove paint, rust, mill oils, and surface contaminants at connection points.

3.3 EXISTING WORK

A. Modify existing grounding system to maintain continuity to accommodate renovations.

B. Extend existing grounding system using materials and methods compatible with existing electrical installations, or as specified.

3.4 INSTALLATION

A. Install in accordance with IEEE 142
   1. Where sensitive equipment is present, install in accordance with IEEE 1100.

B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

C. Install grounding and bonding conductors concealed from view.

D. Install grounding well pipe with cover at rod locations as indicated on Drawings. Install well pipe top flush with finished grade.

E. Install 2 AWG bare copper wire in foundation footing as indicated on Drawings.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Bond together reinforcing steel and metal accessories in water containment structures.

H. Install ground grid under access floors. Construct grid of 2 AWG bare copper wire installed on 24 inch centers both ways. Bond each access floor pedestal to grid.

I. Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Install 2 AWG bare copper bonding conductor.

J. Install isolated grounding conductor for circuits supplying, personal computers and other such sensitive electronics in accordance with IEEE 1100.

K. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

L. Install continuous grounding using underground cold water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.

M. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.

N. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.

O. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

P. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.

Q. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.

C. Perform ground resistance testing in accordance with IEEE 142.

D. Perform leakage current tests in accordance with NFPA 99.

E. Perform continuity testing in accordance with IEEE 142.

F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Conduit supports.
   2. Formed steel channel.
   3. Spring steel clips.
   4. Equipment bases and supports.

1.2 REFERENCES

A. ASTM International:
   1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. FM Global:
   1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

D. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 SUBMITTALS

A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

B. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

C. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

D. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with all applicable standards.

B. Maintain two copies of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience or approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Manufacturers:
   1. ERICO International Corporation.
   2. Thomas & Betts Corporation: A Member of the ABB Group.
   3. Unistrut: Part of Atkore International.

B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.

E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.

F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

A. Manufacturers:
   1. B-Line, and Eaton Business.

2. Unistrut: Part of Atkore International.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

A. Manufacturers:
1. B-line, an Eaton Business.
2. Minerallac Company.
3. Morris Products, Inc.

B. Product Description: Mounting hole and screw closure.

2.4 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Pipeline Seal and Insulator, Inc.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove incompatible materials affecting bond.

B. Install backing and/or damming materials to arrest liquid material leakage where required.

C. Obtain permission from Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

3.2 INSTALLATION - HANGERS AND SUPPORTS

A. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors and preset inserts.
2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

B. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of or recessed into and grouted flush with slab as indicated on drawings.

C. Install conduit and raceway support and spacing in accordance with NEC.

D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

E. Install multiple conduit runs on common hangers.

F. Supports:
   1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
   2. Install surface mounted cabinets and panelboards with minimum of four anchors.
   3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
   4. Support vertical conduit at every floor.

3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.4 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.

C. Set sleeves in position in forms. Provide reinforcing around sleeves.

D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing or fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

G. Install chrome plated steel plastic or stainless steel escutcheons at finished surfaces.

3.5 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
3. Section 26 05 53 - Identification for Electrical Systems.
4. Section 26 05 83 - Equipment Wiring Connections.
5. Section 26 27 16 - Electrical Cabinets and Enclosures.
6. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide rigid steel conduit, plastic coated conduit, or thickwall nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit or plastic coated conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: Provide rigid steel conduit, plastic coated conduit or thickwall nonmetallic conduit. Provide cast or nonmetallic metal boxes.

E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.

F. In Slab Above Grade: Provide rigid steel conduit, intermediate metal conduit or thickwall nonmetallic conduit. Provide sheet metal boxes.

G. Wet and Damp Locations: Provide rigid steel conduit, plastic coated conduit or thickwall nonmetallic conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

H. Concealed Dry Locations: Provide rigid steel conduit or thickwall nonmetallic conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

I. Exposed Dry Locations: Provide rigid steel conduit or electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

J. Hazardous Locations: Provide rigid steel conduit, or plastic coated conduit. Provide Explosionproof boxes. Provide hinged enclosure for large pull boxes. All connections and penetrations shall be sealed to prevent intrusion of gases.

K. Pump Stations: Provide rigid steel conduit, or thickwall nonmetallic conduit (as listed above). Provide ventilated hinged enclosures for pull boxes. All connections and penetrations shall be sealed to prevent intrusion of moisture and gases.

1.4 DESIGN REQUIREMENTS

A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.5 SUBMITTALS

A. Product Data: Submit for the following:
   1. Flexible metal conduit.
   2. Liquidtight flexible metal conduit.
   3. Nonmetallic conduit.
   4. Flexible nonmetallic conduit.

5. Nonmetallic tubing.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Wireway.
10. Pull and junction boxes.
11. Handholes.

B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Record actual routing of conduits larger than 1 inch.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. Protect PVC conduit from sunlight.

1.8 COORDINATION

A. Coordinate installation of outlet boxes for equipment connected under Section 26 05 83.

B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 - PRODUCTS

2.1 METAL CONDUIT

A. Manufacturers:
1. Allied Tube & Conduit; a part of Atkore International.
2. EGS/Appleton Electric.
3. Thomas & Betts Corporation; A Member of the ABB Group.

B. Rigid Steel Conduit: ANSI C80.1.

C. Rigid Aluminum Conduit: ANSI C80.5.

D. Intermediate Metal Conduit (IMC): Rigid steel.

E. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 PVC COATED METAL CONDUIT

A. Manufacturers:
   1. Plasti-Bond.
   2. Thomas & Betts Corporation; A Member of the ABB Group.

B. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.

C. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

2.3 FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. AFC Cable Systems; a part of Atkore International.
   2. EGS/Appleton Electric.
   3. Southwire Company.

B. Product Description: Interlocked steel construction.

C. Fittings: NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. AFC Cable Systems; a part of Atkore International.
   2. EGS/Appleton Electric.
   3. Southwire Company.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   1. Carlon; a brand of Thomas & Betts Corporation.
   2. Republic Conduit.
   3. Western Tube and Conduit Corporation.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, set screw type.

2.6 NONMETALLIC CONDUIT

A. Manufacturers:
   1. Carlon; a brand of Thomas & Betts Corporation.
   2. EGS/Appleton Electric.

B. Product Description: NEMA TC 2; Schedule 40 PVC and Schedule 80 PVC, as indicated.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.7 NONMETALLIC TUBING

A. Manufacturers:
   1. Carlon; a brand of Thomas & Betts Corporation.

B. Product Description: NEMA TC 2.

C. Fittings and Conduit Bodies: NEMA TC 3.

2.8 SURFACE METAL RACEWAY

A. Manufacturers:
   1. Niedax Inc.
   2. Panduit Corp.
   3. Wiremold / Legrand.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: Per Code plus additional 25% spare, unless otherwise indicated.

D. Finish: Gray enamel. Stainless steel in hazardous locations or where corrosive elements are present.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.9 SURFACE NONMETAL RACEWAY

A. Manufacturers:
   1. Panduit Corp.
   2. Wiremold / Legrand.

B. Product Description: Fiberglass channel with fitted cover, suitable for use as surface raceway.

C. Size: Per Code plus additional 25% spare, unless otherwise indicated.

D. Finish: Gray.

E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories, finish to match raceway.

2.10 WIREWAY

A. Manufacturers:
   1. Carlon; a brand of Thomas & Betts Corporation.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Square D; by Schneider Electric.

B. Product Description: General purpose, Oiltight and dust-tight, or Raintight type wireway. Product rating shall match NEMA Rating for enclosures in same location.

C. Knockouts: Manufacturer's standard. Bottom only in Wet, Damp or Outdoor locations.

D. Size: 4 x 4 inch, 6 x 6 inch, 8 x 8 inch, and 12 x 12 inch; length as indicated on Drawings.

E. Cover: Hinged or Screw cover with full gaskets.

F. Connector: Slip-in or Flanged.

G. Fittings: Lay-in type with removable top, bottom, and side; captive screws and drip shield.

H. Finish: Rust inhibiting primer coating with gray enamel finish.

2.11 OUTLET BOXES

A. Manufacturers:
   1. Allied Moulded Products, Inc.
   2. Carlon; a brand of Thomas & Betts Corporation.
   3. RACO; Hubbell.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.12 PULL AND JUNCTION BOXES

A. Manufacturers:
   1. Emerson Process Management; Rosemount Division.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. RACO; Hubbell.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Hinged Enclosures: As specified in Section 26 27 16.

D. Surface Mounted Cast Metal Box: NEMA 250, Type 4, 4X or 6 (per environmental conditions); flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

E. In-Ground Cast Metal Box: NEMA 250, Type 6, flanged, recessed cover box for flush mounting:
   1. Material: Galvanized cast iron.
   2. Cover: Smooth or Nonskid cover (to match surrounding surfaces) with neoprene gasket and stainless steel cover screws.
   3. Cover Legend: "ELECTRIC" unless otherwise indicated.

F. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
   1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
   2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.

F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 26 05 26.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.

C. Identify raceway and boxes in accordance with Section 26 05 53.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

F. Do not attach raceway to ceiling support wires or other piping systems.

G. Construct wireway supports from steel channel specified in Section 26 05 29.

H. Route exposed raceway parallel and perpendicular to walls.

I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.

J. Route conduit in and under slab from point-to-point.

K. Maximum Size Conduit in Slab Above Grade: 3/4 inch. Do not cross conduits in slab.

L. Maintain clearance between raceway and piping for maintenance purposes.

M. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

N. Cut conduit square using saw or pipe cutter; de-burr cut ends.

O. Bring conduit to shoulder of fittings; fasten securely.

P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.

S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

X. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

A. Install wall mounted boxes at elevations to accommodate mounting heights specified in section for outlet device, unless indicated on Drawings.

B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.

H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

K. Install adjustable steel channel fasteners for hung ceiling outlet box.

L. Do not fasten boxes to ceiling support wires or other piping systems.

M. Support boxes independently of conduit.

N. Install gang box where more than one device is mounted together. Do not use sectional box.

O. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

A. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation as required.

B. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.

C. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused openings in boxes.

3.8 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Labels.
   3. Wire markers.
   4. Conduit markers.
   5. Stencils.
   6. Underground Warning Tape.
   7. Lockout Devices.

1.2 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's catalog literature for each product required.
   2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

B. Samples:
   1. Submit one sample of each type of identification products applicable to project.
   2. Submit one nameplate, 4 x 4 inch in size illustrating materials and engraving quality.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with all applicable Federal, State, and local code and ordinances.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience or approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept identification products on site in original containers. Inspect for damage.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.8 EXTRA MATERIALS

A. Furnish two containers of any spray-on adhesives used.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Craftmark Pipe Markers.
   2. Kolbi Pipe Marker Co.
   3. Seton Identification Products.

B. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color, unless otherwise indicated.

C. Letter Size:
   1. 1/8 inch high letters for identifying individual equipment and loads.
   2. 1/4 inch high letters for identifying grouped equipment and loads.
   3. Minimum 1/8 inch high letters for identifying any required information, not otherwise specified.

D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Manufacturers:
   1. Brady ID.
   2. Seton Identification Products.

B. Labels: Embossed adhesive tape, with 3/16 inch black letters on white background.

2.3 WIRE MARKERS

A. Manufacturers:
   1. Brady ID.
   2. Grafoplast Wire Markers.
   3. Ideal Industries, Inc.

B. Description: Cloth tape, split sleeve, or tubing type wire markers.

C. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
   2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams. Where shop drawings indicate a different labeling methodology at the same location, EACH wire shall bear BOTH labels for clarity.
   3. Communication Cables: Communication and cable type using industry standard designations or as indicated on Drawings.

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:
   1. Brady ID.
   2. Ideal Industries, Inc.

B. Description:
   1. Where susceptible to mechanical damage: Nameplate fastened with straps
   2. With flat smooth surface not susceptible to mechanical damage: Nameplate fastened with adhesive.
   3. Without flat smooth surface: Labels fastened with adhesive.
   4. All other locations, where identification is required: Stencils.

C. Color:
   1. Medium Voltage System: Black lettering on white background.
   2. 480 Volt System: Black lettering on white background.
   3. 208 Volt System: Black lettering on white background.
   4. All other Systems: Black lettering on white background.

D. Legend:
   1. Medium Voltage System: HIGH VOLTAGE.
   2. 480 Volt System: 480 VOLTS.

3. 208 Volt System: 208 VOLTS.
4. Instrumentation & Controls: I & C.
5. Communications: COMMUNICATIONS

2.5 STENCILS

A. Manufacturers:
   1. Kolbi Pipe Marker Co.
   2. Pipemarker.com; Brimar Industries, Inc.
   3. Seton Identification Products.

2.6 UNDERGROUND WARNING TAPE

A. Manufacturers:
   1. Brady ID.
   2. Kolbi Pipe Marker Co.
   3. Seton Identification Products.

B. Description: 4 inch wide plastic tape, detectable type, colored red or yellow, based on warning type, with suitable warning legend describing buried electrical lines.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Manufacturers:
      a. Brady ID.
      b. Master Lock Company, LLC.
   2. Anodized aluminum with erasable label surface; size minimum 7-1/4 x 3 inches.
      a. Reinforced nylon hasp may be allowed in hazardous or corrosive locations per Engineer's approval.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 EXISTING WORK

A. Install identification on existing equipment to remain in accordance with this section.

B. Install identification on unmarked existing equipment and materials associated with proposed work.

C. Replace lost nameplates, labels, and markers.

D. Re-stencil existing equipment.

3.3 INSTALLATION

A. Install identifying devices after completion of painting.

B. Nameplate Installation:
   1. Install nameplate parallel to equipment lines.
   2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
   3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
   4. Secure nameplate to equipment front using screws, rivets, or adhesive.
      a. Screws shall be Standard or Philips type.
      b. Rivets must be approved by Engineer prior to purchase and installation.
   5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
   6. Install nameplates for the following:
      a. Switchboards.
      b. Panelboards.
      c. Transformers.
      d. Service Disconnects.
      e. Control Cabinets.
      f. Remote Instrumentation and Control Enclosures.
      g. Terminal Boxes.

C. Label Installation:
   1. Install label parallel to equipment lines.
   2. Install label for identification of individual control device stations.
   3. Install labels for permanent adhesion and seal with clear lacquer.

D. Wire Marker Installation:
   1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
   2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
   3. Install labels at data outlets identifying patch panel and port designation.

E. Conduit and Raceway Marker Installation:
   1. Install Conduit and Raceway marker for each Conduit and Raceway longer than 6 feet.
   2. Conduit and Raceway Marker Spacing: 20 feet on center.
   3. Raceway Painting: Identify conduit using field painting in accordance with Section 09 90 00.
      a. Paint colored band on each conduit longer than 6 feet.
      b. Paint bands 20 feet on center.

c. Color:
    1) 480 Volt System: Blue.
    2) 208 Volt System: Yellow.
    3) Other Systems: As indicated on Drawings.

F. Underground Warning Tape Installation:
    1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 05 83
WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electrical connections to equipment.

B. Related Sections:
   1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA WD 1 - General Requirements for Wiring Devices.
   2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

B. Manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 - PRODUCTS

2.1 CORD AND PLUGS

A. Manufacturers:
   1. Leviton Manufacturing Co., Inc.
   2. Pass & Seymour/Legrand (Pass & Seymour).
   3. Square D; by Schneider Electric.

B. Attachment Plug Construction: Conform to NEMA WD 1.

C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.

D. Cord Construction:
   1. Multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
      a. Up to 277 Volts: Type SJO.
      b. Up to 600 Volts: Type SO.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 EXISTING WORK

A. Remove exposed abandoned equipment wiring connections, including abandoned connections above accessible ceiling finishes.

B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.

C. Extend existing equipment connections using materials and methods compatible with existing electrical installations, or as specified.

3.3 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.4 ADJUSTING

A. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Two-winding transformers.
   2. Shielded transformers.

B. Related Requirements:
   1. Section 03 30 00 - Cast-In-Place Concrete: Housekeeping pads.
   2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   4. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
   5. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
   2. NEMA ST 20 - Dry Type Transformers for General Applications.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

B. Test and Evaluation Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

C. Source Quality Control Submittals: Indicate results of shop tests, factory tests, and inspections.

D. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Record Documentation: Record actual locations of transformers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
   1. Eaton.
   2. General Electric Company/GE Prolec.
   3. Schneider Electric USA, Inc.

B. Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated on Drawings.

C. Operation:
   1. Primary Voltage: 480 volts, 1 phase.
   2. Secondary Voltage: 240/120 volts, 1 phase.
   3. Insulation system and average winding temperature rise for rated kVA as follows:
      a. 1-15 kVA: Class 185 with 80 degrees C rise.
      b. 16-500 kVA: Class 220 with 115 degrees C rise.
   4. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
   5. Winding Taps:
      a. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
      b. Transformers 15 kVA and Larger: NEMA ST 20.
   6. Sound Levels: NEMA ST 20.
   7. Basic Impulse Level: 10 kV.
   8. Mounting:
      a. 1-15 kVA: Suitable for wall mounting.
      b. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
      c. Larger than 75 kVA: Suitable for floor mounting.

D. Materials:
   1. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
   2. Coil Conductors: Continuous copper windings with terminations brazed or welded.
   3. Enclosure:
      a. NEMA ST 20
      b. Furnish lifting eyes or brackets.
      c. Indoor, Dry Locations: Type 1
      d. Wet/Damp Locations: Type 3R

E. Fabrication:
   1. Isolate core and coil from enclosure using vibration-absorbing mounts.
   2. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SHIELDED TRANSFORMERS

A. Manufacturers:
   1. Eaton.
   2. Schneider Electric USA, Inc.
   3. Sola/Hevi-Duty; a brand of Emerson Electric Co.

B. Description: NEMA ST 20, factory-assembled, air-cooled, dry type shielded isolation transformers, ratings as indicated on Drawings.

C. Operation:
   1. Primary Voltage: 480 volts, 1 phase.
   2. Secondary Voltage: 240/120 volts, 1 phase.
   3. Insulation system and average winding temperature rise for rated kVA as follows:
      a. 10-15 kVA: Class 185 with 115 degrees C rise.
      b. 16-500 kVA: Class 220 with 150 degrees C rise.
   4. Case temperature: Do not exceed 50 degrees C rise above ambient at warmest point at full load.
   5. Winding Taps:
      a. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
      b. Transformers 15 kVA and Larger: NEMA ST 20.
   6. Sound Levels: NEMA ST 20.
   7. Basic Impulse Level: 10 kV.
   8. Winding Shield: Electrostatic, with separate insulated grounding connection.
   9. Mounting:
      a. 1-15 kVA: Suitable for wall mounting.
      b. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
      c. Larger than 75 kVA: Suitable for floor mounting.

D. Materials:
   1. Ground core and coil assembly to enclosure with visible flexible copper grounding strap.
   2. Coil Conductors: Continuous copper windings with terminations brazed or welded.

3. Enclosure:
    a. NEMA ST 20
    b. Furnish lifting eyes or brackets.
    c. Indoor, Dry Locations: Type 1
    d. Wet/Damp Locations: Type 3R

E. Fabrication:
    1. Isolate core and coil from enclosure using vibration-absorbing mounts.
    2. Nameplate: Include transformer connection data.

2.3 SOURCE QUALITY CONTROL

A. Production test each unit according to NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 PREPARATION

A. Provide concrete pads under provisions of Section 03 30 00.

3.3 DEMOLITION

A. Disconnect and remove abandoned transformers.

B. Maintain access and adequate ventilation to existing transformers and other installations remaining active and requiring access and ventilation. Modify installation or provide access panel or ventilation grilles.

3.4 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 26 05 33, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Support transformers in accordance with Section 26 05 29.
    1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
    2. Mount floor-mounted transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

3. Mount trapeze-mounted transformers as indicated on Drawings.

D. Provide seismic restraints.

E. Install grounding and bonding in accordance with Section 26 05 26.

3.5 REPAIR AND RESTORATION

A. Repair existing transformers to remain or to be reinstalled.

3.6 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.7 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

3.8 CLEANING

A. Clean existing transformers to remain or to be reinstalled.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Distribution and branch circuit panelboards.
2. Electronic grade branch circuit panelboards.
3. Load centers.

B. Related Requirements:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.
3. Section 26 28 13 - Fuses.

1.2 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
1. NEMA FU 1 - Low Voltage Cartridge Fuses.
2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NEMA PB 1 - Panelboards.
6. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

E. UL:
1. UL 50 - Cabinets and Boxes
2. UL 67 - Safety for Panelboards.
3. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
4. UL 1283 - Electromagnetic Interference Filters.
5. UL 1449 - Transient Voltage Surge Suppressors.

6. UL 1699 - Arc-Fault Circuit Interrupters.

1.3 SUBMITTALS

A. Product Data: Submit catalog data showing specified features of standard products.

B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker, and fusible switch arrangement and sizes.

C. Source Quality Control Submittals: Indicate results of shop or factory tests and inspections.

D. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.

B. Operation and Maintenance Data: Submit spare parts listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:
1. Furnish two of each panelboard key. Panelboards keyed alike to Owner's current keying system.

1.6 QUALITY ASSURANCE

A. Qualifications
1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

PART 2 - PRODUCTS

2.1 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Eaton.
2. Siemens Industry, Inc.
3. Square D; by Schneider Electric.

B. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Materials:
1. Panelboard Bus: Copper, current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard; furnish insulated ground bus as indicated on Drawings.

2. For non-linear load applications subject to harmonics furnish 200 percent rated, plated copper, solid neutral.
3. Minimum Integrated Short Circuit Rating: 10,000 A rms symmetrical for 240 V panelboards; 65,000 S rms symmetrical for 480 V panelboards, or as indicated on Drawings.
4. Molded Case Circuit Breakers: UL 489, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Provide UL class 760 arc-fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
5. Current Limiting Molded Case Circuit Breakers: UL 489, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical A, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.
6. Surge Suppresser: External Device, installed next to panelboard; refer to Section 26 35 53. Match Panelboard Manufacturer.
7. Enclosure: NEMA PB 1, Type 1 (Indoor), Type 3R (Outdoor).
8. Cabinet Box: Minimum 6 inches deep.

D. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike. Finishes:
1. Finish in manufacturer's standard gray enamel.

2.2 LOAD CENTERS

A. Manufacturers:
1. Eaton.
2. Siemens Industry, Inc.
3. Square D; by Schneider Electric.

B. Description: Circuit breaker load center, with bus ratings as indicated on Drawings.

C. Performance:
1. Minimum Integrated Short Circuit Rating: 10,000 A rms symmetrical.

D. Materials:
1. Molded Case Circuit Breakers: UL 489, plug-on type thermal magnetic trip circuit breakers, with common trip handle for poles, listed as Type SWD for lighting circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
2. Enclosure:
   a. Indoor and Dry Locations: General Purpose
   b. Outdoor, Wet, or Damp Locations: Rainproof.

E. Box: Flush or Surface type with door and lock on door. Finishes:
1. Finish in manufacturer's standard gray enamel.

2.3 SOURCE QUALITY CONTROL

A. Independently test surge suppressers with category C3 high exposure waveform (20 kV-1.2/50us, 10kA-8/20 us) per IEEE C62.41.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Disconnect abandoned panelboards and load centers. Install blank cover for abandoned panelboards and load centers.

B. Maintain access to existing panelboard and load centers remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

A. Install panelboards and load centers according to NEMA PB 1.1.

B. Install panelboards and load centers plumb.

C. Install recessed panelboards and load centers flush with wall finishes.

D. Height: 6 feet to top of panelboard and load center; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Install filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard and load center. Revise directory to reflect circuiting changes to balance phase loads. Identify each circuit as to its clear, evident and specific purpose of use.

G. Install engraved plastic nameplates according to Section 26 05 53.

H. Install spare conduits out of each recessed panelboard to accessible location above ceiling or below floor. Minimum spare conduits: 25%, empty 1 inch. Identify each as spare.

I. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels according to NFPA 70.

3.3 REPAIR AND RESTORATION

A. Repair existing panelboards and load centers to remain or to be reinstalled.

3.4 FIELD QUALITY CONTROL

A. Inspect and test according to NETA ATS, except Section 4.

B. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.

C. Perform switch inspections and tests listed in NETA ATS, Section 7.5.

D. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.

3.5 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 5 percent of each other. Maintain proper phasing for multi-wire branch circuits.

3.6 CLEANING

A. Clean existing panelboards and load centers to remain or to be reinstalled.

END OF SECTION

SECTION 26 27 16
ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hinged cover enclosures.
   2. Cabinets.
   3. Terminal blocks.
   4. Accessories.

B. Related Requirements:
   1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's standard data for enclosures, cabinets, and terminal blocks.

B. Manufacturer's Instructions: Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Qualification Statements:
   1. Submit manufacturer, installer, and licensed professional experience qualifications.
   2. Submit manufacturer's approval of installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:
   1. Furnish two of each key.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 HINGED COVER ENCLOSURES

A. Manufacturers:
   1. Saginaw Control Engineering
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Wiegmann; Hubbell Inc.

B. Description: NEMA 250, steel, stainless steel, or fiberglass enclosure.
   1. Indoor, Dry Locations: NEMA 1, steel
   2. Wet, Damp, or Outdoor Locations: NEMA 3R, steel
   3. Hazardous Locations: NEMA 4X, stainless steel
      a. NEMA 4X, Fiberglass where corrosive materials are present.
   4. Covers: Continuous hinge, held closed by flush latch operable by screwdriver or key (as indicated), hasp and staple for padlock.
   5. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
   6. Enclosure Finish: Manufacturer's standard enamel, unless stainless steel.

2.2 CABINETS

A. Manufacturers:
   1. Saginaw Control Engineering
   2. Hammond Mfg. Co. Inc.
   3. Hoffman; a brand of Pentair Equipment Protection.

B. Description:
   1. Boxes: Galvanized steel.
   2. Box Size: As required for wiring and components plus 25% spare, or as shown on drawings.
   3. Backplate: Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
   4. Fronts: Steel, flush or surface type (as indicated) with concealed trim clamps, screw cover front, door with concealed hinge, and flush lock keyed to match branch circuit panelboard.
   5. Knockouts: Manufacturer’s standard, unless otherwise indicated.
   6. Ratings: NEMA ICS 6:
      a. Indoor, Dry Locations: Type 1 or 12
      b. Indoor, Wet or Damp Locations: Type 3R, 4 or 4X
      c. Outdoor Locations: Type 3R, 4 or 4X
      d. Hazardous Locations: Type 4X

C. Fabrication
   1. Furnish metal barriers to form separate compartments wiring of different systems and voltages.
   2. Furnish accessory feet for free-standing equipment.

D. Finishes:
   1. Finish with gray baked enamel.

E. Spare Capacity: Minimum 25 percent space.
   1. Space shall be defined as Square Inches of exposed Enclosure's Sub-panel, typically White in color, in which future components can be installed.

2.3 CONTROL PANEL ENCLOSURES

A. Manufacturers:
   1. Saginaw Control Engineering
   2. Hammond Mfg. Co. Inc.
   3. Hoffman; a brand of Pentair Equipment Protection.

B. Description: NEMA 250, steel with continuously welded seams.
   1. Indoor, Dry Locations: NEMA 12
   2. Wet, Damp, or Outdoor Locations: NEMA 3R, 4, or 4X
   3. Hazardous Locations: NEMA 4X, stainless steel
      a. NEMA 4X, Fiberglass where corrosive materials are present.
   4. Gasketed door(s), held closed by flush latch operable by screwdriver, hasp and staple for padlock.
   5. Furnish interior metal sub-panel for mounting terminal blocks and electrical components; finish with white enamel.
   6. Enclosure Finish: Manufacturer's standard enamel, unless stainless steel or non-metallic.
   7. Spare Capacity: Minimum 25 percent spare "white space" on enclosure's interior sub-panel.

2.4 TERMINAL BLOCKS

A. Manufacturers:
   1. Allen-Bradley/Rockwell Automation.
   2. Bussmann, an Eaton business.
   3. Square D; by Schneider Electric.

B. Description:
   1. Terminal Blocks: NEMA ICS 4.
   2. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
   3. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
   4. Furnish ground bus terminal block, with each connector bonded to enclosure.

C. Spare Capacity: Minimum 25 percent additional Terminals for each power and signal type including, but not limited to:
   1. Power: 480vac, 120vac, 24vdc.
   2. Signal: Discrete Input, Discrete Output, Analog Input, Analog Output.

2.5 PLASTIC RACEWAY

A. Manufacturers:
   1. Panduit Corp.
   2. Wiremold / Legrand.

B. Description: Plastic channel with hinged or snap-on cover.

2.6 CORROSION PROTECTION

A. Manufacturers; Emitter:
   1. Cortec Corporation.
   2. Description: Foam emitter to provide long term protection against corrosion by airborne contaminants.
      a. For each enclosure, furnish quantity as indicated in manufacturer's instructions to protect the enclosure.

B. Manufacturers; Absorber:
   1. Cortec Corporation.
   2. Description: Plastic cup with breathable membrane to absorb corrosive gasses from the enclosure.
      a. For each enclosure, furnish quantity as indicated in manufacturer's instructions to protect the enclosure.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Remove abandoned cabinets and enclosures, including abandoned cabinets and enclosures above accessible ceiling finishes. Patch surfaces.

B. Maintain access to existing cabinets and enclosures and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Extend existing cabinets and enclosures using materials and methods compatible with existing electrical installations, or as specified.

3.2 REPAIR AND RESTORATION

A. Repair existing cabinets and enclosures to remain or to be reinstalled.

3.3 INSTALLATION

A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner in accordance with Section 26 05 29.

B. Install cabinet fronts plumb.

3.4 CLEANING

A. Clean existing cabinets and enclosures to remain or to be reinstalled.

B. Clean electrical parts to remove conductive and harmful materials.

C. Remove dirt and debris from enclosure.

D. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.

B. Related Sections:
   1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA WD 1 - General Requirements for Wiring Devices.
   2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

B. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 EXTRA MATERIALS

A. Furnish two of each style, size, and finish wall plate.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:

1. Leviton Manufacturing Co., Inc.
2. Lutron Electronics Co., Inc.
3. Pass & Seymour/Legrand (Pass & Seymour).

B. Product Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch.

C. Body and Handle: Ivory plastic with toggle handle.

D. Indicator Light: Lighted handle type switch or Separate pilot strap; red color handle or lens.

E. Locator Light: Lighted handle type switch; green color handle.

F. Ratings:
1. Voltage: 120-277 volts, AC.
2. Current: 20 amperes.

2.2 RECEPTACLES

A. Manufacturers:
1. Eaton (Arrow Hart).
2. Hubbell Premise Wiring.
3. Leviton Manufacturing Co., Inc.

B. Product Description: NEMA WD 1, Heavy-duty general use receptacle.

C. Device Body: Ivory plastic.

D. Configuration: NEMA WD 6, type.

E. Convenience Receptacle: Type 5-20.

F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
1. Status Indicator Light: Red or Green LED
2. TEST and RESET Pushbuttons

2.3 WALL PLATES

A. Manufacturers:
1. Leviton Manufacturing Co., Inc.
2. RACO; Hubbell.
3. Square D; by Schneider Electric.

B. Decorative Cover Plate: Smooth 302 stainless steel.

C. Jumbo Cover Plate: Smooth 302 stainless steel.

D. Weatherproof Cover Plate: Stainless steel plate with threaded and gasketed device cover.

2.4 MULTIOUTLET ASSEMBLY

A. Manufacturers:
   1. Cutler-Hammer.
   2. Wiremold / Legrand.

B. Multi-outlet Assembly: Sheet metal channel with fitted cover, with pre-wired receptacles, suitable for use as multi-outlet assembly.

C. Size: As required or indicated on Drawings.

D. Receptacles: Furnish covers and accessories to accept receptacles specified in this Section.

E. Receptacle Spacing: As indicated on Drawings.

F. Receptacle Color: Ivory.

G. Channel Finish: Ivory enamel.
   1. Wet, Damp, or Outdoor Locations: Stainless steel.

H. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 EXISTING WORK

A. Disconnect and remove abandoned wiring devices.

B. Modify installation to maintain access to existing wiring devices to remain active.

C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.4 INSTALLATION

A. Install devices plumb and level.

B. Install switches with OFF position down.

C. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Install receptacles with grounding pole on bottom.

F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

G. Install wall plates on flush mounted switches, receptacles, and blank outlets.

H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

I. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

J. Use jumbo size plates for outlets installed in masonry walls.

K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified and as indicated on drawings.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle Minimum 18 inches above finished floor.

D. Install convenience receptacle 6 inches above counter.

E. Install dimmer 48 inches above finished floor.

3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fuses.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 SUBMITTALS

A. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.5 MAINTENANCE MATERIALS

A. Spare Parts:
1. Furnish two fuse pullers.

B. Extra Materials:
1. Furnish three spare fuses of each Class, size, and rating installed.

1.6 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Bussmann, an Eaton business.

2.2 DESIGN REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.

B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

2.3 FUSES PERFORMANCE REQUIREMENTS

A. Main Service Switches Larger than 600 amperes: Class L (time delay).

B. Main Service Switches: Class RK1 (time delay). RK5. J (time delay).

C. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).

D. Power Load Feeder Switches: Class RK1 (time delay). RK5. J (time delay).

E. Motor Load Feeder Switches: Class RK1 (time delay). RK5. J (time delay).

F. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay.

G. Lighting Load Feeder Switches: Class RK1 (time delay). RK5. J (time delay).

H. Other Feeder Switches Larger than 600 amperes: Class L time delay.

I. Other Feeder Switches: Class RK1 (time delay). RK5. J (time delay).

J. General Purpose Branch Circuits: Class RK1 (time delay). RK5. J (time delay).

K. Motor Branch Circuits: Class RK1 (time delay). RK5. J (time delay).

L. Lighting Branch Circuits: Class G.

2.4 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.5 CLASS RK1 (TIME DELAY) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.6 CLASS RK1 (NON-TIME-DELAY) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.7 CLASS RK5 FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.8 CLASS J (TIME DELAY) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.9 CLASS J (NON-TIME-DELAY) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.10 CLASS T FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.11 CLASS L (FAST-ACTING) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.12 CLASS L (TIME DELAY) FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.13 CLASS G FUSES

A. Dimensions and Performance: NEMA FU 1.

B. Voltage: Rating suitable for circuit phase-to-phase voltage.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Remove fuses from abandoned circuits.

B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

A. Install fuse with label oriented so manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible.
   2. Nonfusible switches.

B. Related Requirements:
   1. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   2. Section 26 05 53 - Identification for Electrical Systems.
   3. Section 26 28 13 - Fuses.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. Square D; by Schneider Electric.
   2. Eaton.
   3. Siemens Power Transmission & Distribution, Inc.

B. Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Operation:
   1. Switch Ratings
      a. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
      b. Short Circuit Current Rating: UL listed for 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere). 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

D. Materials:
   1. Fuse clips: Designed to accommodate NEMA FU 1 fuses.
      a. Fuse Class to match required application.
   2. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
      a. Interior Dry Locations: Type 1.
      b. Exterior Locations: Type 3R or 4.
      c. Industrial Locations: Type 4X.
      d. Hazardous Locations: Type 4X.
   3. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
   4. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
   1. Square D; by Schneider Electric.
   2. Eaton.
   3. Siemens Power Transmission & Distribution, Inc.

B. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

C. Operation:
   1. Switch Ratings
      a. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

b. Short Circuit Current Rating: UL listed for 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere). 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes). 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

D. Materials:
   1. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
      a. Interior Dry Locations: Type 1.
      b. Exterior Locations: Type 3R or 4.
      c. Industrial Locations: Type 4X.
      d. Hazardous Locations: Type 4X.
   2. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
   3. Furnish switches with entirely copper current carrying parts.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Disconnect and remove abandoned enclosed switches.

B. Maintain access to existing enclosed switches and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

A. Install enclosed switches where indicated.

B. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.

C. Height: 5 feet to operating handle.

D. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.

E. Install engraved plastic nameplates in accordance with Section 26 05 53. Engrave nameplates with the equipment served and the panel and circuit number supplying the switch.

F. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.3 REPAIR AND RESTORATION

A. Repair and Restore existing enclosed switches to remain or to be reinstalled in accordance to Owner's standards and requirements.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.5.

3.5 CLEANING

A. Clean existing enclosed switches to remain or to be reinstalled.

END OF SECTION

SECTION 26 29 23
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes variable frequency controllers.

B. Related Sections:
   1. Section 26 28 13 - Fuses.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.
   4. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.

C. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Test Reports: Indicate field test and inspection procedures and test results.

D. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions complying with NEMA ICS 7.1. Include procedures for starting and operating controllers, and describe operating limits possibly resulting in hazardous or unsafe conditions. Include routine preventive maintenance schedule.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Conform to NEMA ICS 7 service conditions during and after installation of variable frequency controllers.

1.8 WARRANTY

A. Furnish five year manufacturer warranty for variable frequency controller.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of variable frequency controller for one year from Date of Substantial Completion.

1.10 MAINTENANCE MATERIALS

A. Furnish two of each air filter.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY CONTROLLER

A. Manufacturers:
   1. ABB.
   2. Allen-Bradley/Rockwell Automation.
   3. Square D, by Schneider Electric.

B. Product Description: NEMA ICS 7, enclosed variable frequency controller suitable for operating indicated loads. Select unspecified features and options in accordance with NEMA ICS 7.1.

C. Ratings:
   1. Rated Input Voltage: As stated on drawings.
   2. Motor Nameplate Voltage: As stated on drawings.
   3. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
   4. Operating Ambient: 0 degrees C to 40 degrees C.
   5. Minimum Efficiency at Full Load: 98 percent.

D. Design Features:
   1. Employ microprocessor-based inverter logic isolated from power circuits.
   2. Employ pulse-width-modulated inverter system.
   3. Design for ability to operate controller with motor disconnected from output.
   4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

E. Indicators and Manual Controls:
   1. Input Signal: Selectable as 4 - 20 mA DC or 0-10 mV DC.
   2. Display: Furnish integral digital display to indicate output voltage, output frequency, and output current.
   3. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
   4. Volts Per Hertz Adjustment: Plus or minus 10 percent.
   5. Current Limit Adjustment: 60 - 110 percent of rated.
   6. Acceleration Rate Adjustment: 0.5 - 30 seconds.
   7. Deceleration Rate Adjustment: 1 - 30 seconds.
   8. HAND-OFF-AUTOMATIC selector switch and manual speed control.
   9. Control Power Source: Integral control transformer.

F. Safeties and Interlocks:
   1. Includes undervoltage release.
   2. Door Interlocks: Mechanical means to prevent opening of equipment with power connected, or to disconnect power when door is opened; include means for defeating interlock by qualified persons.
   3. Safety Interlocks: Terminals for remote contact to inhibit starting under both manual and automatic mode.
   4. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.

5. Manual Bypass: Includes contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of motor. Includes isolation switch to allow maintenance of inverter during bypass operation.
6. Emergency Stop: Use dynamic brakes for emergency stop function.
7. Disconnecting Means: Integral circuit breaker on line side of each controller.

G. Fabrication:
1. Wiring Terminations: Match conductor materials and sizes as indicated on Drawings.
2. Enclosure: NEMA 250, Type 1, suitable for equipment application in places accessible only to qualified personnel.
3. Finish: Manufacturer's standard enamel.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Manufacturers:
1. Bussmann, an Eaton business.
2. General Electric Company.
3. SIEMENS Industry, Inc.; Energy Management Division.

B. Product Description: IEEE C62.41, factory-mounted transient voltage surge suppressor, selected to meet requirements for high exposure and to coordinate with system circuit voltage.

2.3 SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller.

B. Make completed controllers available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner and Architect/Engineer at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner and Architect/Engineer at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify building environment is maintained within service conditions required by manufacturer.

3.2 EXISTING WORK

A. Disconnect and remove abandoned controllers.

B. Clean and repair existing controllers to remain or to be reinstalled.

3.3 INSTALLATION

A. Install in accordance with NEMA ICS 7.1.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Install fuses in fusible switches.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Install engraved plastic nameplates in accordance with Section 26 05 53.

F. Neatly type label inside controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

G. Ground and bond controller in accordance with Section 26 05 26.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.16 and NEMA ICS 7.1.

3.5 MANUFACTURER'S FIELD SERVICES

A. Prepare and startup variable frequency controller.

3.6 DEMONSTRATION AND TRAINING

A. Furnish 4 hours of instruction each for a minimum of two persons, to be conducted at project site with manufacturer's representative.

END OF SECTION

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes engine generator set, exhaust silencer and fittings, transfer switch, fuel fittings, battery, and charger.

B. Related Sections:
   1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   2. Section 26 05 53 - Identification for Electrical Systems.
   3. Section 26 36 13 - Enclosed Transfer Switches.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
   3. NEMA MG 1 - Motors and Generators.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
   1. NFPA 30 - Flammable and Combustible Liquids Code.
   2. NFPA 99 - Standard for Health Care Facilities.
   3. NFPA 110 - Standard for Emergency and Standby Power Systems.

D. Underwriters Laboratories Inc.:
   1. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.3 SYSTEM DESCRIPTION

A. Description: Engine generator assembly and accessories to provide source of power for Level 1 and 2 applications in accordance with NFPA 110, and conforming to NFPA 99.

B. Capacity: As stated on drawings, at elevation of 1000 feet above sea level, standby rating using specified engine cooling scheme.

1.4 SUBMITTALS

A. Shop Drawings: Indicate electrical characteristics and connection requirements. Include plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

B. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, transfer switch, battery, battery rack, battery charger, exhaust silencer, vibration isolators, and remote radiator.

C. Test Reports: Indicate results of performance testing.

D. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of project.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.7 WARRANTY

A. Furnish five year manufacturer warranty.

1.8 MAINTENANCE SERVICE

A. Furnish service and maintenance of engine generator and transfer switch for one year from Date of Substantial Completion.

1.9 MAINTENANCE MATERIALS

A. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.

B. Furnish two of each fuel, oil and air filter element.

PART 2 - PRODUCTS

2.1 ENGINE

A. Manufacturers:
   1. Cummins Power Generation.
   2. Kohler.
   3. Caterpillar.

B. Product Description: Water-cooled in-line or V-type, four-stroke cycle, electric ignition internal combustion engine.

C. Rating: Sufficient to operate under 10 percent overload for one hour in ambient of 90 degrees F (32 degrees C) at elevation of 1,000 feet

D. Fuel System: Natural gas.

E. Engine speed: 1800 rpm.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 120 volts AC.

I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F (43 degrees C). Radiator air flow restriction 0.5 inches of water (1.25 Pa) maximum.

J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Furnish fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.

K. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.

2.2 GENERATOR

A. Manufacturers:
   1. Cummins Power Generation.
   2. Kohler.
   3. Caterpillar.

B. Product Description: NEMA MG1, three phase, six pole, reconnectable brushless synchronous generator with brushless exciter.

C. Rating: As stated on drawings.

D. Insulation Class: F.

E. Temperature Rise: 130 degrees C Standby.

F. Enclosure: NEMA MG1, open drip proof, Type 2 Sound Attenuated.

G. Voltage Regulation: Furnish generator mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

2.3 GOVERNOR

A. Manufacturers:
   1. Cummins Power Generation.
   2. Kohler.
   3. Caterpillar.

B. Product Description: Electronic or Isochronous governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

2.4 AUTOMATIC TRANSFER SWITCH

A. Manufacturers:
   1. As provided by generator supplier.

B. Product Description: NEMA ICS 10, automatic transfer switch.

C. Configuration: Electrically operated, mechanically held transfer switch.

D. Interrupting Capacity: 100 percent of continuous rating.

E. Withstand Current Rating: 25,000 rms symmetrical amperes, when used with molded case circuit breaker.

F. Control Features and Functions:
   1. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.
   2. Test Switch: Mount in cover of enclosure to simulate failure of normal source.

3. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
4. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.
5. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
6. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 Hertz from rated nominal value.
7. In-Phase Monitor: Inhibit transfer until source and load are within 8 electrical degrees.
8. Switched Neutral: Non-Overlapping contacts.

G. Automatic Sequence of Operation:
1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
2. Time Delay To Start Alternate Source Engine Generator: 0 to 120 seconds, adjustable.
3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay Before Transfer to Alternate Power Source: 0 to 120 seconds, adjustable.
5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
6. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

H. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

I. Engine Exerciser: Start engine every 7, 14, or 30 days; run for 30 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.

J. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

K. Enclosure:
1. Enclosure:
a. ICS 10
b. Indoor: Type 1 or 12
c. Outdoor: Type 3R or 4X
2. Finish: Manufacturer's standard enamel.

2.5 ACCESSORIES

A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.

B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 150 Ampere-hours minimum capacity unless otherwise stated by Generator Manufacturer. Match battery voltage to starting system. Furnish cables and clamps.

C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

D. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Furnish wall mounted enclosure to meet NEMA 250, Type 1 requirements.

E. Battery Heater: 120 volts AC battery tray heater, set to maintain temperature range between 65 and 80 Degrees F.

F. Alternator Heater: 120 volts AC, 100 Watt Minimum, anti-condensation heater.

G. Line Circuit Breaker: UL 489, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole. Furnish battery voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements.

H. Engine-Generator Control Panel: NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment and features:
   1. Frequency Meter: 45-65 Hz. range, 3.5 inch (89 mm) dial.
   2. AC Output Voltmeter: 3.5 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.
   3. AC Output Ammeter: 3.5 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.
   4. Output voltage adjustment.
   5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
   6. Engine start/stop selector switch.
   7. Engine running time meter.
   8. Oil pressure gage.
   9. Water temperature gage.
   10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
   11. Additional visual indicators and alarms in accordance with by NFPA 110.
   12. Remote Alarm Contacts: Factory wire SPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110, unless otherwise specified.

I. Remote Annunciator Panel: Surface mounted panel with painted finish, black color. Furnish alarm horn, and indicators and alarms as follows:
   1. High battery voltage (alarm).
   2. Low battery voltage (alarm).
   3. Low fuel pressure (alarm).
   4. System ready.
   5. Anticipatory-high water temperature.
   6. Anticipatory-low oil pressure.
   7. Low coolant temperature.
   8. Switch in off position (alarm).
   9. Overcrank (alarm).
   10. Emergency stop (alarm).
   11. High water temperature (alarm).
   12. Overspeed (alarm).
   13. Low oil pressure (alarm).

14. Line power available.
15. Generator power available.
16. Lamp test and horn silence switch.

J. Weather-protective Enclosure: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Furnish fixed louvers, battery rack, and silencer.

2.6 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Make completed engine-generator assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner and Architect/Engineer at least seven days before inspection is allowed.

C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner and Architect/Engineer at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned engine-generator assemblies and accessories.

B. Clean and repair existing engine-generator assemblies to remain or to be reinstalled.

3.2 INSTALLATION

A. Install engraved plastic nameplates in accordance with Section 26 05 53.

B. Ground and bond generator and other electrical system components in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.22.

C. Engineer to be present during generator start-up and testing. Provide at least one week advance notice.

D. Provide full load test utilizing portable test bank, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

E. During test, record the following at 20 minute intervals:
   1. Kilowatts.
   2. Amperes.
   3. Voltage.
   4. Coolant Temperature.
   5. Ambient Temperature.
   6. Frequency.
   7. Oil Pressure.

F. Test alarm and shutdown circuits by simulating conditions.

3.4 MANUFACTURER'S FIELD SERVICES

A. Prepare and start up engine-generator assembly.

3.5 ADJUSTING

A. Adjust generator output voltage and engine speed to meet specified ratings.

3.6 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters with new.

3.7 DEMONSTRATION AND TRAINING

A. Furnish four (4) hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

B. Describe loads connected to emergency and standby system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and standby power.

END OF SECTION

SECTION 26 35 53
VOLTAGE REGULATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Transient voltage surge suppressors.

B. Related Sections:
   1. Section 26 24 16 - Panelboards: Transient voltage surge suppressors integrated in panelboards.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   1. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
   2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   3. IEEE C62.45 - Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
   1. NEMA LS 1 - Low Voltage Surge Protection Devices.

C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
   2. NFPA 780 - Standard for the Installation of Lightning Protection Systems.

D. UL:
   1. UL 1283 - Electromagnetic Interference Filters.
   2. UL 1449 - Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

A. Product Data: Submit capacity, dimensions, weights, details, and wiring configuration.

B. Test Reports:
   1. Indicate let-through voltage test data.
   2. Submit spectrum analysis of each unit.
   3. Submit test reports from nationally recognized independent testing laboratory verifying suppressors can survive published surge current rating.

C. Manufacturer's Installation Instructions: Submit installation instructions and connection requirements.

D. Manufacturer's Certificate: Certify transient voltage surge suppression device complies with UL 1449 Second Edition Surge Voltage Ratings.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of transient voltage surge suppressors.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. List individual units under UL 1449 and UL 1283.

B. Perform Work according to all applicable Federal, State, and Local Codes and Ordinances.

C. Maintain one copy of each document on Site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment on Site in factory packaging. Inspect for damage.

B. Protect equipment from damage by providing temporary covers until construction is complete in adjacent space.

1.8 WARRANTY

A. Furnish five-year manufacturer's warranty for transient voltage surge suppressor part failure.

PART 2 - PRODUCTS

2.1 TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS)

A. Manufacturers:
   1. Square D, by Schneider Electric.

2. Cooper Industries, Inc.
3. General Electric Company.
4. Siemens Industry, Inc.

B. Product Description: Surge protective devices for protection of AC electrical circuits.

C. Types: Service entrance switchboards, Enclosed switchgear, Busway systems, Distribution switchboards, Power panelboards, Lighting panelboards.

D. Unit Operating Voltage: As indicated on Drawings.

E. Maximum Continuous Operating Voltage: Greater than 115 percent of nominal system operating voltage.

F. Construction:
1. Finish: Factory finish of baked enamel.
2. Balanced Suppression Platform: Equally distribute surge current to metal oxide varistor (MOV) components to ensure equal stressing and maximum performance. Furnish surge suppression platform with equal impedance paths to each matched MOV.
3. Internal Connections: Hardwired with connections using low impedance conductors and compression fittings.
4. Safety and Diagnostic Monitoring: Equipped with standard overcurrent protection:
   a. Continuous monitoring of fusing system.
   b. Monitor individual MOVs (including neutral to ground). Capable of identifying open circuit failures not monitored by conventional fusing systems.
   c. Monitor for overheating in each mode due to thermal runaway.
   d. Furnish green and red solid state indicator light on each phase. Absence of green light and presence of red light indicates which phases have been damaged. Fault detection activates flashing trouble light. Units not capable of detecting open circuit damage, thermal conditions, and over current will not be accepted.
5. Labeling: Permanently affix UL 1449 suppression voltage ratings and CSA to unit.

G. Rating:
1. Electrical Noise Filter: Furnish each unit with high performance EMI/RFI noise rejection filter. Electric line noise attenuation no less than 45 dB at 100 kHz using MIL-STD-220A insertion loss test method.

H. Accessories:
1. Digital display transient event counter with manual reset.
2. Local audible alarm.
3. Form C dry contacts one normally open (NO) and one normally closed (NC) for remote status monitoring.
4. Push-to-test feature.

I. Surge Current Capacity:
1. Total Surge Current Survival Based on 8-by-20-microsecond Waveform:
   a. Service Entrance (Switchboards, Switchgear, and MCCs):
      1) Minimum Surge Current per Phase: 250kA.
      2) Minimum Surge Current per Mode: 125kA.

b. High-Exposure Rooftop Locations:
   1) Minimum Surge Current per Phase: 160kA.
   2) Minimum Surge Current per Mode: 80kA.
c. Distribution and Branch Locations (Panelboards, MCCs, Bus Ducts):
   1) Minimum Surge Current per Phase: 120kA.
   2) Minimum Surge Current per Mode: 60kA.

J. Protection Modes: For Wye configured system, furnish device with directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For Delta configured system, furnish device with suppression elements between line to line (L-L) and line to ground (L-G).

K. Do not exceed following for maximum UL 1449 suppression voltage ratings:
1. WYE; L-N, L-G, N-G:
   a. 208Y/120: 400 V.
   b. 480Y/277: 800 V.
   c. 600Y/347: 1,200 V.
2. Delta; L-L, L-G:
   a. 208Y/120: 800 V.
   b. 480Y/277: 1,500 V.
   c. 600Y/347: 2,000 V.

L. ANSI/IEEE Catalog C3 Let Through Voltage: Based on ANSI/IEEE C62.41 and C62.45 recommended procedures for Catalog C3 surges (20 kV, 10kA) and not less than:
1. 208Y/120; L-N: 500 V.
2. 480Y/277; L-N: 900 V.
3. 600Y/347; L-N: 1,300 V.

M. ANSI/IEEE Cat. B3 Let Through Voltage: Based on ANSI/IEEE C62.41 and C62.45 recommended procedures for ANSI/IEEE Catalog B3 Ringwave (6 kV, 500 amps) not less than:
1. 208Y/120:
   a. WYE; L-N, L-G, N-G: 400 V.
   b. L-N: 170 V.
2. 480Y/277:
   a. WYE; L-N, L-G, N-G: 800 V.
   b. L-N: 300 V.
3. 600Y/347:
   a. WYE; L-N, L-G, N-G: 1,200 V.
   b. L-N: 470 V.

2.2 SOURCE QUALITY CONTROL AND TESTS

A. Test units to specified surge ratings to ensure devices will achieve required life expectancy and reliability. Testing to full ratings also verifies internal construction quality of suppressors. Provide withstand testing for each mode and each phase basis.

B. Perform actual let-through voltage test data in form of oscillograph results for ANSI/IEEE C62.41 Catalog C3 (20 kV, 10 kA), Catalog C1 (6 kV, 3 kA), and Catalog. B3 (6 kv, 500 A at 100 kHz) tested according to ANSI/IEEE C62.45.

C. Perform spectrum analysis of each unit based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying device noise attenuation exceeds 45 dB at 100 kHz.

D. Perform test verifying suppressors can survive published surge current rating for each mode and each phase basis. Test wave based on ANSI/IEEE C62.41, 8-by-20-microsecond current wave.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify mounting area is ready for equipment.

B. Verify circuit rough-ins are at correct location.

3.2 INSTALLATION

A. Install according to IEEE 1100.

B. Install service entrance suppressors in switchboard or switchgear at point of origination for each power configuration within distribution system.

C. Install distribution and branch suppressors externally, next to panelboards.

D. Install using direct bus bar connection.

E. Install indicator lights, trouble alarms, and surge counter in face of switchboard, switchgear, and panelboard.

F. Install with maximum conductor length of 14 inches. Install suppressor with internal fusing.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes interior luminaires, lamps, ballasts, and accessories.

B. Related Sections:
   1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
   2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.

B. Product Data: Submit dimensions, ratings, and performance data.

C. Samples: Submit two color chips 3 x 3 inch (75 x 75 mm) in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 MAINTENANCE MATERIALS

A. Furnish two of each plastic lens type.

B. Furnish one package of replacement lamps for each lamp installed.

C. Furnish two of each ballast type.

D. Furnish two of each LED Driver type.

E. Furnish two of each accessory type.
   1. This includes, but is not limited to, photocells, motion sensors, and fuses.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES

A. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.

B. See drawings for luminaire schedules.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned luminaires, lamps, and accessories.

B. Extend existing interior luminaire installations using materials and methods compatible with existing installations, or as specified.

C. Clean and repair existing interior luminaires to remain or to be reinstalled.

3.2 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

B. Support luminaires larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.

C. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.

D. Install wall-mounted luminaires at height as indicated on Drawings.

E. Install accessories furnished with each luminaire.

F. Connect luminaires to branch circuit outlets provided under Section 26 05 33 using flexible conduit.

G. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

H. Install specified lamps in each luminaire.

I. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.4 ADJUSTING

A. Aim and adjust luminaires as indicated on Drawings.

3.5 CLEANING

A. Remove dirt and debris from enclosures.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

A. Relamp luminaires having failed lamps at Substantial Completion.

B. Replace all failed luminaire components and accessories at Substantial Completion.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes exterior luminaries, poles, and accessories.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
   2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
   3. ANSI O5.1 - Wood Poles, Specifications and Dimensions.

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.

B. Product Data: Submit dimensions, ratings, and performance data.

C. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and handle solid wood poles in accordance with ANSI O5.1.

1.6 COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.7 MAINTENANCE MATERIALS

A. Furnish two of each lamp installed.

B. Furnish two gallons of touch-up paint for each different painted finish and color.

C. Furnish two ballasts and/or drivers of each type installed.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.

B. See drawings for luminaire schedules and assembly details.

2.2 LAMPS - GENERAL

A. Minimum Efficacy, Lamps Greater Than 100 Watts: 60 lumens/W, except where otherwise indicated or permitted by applicable code.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify foundations are ready to receive fixtures.

3.2 EXISTING WORK

A. Disconnect and remove abandoned exterior luminaries.

B. Extend existing exterior luminaire installations using materials and methods compatible with existing installations, or as specified.

C. Clean and repair existing exterior luminaries to remain or to be reinstalled.

3.3 INSTALLATION

A. Install concrete bases for lighting poles at locations as indicated on Drawings, in accordance with Section 03 30 00.

B. Install poles plumb. Install shims and/or double nuts as required to adjust plumb. Grout around each base.

C. Install lamps in each luminaire.

D. Bond and ground luminaries,metal accessories and metal poles in accordance with Section 26 05 26. Install supplementary grounding electrode at each pole.

3.4 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

B. Measure illumination levels to verify conformance with performance requirements.

C. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.5 ADJUSTING

A. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.6 CLEANING

A. Clean photometric control surfaces as recommended by manufacturer.

B. Clean finishes and touch up damage.

3.7 PROTECTION OF FINISHED WORK

A. Relamp luminaries having failed lamps at Substantial Completion.

END OF SECTION

SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Topsoil materials.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earthwork.
   2. Section 31 23 17 - Trenching.
   3. Section 31 23 23 - Fill.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

B. ASTM International:
   1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Samples: If requested, submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.

B. Materials Source: Submit name of imported materials source.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout the Work.

B. Perform Work in accordance with State of Michigan Department of Transportation standard specifications for construction.

PART 2 - PRODUCTS

2.1 SUBSOIL MATERIALS

A. Subsoil Type S1: Native material conforming to State of Michigan Department of Transportation standard specifications for construction.

B. Subsoil Type S2:
   1. Native material.
   2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.

2.2 TOPSOIL MATERIALS

A. Topsoil Type S3: Conforming to State of Michigan Department of Transportation standard specifications for construction.

B. Topsoil Type S4:
   1. Native topsoil.
   2. Free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds and foreign matter.
      a. Screening: Double screened.

C. Topsoil Type S5:
   1. Imported borrow.
   2. Friable loam.
   3. Reasonably free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds, and foreign matter.
      a. Screening: Double screened.
   4. Acidity range (pH) of 5.5 to 7.5.
   5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SOURCE QUALITY CONTROL

A. Testing and Analysis of Subsoil Material: Perform in accordance with AASHTO T180.

B. Testing and Analysis of Topsoil Material: Perform in accordance with AASHTO T180.

C. When tests indicate materials do not meet specified requirements, change material and retest.

D. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.

B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

C. Remove excess excavated materials, subsoil, and topsoil not intended for reuse, from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations approved by Owner.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Stockpile topsoil 8 feet high maximum.

E. Prevent intermixing of soil types or contamination.

F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

G. Stockpile unsuitable or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16
AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coarse aggregate materials.
   2. Granular materials.

B. Related Sections:
   1. Section 03 30 00 - Cast in Place Concrete
   2. Section 31 05 13 - Soils for Earthwork: Fill and grading materials.
   3. Section 31 23 17 - Trenching.
   4. Section 31 23 23 - Fill.
   5. Section 33 05 13 – Manholes and Structures
   6. Section 33 31 13 – Public Sanitary Sewerage Gravity Piping.

C. American Association of State Highway and Transportation Officials:
   1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
   2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

D. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.2 SUBMITTALS

A. Samples: May be requested for submittal by the Engineer for testing.

B. Materials Source: Submit name of imported materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed Michigan Department of Transportation’s associated crushed stone specifications.

1.3 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with State of Michigan standard for construction.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate Type A1 6A compacted crushed limestone: Conforming to State of Michigan Department of Transportation standard within the following limits:

Sieve Size	Percent Passing
1-1/2 inches	100
1 inch	95 to 100
3/4 inch	
1/2 inches	30 to 60
3/8 inches	
No. 4	0 to 8
No. 8	
No. 40	
No. 200	0-2

Table 902-2
Physical Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates

		Gravel, Stone, and Crushed Concrete						Slag (a)		All Aggregates
Material	Series/ Class	Crushed Material, % min (MTM 117)	Loss, % max, Los Angeles Abrasion (MTM 102)	Soft Particles, % max (MTM 110)	Chert, % max (MTM 110)	Sum of Soft Particles and Chert, % max (MTM 110)	Freeze-Thaw Dilation, % per 100 cycle max (MTM 115) (d)	Sum of Coke and Coal Particles, % max (MTM 110)	Freeze-Thaw Dilation, % per 100 cycles max (MTM 115) (d)	Flat and Elongated Particles, ratio % max (ASTM D 4791)
Coarse Aggregates (n)	4 AA (b)	—	40	—	—	2.0 (c)	0.020	1.0	0.020	3:1–15.0 (l)
	6 AAA	—	40	2.0 (e)	2.5	4.0	0.040 (f)	1.0	0.040 (f)	—
	6 AA (g)	—	40	2.0 (e)	—	4.0	0.067 (h)	1.0	0.067	—
	6 A (g)	—	40	3.0 (e)	7.0	9.0	0.067	1.0	0.067	—
	17 A (g)	—	40	3.5 (e)	8.0	10.0	0.067	1.0	0.067	—
	25 A	95	45	8.0 (i)	—	8.0	—	1.0	—	3:1–20.0 (m)
	26 A (g)	—	40	2.0 (e)	—	4.0	0.067	1.0	0.067	—
	29 A	95	45	8.0 (i)	—	8.0	—	1.0	—	3:1–20.0 (m)
Dense-Graded Aggregates (j)	21 AA	95	50	—				—		—
	21 A	25	50	—				—		—
	22 A	25	50	—				—		—
	23 A	25	50	—				—		—
Open-Graded Aggregates	4 G	95	45 (k)	—				—		—
	34 R	≤20	45 (k)	—				—		—
	34 G	100	45 (k)	—				—		—

B. Coarse Aggregate Type A2 22A compacted crushed limestone: Conforming to State of Michigan Department of Transportation standard specification for construction within the following limits:

Sieve Size	Percent Passing
2 inches	0
1 inch	100
3/4 inch	90 to 100
1/2 inches	
3/8 inches	65 to 85
No. 4	
No. 8	30 to 50
No. 40	
No. 200	4 to 8

C. Dense Aggregate Type A3 23A compacted crushed stone: Conforming to State of Michigan Department of Transportation standard specification for construction within the following limits:

Sieve Size	Percent Passing
2 inches	
1 inch	100
3/4 inch	
1/2 inches	
3/8 inches	60 to 85
No. 4	
No. 8	25 to 60
No. 40	
No. 200	9 to 16

2.2 FINE AGGREGATE MATERIAL

A. Fine Aggregate Type A4 MDOT Class II Sand: Conforming to State of Michigan Department of Transportation standard specification for construction.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	95 to 100
No. 8	65 to 95
No. 16	35 to 75
No. 30	20 to 55
No. 50	10 to 30
No. 100	0 to 10
No. 200	3.0

2.3 SOURCE QUALITY CONTROL

B. Aggregate Material - Testing and Analysis: Perform according with MTM 109 and MTM 108 and other applicable MDOT testing standards.

C. Fine Aggregate Material - Testing and Analysis: Perform according to MTM 109 and MTM 108 and other applicable MDOT testing standards.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site at locations approved by the Owner.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.2 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 19.13
GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nonwoven geotextile material (Filter Fabric).
   2. Geotextile for Subgrade Reinforcement Applications (Geotextile Reinforcement).
   3. Geogrid for Subgrade and Aggregate Base Reinforcement Applications (Geogrid Reinforcement).

B. Related Requirements:
   1. Division 31 - Earthwork
   2. Section 32 11 23 - Aggregate Base Courses
   3. Section 33 47 15 - Liners
   4. Project Appendices for soils information.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

B. ASTM International:
   1. ASTM D-3786 - Test method for Mullen Burst.
   2. ASTM D-3787 - Test method for Puncture Strength.
   3. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   4. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   5. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   6. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   7. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   8. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
   9. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
   10. ASTM D4884 - Standard Test Method for Strength of Sewn or Bonded Seams of Geotextiles.
   11. ASTM D4886 - Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
   12. ASTM D6525 - Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
   13. ASTM D6566 - Standard Test Method for Measuring Mass per Unit Area of Turf Reinforcement Mats.
   14. ASTM D6818 - Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.

15. D 1388-96 – Standard Test Method for Stiffness of Fabrics, Option A.
16. D 6637-01 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
17. D 4354-96 – Practice for Sampling of Geosynthetics for Testing.
18. D 4759-92 – Practice for Determining the Specification Conformance of Geosynthetics.
19. D 5818-95 – Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage.

C. Geosynthetic Research Institute (GRI): GG2-87 – Standard Test Method for Geogrid Junction Strength.

1.3 SUBMITTALS

A. Shop Drawings and Product Data: Submit manufacturer product sheets for all materials specified, and ensure they include tensile strength, elongation, thickness, UV resistance, and other material specifications. Indicate fabric layout, seam locations, and overlap details in installation drawings.

B. Submit shop drawings illustrating structural connection (e.g. bodkin, hog rings, etc.) with product information and manufacturer's certificate of connection strength valves for the geogrid connection. Structure connections shall resist a minimum force of 900 pounds per foot of pipe.

C. Manufacturer's Certificate: Submit manufacturer's certificate, which shall show actual test values, that materials supplied meet the requirements of this Section and the minimum properties published for the materials identified in the GFR 2004 Specifier's Guide.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures. Submit manufacturer's product information for recommended lightweight construction equipment with low pressure tracks to be used to construct the geotextile reinforced embankment sections.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of geotextile material, including placement depth.

1.5 QUALITY ASSURANCE

A. Perform Work according to municipality standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Comply with ASTM D4873.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 NONWOVEN GEOTEXTILE MATERIALS

A. Filter fabric for under rip rap.

B. Description:
   1. Non-biodegradable, UV-resistant, nonwoven geotextile fabric.
   2. Calendar such that yarns will retain relative positions.
   3. Mechanically bonded, non-woven, long-chain polymeric fibers or yarns.
   4. The edges of the fabric shall be finished to prevent the outer fiber from pulling away from the fabric.

C. Filter fabric for riprap applications is to have, at minimum, the following properties:

Tensile Strength	200	lbs
Tensile Elongation (max)	100	%
Mullen Burst	350	psi
Trapezoidal Tear Strength	75	lbs
Puncture Strength	100	lbs
Apparent Opening Size (max)	80	sieve
Flow Rate	95	gal/min/ft^2 Open Area

2.2 GEOTEXTILE MATERIALS

A. Geotextile Wrap
   1. High strength geotextile wrap shall consist of StrataGRS 4800 or equal.

B. Geogrid

1. Geogrid shall consist of Tensar BX1500 biaxial or equal, manufactured by Tensar Earth Technologies, Inc and supplied by Hanes Geo Components (800-248-8230).

2.3 ACCESSORIES

A. Sewing Thread:
   1. Material: Polypropylene, Polyester, or Kevlar, as recommended by manufacturer.
   2. Durability: Equal to or greater than durability of geotextile.

B. Securing Pins:
   1. Material: Steel rods or bars.
   2. Diameter: 3/16 inch
   3. Minimum Length: 12 inches
   4. Washers:
      a. Material: Steel.
      b. Outside Diameter: Minimum 1-1/2 inches
      c. Inside Diameter: 1/4 inch.
      d. Thickness: 1/8 inch

C. Wire Staples:
   1. Material: Steel.
   2. Minimum Size: 10 gauge.
   3. Minimum Length: 6 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that underlying surface is smooth and free of ruts or protrusions that could damage geotextile material.

B. The Contractor shall verify the correct fabric is delivered to the Site for the specified use.

C. The Contractor shall check all materials upon delivery to verify that the proper material has been received.

D. At the time of installation, materials may be rejected at the discretion of the Engineer if they have defects, tears, punctures, or damage incurred during manufacture, shipment or storage.

E. No damaged materials shall be installed.

3.2 STORAGE

A. During all periods of shipment and storage, materials shall be protected from physical or chemical abrasion, direct sunlight, ultraviolet rays, and temperatures below –20° F and above 140° F (or as directed by the manufacturer).

B. To the extent possible materials shall be maintained in packaging provided by the manufacturer.

C. Rolled materials may be laid flat or stood on end.

3.3 PREPARATION

A. Subgrade Material and Compaction Requirements: As specified in Section 31 23 16.13 – Trenching and 31 23 23 - Fill.

B. The subgrade soil shall be prepared as indicated on the construction drawings, specified herein, or as directed by the Engineer, whichever applies.

C. Remove large stones or other debris, which could damage the filter fabric.

D. Adjacent Surfaces: Protect adjacent surfaces.

3.4 INSTALLATION

A. Geotextile Material:
   1. Lay and maintain smooth and free of tensile stresses, folds, wrinkles, or creases.
   2. Ensure that material is in direct contact with subgrade.
   3. Orientate with long dimension of each sheet parallel to direction of slope.
   4. Minimum Unseamed Joints Overlap: 18 inches.
   5. Edges of filter fabric shall be toed in 12 inches unless specified otherwise. Work will not pass inspection if filter fabric is not "toed in."

B. Seams:
   1. Minimum Seamed Joints Overlap: 12 inches at longitudinal and transverse joints.
   2. Seams across Slope: Lap upper panel over lower panel.
   3. Sewn Seams:
      a. Continuously sew seams on slopes steeper than 1 vertical on 2 horizontal.
      b. Stitch Type: As recommended by geotextile manufacturer.
      c. Tie off thread at the end of each seam to prevent unraveling.
   4. Thermal Seams:
      a. As recommended by geotextile manufacturer.
      b. Comply with ASTM D4886.

C. Penetrations: As recommended by geotextile manufacturer.

D. Repairing Damaged Geotextiles:
   1. Repair torn or damaged geotextile by placing patch of same type of geotextile over damaged area minimum of 12 inches beyond edge of damaged area, and fasten as recommended by geotextile manufacturer.
   2. Remove and replace geotextile rolls which cannot be repaired.

E. All areas immediately beneath the installation area for geotextiles, geogrids and geocells shall be properly prepared as shown on the drawings, in specifications, or as directed by the Engineer.

F. Materials shall be installed as specified. Unless otherwise specified, install materials as recommended by the manufacturer or as directed by the Engineer.

G. Materials shall be laid at the proper elevation, alignment, and orientation as shown on the construction drawings.

H. The Contractor shall verify correct orientation (roll direction) of the materials.

I. To prevent undue exposure or damage, place only that amount of material required for immediately pending Work.

J. Temporarily secured in place with staples, pins, sand bags or backfill as required by fill properties, fill placement procedures, or weather conditions as directed by the manufacturer, or as directed by the Engineer.

K. Fill placement over geotextiles, geogrids or geocells:
   1. Fill material shall be placed in lifts and compacted as directed under Sections 31 22 13 – Rough Grading, 31 23 23 - Fill and Section 32 11 23 – Aggregate Base Course. Fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geotextile or geogrid, maintains the openings of geocells, and prevents movement of the geotextile, geogrid, or geocell.
   2. Place a minimum loose fill thickness of 24 inches over geotextiles, 6 inches over geogrids, and 2 inches over geocells prior to operation of tracked vehicles over geotextiles, geogrids, or geocells. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and/or damaging the geotextiles, geogrids and geocells. Rubber-tired equipment may pass over geogrids at slow speeds (less than 10 mph) prior to filling provided sudden braking and sharp turning movements shall be avoided.

L. Geogrid Encapsulation:
   1. Geogrid shall be wrapped taut around the aggregate fill as shown on the drawings.
   2. Anchor the geogrid in position as needed until the geogrid wrapped aggregate is backfilled and the Bodkin connection is installed.
   3. Structure connections shall be used to connect areas where geogrid overlap in the direction of the pipe.
   4. Seams in the geogrid perpendicular to the direction of the pipe shall be overlapped a minimum of 24 inches.

M. Geotextile Reinforcement:
   1. Prior to placing geogrid, place a filter fabric over prepared subgrade as directed by the Engineer.
   2. Place geogrid over prepared subgrade, which may require a filter fabric.
   3. Place geogrid with the geogrid's highest tensile strength in the direction where maximum strength is needed as shown on the drawings, or as directed by the Engineer.
   4. Seams in the geogrid shall be overlapped 18 inches, or as directed by the Engineer.
   5. Pull the geogrid taut during placement and prior to backfill placement.
   6. Anchor the geogrid in position as directed by Engineer.
   7. Backfill as directed by the Engineer.

N. Repair:
   1. The Contractor, at no additional cost to the Owner, shall replace any materials damaged during installation as directed by the Engineer.
   2. The Engineer will determine the limits of repairs based on the intent of the design.

3.5 FIELD QUALITY CONTROL

A. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

3.6 PROTECTION

A. Ballast: Adequate to prevent uplift of material by wind.

B. UV Exposure: Do not leave material uncovered for more than 14 days after installation.

C. Do not use staples or pins to hold geotextiles in place where located adjacent to other geosynthetic layers that could be damaged.

D. Do not operate equipment directly on top of geotextile.

END OF SECTION

SECTION 31 23 17
TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Excavating trenches for utilities within existing facility grounds.
2. Excavating trenches for utilities from 5 feet outside building to utility service.
3. Compacted fill from top of utility bedding to subgrade elevations.
4. Backfilling and compaction.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Thrust blocks.
2. Section 31 05 13 - Soils for Earthwork: Soils for fill.
3. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
4. Section 31 23 23 - Fill

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable OSHA regulations.

1.5 SUBMITTALS

A. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

B. Product Data: Submit data for geotextile fabric indicating fabric and construction.

C. Materials Source: Submit name of imported fill materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with State of Michigan and Municipality standards.

1.7 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Michigan.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1 or S2 as specified in Section 31 05 13.

B. Structural Fill: Type A1 as specified in Section 31 05 16.

C. Granular Fill: Type A3 as specified in Section 31 05 16.

D. Concrete: Structural concrete as specified in Section 03 30 00 Cast-in-Place Concrete with compressive strength of 3500 psi.

2.2 EXCAVATION SUPPORT MATERIALS

A. Timber and lumber for shoring and bracing shall be new, merchantable pine. Douglas Fir or Spruce, unless otherwise shown or specified. Secondhand timber or lumber shall not be used where strength and/or appearance are important considerations.

B. Steel for sheeting, shoring, and bracing shall be as per the referenced ASTM specifications.

C. Temporary Sheeting: Select section modulus, embedment depth and bracing required to complete the work.

PART 3 EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.
   1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Call Miss Dig not less than three working days before performing Work. Request underground utilities to be located and marked within and surrounding construction areas.

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

C. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

A. Excavate subsoil required for utilities as shown on the plan, and as stated in the proposal.

B. Excavate subsoil for utility piping and accessories as indicated on the drawings.

C. Excavate on required line to depth required below pipe grade for bedding thickness required.

D. Remove lumped subsoil, boulders, and rock up of 1/6 cubic yard, measured by volume. Remove larger material as specified in Section 31 23 18.

E. Do not advance open trench more than one pipe length ahead of installed pipe.

F. Cut trenches to width indicated on Drawings. Remove water or materials that interfere with Work.

G. Excavate bottom of trenches in accordance with trench details or specifications.

H. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and utilities being installed.

I. Excavate trench widths exceed the maximum specified above, the Owner's representative may require special bedding or the use of extra strength pipe at the Contractor's expense.

J. Do not interfere with 45 degree bearing splay of foundations.

K. When Project conditions permit, slope side walls of excavation starting 1 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

L. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered.

M. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type A and compact to density equal to or greater than requirements for subsequent backfill material.

N. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

O. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.

P. Remove excess subsoil not intended for reuse, from site.

Q. Grade top perimeter of excavation to prevent surface water from draining into excavation.

R. Notify Owner's representative of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

S. Protect excavation by methods required to prevent cave-in or loose soil from failing into excavation.

T. Provide, operate, and maintain pumping equipment to keep trench free of water.

U. Use trench boxes or other form of temporary protection when required by OSHA Standards or when protection of existing utilities is necessary.

V. Stockpile excavated material in area designated on site in accordance with Section 31 05 13.

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. The Contractor is responsible for the design and location of all sheeting, shoring, and bracing.

E. When required to properly support the surfaces of excavations and to protect the construction work and workmen, sheeting, bracing and shoring shall be provided.

F. If the Owner's representative is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports at the expense of the Contractor, but neither the placing of such additional supports by the order of the Owner's representative nor the failure of the Owner's representative to order such additional supports placed shall release the Contractor from his responsibility for the sufficiency of supports and the integrity of work.

G. Damage to new or existing structures occurring through settlements due to failure or lack of sheeting or bracing shall be repaired by the Contractor at his own expense.

H. Conflict of opinion as to whether the settlement is due to the work of the Contractor or to any other cause will be determined by the Owner's representative.

I. In general, the sheeting and bracing shall be removed, as the trench or excavation is refilled, in such a manner as to avoid the caving in of the work.

J. Fill voids left by the withdrawal of the sheeting by ramming, or otherwise as directed.

K. Obtain permission of Owner/Engineer prior to the removal of any shoring, sheeting or bracing.

L. When sheeting and bracing is removed, the Contractor shall assume full responsibility for injury to structures or to other property or persons arising from failure to leave in place such sheeting or bracing.

M. For the purpose of preventing injury to the structures, or to other property or to persons, the Contractor shall leave in place any sheeting or bracing shown on the plans or ordered in writing by the Owner's representative.

N. Cutoff sheeting left in place at elevation ordered but not less than 18" below final ground surface.

O. Bracing remaining in place shall be driven up tight.

P. The right of the Owner's representative to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders.

Q. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

R. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

A. Verify all materials to be reused as acceptable.

B. Backfill trenches to proposed contours and elevations with unfrozen fill materials.

C. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

D. Place geotextile fabric over Fill Type A1 prior to placing subsequent fill materials.

E. Place material in continuous layers as follows:
   1. Subsoil Fill: Maximum 8 inches compacted depth.
   2. Structural Fill: Maximum 6 inches compacted depth.
   3. Granular Fill: Maximum 8 inches compacted depth.

F. Place geotextile fabric over Type A1 fill bedding prior to placing last lift of bedding.

G. Employ placement method that does not disturb or damage, utilities in trench, pavement, sidewalk, and driveways.

H. Maintain optimum moisture content of fill materials to attain required compaction density.

I. Do not leave more than 20 feet of trench open at end of working day.

J. Protect open trench to prevent danger to Owner.

K. Backfill against supported foundation walls.

L. Make grade changes gradual. Blend slope into level areas.

M. Slope fill away from structures a minimum 2 inches in 10 feet.

N. Leave fill material stockpile areas completely free of excess fill materials.

O. Employ a compaction method for trench backfill that does not disturb or damage installed utilities and existing utilities in the trench. Compact backfill to specified density. If required compaction is not achieved and verified using mechanical methods, settling or spiking the trench with water may be used as a compaction method in conformance with ASTM C13 and D2321, as approved by the Engineer.

P. Backfill simultaneously around all sides of structures, manholes and catch basins.

3.6 TOLERANCES

A. Top Surface of Backfilling under Paved Areas: Plus or minus 1/2 inch from required elevations.

B. Top surface of fill for building pads plus or minus 1/4 inch form required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Tests and analysis of fill material will be performed in accordance with MDOT Standard Requirements.

B. Compaction testing will be performed in accordance with MDOT Standard Requirements.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

D. Frequency of Tests: As directed by Soils Engineer.

E. Proof roll compacted fill surfaces under paving.

3.8 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Backfilling building perimeter to subgrade elevations.
2. Backfilling site structures to subgrade elevations.
3. Fill under slabs-on-grade.
4. Fill under paving.
5. Fill for over-excavation.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Concrete materials.
2. Section 31 05 13 - Soils for Earthwork: Soils for fill.
3. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
4. Section 31 23 17 - Trenching: Backfilling of utility trenches.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Product Data: Submit data for geotextile fabric indicating fabric and construction.

B. Materials Source: Submit name of imported fill materials suppliers.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with State of Michigan and Municipality standards.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Subsoil Fill: Type S1 or S2 as specified in Section 31 05 13.

B. Structural Fill: Subsoil type S1 as specified in Section 31 05 13 as allowable per location and aggregate/granular types as specified in Section 31 05 16

C. Granular Fill: Type A4 as specified in Section 31 05 16.

D. Concrete: Structural concrete as specified in Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

B. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

C. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with granular fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 3 inch.

D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Place geotextile fabric over fill prior to placing next lift of fill.

D. Place material in continuous layers as follows:

1. Subsoil Fill: Maximum 12 inches compacted depth.
2. Structural Fill: Maximum 6 inches compacted depth.
3. Granular Fill: Maximum 6 inches compacted depth.

E. Employ placement method that does not disturb or damage other work.

F. Maintain optimum moisture content of backfill materials to attain required compaction density.

G. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.

H. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.

I. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft, unless noted otherwise.

J. Make gradual grade changes. Blend slope into level areas.

K. Remove surplus backfill materials from site.

L. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

A. Top Surface of Backfilling Within Building Areas: Plus or minus 1 inch from required elevations.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D1557.

B. Perform in place compaction tests in accordance with the following:
1. Density Tests: ASTM D1556.
2. Moisture Tests: ASTM D3017.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: As directed by Engineer.

E. Proof roll compacted fill surfaces under slabs-on-grade, pavers, and paving.

3.6 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic.

3.7 SCHEDULE

A. Fill Under Grass Area:
   1. Subsoil Type S2 fill, to 6 inches below finish grade, compacted to 95 percent maximum dry density as determined by MDOT Standard Requirements.

B. Fill Under Asphalt Paving:
   1. A3 to underside of aggregate base course elevation, compacted to 95 percent maximum dry density as determined by MDOT Standard Requirements.

C. Fill Within 1:1 Influence of Structures and Paving:
   1. Compact subsoil to 95 percent of its maximum dry density.
   2. Fill Type A3, to 6 inches below finish paving elevation, compact uniformly to 95 percent of maximum density

D. Fill Under Concrete Pads, Concrete Curb and Gutter and Sidewalks:
   1. A3 to within 4" of underside of concrete slab. All fill to be compacted to 95 percent maximum dry density as determined by MDOT Standard Requirements.

E. Fill to Correct Over-excavation:
   1. Lean concrete to minimum compressive strength of 1000 psi

F. Backfill for Utility Trenches:
   1. Bedding as specified in individual water and sewer utility standard detail sheets.

G. Fill for Subgrade and Undercutting:
   1. A1 – (6A Compacted Crushed Limestone) fill to proposed subgrade elevation, compacted to 95 percent maximum dry density as determined by MDOT Standard Requirements.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aggregate subbase.
   2. Aggregate base course.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earth Work.
   2. Section 32 12 16 - Asphalt Paving
   3. Section 32 13 13 - Concrete Paving
   4. Section 33 31 13 - Public Sanitary Utility Sewerage Piping

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

B. ASTM International:
   1. ANSI/ASTM C117 – Test Method for Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. ANSI/ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
   3. Test method for density of soil in place with loss by wash less than 15% - One Point Michigan Cone Test.
   4. Test method for density of soil in place with loss by wash greater than 15% - One Point T-99 Test.
   5. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   6. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
   7. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   8. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

C. MDOT Standard Specifications for Construction.

1.3 SUBMITTALS

A. Product Data:
   1. Submit data for geotextile fabric and herbicide.

B. Samples may be requested by the Engineer: Submit, in air-tight containers, 10 lb sample of each type of aggregate fill to testing laboratory.

C. Materials Source: Submit name of aggregate materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed requirements for MDOT 22A, 23A, and Class II sand.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with State of Michigan and Municipality Standards.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIALS

A. Coarse Aggregate: Fill Class 22A Compacted Crushed Limestone as specified in the current MODT Standard Specifications for Construction.

B. Fine Aggregate: Fill Type Class II Sand as specified in the current MDOT Standard Specifications for Construction.

C. Dense-Graded Aggregates: Fill Class 23A Gravel as specified in the MDOT Standard Specifications for Construction.

2.2 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene. Maybe required for winter construction.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted substrate is dry and ready to support paving and imposed loads.
   1. Proof roll substrate with 3 ton in minimum two perpendicular passes to identify soft spots.
   2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

B. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. Install geotextile fabric over subgrade in accordance with manufacturer's instructions.

1. Lap ends and edges minimum 12 inches.
2. Anchor fabric to subgrade when required to prevent displacement until aggregate is installed.

B. Gradation of Aggregate: In accordance with ASTM C136.

C. Spread aggregate over prepared substrate to total compacted thickness as indicated on drawings and stated in the proposal.

D. Level and contour surfaces to elevations, profiles, and gradients indicated.

E. Add small quantities of fine aggregate to coarse aggregate when required to assist compaction.

F. Maintain optimum moisture content of fill materials to attain specified compaction density. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 COMPACTION

A. Compact materials to 98 percent of maximum density as determined from test strip, in accordance with ASTM D2940.

3.5 TOLERANCES

A. Maximum Variation From Flat Surface: 1/4 inch measured with 10 foot straight edge.

B. Maximum Variation From Thickness: 1/4 inch.

C. Maximum Variation From Elevation: 1/2 inch.

3.6 FIELD QUALITY CONTROL

A. Compaction testing will be performed in accordance with ASTM D2922.

B. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to the Owner.

C. Frequency of Tests: As determined by the Engineer in the field with a minimum of one test for every 500 square yards of each layer compacted aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt materials.
   2. Asphalt paving base course and wearing course.
   3. Asphalt paving overlay for existing paving.

B. Related Requirement:
   1. Section 31 23 17 - Trenching
   2. Section 32 11 23 - Aggregate Base Courses

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
   3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
   4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
   5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
   6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
   7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
   8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

B. Asphalt Institute:
   1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
   2. AI MS-19 - Basic Asphalt Emulsion Manual.
   3. AI SP-2 - Superpave Mix Design.

C. ASTM International:
   1. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
   2. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
   3. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
   4. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
   5. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
   6. ASTM D977 - Standard Specification for Emulsified Asphalt.

7. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
8. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
9. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
10. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
11. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
12. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
13. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
14. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
15. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
16. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
17. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
18. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
19. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
20. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
21. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

D. MDOT 2012 Standard Specifications for Construction.

1.3 SUBMITTALS

A. Product Data:
   1. Submit product information for asphalt and aggregate materials.
   2. Submit mix design with laboratory test results supporting design.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements for MDOT Standard Construction Specifications.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to State of Michigan Department of Transportation Standard.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with MDOT Standard Specifications for Construction.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable local codes for paving work.

1.6 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.7 AMBIENT CONDITIONS

A. Do not place asphalt mixture when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.

B. Place asphalt mixture when temperature is not more than 15 degrees F less than initial mixing temperature.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt Cement: In accordance with MDOT standards.

B. Aggregate for Leveling Course Mix: As stated on the Bid Form, in accordance with MDOT Standard Specifications for Construction.

C. Aggregate for Wearing Course Mix: As stated on the Bid Form, in accordance with MDOT Standard Specifications for Construction.

D. Fine Aggregate: As stated on the Bid Form, in accordance with MDOT Standard Specifications for Construction.

E. Mineral Filler: ASTM D242, finely ground mineral particles, free of foreign matter.

2.2 ACCESSORIES

A. Primer: Homogeneous, medium curing, liquid asphalt in accordance with MDOT standards.

B. Tack Coat: Homogeneous, medium curing, liquid asphalt in accordance with MDOT standards.

2.3 ASPHALT PAVING MIX

A. Use dry material to avoid foaming. Mix uniformly.

B. Base Course: Provide mix in accordance with MDOT uniformity tolerances for bituminous mixtures.

C. Wearing Course: Provide mix in accordance with MDOT uniformity tolerances for bituminous mixtures.

2.4 SOURCE QUALITY CONTROL

A. Submit proposed mix design of each class of mix for review prior to beginning of Work.

B. Submit MDOT approved job mix formula (JMF) of each mix for review 14 days prior to commencement of work.

C. Test samples in accordance with AI MS-2 and MDOT standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

B. Verify compacted subgrade and subbase is dry and ready to support paving and imposed loads.
   1. Proof roll subbase with 7 ton in minimum two perpendicular passes to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 31 11 23.

C. Verify gradients and elevations of base are correct.

D. Verify gutter drainage grilles and frames manhole frames and valve boxes are installed in correct position and elevation.

3.2 PREPARATION

A. Prepare subbase in accordance with State of Michigan Department of Transportation standards.

3.3 DEMOLITION

A. Saw cut and notch existing paving, saw cutting shall be paid for as part of pavement removal.

B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 INSTALLATION

A. Subbase:
   1. Aggregate Subbase: Install as specified in Section 32 11 23.

B. Primer:
   1. Apply primer in accordance with AI MS-2. State of Michigan Department of Transportation standards.
   2. Use clean sand to blot excess primer.

C. Tack Coat:
   1. Apply bond coat on existing, abutting asphalt and concrete surfaces according to manufacturer's instructions and MDOT standards.
   2. Apply bond coat to contact surfaces of curbs, gutters, building walls and sidewalks. Prevent overspray from reaching adjacent surfaces.

3. Coat surfaces of manhole and catch basin frames with oil to prevent bond with asphalt pavement. Do not bond coat these surfaces.
4. Use clean sand to blot excess primer.

D. Single Course Asphalt Paving:
1. Install Work in accordance with State of Michigan Department of Transportation standards.
2. Place asphalt within 24 hours of applying primer or tack coat.
3. Place asphalt wearing course to compacted thickness as indicated on the drawings and stated in the proposal.
4. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

E. Double Course Asphalt Paving:
1. Place asphalt binder course within 24 hours of applying primer or tack coat.
2. Place binder course to compacted thickness indicated on drawings and as stated in the proposal.
3. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
4. Place wearing course to compacted thickness indicated on drawings and as stated in the proposal.
5. Install gutter drainage grilles and frames, manhole frames, valve and monument boxes in correct position and elevation.
6. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
7. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

F. Asphalt Paving Overlay
1. Apply asphalt cement tack coat to existing paving surface at rate recommended by geotextile fabric manufacturer.
2. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches.
3. Place wearing course to compacted thickness indicated on drawings and as stated in the proposal.
4. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

G. Hand Patching
1. Install uniform thickness surface slurry over existing paving in accordance with ASTM Install work according to current MDOT standards.
2. Place to compacted thickness as specified on plans.
3. Compact in maximum lifts by use of a machine vibrator or approved roller according to current MDOT standards.

3.5 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from Indicated Elevation: Within 1/4 inch.

3.6 FIELD QUALITY CONTROL

A. Take samples and perform tests in accordance with State of Michigan Department of Transportation Standards.

B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

C. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving.

D. Asphalt Paving Density: ASTM D2950 nuclear method; density testing shall be performed at the discretion of the Engineer.

3.7 PROTECTION

A. Immediately after placement, protect paving from mechanical injury for 3 days.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete paving for:
      a. Concrete sidewalks.

B. Related Requirements:
   1. Section 03 30 00 - Cast In Place Concrete
   2. Section 32 11 23 - Aggregate Base Courses

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

B. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete.
   2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

C. ASTM International:
   1. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
   2. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   3. ASTM A497/A497M - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
   4. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   5. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   6. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   7. ASTM A775/A775M - S Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
   8. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
   9. ASTM A934/A934M - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
   10. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   11. ASTM C33 - Standard Specification for Concrete Aggregates.
   12. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   13. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.

14. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. ASTM C150 - Standard Specification for Portland Cement.
16. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
17. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
18. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
20. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
21. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
22. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
23. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
24. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
25. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
26. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
27. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
28. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
29. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
30. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
31. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
32. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
33. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
34. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
35. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
36. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
37. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
38. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.3 SUBMITTALS

A. Product Data:
   1. Submit data on concrete materials, joint filler and admixtures curing compounds.

B. Design Data:
   1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:

a. Hot and cold weather concrete work.
2. Identify mix ingredients and proportions, including admixtures.
3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.

C. Source Quality Control Submittals: Indicate results of shop tests and inspections.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Obtain cementitious materials from same source throughout.

C. Perform Work in accordance with Tuscola County Road Commission standard.

D. Maintain one copy of document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.6 AMBIENT CONDITIONS

A. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Aggregate Base Course: As specified in Section 32 11 23.

2.2 CONCRETE PAVING

A. Performance / Design Criteria:
1. In accordance with Municipal, State, and Federal standards.

B. Form Materials:
1. Form Materials: As specified in Section 03 10 00.
2. Wood or Steel form material, profiled to suit conditions.
3. Joint Filler: ASTM D1751; Asphalt impregnated fiberboard or felt, 1/2 inch thick.
4. ANSI/ASTM D1751, performed type; 1/2 inch thick, full depth of concrete manufactured by ACD International, W.R. Meadows or equal.

C. Reinforcement:
1. Reinforcing Steel and Wire Fabric: Conform to Municipal, State and Federal Standards. All reinforcement steel shall be epoxy coated.

D. Concrete Materials:
   1. Concrete Materials: As specified in Section 03 30 00.

2.3 MIXES

A. Concrete Mix - By Performance Criteria:
   1. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94/C94M.
   2. Select proportions for normal weight concrete in accordance with ACI 301 Method 2.
   3. Provide concrete to the following criteria:
      a. As specified in 03 30 00 Concrete Cast in Place.
   4. Limit the following cementitious materials to maximum percentage by mass of all cementitious materials:
      a. As specified in 03 30 00.
   5. Use accelerating admixtures in cold weather only when approved by the Architect/Engineer in writing. Use of admixtures will not relax cold weather placement requirements.
   6. Use calcium chloride only when approved by the Engineer in writing.
   7. Use set retarding admixtures during hot weather only when approved by the Engineer in writing.

2.4 FINISHES

A. Shop Finishing - Reinforcement:
   1. Galvanized Finish for Steel Bars: ASTM A767/A767M, Class I, hot dip galvanized after fabrication.
   2. Epoxy Coated Finish for Steel Bars: ASTM A775/A775M.

B. Epoxy Coated Finish for Steel Wire: ASTM A884/A884M; Class A, using ASTM A775/A775M.

2.5 ACCESSORIES

A. Curing Compound: ASTM C309, Type 1, FS TT-C-800, 30 percent solids manufactured by ACD International or equal.

B. Liquid Surface Sealer: Son-No-Mar manufactured by Sonneborn Building Products or equal.

C. Joint Sealers: Type II or Type III; hot applied type.

2.6 SOURCE QUALITY CONTROL

A. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of work. Engineer will then submit to MDOT.

B. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.

C. Test samples in accordance with ACI 301.

D. Provide certification that materials conform with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade and granular subbase is dry and ready to support paving and imposed loads.
   1. Remove soft subbase and replace with compacted fill as specified in Section 32 11 23.

B. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Moisten substrate to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete paving.

C. Verify correct line and grade of base.

D. Firmly stake forms to the required line and grade and provide for a finish transverse slope of 1/4 inch per foot towards the center of the road.

E. Notify Engineer minimum 48 hours prior to commencement of concreting operations.

F. Form sub-grade by excavating or filling to the required line and grade for bottom of concrete.

G. Make fills with granular material.

H. Remove unstable material from sub-grade.

I. Compact sub-grade to insure stability.

3.3 INSTALLATION

A. Subbase:
   1. Aggregate Subbase: Install as specified in Section 32 11 23.

B. Forms:
   1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
   2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Removal:
   1. Provide curb cut by saw-cutting and removing the full curb section and gutter pan at locations where the proposed sidewalk adjoins existing curb and gutter at roadways and drives.
   2. Remove concrete curb full depth as shown on the drawings.
   3. Remove rubble, place compacted granular fill to correct line and grade.
   4. Leave existing reinforcement to extend 6 inches into proposed gutter pan.

D. Reinforcement:
   1. Place two #4 bars the entire length of the proposed gutter pan, lapped and tied to the existing reinforcement.

2. Dowel proposed #4 bars 12 inches into existing gutter pan where existing bars were cut off or are absent.
3. Place reinforcing at mid-height of paving.
4. Interrupt reinforcing at contraction expansion joints.
5. Place dowels to achieve paving and curb alignment as detailed.
6. Provide doweled joints as specified in MDOT 2002 Standard Specifications for Construction.
7. Repair damaged galvanizing or epoxy coating to match shop finish.

E. Placing Concrete:
1. Place concrete using the slip form technique.
2. Ensure reinforcing, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
3. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
4. Thickness:
   a. Sidewalks: 4 inches normal and 6 inches at driveways, ramps, and parking areas.
   b. Curb cut and Gutter: Match existing.
5. Width:
   a. Sidewalks: Match existing (minimum of 4').
   b. Cut curb and Gutter: As shown on the drawings.
6. Place concrete in accordance with the Municipality and MDOT current Standards for Construction.

F. Joints:
1. Place expansion joints at 20 foot intervals. Align curb, gutter, and sidewalk joints.
2. Place joint filler between paving components and building or other appurtenances.
3. Cut joints shall be not less than 1/8 inch nor more than 1/4 inch in width and shall be finished smooth and true to line. Cut 1/4 minimum into depth of slab.
4. Seal joints as in accordance with MDOT Standard Specification for Construction.
5. Place expansion joints between sidewalk and back of abutting parallel curb or gutter and between sidewalk and buildings or other rigid structures.
6. Place expansion joints between sidewalk approaches and back of curb or gutter or edge of pavement.
7. Place expansion joint filler the full length of the sidewalk with the top flush with the finished surface of the sidewalk.
8. Contraction Joints: Divide sidewalk into square unit areas of nor more than 36 square feet nor less than 16 square feet.
9. Place joint over culvert.

G. Finishing:
1. After concrete has been struck off to finish grade, float surface with a steel float to produce a smooth surface.
2. Area Paving: Light broom.
3. Sidewalk Paving: Light broom.
4. Median Barrier: Light broom.
5. Curbs and Gutters: Light broom.
6. Direction of Texturing: Lightly broom transversely across the surface to create a slightly rough surface. Round edges and joint to a radius of 1/4 inch with an approved finishing tool.

7. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

H. Curing and Protection:
   1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
   2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
   3. During cold weather, protect concrete from freezing for a period of 3 days.
   4. Protect concrete from traffic for a minimum of 7 days.

I. Finish Grading:
   1. Place surplus excavation in outlawn and level to existing contours.
   2. Remove excess excavation unable to be used in outlawn.
   3. Spread 4 inches minimum topsoil over entire disturbed area.
   4. Furnish and install embankment in accordance with MDOT Standard Specifications, Section 2.08.11.

J. Curb Cuts and Sidewalk Ramps:
   1. Provide curb cut by saw-cutting and removing the full curb section and gutter pan at locations where the proposed sidewalk adjoins existing curb and gutter at roadways and drives.
   2. Remove concrete curb full depth as shown on the drawings.
   3. Remove rubble, place compacted granular fill to correct line and grade.
   4. Construct sidewalk ramps where the proposed walk adjoins existing curbs and gutters at roadways, driveways, and as shown on the drawings or ad directed by the Engineer.
   5. Construct sidewalk ramps in accordance with drawing or stated in the specifications for the project.

3.4 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Engineer will take cylinders and perform slump and air entrainment tests in accordance with ACI 301. The frequency the tests are taken, shall be at the Engineer's discretion.

B. Strength Test Samples:
   1. Sampling Procedures: ASTM C172.
   2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured.
   3. Sample concrete and make one set of three cylinders for every 75 cu yds or less of each class of concrete placed each day.
   4. Make one additional cylinder during cold weather concreting, and field cure.

C. Field Testing:
   1. Slump Test Method: ASTM C143/C143M.
   2. Air Content Test Method: ASTM C173/C173M.

3. Temperature Test Method: ASTM C1064/C1064M.
4. Measure slump and temperature for each compressive strength concrete sample.
5. Measure air content in air entrained concrete for each compressive strength concrete sample.

D. Cylinder Compressive Strength Testing:
1. Test Method: ASTM C39/C39M.
2. Test Acceptance: In accordance with State of Michigan DOT Standards.
3. Test one cylinder at 7 days.
4. Test two cylinders at 28 days.
5. Dispose remaining cylinders when testing is not required.

E. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.6 PROTECTION

A. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian or vehicular traffic over paving for 7 days minimum after finishing.

END OF SECTION

SECTION 33 01 30.11
TELEVISION INSPECTION OF SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipeline flushing and cleaning.
2. Television inspection of sewer pipelines.
3. Audio-video recording of pipeline interior.
4. Requirements for deliverables.

B. Related Requirements:
1. Section 33 01 30.13 – Sewer and Manhole Testing: Television witnessing of mandrel testing.
2. Section 33 01 30.72 - Cured-in-Place Pipe Lining: Television inspection of finished Work.

1.2 COORDINATION

A. Coordinate Work of this Section with Owner and Engineer.

B. Coordinate Work of this Section to avoid conflict with manhole rehabilitation work.

1.3 SCHEDULING

A. Schedule Work of this Section to coincide with lining sewers.

1.4 SUBMITTALS

A. Portable Storage Devices:
1. Submit completed CCTV records identified by Project name, street name, right-of-way property name, and pipe reference number.
2. Storage devices become property of Owner upon delivery.

B. PACP Database – Supply PACP Exchange database in .mdb format.

C. Inspection Reports:
1. Submit cleaning and televising inspection reports for each section of sewer line to be rehabilitated.
2. Each inspection report shall include all required fields specified in the current PACP manual including images of the observation snapshots.
3. At a minimum include all inspections onto a combined .mdb database suitable for importation into a licensed NASSCO compatible software.

D. Submit specific detailed description of proposed bypass pumping system, including written description of plan addressing schedule, quantity, capacity, and location of pumping equipment, as necessary to facilitate CCTV activities in pipelines.

E. Submit spill plan to address any spills that might occur.

F. Qualifications Statement:
   1. Submit qualifications for CCTV Inspector performing CCTV inspections.

1.5 QUALITY ASSURANCE

A. Perform Work according to NASSCO Sewer Pipe Cleaning Specification Guide (current edition) standards, NASSCO PACP and LACP (current edition) standards, and Municipality standards.

1.6 QUALIFICATIONS

A. Company specializing in performing Work of this Section with minimum three years' documented experience.

B. The certified Inspector must remain onsite at all times during the entire survey.
   1. If video is to be coded separately from the actual recording, both the onsite Operator and the individual performing the PACP coding shall be PACP certified.
   2. The Contractor shall provide proof of certification prior to the commencement of work, prior to a change in personnel involved in data collection, and as requested by the Engineer.

PART 2 - PRODUCTS

2.1 PORTABLE STORAGE DEVICES

A. Description: External hard drive devices with minimum 500GB storage capacity meeting USB 3.0 specifications.

2.2 REPORTS

A. Description: Printed reports in PDF format.

B. Printed reports containing all header forms, defects, quick ratings, and pictures of defects and/or observations. Reports shall contain all required headers as specified in the most current NASSCO – PACP and LACP version and using current naming conventions.

2.3 DATABASE FILES

A. Description: Microsoft access database file.
   1. Extension: .mdb

B. Database file containing all records of pipeline inspections including videos, pictures of defects, descriptions and details of defects, and is accessible universally through all PACP software platforms.

2.4 VIDEOS

A. MPEG 1 formatted.

B. Naming convention to be dictated by pipe segment reference number from upstream manhole to downstream manhole. Example: PSR#_US MH ID_ DS MH ID.

PART 3 - EXECUTION

3.1 GENERAL

A. Cleaning and televising of the pipeline prior to CIPP liner installation shall ensure the host pipe has been prepared in a sufficient manner to allow for an unimpeded installation of the CIPP liner. The Contractor shall ensure all obstructions (deposits, debris, roots, intruding tap connections, etc.) have been removed prior to the installation of the CIPP liner.

B. Perform Pre-, Post-, and 30-day Post CCTV inspections as specified in Section 33 01 30.72-Cured In Place Pipe Lining.

C. The Contractor shall furnish and maintain, in good condition, all cleaning and televising equipment necessary for proper execution of the work.

D. Maintaining Flow: It will be the responsibility of the Contractor, throughout the tenure of this contract, to provide and maintain sufficient flow at all times to pass any flash of storm flow and prevent any basement flooding due to obstruction caused by cleaning or CCTV equipment.

E. Retrieval of Materials and Equipment: It shall be the Contractor's responsibility to remove materials and equipment that has been lodged in the sewer from cleaning, television inspection, or point repair excavations.

F. Work Schedule. This schedule shall outline the sequence in which the Contractor proposes to conduct his operations and shall be approved by the Owner before work is started. The Contractor shall use a time-scaled logic diagram format. The level of detail of activities shall provide clear, concise communication of the plan of work. At a minimum, activities showing initial mobilization, start-up, cleaning and televising, and any resultant point repairs shall be included.

G. Original and updated schedules must be provided to the Owner in writing. The software used for producing the schedules must have the capability to tailor the form and format of schedules, and accompanying reports, to the Owner’s requirements.

H. The Owner may require additional updates to the schedule as changes occur. These additional updates will be submitted to the Owner within 24 hours of the request. Changes to the schedule are subject to approval of the Owner.

3.2 EXAMINATION

A. Verify location of sewer pipelines to be inspected.

3.3 PREPARATION

A. Flush and clean pipeline to remove sludge, dirt, sand, stone, grease, and other materials to ensure clear view of interior conditions.

1. Contractor shall perform cleaning as needed to ensure a thorough inspection is performed at each segment of pipe.
2. Cleaning shall be defined as unlimited amount of passes of a hydraulic flusher to remove all loose sludge, dirt, sand, stone, grease, attached deposits or encrustations and other materials as well as collection for removal from all pipelines, drop connections, and structure benches.
3. Heavy cleaning may incorporate the use of robotic devices or mechanical devices at the discretion of the Contractor. Heavy cleaning shall be performed in a manner that does not compromise the structural integrity of the mainline pipe or service connections. Any damage to the pipe resulting from the Contractors means and methods shall be repaired at the Contractor's expense.
4. Cleaning shall ensure a clear view of all interior conditions of pipelines and manholes.

B. Debris:
1. Intercept flushed debris at next downstream manhole using weir or screening device.
2. Remove and dispose of debris off Site.

C. Bypassing:
1. Furnish temporary bypass pumping system around Work area for time required to complete television inspection.
2. Provide standby pump of equal or greater capacity at bypass location.

D. Traffic Control:
1. Provide traffic control, including barricades, lights, and flaggers as necessary.

E. Closed-Circuit Television (CCTV) Camera System:
1. Use cameras specifically designed and constructed for closed-circuit sewer line inspection. Use camera equipment with color pan and tilt capability or a side wall scanning (panoramic) camera to view each lateral connection, defect, and general observations at multiple angles.
2. Use camera capable of moving both upstream and downstream with minimum 1,000 feet horizontal distance within one setup and direct-reading cable position meter.
3. Side wall scanning inspection systems are imaging cameras that are capable of a continuous 360-degree image capture of the wall of the pipeline being inspected. These systems may have one or multiple cameras to capture the complete interior view of the pipeline. Due to the high resolution of the image quality, the inspections may be conducted at a higher speed than color pan and tilt CCTV method. Once the pipeline inspections are completed, the captured images can be linked with a companion software package that allows for identifying and coding defects and features in the pipeline. Typically, these systems provide a fold flat view and a perspective view (typical of CCTV) of the pipeline.
4. If the image quality is not adequate for post-inspection coding, the Contractor shall be required to repeat the survey at the Contractor's expense.
5. All television inspection reports shall be within +/- two (2) feet of the measured linear footage between manholes along the existing sewer centerline from the start of pipe to end of pipe.
6. Lighting for the pan and tilt camera or side wall scanning camera shall provide a clear picture of the entire periphery of the existing sewer.

7. All PACP Header information shall be completed in accordance with PACP guidelines. In addition to mandatory Header fields, additional fields may be required by the Engineer or Municipality.
8. The documentation of the work shall consist of PACP CCTV Reports, PACP database, logs, electronic reports, etc. noting important features encountered during the inspections. The speed of travel shall be slow enough to inspect each pipe joint, tee connection, structural deterioration, infiltration and inflow sources, and deposits, but should not, at any time, be faster than 30 feet per minute, except as noted otherwise in this document.
9. The camera must be centered in the pipe to provide accurate distance measurements to provide locations of features in the sewer and these footage measurements shall be displayed and documented on the video. All PACP Observations shall be identified on PACP log. All video must be continuously metered from manhole. The pipe should be clean enough to ensure all defects, features and observations are seen and logged.
10. The recorded video must show the entire circumference of the sewer. Any flow control to remove standing water and debris shall be incidental to the contract. It is not the intent of this specification to require bypass pumping to control heavy flow; however, the Contractor must, at a minimum, make reasonable effort to control flow. The Contractor must also consider weather conditions to obtain the best video image of the sewer. This may require the Contractor to delay any video work after major rain events until the system can return to lower dry weather flow.
11. The sections of sewer to be cleaned and televised through this contract will be located within paved areas as well as areas located in public easements found on private property. The successful bidder will be responsible to coordinate and gain access to any and all sewer sections and will be responsible for any restoration required to restore damages to property incurred in the inspection process.
12. The Contractor shall furnish all labor, components, materials, tools, and appurtenances necessary for the performance and completion of the contract.
13. The Contractor will be held fully liable for any damages incurred that are caused by his or her negligence.
14. Patents, Trade Secrets, and Copyrights: The Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the work or the incorporation in the work of any invention, design, process, product or device which is the subject of patent rights, trade secrets protection rights, or copyrights held by others. The Contractor shall indemnify and hold harmless the Owner and Engineer and anyone directly or indirectly employed by either of them from and against all claims, damages, losses and expenses (including attorney's fees and court and arbitration costs) arising out of any infringement of patent rights, trade secret protection rights, or copyright incident to the use in the performance of the work or resulting from the incorporation in the work of any invention, design, process, product or device not specified in the contract documents, and shall defend all such claims in connection with any alleged infringement of such rights.
15. Work not following these specifications may be rejected and the Contractor may be required to redo the Work.

F. REPORTING
1. The Contractor must immediately report to Owner any conditions that have cause to create imminent damage to the public and/or environment.

2. In the event of a condition that causes the CCTV inspection to be suspended, the Contractor shall continue inspection from the opposite direction in order to complete the inspection of that section of pipe and to determine the extent of the event that suspended the initial inspection. The Contractor must immediately report the obstruction to the Owner.

3.4 USE OF PREMISES

A. The Contractor shall not trespass upon or in any way disturb private property without first obtaining written permission from the property Owner and/or Owner or Prime Contractor as appropriate to do so. A copy of such written permission shall be furnished to the Owner prior to accessing the site.

B. It shall be the Contractor's responsibility to work equipment around poles, trees, or other obstructions and to do so at his own expense.

C. If the Contractor finds it necessary to obtain additional working area, it shall be the Contractor's responsibility for its acquisition.

D. The Contractor shall, at no additional expense, restore such property to the original condition in the sole and unfettered opinion of the system Owner. The Contractor must take photographs and/or videos of existing properties prior to disturbance of each property and make a copy available to the system Owner.

E. All items within the street right-of-way or sewer easement shall be removed, or removed and replaced, or restored as directed by the Owner.

F. The Contractor shall ensure all employees have a badge or visible identification during any time that they on the project site or within private property. This identification must be worn so that it is readily recognized and readable to the public.

3.5 CLEANUP

A. The Contractor shall keep the work area in an uncluttered condition by the frequent removal of debris. The Contractor shall remove all debris and unused material and leave the area in a condition similar to the condition of the area before any work was performed.

3.6 PROPERTY DAMAGE

A. The Contractor shall immediately investigate any and all reports of sewage backing up into fixtures served by the sewer section that is being cleaned or televised.

B. The Contractor will be required to notify the Owner immediately if he causes any damage to private or public property caused by activities related to this contract. The Contractor shall make repairs and/or clean the property immediately in a timeframe that is acceptable to the Owner.

3.7 ACCESS TO MUNICIPAL WATER SUPPLIES

A. Coordinate with Municipality.

3.8 FIELD QUALITY CONTROL

A. The Contractor shall keep the work areas in an uncluttered condition by the frequent removal of debris. The Contractor shall remove all debris and unused material and leave the area in a condition similar to the condition of the area before any work was performed.

B. The Contractor shall immediately investigate any and all reports of sewage backing up into fixtures served by the sewer section that is being cleaned or televised.

C. The Contractor will be required to notify the Engineer and Municipality immediately if he causes any damage to private or public property caused by activities related to this contract. The Contractor shall make repairs and/or clean the property immediately in a timeframe that is acceptable to the Municipality.

END OF SECTION

SECTION 33 01 30.13
SEWER AND MANHOLE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing of Gravity Sewer Piping:
      a. Low pressure air testing.
   2. Testing of pressure piping.
   3. Deflection testing of plastic sewer piping.
   4. Testing of Manholes:
      a. Vacuum testing.
      b. Exfiltration testing.

B. Related Requirements:
   1. Section 33 05 13 – Manholes and Structures
   2. Section 33 31 00 - Sanitary Utility Sewerage Piping: Pipe materials, manholes, and accessories normally encountered with gravity sanitary drain building piping from 5 feet outside building to final connection.
   3. Section 33 34 00 - Sanitary Utility Sewerage Force Mains: Pipe materials and accessories normally encountered with municipal sanitary sewage force mains.

1.2 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
   2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

B. American Water Works Association:
   1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit following items prior to start of testing:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.
   6. Deflection mandrel drawings and calculations.

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 - PRODUCTS

2.1 VACUUM TESTING

A. Equipment:
1. Vacuum pump.
2. Vacuum line.
3. Vacuum Tester Base:
   a. Compression band seal.
   b. Outlet port.
4. Shutoff valve.
5. Stopwatch.
6. Plugs.
7. Vacuum Gage: Calibrated to 0.1 in. Hg.

2.2 EXFILTRATION TESTING

A. Equipment:
1. Plugs.
2. Pump.
3. Measuring device.

2.3 AIR TESTING

A. Equipment:
1. Air compressor.
2. Air supply line.
3. Shutoff valves.
4. Pressure regulator.
5. Pressure relief valve.
6. Stopwatch.
7. Plugs.
8. Pressure Gage: Calibrated to 0.1 psi.

2.4 DEFLECTION TESTING

A. Equipment:
1. "Go, no go" mandrels.
2. Pull/retrieval ropes.

2.5 HYDROSTATIC TESTING

A. Equipment:
1. Hydro pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that manholes and piping are ready for testing.

C. Verify that trenches are backfilled.

D. Verify that pressure piping thrust restraint system is installed.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for preparation.

B. Lamping:
1. Lamp gravity piping after flushing and cleaning.
2. Perform lamping operation by shining light at one end of each pipe section between manholes.
3. Observe light at other end.
4. Pipe not installed with uniform line and grade will be rejected.
5. Remove and reinstall rejected pipe sections.
6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:
1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Testing of Gravity Sewer Piping:
1. Low Pressure Air Testing:
   a. Test each reach of gravity sewer piping between manholes.
   b. Introduce air pressure slowly to approximately 4 psig.
      1) Determine ground water elevation above spring line of piping.
      2) For every foot of ground water above spring line of piping, increase starting air test pressure by 0.43 psi.
      3) Do not increase pressure above 10 psig.
   c. Allow pressure to stabilize for at least five minutes.
   d. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.

e. Testing:
   1) Determine test duration for reach of sewer with single pipe size from following table; do not make allowance for laterals.

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
3	0.2
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

   2) Record drop in pressure during testing period.
   3) If air pressure drops more than 1.0 psi during testing period, piping has failed.
   4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
   5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

2. Infiltration Testing:
   a. Maximum Allowable Infiltration: 100 gal./in. of pipe diameter for each mile per day for reach of piping undergoing testing.
   b. Include allowances for leakage from manholes.
   c. Perform testing with minimum positive head of 2 feet.

C. Testing of Pressure Piping:
   1. Test system according to AWWA C600 and following:
      a. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping or 100 psi, based on elevation of lowest point in piping corrected to elevation of test gage.
      b. Conduct hydrostatic testing for at least two hours.
      c. Slowly fill with water portion of piping to be tested, expelling air from piping at high points.
      d. Install corporation cocks at high points.
      e. Close air vents and corporation cocks after air is expelled.
      f. Raise pressure to specified test pressure.
      g. Observe joints, fittings, and valves undergoing testing.
      h. Remove and renew cracked pipes, joints, fittings, and valves that show visible leakage.
      i. Retest.
      j. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
      k. Maintain pressure within plus or minus 5.0 psi of test pressure.

l. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of testing. Compute maximum allowable leakage using following formula:

L = [**SD x sqrt(P)**]/C
L = testing allowance, gph
S = length of pipe tested, feet
D = nominal diameter of pipe, inches
P = average test pressure during hydrostatic testing, psig
C = 148,000
Note: 1. When pipe undergoing testing contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each pipe size.

2. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.
3. Correct visible leaks regardless of quantity of leakage.

D. Deflection Testing of Plastic Sewer Piping:
1. Perform vertical ring deflection testing on PVC and acrylonitrile butadiene styrene sewer piping after backfilling has been in place for at least 30 days but not longer than 12 months.
2. Allowable maximum deflection for installed plastic sewer pipe is no greater than five percent of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122.
5. Perform testing without mechanical pulling devices.
6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

E. Testing of Manholes:
1. Description:
   a. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.
   b. Repair both outside and inside of joint to ensure permanent seal.
   c. Test manholes with manhole frame set in place.
2. Vacuum test according to ASTM C1244 and following:
   a. Plug pipe openings; securely brace plugs and pipe.
   b. Inflate compression band to create seal between vacuum base and structure.
   c. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg.
   d. Close valve.
   e. Testing:
      1) Determine manhole testing duration using following table:

MANHOLE DIAMETER (feet)	TEST PERIOD
4	60 seconds
5	75 seconds
6	90 seconds

      2) Record vacuum drop during test period.
      3) If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.

4) If vacuum drop of 1 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.
5) If vacuum test fails to meet 1 in. Hg drop in specified time after repair, repair and retest manhole.

3. Exfiltration Testing:
   a. Plug pipes in manhole.
   b. Remove water from manhole.
   c. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.
   d. Determine ground water level outside manhole.
   e. Fill manhole with water within 4 inches of top of cover frame.
   f. Prior to testing, allow manhole to soak from minimum of four hours to maximum of 72 hours.
   g. After soak period, adjust water level inside manhole to within 4 inches of top of cover frame.
   h. Measure water level from top of manhole frame.
   i. At end of four- hour testing period, again measure water level from top of manhole frame; compute drop in water level during testing period.
   j. Manhole exfiltration test is considered satisfactory when drop in water level is less than values listed in following table:

MANHOLE DEPTH (FEET)	ALLOWABLE LEAKAGE IN FEET FOR MANHOLE DIAMETER		
	4	5	6
4	0.11	0.14	0.17
6	0.17	0.21	0.26
8	0.23	0.29	0.35
10	0.28	0.35	0.42
12	0.34	0.43	0.51
14	0.40	0.50	0.60
16	0.45	0.56	0.68
18	0.51	0.64	0.77
20	0.57	0.71	0.86
22	0.62	0.78	0.93
24	0.68	0.85	1.02
26	0.74	0.93	1.11
28	0.79	0.99	1.19
30	0.85	1.06	1.28

4. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.
5. Repair visible leaks regardless of quantity of leakage.

3.4 SCHEDULES

A. Table 1 – Allowance for expansion of polyethylene pipe.

B. Pipe Restraint Schedule.

TABLE 1
ALLOWANCE FOR EXPANSION OF POLYETHYLENE PIPE
UNDER TEST PRESSURE

Nominal Pipe Size (inches)	U.S. GALS/100 FEET OF PIPE Test:1 - Hour	2 - Hour	3 - Hour
2	0.08	0.12	0.15
3	0.10	0.15	0.25
4	0.13	0.25	0.40
5	0.21	0.41	0.63
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
28	5.5	11.1	16.8
30	6.2	12.6	19.1
32	7.0	14.3	21.5
36	9.0	18.0	27.0

PIPE RESTRAINT SCHEDULE FOR GROUND BURIED PRESSURE PIPES [a] [b]

LENGTH OF RESTRAINT REQUIRED [c]							
Deflection Angle / Pipe	22 1/2	33 3/4	45	56 1/4	67 1/2	78 3/4	90 , tee or dead end
6" and smaller	8	12	16	20	25	31	59
8"	10	15	20	26	33	40	77
10"	12	18	25	32	40	49	93
12"	14	21	29	37	47	57	109
14"	16	24	33	41	54	66	125
16"	18	27	37	47	60	74	141

[a] This table is based on a test pressure of 150 PSI (Operating pressure + water hammer). For other test pressures, all values shall be increased or decreased proportionally.

[b] Table is valid for depths of bury 5' or greater. For depths of bury less than 5', consult D.I.P.R.A. guidelines.

[c] In each direction from point of deflection or termination, except for tee at which only the branch in the direction of the tee stem.

END OF SECTION

SECTION 33 01 30.43

MANHOLE COATINGS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Work, materials, and equipment required to install a monolithic multi-layer/component concrete manhole lining system to provide infiltration and corrosion protection.
2. The lining system shall be three (3) parts consisting of a polyurea adhesion inner layer, polymer surface middle layer, and exterior polyurea layer

B. Related Sections:

1. Section 01 50 50 - Temporary Bypass Pumping.
2. Section 01 55 26 - Traffic Control / Maintaining Traffic.
3. Section 33 01 30.13 - Sewer and Manhole Testing
4. Section 33 01 30.72 - Cured-In-Place Pipe Lining

1.2 References:

A. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
B. ASTM D638 - Standard Test Method for Tensile Properties of Plastics
C. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics
D. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
E. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
F. ASTM D2344 - Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
G. ASTM D3039 - Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
H. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
I. ASTM D4787 – Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
J. ASTM D7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers

1.3 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.
B. All materials and procedures required to establish compliance with the specifications shall be submitted to the owner/engineer for review/approval. Submittals shall include at least the following:

1. Technical Data Sheet on each product used.
2. Material Safety Data Sheet (MSDS) for each product used.
3. Manufacturer’s Certification of Applicator

4. Certified Applicator Minimum Qualifications
5. Descriptive literature, bulletins and or catalogs of materials.
6. Work procedures including but not limited to bypass pumping, traffic control, method of repair, and installation procedures for a complete manhole lining system.
7. Material and method for repair of leaks or cracks in the structure.
8. Statement of 20 Year Warranty.
9. All calculations used for determining the properties of each lining system

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with Delta Charter Township standards for construction.

B. Coating products shall be capable of being installed and curing properly within the specified environments. Coating products shall be resistant of all forms of chemical or bacteriological attack found in municipal sanitary sewer systems and capable of adhering to the substrates and repair products.

C. Coating products must have been tested by and passed ASTM G210-13 Severe Wastewater analysis Testing (SWAT).

D. Contractor shall utilize equipment for spray application of the coating product(s) which has been approved by the coating product manufacturer, and, Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.

E. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application, and inspection of the coating product(s) to be used as specified herein.

F. Contractor shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating products to be used as specified herein.

G. The manufacturer and/or applicator of the total liner system of manholes shall be a company that specializes in the design, manufacture, or installation of corrosion protection systems for manholes. Applicator shall be completely trained in leak repair, surface preparation and corrosion materials application on manholes. Corrosion materials/products shall be suitable for installation in a severe hydrogen sulfide environment without any deterioration to the liner.

H. The applicator shall be trained and certified by the manufacturer for the handling, mixing, application, wet out procedures, and inspection of the liner system as described herein.

I. To ensure total unit responsibility, all materials and installation thereof shall be furnished and coordinated by Manufacturer/Certified Applicator.

J. Certified Applicator must have successfully installed 3,000 vertical feet of approved liner system in the last three (3) years. A documented installation history shall be supplied upon

request to include; Owner Name, Contact Information, Project Description, Volume of Product Installed and Contract Duration.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver and store materials per manufacturer's recommendations.

C. Liquid products shall be protected from freezing while being stored.

1.6 WARRANTY

A. Manufacturer and Applicator warrant the system against failure for a period of 20 years. "Failure" will be deemed to have occurred if the protective lining fails to:

1. Prevent the internal deterioration or corrosion of the structure, or
2. Protect the substrate and environment from contamination by effluent, or
3. Prevent groundwater infiltration.

B. Contractor to supply letter agreeing to an effective start date of warranty. Effective start date of warranty must be agreed upon with the Owner / engineer and after final completion.

C. If any such failure occurs within 20 years of initial completion of work on a structure, the damage will be repaired to restore the system at no cost to the Owner within 60 days after written notification of the failure.

D. "Failure" does not include damage resulting from mechanical or chemical abuse or act of God.

E. Mechanical or chemical abuse means exposing the lined surfaces of the structure to any mechanical force or chemical substance not customarily present or used in connection with structures of the type involved.

F. There are no warranties express or implied other than those specifically stated in this section.

G. Any liability for consequential and incidental damages is expressly disclaimed. Liability is limited to and shall not exceed the purchase price paid.

PART 2 - PRODUCTS

LINER SYSTEM

A. Approvable Products:

1. Protective multi-layer component lining system by OBIC consisting of
   a. Polyurea Adhesion Coating
   b. Polymer Surface Layer
   c. Polyurea Armor Layer

B. The complete system shall have a final (dry) thickness of 500 mils. Application rates for each layer are outlined as follows:

1. Polyurea Adhesion Coating: 100 mils
2. Polymer Surface Layer (Foam): 300 mils
3. Polyurea Armor Layer: 100 mils

C. Armor Layer shall be 100% solids, no VOC's, moisture tolerant, elastomeric polyurea coating to provide infiltration and corrosion protection. Material shall be capable of curing properly and conform to the following minimum physical requirements.

Property	Value
Hardness, D-412	D 48
Tensile Strength, D-412	3315 psi
100% Modulus, D-412	1668 psi
200% Modulus, D-412	1960 psi
300% Modulus, D-412	2650 psi
Tear resistance/DIE-C, D-624	417 pli
Ultimate elongation, D-412	395 %
Taber Abrasion, mg loss CS17	15 mg loss
Flexibility, 1/8" mandrel	Pass
ASTM G210-13 SWAT	pass

D. Surface Layer shall be 100% solids, no VOC's, moisture tolerant, elastomeric polyurea coating to provide infiltration and corrosion protection. Material shall be capable of curing properly and conform to the following minimum physical requirements.

Property	Value
Density (ASTM D-1662)	6-8 pcf
Compressive Strength 1"	130-180 psi
Closed Cell Content	>94%
Water Absorption	<0.03 lbs/sqft
Maximum Service Temp	180 deg
Viscosity (A side) @ 72 deg F	675
Viscosity (B side) @ 72 deg F	200
ASTM G210-13 SWAT	Pass

E. The materials to be utilized in the coatings of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. The Manufacturer of corrosion protection products shall have long proven experience in the production of the lining products utilized and shall have a satisfactory installation record.

F. Surface preparation equipment shall be suited to remove corroded materials from the existing concrete structures.

G. Equipment for installation of coating materials shall be high quality grade and be as recommended by the manufacturer.

H. Contractor is to provide all necessary bypass pumping necessary to achieve a complete installation of the manhole coating system.

PART 3- EXECUTION

3.1 SURFACE PREPARATION

A. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and surface preparation equipment.

B. Surface preparation methods include 5,000 psi hydro-blasting, abrasive blasting, grinding, detergent water cleaning and shall be suited to provide a surface compatible for installation of the liner system per the corrosion protection system's manufacturer's written instructions.

C. Surface preparation method shall produce a cleaned, abraded and sound surface with no evidence of laitance, loose concrete, brick or mortar, contaminants or debris, and shall display a surface profile suitable for application of liner system.

D. After completion of surface preparation, perform inspection for:
   1. Leaks
   2. Cracks
   3. Holes
   4. Exposed Rebar
   5. Ring and Cover Condition
   6. Insert Condition
   7. Inlet and Outlet Pipe Condition
   8. Flow Channel / Bench Condition

E. After the defects in the structure are identified, repair all leaks with a chemical or hydraulic sealant designed for use in field-sealing of groundwater. Severe cracks shall be repaired with a urethane based chemical sealant, or hydraulic cement, and product to be utilized shall be as approved by corrosion protection system manufacturer, Owner, and Engineer prior to installation. Sealants and cementitious products shall be compatible with liner system.

F. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be repaired utilizing non-shrink grout or approved alternative method.

G. Subject to compliance with the polyurea coating manufacturer's requirements, the following products shall be acceptable as compatible repair base coat materials for polyurea top coating:
   1. A hydraulic cement and/or plug shall be used to stop active infiltration. The hydraulic cement and plug shall be suitable for polyurea top coating and shall be approved by the polyurea coating manufacturer.
   2. Hydrophobic and/or Hydrophilic polyurethane chemical grouts used to stop active infiltration. The chemical grouts shall be suitable for the polyurea top coating, and shall be approved by the polyurea coating manufacturer.

3.2 MATERIAL INSTALLATION

A. Application procedures shall conform to recommendations of the manufacturer, including materials handling, mixing, wet out, environmental controls during application, and safety equipment.

B. Spray equipment shall be specifically designed to accurately ratio and apply the liner system.

C. Provide final written report to Owner/Engineer detailing the location, date of report, and description of repair.

3.3 INSPECTION

A. Applicator shall take appropriate action to comply with all local, state and federal regulations including those set forth by OSHA, EPA, the State of Michigan, the Owner and any other applicable authorities.

B. Prior to conducting any work, perform inspection of structure to determine need for protection against hazardous gases or oxygen depleted atmosphere and the need for flow control or flow diversion.

C. Submit plan for flow control or bypass to owner/engineer for approval prior to conducting the work.

D. Final system shall be completely free of pinholes or voids. Entire exposed manhole surface shall be protected with the system. Thickness shall be the minimum value as described herein. The contractor is to provide holiday testing on the entirety of each manhole lining system. Engineer's representative shall be present during entirety of each test to verify all pinholes are identified and repaired according to manufacturer's recommendations.

E. Visual inspection shall be made by the Owner/Engineer. Any/all deficiencies in the finished liner system shall be identified and repaired according to the procedures set forth by Manufacturer.

F. The sewer system may be returned to full operational service as soon as the final inspection has taken place.

1.7 TESTING

A. Holiday Testing (spark testing) shall be performed on entire surface area to identify pinholes, thin material, and any defects that will affect the life of the installed system. During holiday testing, a defect or pin hole is found, Contractor shall identify location of the defect and reapply coating system within the recoat window. Final acceptance will be contingent on elimination of all pinholes. The contractor shall have work performed by someone certified by the manufacturer to do so. All reports shall be provided to the Engineer for acceptance.

END OF SECTION

SECTION 33 01 30.72
CURED-IN-PLACE PIPE LINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liners for existing sewers:
      a. Inverted resin-impregnated tube pipe liner.
   2. Re-establishing service connections.
   3. Trimming lateral connection.
   4. End seals.
   5. CCTV Inspection
   6. Materials Testing for CIPP Liner (end sampling).

B. Related Requirements:
   1. Section 33 01 30.11 - Television Inspection of Sewers: Cleaning & flushing, and CCTV inspections.
   2. Appendix A - Existing CCTV Inspection Reports
   3. NASSCO Cured in Place Pipe (CIPP) Installation Performance Specification Guideline.

1.2 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM D5260 - Standard Classification for Chemical Resistance of Poly (Vinyl Chloride) (PVC) Homopolymer and Copolymer Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   2. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
   3. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   4. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   5. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
   6. ASTM D5813 - Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems.
   7. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
   8. ASTM F1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).
   9. ASTM F2019 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).
   10. ASTM F2599 Standard Practice for Sectional Repair of Damaged Pipe by Means of an Inverted Cured-In-Place Liner.
   11. ASTM F3240 - Standard Practice for Installation of Seamless Molded Hydrophilic Gaskets for Long-Term Watertightness of Cured-In-Place Rehabilitation of Main and Lateral Pipelines.

1.3 COORDINATION

A. Coordinate Work of this Section with Owner and Engineer.

B. Contractor to notify homeowners and businesses at least 48 hours in advance of expected disruption of sanitary service.

C. Contractor shall go door to door in person and discuss notification. Contractor shall leave a door hanger at each affected property, identifying date of work and duration of outage. Door hanger shall have contact information for Contractor / Engineer / Client representative.

D. Limit disruption of service to individual properties to one-time occurrence for maximum of eight hours.

E. Provide and maintain temporary facilities, including piping and pumps, to meet requirements.

1.4 SUBMITTALS

A. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, licensed professional, pipeline assessor.
   2. Submit manufacturer's approval of installer.

B. Contractor shall submit a procedural means and methods document for approval regarding lateral trimming operations.

C. Product Data:
   1. Submit manufacturer information regarding liner material, curing chemicals, and lubricants. Include fabric tube, flexible membrane coating, resins, and pre-liner.
   2. Submit complete description of proposed wet-out procedures.
   3. All MSDS sheets for materials to be furnished on the project.
   4. Fabric tube shall be accompanied by minimal void volume in the felt that will be filled with resin.
   5. Submit copy of wet out report and manufacturers recommended cure schedule for each liner.
   6. Submit liner thickness basis of design including all calculations and selection criteria for the products being supplied.

D. Shop Drawings: Indicate liner dimensions for each pipe size to be relined.

E. Samples: Submit two samples of liner material in both uncured and cured state. For each inversion length, cured sample should be cut from termination point that has been inverted through a like diameter pipe held in place by a suitable heat sink. Sample shall be provided to third party testing agency by Contractor as specified in Section 330130.13.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for liner thickness.

H. Test and Evaluation Reports: Submit reports certifying that liner material meets ASTM testing standards as specified in this Section.

I. Manufacturer Instructions:
   1. Submit detailed description of liner placement and curing procedures for piping.
   2. Include description of procedures for sealing liner material at manholes and reestablishing service connections.
   3. Submit manufacturer's requirements for receiving, handling, and storage of materials.

J. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

K. A detailed Notification Plan including staged notification to residents affected by the CIPP installation.

L. Safety Plan, per NASSCO guidelines:
   1. The Contractor shall conform to all work safety requirements of pertinent regulatory agencies, and shall secure the site for the working conditions in compliance with the same. The Contractor shall erect such signs and other devices as are necessary for the safety of the work site.
   2. The Contractor shall perform all of the Work in accordance with applicable OSHA standards. Emphasis shall be placed upon the requirements for entering confined spaces and with the equipment being utilized for pipe renewal.
   3. The Contractor shall submit a proposed Safety Plan to the Owner, prior to beginning any work, identifying all competent persons. The plan shall include a description of a daily safety program for the job site and all emergency procedures to be implemented in the event of a safety incident. All work shall be conducted in accordance with the Contractor’s submitted Safety Plan.
   4. Compensation for all work required for the submittal of the Safety Plan shall be included in the various pipelining items contained in the Proposal

M. Quality Control Plan (QCP), per NASSCO guidelines:
   1. A detailed quality control plan (QCP) shall be submitted to the Owner that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include the following:
      a. A detailed discussion of the proposed quality controls to be performed by the Contractor.
      b. Defined responsibilities, of the Contractor’s personnel, for assuring that all quality requirements for this contract are met. These shall be assigned, by the Contractor, to specific personnel.
      c. Proposed procedures for quality control, product sampling and testing shall be defined and submitted as part of the plan.
      d. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form.
      e. Scheduled performance and product test result reviews between the Contractor and the Owner at a regularly scheduled job meeting.
      f. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in this contract and submitted with the QCP.

1.5 QUALITY ASSURANCE

A. Perform Work according to manufacturer’s standards and NASSCO CIPP Installation Guidelines (latest edition).

B. Maintain one copy of each standard affecting Work of this Section on Site.

C. Contractor to notify Engineer 48 hours in advance to have Inspector on site for:
   1. Material delivery.
   2. Installation and curing.
   3. Service lateral reinstatement
   4. Post-CIPP inspection.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience in installation of liner materials and certified by manufacturer.
   1. Minimum of 150,000 feet of similar pipe size and length installed in the U.S.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

D. Pipeline Assessor:
   1. Person specializing in assessing condition of sewer pipelines prior to and following relining.
   2. Currently certified in Pipeline Assessment and Certification Program (PACP) of the National Association of Sewer Service Companies (NASSCO).
   3. Provide certification status.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Contractor shall verify field measurements prior to fabrication such as diameter and length.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Furnish 5-year manufacturer's warranty for liner.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design lining material to have sufficient structural strength to support dead loads, live loads, and groundwater load imposed, assuming existing pipe cannot share loading or contribute to structural integrity of liner.

B. Design liner to least-possible thickness to minimize decreasing interior pipe diameter. See Schedule at the end of this section for minimum thickness of liners.

C. Design liner material to provide jointless, continuous, and structurally sound construction able to withstand imposed static, dynamic, and hydrostatic loads on a long-term basis.

D. Identify design provisions for shrinkage control to prevent future misalignment of service reconnections.

E. A copy of the previous CCTV reports are in Appendix A. Contractor shall verify existing pipe condition during the pre-CCTV installation cleaning and televising.

2.2 INVERTED RESIN-IMPREGNATED TUBE PIPE LINER

A. Furnish materials according to Manufacturer's standards.

B. Manufacturers:
   1. National Liner, LLC.
   2. Perma-Liner Industries, LLC
   3. Approved Equal

C. Description:
   1. Fabric Tube:
      a. One or more layers of absorbent, non-woven felt fabric, felt/fiberglass, or fiberglass.
      b. Comply with ASTM D5813, F1216, F1743, and F2019.
      c. Capable of absorbing and carrying resins.
      d. Comply with NASSCO Guidelines
   2. Resin:
      a. Corrosion-resistant polyester or vinyl ester resin and catalyst system.
      b. Comply with ASTM F1216 and F1743.
      c. The resin to tube ratio, by volume shall be furnished as recommended by the manufacturer.
   3. Terminal End Gasket Seal:
      a. Insignia Seal by LMK Technologies.
   4. Wet-Out Fabric Tube:
      a. Furnish uniform thickness and excess resin distribution that, when compressed at installation pressure, will meet or exceed design thickness after cure.
   5. Cure Tracking Technology:
      a. Vericure Temperature Quality Control Wire and cure tracking software.
      b. Contractor shall install Vericure Temperature monitors to continuously monitor the curing process of the CIPP liner. The final temperature data must be submitted to the engineer to review prior to acceptance of the liner.

6. Material Testing for CIPP Liner:
    a. As specified in Part 3 herein.

2.3 SOURCE QUALITY CONTROL

A. Inspect material for defects. Verify liner material is homogeneous and free of defects, cracks, holes, blisters, protrusions, foreign materials, or other deleterious faults.

B. Marking:
    1. For testing purposes, mark each production lot with identical marking number.
    2. Mark each reel of folded PVC pipe at intervals not to exceed 5 feet with coded number identifying manufacturer, size, cell class, machine, shift, and date when liner was extruded.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify location of piping to be relined.

3.2 PREPARATION

A. Initial Video Inspection and Repair:
    1. Conduct closed-circuit video inspection as specified in Section 33 01 30.11 - Television Inspection of Sewers.
    2. Determine condition of existing piping, degree of offset of joints, and locations of crushed walls, obstructions, and defects.
    3. Determine sizes and locations of service entrances and connections.
    4. Evaluate pipe conditions, performed by pipeline assessor.
    5. Clear obstructions, service piping protrusions, and other materials from bottom of existing pipe to ensure that inserted pipe liner directly contacts existing pipe wall.

B. Cleaning: Clean existing sewer pipes of debris, sedimentation, mineral deposits, roots, intruding laterals, and any other defects with high-velocity cleaner, bucket and scraper, root saws, rolling or balling units, or other appropriate means to ensure CIPP liner is installed against the host pipe.

C. Lateral trimming shall be performed in a manner that does not compromise the structural integrity of the mainline pipe or lateral pipe.

D. The use of mechanical devices, including but not limited to chain knockers, saws, and cutters will not be allowed for lateral trimming operations. Lateral trimming operations shall be performed by robotic means. Acceptable robotic means includes use of industry standard equipment similar to Danscutter USA, Schwalm USA, or approved equal.

E. Bypass pumping:
    1. Set up bypassing pump system to isolate each section of piping for relining, as deemed necessary.
    2. Maintain bypass pumping until lining is totally formed and service connections have been reestablished.

3.3 INSTALLATION

A. Excavate for point repairs only on emergency basis and as permitted by Engineer.
   1. In the event of an emergency point repair, contractor shall be responsible to verify all underground utilities prior to excavation.
   2. All roadway repairs, sanitary sewer pipeline repairs, and any other emergency work not anticipated in this contract shall conform to the applicable standards for construction from the utility's governing entity.

B. Perform relining and reestablish service connections without need for excavation while minimizing disruptions to property owners.

C. Inverted Resin-Impregnated Tube Pipe Liner:
   1. Coat layer of fabric tube (before inversion or pull-in, as applicable) with an impermeable, flexible membrane that will contain resin and facilitate, if applicable, vacuum impregnation and monitoring of resin saturation during resin impregnation (wet-out) procedure.
   2. Prior to installation, and as recommended by manufacturer, place remote temperature gages or sensors inside host pipe at 6 o'clock position to monitor temperature during cure cycle.
   3. Positioning:
      a. Position wet-out tube in pipeline using method specified by manufacturer.
      b. Do not damage tube during installation.
   4. Cure installed liner by using appropriate medium according to manufacturer's recommended cure schedule.
   5. Allow installed pipe liner to cool according to manufacturer instructions.
   6. Annular Spaces:
      a. Verify that no gap or annular space exists between finished liner and existing pipe.
      b. Install watertight seals to host pipe at beginning and end of installed liner.

D. Service Connections:
   1. Re-establish existing sewer service connections through use of closed-circuit television camera and remote-controlled cutting device.
   2. Match invert of reestablished service with previously existing invert.
   3. Maintain a minimum of 98 to 100 percent of original service connection opening.
   4. The service connections in this project will receive lateral junction liners in a following project. Service connection opening must allow for future installation of a lateral junction liner.
   5. Re-establish sewer service connection with uniform cuts free of burrs and sharp edges.
   6. After reestablishing service connection, flush piping clean.
   7. Contractor to allow Inspector to observe and document service re-establishment.
   8. Contractor shall collect all debris and "coupons" from the sanitary sewer collection system. No lining debris shall be permitted to be left in the collection system.

3.4 CCTV INSPECTIONS

A. All CCTV inspections shall be performed, reported, and delivered per Section 33 01 30.11 – Television Inspection of Sewers.
   a. Pre-CCTV:
      1) Inspection showing condition of existing pipe and pipe joints and location of existing service connections after cleaning and prior to relining.

2) After CCTV inspection has been completed and documented, cleaning to remove all defects that would interfere with CIPP liner installation shall take place.
3) Pre- CIPP lining inspections shall document that pipes that were properly prepared for lining by being free of defects, obstructions, and infiltration and verify that the host pipe is in suitable condition to install CIPP liner.

b. Post-CCTV:
1) Inspection showing properly cured liner and documentation of properly re-established service connections.

c. 30-day Post-CCTV
1) Inspection showing a properly functioning liner and collection system.

3.5 FIELD QUALITY CONTROL

A. Internal Television Inspection:
1. All main line sanitary sewers receiving CIPP point liners and mainline liners shall be televised.
2. The Contractor shall employ the services of a company specializing in the videotaping services to provide an internal television inspection of the sewers installed under this contract and adhere to Section 33 01 30.11-Television Inspection of Sewers.
3. Perform no sooner than 30 days after completion of lining.

B. Liner Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. If liner fails to form, remove failed liner and install new liner.
3. Conduct closed-circuit video inspection of completed relining Work, indicating no visual defects, including foreign inclusions, dry spots, pinholes, cracks, delamination, wrinkles/fins that interface with flow, or bulging.
4. Confirm that service connections are complete and unobstructed.
5. No infiltration of groundwater is permitted.
6. Make final adjustments to liner under direction of manufacturer's representative.

C. Testing:
1. Contractor shall prepare each pipe/sewer scheduled for cured-in-place lining for end sampling, or as directed by the Engineer.
2. Selected samples shall be tested by a 3rd party testing agency qualified to perform said work.
3. Contractor shall be responsible for all costs associated with sampling and testing.
4. Tests shall be conducted on flexural modulus and wall thickness per Testing Procedures D638, D790, and D3567.
5. Contractor shall provide at a minimum, two (2) sections of PVC pipe to be used for testing procedures of the 12-inch diameter pipe. Price shall be incidental to the cost of lining the pipes as stated in the proposal. PVC Pipe sections will be used to provide sacrificial end samples from two CIPP liners as directed by Engineer.
6. For larger diameter pipelines such as 18 and 21-inch reinforced concrete pipes, a plate sample shall be considered sufficient for testing procedures. The plate sample shall be obtained from the wet-out facility and delivered to Contractor for testing procedures.
7. Testing shall be in accordance with ASTM F1216, ASTM F1743, and ASTM F2019.

D. Furnish installation certificate from manufacturer's representative attesting that liner has been properly installed and is ready for startup and testing.

3.6 CLOSEOUT SUBMITTALS

A. Submit all wet-out logs.

B. Submit all cure logs.

C. Submit results of Contractor-furnished tests and inspections.
   1. Contractor shall provide testing as indicated by the Engineer.
   2. Contractor shall be responsible for costs associated with testing.
   3. Contractor shall employ 3rd party testing agency qualified to perform said work.
   4. Tests shall be conducted on flexural modulus, flexural strength, and wall thickness with test method D790.

D. Project Record Documents: Record actual locations of each service connection. All service connections shall be identified as active or abandoned in accordance with NASSCO defect / observation naming convention.

3.7 SCHEDULE

A. Provide liners with the following minimum thickness:

Pipe ID	Minimum Liner Thickness (mm)
002-001	7.5
003-002	7.5
004-003	7.5
005-004	7.5
006-005	7.5
007-006	7.5
008-007	6.0
009-008	7.5
010-009	6.0
011-010	6.0
012-011	6.0
013-012	6.0
014-013	6.0
015-014	6.0
016-015	6.0
041-013	6.0
085-084	6.0
084-083	6.0
083-044	6.0
127-126	6.0
126-Wet Well	6.0

B. For liner thickness calculations, minimum thickness was determined using the following:
   1. Flexural modulus: Enhanced Polyester Resin 400,000 psi
   2. Flexural strength: 4,500 psi
   3. Ovality: 2%
   4. Maximum external water head to invert: Assume grade to invert depth.
   5. Flexural modulus retention to account for long-term effects: 50%
   6. Safety factor for exter loads: 2.0
   7. Soil depth at top of conduit: most restrictive depth of pipe.
   8. Soil density: 120 pcf
   9. Live load: under highway

END OF SECTION

SECTION 33 05 13
MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Modular precast concrete structures with tongue-and-groove joints covers, anchorage, and accessories.
2. Bedding and cover materials.

B. Related Requirements:
1. Section 03 60 00 - Grouting
2. Section 07 14 00 - Fluid-Applied Waterproofing
3. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
4. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
5. Section 31 23 23 - Fill: Backfilling after manhole and structure installation.
6. Section 33 31 13 - Public Sanitary Utility Sewerage Piping: Piping connections to manholes.

1.2 REFERENCE STANDARDS

A. American Association of State Highway Transportation Officials:
1. AASHTO M91 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
2. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
3. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute:
1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.

C. ASTM International:
1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
4. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
5. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
6. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
7. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

1.3 SUBMITTALS

A. Product Data: Submit data for manhole covers, component construction, features, configuration, dimensions, and antimicrobial additive.

B. Shop Drawings:
   1. Indicate structure locations and elevations.
   2. Indicate sizes and elevations of piping penetrations.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.4 QUALITY ASSURANCE

A. Perform Work according to specified standards.

B. Maintain a copy of each standard affecting Work of this Section on Site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years documented experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:
   1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
   2. Repair property damaged from materials storage.

1.7 AMBIENT CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of Work.

PART 2 - PRODUCTS

2.1 CONCRETE STRUCTURES

A. Manufacturers:
   1. Northern Concrete Pipe or equal.

B. Concrete Sections: Reinforced precast concrete conforming to ASTM C478 with gaskets conforming to ASTM C923.
   1. Joints for Precast Manholes and Structures: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.
   2. Portland Cement shall be Type II, comply with ASTM C150.

2.2 ANTIMICROBIAL ADDITIVE

A. Some structures are to be provided with antimicrobial additive due to the presence of hydrogen sulfide.
   1. Lagoon's influent structure
   2. New manholes for Turner Street Sewer Replacement.

B. Antimicrobial Additive:
   1. Antimicrobial additive, Con^{mic}Shield® or equal, shall be used to render the concrete uninhabitable for bacteria growth.
      a. Basis of Specification: Con^{mic}Shield® as manufactured by Con^{mic}Shield® Technologies, Inc.; 541 Tenth Street NW #233, Atlanta, GA 30318; Phone: (877)543-2094
   2. The liquid antibacterial additive shall be an EPA registered material and the registration number shall be submitted for approval prior to use in the project.
   3. The amount to be used shall be as recommended by the manufacturer of the antibacterial additive. This amount shall be included in the total water content of the concrete mix design.
   4. The additive shall be added into the concrete mix water to insure even distribution of the additive throughout the concrete mixture.
   5. The antibacterial additive shall have successfully demonstrated prevention of MIC in sanitary sewers for ten or more years.
   6. The antibacterial shall be used by factory certified precast concrete plants.
   7. Acceptance: Acceptance shall be a letter of certification from the precaster to the project owner stating that the correct amount and correct mixing procedure were followed for all antimicrobial concrete.
   8. Quality Assurance: The precaster shall retain two labeled specimens from each production run. One set shall be retained by the precaster and the other set shall be sent to manufacturer or independent laboratory as directed by the engineer for verification on a random or as needed basis.

9. Field Repairs: Field repairs to the precast concrete shall be made using antimicrobial additive's manufacturer-provided set grout pre-portioned and factory packaged that requires the addition of no other components. This repair grout may be used for filling joints, lift holes, damaged areas, benches and similar.
10. Product Surface Marking: The name of the antimicrobial additive shall be plainly stenciled on the exterior and interior of each piece. The Contractor shall spray CS IDENTIFIER™ or Equal, green colored sealer, onto the interior surface after installing.

2.3 CONFIGURATION

A. Shaft Construction and Eccentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, sleeved to receive pipe conduit and sections.

B. Shape:
1. Manholes: Cylindrical.
2. Structures: As shown on the Drawings.

C. Clear Inside Dimensions: As indicated on Drawings.

D. Design Depth: As indicated on Drawings.

E. Clear Cover Opening: As indicated on Drawings.

F. Pipe Entry: Furnish openings as indicated on Drawings.

G. Structure Joint Gaskets: ASTM C361; rubber.

H. Steps: 12 inches wide, 16 inches on center vertically, set into structure wall. As indicated on Drawings.

I. Steps: As required by code

2.4 FRAMES AND COVERS

A. Manufacturers:
1. East Jordan Iron Works
2. Substitutions: Not permitted

2.5 ACCESS HATCHES

A. Manufacturers:
1. Halliday Products
2. Bilco
3. Or equal.

B. Description:
1. Materials of Construction: Aluminum; welded.
2. Size: As indicated on Drawings.

3. Door Configuration: As indicated on Drawings.
4. Cover:
    a. Fabrication: 1-4” Aluminum diamond plate.
    b. Loading: 300 lbs psf uniform life load.
    c. Reinforce with structural stiffeners as required to support indicated loads.
    d. Close flush with the frame and rest on a built-in neoprene cushion/gasket.
5. Frame Type: Channel.
6. Continuous anchor flange around frame perimeter.
7. Coating: Bituminous coating where in contact with concrete.
    a. Drainage: 1-1/2” drainage coupling located in front left corner of channel frame.
8. Hinge Material: Stainless steel.
9. Lift Handle:
    a. Type: Flush drop; non-removable.
    b. Mounting: In cover.
10. Lifting Mechanism:
    a. Compression Spring Assist: Stainless steel.
    b. Furnish automatic hold-open and dead stop to retain cover in open position.
    c. Cover springs to prevent contact by personnel entering vault or chamber.
11. Latch Mechanism:
    a. Lock: Stainless steel, slam lock with removable key and non-corrosive handle.
    b. Furnish removable external handle and permanent internal release mechanism.
12. Hardware: Stainless steel.
13. Protective Grating:
    a. Factory-installed, lockable protective grating panel with stainless steel hardware.
    b. Powder coated safety orange color.
    c. Loading: 300 lbs psf uniform life load.
14. Lifetime guarantee against defects in material and/or workmanship.

2.6 COMPONENTS

A. Concrete Structure Steps: Formed polypropylene rungs; 3/4-inch diameter. Formed integral with manhole sections.

B. Foundation Slab: Precast, leveled top surface.

2.7 ACCESSORIES

A. Geotextile Filter Fabric: AASHTO M288 for Subsurface Drainage Non-biodegradable, non-woven.

B. Concrete: Specified in Section 03 30 00.

C. Grout: Specified in Section 03 60 00.

2.8 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type A1 as specified in Section 31 05 16 – Aggregates for Earthwork.

B. Cover: Fill Type A4, as specified in Section 31 05 16 – Aggregates for Earthwork.

C. Soil Backfill from Above Pipe to Finish Grade: Soil Type S2, in green belt areas as specified in Section 31 05 13 – Soils for Earthwork, and fill type A4 anywhere within the 1 on 1 influence of a road, driveway, or structure as specified in Section 31 05 16 – Aggregates for Earthwork.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are properly sized and located.

B. Verify that built-in items are in proper location and are ready for roughing into Work.

C. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

B. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

C. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

D. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type A1 fill and compact to density equal to or greater than requirements for support of pipe or structure and subsequent backfill material.

3.3 INSTALLATION

A. Excavation and Backfill:
   1. Excavate for manholes and structures as specified in Section 31 23 16 - Excavation and in indicated locations and depths.
   2. Provide clearance around sidewalls of manhole or structure for construction operations, granular backfill, and placement of geotextile filter fabric.
   3. If groundwater is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench.
   4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation.

B. Place foundation slab and trowel top surface level.

C. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab.

D. Install manholes and structures supported at proper grade and alignment on crushed stone bedding as indicated on Drawings.

E. Backfill excavations for manholes and structures as specified in Section 31 23 23 - Fill.

F. Form and place manhole or structure cylinder plumb and level, to correct dimensions and elevations.

G. Cut and fit for pipe, sleeves, and/or accessories.

H. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.

I. Set cover frames and covers level to correct elevations without tipping.

J. Precast Concrete Structures:
   1. Lift precast components at lifting points designated by manufacturer.
   2. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
   3. Set precast structures, bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 16 - Excavation or on other support system as indicated on Drawings.
   4. Assembly:
      a. Assemble multi-section manholes and structures by lowering each section into excavation.
      b. Install rubber gasket joints between precast sections according to manufacturer's recommendations.
      c. Lower, set level, and firmly position base section before placing additional sections.
   5. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
   6. Maintain alignment between sections by using guide devices affixed to lower section.
   7. Joint sealing materials may be installed on Site or at manufacturer's plant.
   8. Verify that installed manholes and structures meet required alignment and grade.
   9. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
   10. Cut pipe flush with interior of structure.
   11. Shape inverts through manhole and structures as indicated on Drawings.

K. Doghouse Manholes and Structures:
   1. Stake out location and burial depth of existing sewer line in area of proposed manhole or structure.
   2. Carefully excavate around existing sewer line to adequate depth for foundation slab installation.
   3. Protect existing pipe from damage.

4. Cut out soft spots and replace with granular fill compacted to 95 percent maximum density.
5. Prepare crushed stone bedding or other support system, as indicated on Drawings, to receive foundation slab as specified for precast manholes and structures.
6. Install pre-cast concrete manhole or structure around existing pipe according to applicable Paragraphs in this Section.
7. Grout pipe entrances.
8. Block upstream flow at existing manhole or structure with expandable plug.
9. Use hydraulic saw to cut existing pipe at manhole or structure entrance and exit and along pipe length at a point halfway up the outside diameter on each side of the pipe.
10. Bottom half of pipe to remain as manhole flow channel.
11. Saw cut to smooth finish with top half of pipe flush with interior of manhole or structure.
12. Grout base of manhole or structure to achieve slope to manhole or structure channel.
13. Block upstream flow at existing manhole or structure with expandable plug.
14. Use hydraulic saw to cut existing pipe at manhole or structure entrance and exit and along pipe length at a point halfway up the outside diameter on each side of the pipe. Bottom half of pipe shall remain as manhole flow channel. Saw cut to have a smooth finish with top half of pipe flush with interior of manhole or structure
15. Grout base of manhole or structure to achieve slope to manhole or structure channel.
16. Set cover frames and covers level without tipping, to correct elevations

L. Castings:
1. Set frames using mortar and masonry as indicated on Drawings. Install radially laid concrete brick with 1/4-inch-thick vertical joints at inside perimeter. Lay concrete brick in full bed of mortar and completely fill joints. Where more than one course of concrete brick is required, stagger vertical joints.
2. Set frame and cover 2 inches above finished grade for manholes and other structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.
3. Adjust castings to final grade in areas to be paved.

M. Drainage Structure Collar:
1. Core the existing pavement full depth, centered on the manhole, remove loose material, remove drainage structure plate, install approved collar, trim collar to heights and slope, reinstall casting, and pour concrete to match road finished surface on new or existing drainage structures as described herein, and as shown in the plans.
2. Prior to installation of aggregate base the top of the concrete structure adjustment grade rings or blocks shall be removed to the required elevation to accept the thermo plastic molding. The structure shall be located by witness and GPS to the center of the proposed cover location. The structure opening shall be temporarily plated (steel plate shall be precisely centered on hole) and the roadway base and surface shall be constructed adjacent to and over the structure in a contiguous and homogenous manner to the surrounding road base and surface material. Density

requirements over the structure plate for the aggregate base and HMA surface shall be the same as the surrounding material, pursuant to the specifications.

3.4 CONNECTION TO EXISTING DRAINAGE STRUCTURES

A. Cut a minimum opening equal to the outside diameter of the inlet pipe plus 6 inches into the receiving structure.

B. Pack a minimum 3-inch mortar layer completely around the inlet pipe and strike smooth with the inner wall of the structure.

C. Repair or replace any existing drainage structure damaged during the tapping operation.

3.5 FIELD QUALITY CONTROL

A. Test concrete manhole and structure sections according to ASTM C497.

B. Vertical Adjustment of Existing Manholes and Structures:
   1. If required, adjust top elevation of manholes and structures to temporary grade and final finished grades as indicated on Drawings.
   2. Frames, Grates, and Covers:
      a. Carefully remove frames, grates, and covers cleaned of mortar fragments.
      b. Reset to required elevation according to requirements specified for installation of castings.
   3. Reinforcing Bars:
      a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
      b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

3.6 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

§SECTION 33 31 11
PUBLIC SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sanitary sewerage pipe and fittings.
2. Connection to manholes and structures.
3. Pile support systems.
4. Bedding and cover materials.

B. Related Requirements:
1. Section 03 60 00 - Grouting: Non-shrink grout.
2. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
3. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
4. Section 31 23 17 - Trenching: Execution requirements for trenching required by this Section.
5. Section 31 23 23 - Fill: Requirements for backfill to be placed by this Section.
6. Section 33 05 13 - Manholes and Structures: Concrete manholes for sanitary sewer.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:
1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM A123 - Standard Specification for Zinc Hot-Dip Galvanized Coatings on Iron and Steel Products. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
5. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
7. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
8. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
9. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

10. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
11. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
12. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
13. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

C. American Water Works Association:
1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153 - Ductile-Iron Compact Fittings.

1.3 COORDINATION

A. Coordinate Work of this Section with the system's operating personnel.

B. Notify affected utility companies at least 72 hours prior to construction.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.

B. Shop Drawings:
1. Indicate layout of sewer system and appurtenances.
2. Show size, materials, components of system, and burial depth.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.

E. Manufacturer Instructions:
1. Indicate special procedures required to install specified products.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
1. Submit qualifications for manufacturer and installer.

2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual locations of pipe runs, valves, connections, manholes, and drop connections.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work according to Municipal, State, and Federal standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:
1. Store materials according to manufacturer instructions.
2. Store valves in shipping containers with labeling in place.

C. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.

D. Deliver and store valves in shipping containers with labeling in place.

1.8 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPE AND FITTINGS

A. Gravity Plastic Pipe:
1. Material: Polyvinyl chloride (PVC).
2. Comply with ASTM D3034, SDR-26.
3. Inside Nominal Diameter: As shown on the Drawings.
4. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.
5. Fittings: PVC.
6. Joints:
a. Elastomeric gaskets.
b. Comply with ASTM F477

B. Force Main – Per Section 33 34 00.

2.2 THROUGH WALL PIPE PENETRATION SEALS

A. Manufacturers:
   1. GPT Industries: PSI Link-Seal.

B. Description:
   1. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

C. Material:
   1. Standard Service
      a. Rubber seals: EPDM
      b. Pressure Plates: Delrin or cast iron
      c. Bolts and nuts: zinc phosphate-low carbon steel
   2. Buried, Submerged, or Corrosive Service
      a. Rubber seals: EPDM or Nitrile rubber as recommended by manufacturer
      b. Pressure Plates: Delrin
      c. Bolts and nuts: Type 18-8 stainless steel
   3. Fire Resistant Service
      a. UL and FM approved

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

A. Manufacturers:
   1. Trelleborg – Kor N Seal Flexible Connector

B. Description:
   1. Material: Ethylene propylene rubber (EPDM).
   2. Comply with ASTM C923.
   3. Attachment: Stainless-steel clamp and hardware.

2.4 MATERIALS

A. Bedding and Cover:
   1. Bedding: Fill Type A4 as specified in Section 31 05 16 - Aggregates for Earthwork.
   2. Cover: Fill Type A4 as specified in Section 31 05 16 - Aggregates for Earthwork.
   3. Soil Backfill from Above Pipe to Finish Grade:
      a. Soil Type S2 as specified in Section 31 05 13 - Soils for Earthwork.
      b. Subsoil with no rocks over 6 inches in diameter, frozen earth, or foreign matter.

B. Grout: As specified in Section 03 60 00 – Grouting

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Hand trim trench excavation to required elevations. Correct over excavation with compacted Type A1 compacted crushed limestone as specified in 31 05 16 - Aggregates for Earthwork at no additional cost.

B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

C. Protect and support existing sewer lines, utilities, and appurtenances.

D. Utilities:
   1. Maintain profiles of utilities.
   2. Coordinate with other utilities to eliminate interference.
   3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:
   1. Excavate pipe trench as specified in Section 31 23 17 - Trenching.
   2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of encasement.
   3. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.
   4. Provide sheeting and shoring as specified in Section 31 23 17 - Trenching.
   5. Placement:
      a. Place bedding material at trench bottom.
      b. Level materials in continuous layer not exceeding12 inches compacted depth.
      c. Compact to 95 percent of maximum density.

B. Piping:
   1. Install pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
   2. Lay pipe to slope gradients noted on layout drawings by the use of a laser beam alignment method proven reliable and operated by competent, experienced personnel.
   3. Maximum Variation from Indicated Slope: 1/8 inch in 10 feet.
   4. Begin at downstream end and progress upstream.
   5. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Architect/Engineer.
   6. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.

7. Cap open ends during periods of Work stoppage.
8. Lay bell and spigot pipe with bells upstream.
9. Polyethylene Pipe Encasement: Conform to AWWA C105, Method A.
10. Backfill and compact as specified in Section 31 23 17 - Trenching.
11. Do not displace or damage pipe when compacting.
12. Connect pipe to existing sewer system at existing wet wells using doghouse manhole connection.

C. Connection to Existing Structures:
1. Drilling:
a. Core drill existing manhole to clean opening.
b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.
2. Install watertight Kor N Seal boot and seal.
3. Prevent construction debris from entering existing sewer line when making connection.

D. Service Leads:
1. Concurrent with pipe-laying operations, install service lateral fittings at locations indicated on Drawings or at locations for reconnecting existing service leads.
2. Connect to existing service leads with a Fernco fitting.

E. Backfilling:
1. Backfill around sides and to top of pipe with cover fill in minimum lifts of 12 inches, tamp in place, and compact to 95 percent of maximum density; place and compact material immediately adjacent to pipes to avoid damage to pipe and prevent pipe misalignment.

3.4 FIELD QUALITY CONTROL

A. Testing:
1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Compaction Testing - Comply with ASTM D1557

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.6 TESTING

A. Pressure Test: As specified in Section 33 01 30.13 - Sewer Testing.

END OF SECTION

SECTION 33 32 16
PACKAGED UTILITY WASTEWATER PUMPING STATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged pumping stations.

B. Related Requirements:
1. Section 31 05 13 - Soils for Earthwork: Soil backfill to finish grade.
2. Section 31 05 16 - Aggregates for Earthwork: Aggregate for basin backfill.
3. Section 31 23 17 - Trenching: Requirements for direct-burial cable to be placed by this Section.
4. Section 31 23 23 - Fill: Requirements for basin backfill to be placed by this Section.
5. Section 33 05 13 - Manholes and Structures: Installation of pumping station wet well.
6. Section 40 91 23.33 - Flow Process Measurement Devices: Magmeter

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME PTC 19.5 - Flow Measurement.

B. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 25.2 - Rolling Bearings, Linear Motion Recirculating Ball, Sleeve Type - Inch Series.

C. ASTM International:
1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rods 60 000 PSI Tensile Strength.
5. ASTM A709 - Standard Specification for Structural Steel for Bridges.
6. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
8. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
9. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
10. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
11. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

12. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code (NEC).

F. Underwriters Laboratories Inc.:
   1. UL 83 - Thermoplastic-Insulated Wires and Cables.

1.3 SUBMITTALS

A. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

B. Product Data:
   1. Submit following for each type of packaged pumping station.
      a. Manufacturer's catalog data for pump base elbows, intermediate and upper guiderail brackets, discharge piping, magnetic flow meter/flow transmitter, plug valves, level controller with device, back up float control with Relay Logic, cover, hinged doors, slide rail assembly with intermediate brackets, junction box, and control panel.
      b. Manufacturer's pump catalog data, including performance curve, full load amps, breakaway fittings data, and access frame data.
      c. Control panel data and panel wiring schematic.

C. Shop Drawings:
   1. Indicate station layout designed by station manufacturer.
   2. Indicate size, materials, and components of system.
   3. Indicate basin size, inlet and discharge locations, cover dimensions, vent location, lifting cable location, check valve locations, ball valve locations, pump locations, discharge piping location, junction box location, guide rail assembly location, level control locations, flow meter location, and ballast support flange dimensions.

D. Manufacturer's Certificate: Certify that products meet or exceed design requirements.

E. Manufacturer Instructions: Submit manufacturer's installation instructions and instructions for basin, pump, and panel systems procedures.

F. Hydrostatically test and test run pumps before shipping.
   1. Produce non-witnessed certified test curves for each pump.
   2. Test curves shall show head, capacity, and brake horsepower over a range covering the specified duty points

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Manufacturer Reports:
   1. Submit report of each visit of manufacturer's representative to provide technical assistance during installation.
   2. Submit startup report before final acceptance of pumps to document that pumping station operation meets performance requirements.

1.4 CLOSEOUT SUBMITTALS

A. Record actual locations of packaged pumping stations, including basins and control panel.

B. Submit certification of pumping stations after performance testing.

1.5 QUALITY ASSURANCE

A. Perform Work according to Municipal, State, and Federal standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum 5 years' documented experience and approved by manufacturer.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Support basin with nylon slings connected to structural lift points during handling.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Store sensitive materials intended for field assembly in dry area and in original shipping containers.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide temporary end caps and closures on piping and fittings, and maintain in place until installation.
   3. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

A. Do not install concrete basin base when bedding is wet or frozen.

1.9 WARRANTY

A. Furnish **5-year** prorated manufacturer's warranty for pumps and magmeter.

PART 2 - PRODUCTS

2.1 UNITARY RESPONSIBILITY

A. In order to unify responsibility for proper operation of the complete pumping station, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source). The pumping station must be standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts complied and assembled by a manufacturer's representative or distributor be accepted.

2.2 DESIGN

A. Fox Street Pump Station: Duplex submersible station, rated for 200 gpm at 56' TDH.

B. Ohmer Road Pump Station: Duplex submersible station, rated for 120 gpm at 80' TDH.

2.3 PUMP MANUFACTURER

A. Flygt, Gorman Rupp, Hydromatic, ABS, KSB, Grundfos, or equal.

B. Description:
   1. Submersible non-clog pumps, each equipped with submersible electric motor.
   2. The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged. The use of shower systems, secondary pumps or cooling fans to cool the motor shall not be acceptable.
   3. The pump, mechanical seals and motor units provided under this specification shall be from the same manufacturer.
   4. Suitable for use in a Class 1, Division 1, Group D location
   5. Designed for handling raw, unscreened sewage, wipes, rags and wastewater and shall be fully guaranteed for this use.
   6. Connection: Automatic to discharge connection elbows when lowered into place, and easily removed for inspection or service.
   7. Capable of continuous submergence underwater without loss of watertight integrity to depth of 65 feet.

2.4 PUMP DESIGN

A. Impeller and Volute:
   1. Impeller:
      a. Close-grained cast iron, ASTM A48 Class 30 or stainless steel.
      b. Dynamically balanced.
      c. Non-clogging design having long throughlet without acute turns.
      d. Capable of passing minimum 3-inch solid sphere.
      e. Capable of handling solids, fibrous materials, sludge, and other matter found in normal sewage applications.

f. Impeller and Shaft Fit: Sliding fit with one key.

2. Volute:
   a. Gray cast iron, ASTM A48, Class 35B.
   b. Single piece.
   c. Non-concentric design.
   d. Smooth fluid passages capable of passing solids through impeller.
3. Wear Ring:
   a. Use for sealing between volute and impeller.
   b. Stationary ring composed of nitrile rubber, molded with steel ring insert drive-fitted to volute inlet.
   c. Rotating ASTM A276, Type 304 stainless-steel ring drive-fitted to impeller skirt.

B. Mechanical Seal System:
1. Shaft:
   a. ASTM A276, Type 420 stainless steel.
   b. Continuous pump and motor shaft.
   c. Completely isolated from the pumped liquid.
2. Shaft Seal: Tandem mechanical type.
   a. Upper Tandem Set of Seals:
      1) Operating in oil chamber located just below stator housing.
      2) One stationary tungsten-carbide ring and one positively driven rotating carbon ring.
   b. Lower Tandem Set of Seals: Stationary tungsten-carbide ring and positively driven rotating tungsten-carbide ring.
3. Oil Chamber for Shaft-Sealing System: Drain and inspection plug, with positive anti-leak seal, accessible from outside.

C. Bearings:
1. Rotate shaft on two permanently lubricated bearings.
2. Upper Bearing: Single-row roller bearing.
3. Lower Bearings:
   a. At least one roller bearing.
   b. At least one angular-contact ball bearing.
4. Minimum L10 bearing life: 100,000 hours.

D. Cable Entry Seal:
1. Single or dual cylindrical elastomer grommet, flanked by stainless-steel washers with close tolerance fit against cable outside diameter and entry inside diameter, and compressed by entry body containing strain-relief function, separate from function of sealing cable.
2. Bear assembly against shoulder in pump top.
3. Separate cable entry junction chamber and motor by stator-lead sealing gland or terminal board, which isolates motor interior from foreign material gaining access through pump top.

E. Operation:
1. Electrical Characteristics: As specified in Section 26 05 03 - Equipment Wiring Connections and as shown on the Drawings.
2. Pump Motor:
   a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.

b. Inverter duty rated, capable of being operated with variable frequency drive if indicated in the project description and drawings.
c. Non-overloading throughout entire pump performance range based on 1.0 service factor.
d. Continuous duty, capable of sustaining minimum of 15 starts per hour.
e. Indefinite operation without overheating when unsubmerged and operating in air.
f. Stators:
    1) Dipped and baked three times in Class F varnish.
    2) Heat-shrink-fitted into stator housings.
    3) Thermal sensors to monitor stator temperatures.
g. Include three thermal switches embedded in end coils of stator winding, for one switch in each stator phase.
h. Stator Windings and Leads: Insulated with moisture-resistant Class F insulation capable of resisting temperature of 311 degrees F.
i. Each unit shall be provided with an integral motor cooling system above 10 hp.
    1) Water jacket encircling stator housing.
    2) Furnish cooling media channels.
j. Combined service factor: 1.15

3. Power Cable:
    a. Sized according to NEC and ICEA standards.
    b. Sufficient length to reach the junction box without the need of any splices.
    c. Outer Jacket: oil resistant chloroprene rubber.
4. Protection
    a. Provide manufacturer's standard motor thermal and seal leak monitoring relay, and be tied to activate an alarm.

F. Materials:
1. Exposed Nuts, Bolts, and Washers: ASTM A276, Type 304 stainless-steel construction.
2. Finishes: Spray exterior with PVC epoxy primer and chloric rubber paint finish.

G. Accessories:
1. Pump Base/Discharge Connection Elbow.
    a. Permanently installed in wet well, fixed to the floor.
    b. Firmly connected to the discharge piping.
    c. Material: Mating cast iron.

2. Pump Removal System
    a. Sliding guide bracket integral to pumping unit.
    b. Machined connecting flange to the pump casing.
    c. Stainless steel pipe guide rails.
        1) Complete with intermediate stainless-steel support brackets.
    d. Entire weight of pump unit guided by not less than two guide bars, and pressed tightly against discharge connection elbow with a watertight, metal-to-metal contact interface seal. No portion of the pump shall be supported directly on the bottom of the wet well, guide rails, or lifting cable.
    e. Upper guide rail holders.
    f. Level sensor cable holders.
    g. Power and pilot cable supports.
    h. Lifting cable shall consist of a stainless-steel braided wire cable attached to the pump lifting bail. Stainless Steel fasteners. A crimped ball end shall be provided at the upper end of this cable for attaching to the wet well access frame.

3. All bolts, machine screws, nuts, washers, and lockwashers for complete assembly of access cover, guide rails, and discharge elbow shall be stainless steel.

2.5 STATION ENCLOSURE

A. The station enclosure shall contain and enclose all valves, and associated controls and shall be constructed to enhance serviceability by incorporating the following design characteristics:
   1. Two access panels per side of station shall be provided. Panels shall be sized and placed to permit routine maintenance operations through the panel openings of the enclosure. For these purposes, routine maintenance shall include frequently performed adjustments and inspections of the electrical components, controls and valves.
   2. The access panels shall be provided with a hinge and latch. Hinge shall be the continuous type. Latch shall engage the enclosure at not less than three places, and shall be protected by a keyed lock.
   3. One enclosure side shall contain a screened vent to maximize air flow for enclosure ventilation.
   4. Station enclosure, less base, must be removable or able to be disassembled following the removal of reusable hardware.
   5. Removal or disassembly of the enclosure shall be accomplished by not more than two maintenance personnel without the use of lifting equipment.

B. The station enclosure shall be manufactured of molded reinforced orthophthalic polyester resins with a minimum of 30% fiberglass, and a maximum of 70% resin. Resin fillers or extenders shall not be used.

C. Glass fibers shall have a minimum average length of 1 1/4 inches. Major design considerations shall be given to structural stability, corrosion resistance, and watertight properties. The polyester laminates shall provide a balance of mechanical, chemical, and electrical properties to insure long life. They must be impervious to microorganisms, mildew, mold, fungus, corrosive liquids, and gases which can reasonably be expected to be present in the environment surrounding the wet well.

D. All interior surfaces of the housing shall be coated with a polyester resin rich finish. It shall provide:
   1. Maintenance free service
   2. Abrasion resistance
   3. Protection from sewage, greases, oils, gasoline, and other common chemicals
   4. The outside of the enclosure shall be coated with a suitable pigmented resin, compounded to insure long maintenance free life.

E. An exhaust blower shall be mounted in the roof of the enclosure. Blower capacity shall be sufficient to change station air a minimum of once every two minutes. Blower motor shall be operated automatically and shall be turned on at approximately 70 degrees F and shall be turn off at 55 degrees F. Blower motor and control circuit shall be protected by a thermal magnetic air circuit breaker to provide overcurrent and overload protection. Blower exhaust outlet shall be designed to prevent the entrance of rain, snow, rocks, and foreign material.

2.6 STATION BASE

A. Station base shall be constructed of precast, reinforced concrete bonded inside a fiberglass form covering top and sides, and shall be designed to insure adequate strength to resist deformation

of the structure during shipping, lifting, or handling. The enclosure base shall function at the wet well top and incorporate a duplex access lid, sized for the installation and removal of the specified pumps, and shall be of sufficient size to permit access to the wet well. Color used shall de-emphasize the presence of dirt, grease, etc., and shall be provided with a non skid surface.

B. A static wet well vent shall be mounted in the station base, and be housed in the station enclosure. The station enclosure shall provide a transition area between the wet well and the vent outlet. The vent shall terminate through the station wall with a screened opening which shall be designed to prevent the entrance of rain, snow, rocks and foreign material.

C. The station base shall incorporate a cable transition adapter for the pump cables, level controls, and associated wiring. The adapter shall provide for a vapor tight transition between the wet well and the lift station enclosure. The adapter shall incorporate cable grips for each cable and be provided with a gasket between the adapter and the station for a positive seal. Junction boxes shall not be considered for cable transition.

D. The station base shall be furnished with elastomeric compression sealing devices for all piping penetrations to provide for a vapor tight transition between the wet well and lift station enclosure.

E. Station Heater:
   1. Pump station shall be provided with a 1300/1500 watt, 115volt electric heater with cord, thermostat and grounding plug. Ungrounded heaters shall not be acceptable.

F. Insulation Package:
   1. The pump station shall be furnished with 1” thick spray foam insulation, which shall be applied to the roof, doors, and corner panels.

2.7 WET WELL ACCESS

A. The wet well access shall be fabricated from welded aluminum sections. A hinged aluminum door shall be provided for each pump. The hinged door shall be fabricated from 1/4" thick aluminum with non skid diamond tread on upper surface. All hardware on access assembly shall be stainless steel with a flush upper surface without protrusions. For safety, the door shall have a 300 pound per square foot rating and be fitted with a recessed staple for padlock. Door shall be furnished with a flush aluminum drop handle and automatic hold open arm.

B. Wet well access opening shall include two (2) aluminum protective grates at hatch opening. When in down position, protective grates shall allow access to pump cables, pump lifting cables and guiderail brackets. Protective grates shall be hinged, latchable in the open (up) position, include 316 stainless steel hardware and be rated for 300 pounds per square foot loading.

2.8 VALVES AND PIPING

A. Check Valves – Per Section 40 05 23.24.

B. Plug Valves – Per Section 40 05 23.21.

C. Piping:
   1. Flanged header shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and Class 53 thickness.

2. Flanges shall be cast iron Class 125 and Comply with ANSI B16.1.
3. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.
4. Bolt holes shall be in angular alignment within ½° between flanges. Flanges shall be faced and a gasket finish applied.
5. All pipes connected to the pump station shall be supported according to good commercial practice.

D. Discharge Bypass Piping:
1. The station header pipe shall incorporate a 2 way plug valve to permit emergency access to the pump station force main after isolation of the pumps. The plug valve shall be non-lubricated, tapered type. Valve body shall be cast iron with flanged end connections drilled to 125-pound standard. Valve shall be furnished with a drip tight shutoff plug mounted in stainless steel or teflon over phenolic bearings, and shall have a resilient facing bonded to the sealing surface.
2. The header pipe shall penetrate the station side wall and terminate with a 4" or 6" male OPW type quick connect fitting.

E. Suction Bypass Piping;
1. The station will incorporate piping to permit emergency access to the pump station wet well.
2. The pipe shall penetrate the station side and terminate with a 4" or 6" male OPW type quick connect fitting.

F. Vacuum Break/Air Release Valves:
1. The header piping shall be equipped with ball type check valves on the discharge side of each pump to allow a vacuum break to occur, as well as assist purging air from the system in the event that there is insufficient atmospheric pressure available to support the resultant water column. A ball valve and PVC line extending through the pump station base for drainage back to the wet well shall be installed in each pump discharge line.

G. Pressure Gauges:
1. Per Section 40 05 13.53-Ductile Iron Process Piping.

2.9 ELECTRICAL CONTROL COMPONENTS

A. The pump station control panel will be tested as an integral unit by the pump station manufacturer.

B. Panel Enclosure:
1. The electrical control equipment shall be mounted within a NEMA 1 stainless steel, dead front type control enclosure. The enclosure door shall be hinged and sealed with a neoprene gasket. It shall include a removable plated steel back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Operator controls shall be mounted on the enclosure door. The enclosure shall be mounted within the fiberglass valve enclosure. The control panel shall be equipped with vapor emission type corrosion inhibitors.
2. All control components shall be securely fastened to a removable back panel with screws and lock washers. Switches, indicators and instruments shall be mounted through the control panel door. All control devices and instruments shall be secured to the sub-plate with machine screws and lockwashers. Mounting holes shall be drilled and tapped; Self

tapping screws shall not be used to mount any components. All connections from the back panel to door mounted or remote devices shall be made through terminal blocks. All control devices shall be clearly labeled to indicate function.

3. A main terminal block and ground bar shall be furnished for field connection of the electrical supply. The connections shall be designed to accept copper conductors of sufficient size to serve the pump station loads. The main terminal block shall be mounted to allow incoming wire bending space in accordance with Article 373 of the National Electrical Code (NEC).
4. Terminals shall be provided in the control panel enclosure for the following alarm dry contacts:
    a. High water alarm.
    b. Pump 1 failure (pump seal failure, overload or high temperature).
    c. Pump 2 failure (pump seal failure, overload or high temperature).
    d. Backup float activation.
    e. Station power failure.
    f. Station enclosure low temperature.
    g. Low water alarm.

C. UL Label Requirement:
1. Pump station components and controls shall conform to third party safety certification. The station shall bear a UL label listed for “Packaged Pumping System”. The panel shall bear a serialized UL label listed for "Enclosed Industrial Control Panels". The pump station components, panel enclosure, and all components mounted on the sub panel or control cover shall conform to UL descriptions and procedures.

D. Transient Voltage Surge Suppressor
1. The control panel shall be equipped with a transient voltage surge suppressor to minimize damage to the pump motors and control from transient voltage surges. The suppressor shall utilize thermally protected silicon oxide varistors encapsulated in a non conductive housing. Mechanical indicators shall be provided on each phase to indicate protection has been lost. The suppressor shall have a surge current rating of 100,000 Amps per phase and a 100kA interrupting rating.

E. Voltage Alert Indication:
1. The control panel shall include a voltage alert indicator to reduce the risk of electrical arc flash by pre-verifying the electrical isolation from outside of the control panel. Hardwired to the main incoming point of termination, the indicator shall be powered by the same voltage that it indicates utilizing redundant circuitry, thereby flashing whenever voltage is present. An eight detector display shall visually alert the presence of dangerous AC or DC potentials occurring between any combination of the monitored input lines.

F. Station Enclosure Low Temperature Alarm:
1. Pump station shall be supplied with a thermostat which shall monitor interior station temperature. The control shall incorporate an unpowered dry contact wired to terminal blocks for field connection to a remote alarm device. The contact will close in the event that the temperature within the enclosure falls below approximately 35 degrees F.

G. Motor Branch Components:
1. A properly sized heavy duty air circuit breaker shall be furnished for each pump motor. All circuit breakers shall be sealed by the manufacturer after calibration to prevent tampering.

2. A padlocking operating mechanism shall be installed on each motor circuit breaker. Operator handles for the mechanisms shall be located on the door, with interlocks which permit the door to be opened only when circuit breakers are in the "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.
3. Motor Starter:
    a. An open frame, across-the-line, NEMA rated magnetic motor starter shall be furnished for each pump motor. Starters of NEMA size 1 and above shall be designed for addition of at least two auxiliary contacts and shall have at least two auxiliary contacts installed. Starters rated "O", "OO", or fractional size shall not be acceptable. Power contacts shall be double break and made of cadmium oxide silver. Coils shall be epoxy molded for protection from moisture and corrosive atmospheres. The starter assembly shall be equipped with a metal mounting plate for durability. All motor starters shall be equipped to provide under voltage release and overload protection on all three phases. Motor starter contacts and coils shall be easily replaceable without removing the motor starter from its mounted position.
    b. Overload relays shall be solid state block type, having visual trip indication with trip-free operation. Electrically resetting the overload will cause one (1) normally open and one (1) normally closed isolated alarm/control contact to reset, thus reestablishing a control circuit. Trip setting shall be governed by solid state circuitry and adjustable current setting. Trip classes shall be 10, 15 and 20. Additional features to include phase loss protection, selectable jam/stall protection and selectable ground fault protection.
    c. A reset pushbutton, mounted through the control panel door, shall permit resetting the overload relays without opening the door.
4. All motor branch and power circuit components shall be of highest industrial quality. The short circuit current rating of all power circuit devices shall be a tested combination or evaluated per the National Electrical Code Article 409. The lowest rated power circuit component shall be the overall control panel short circuit rating and shall not be less than the fault current available. The minimum control panel rating shall not be less than 10 kA, rms symmetrical. Control assemblies operating at 120 volts nominal or less may be provided with transformers which limit the fault current and may be rated less than the minimum required short circuit rating.

H. Other Control Components:
1. The pump control panel shall be equipped to terminate pump operation due to high motor winding temperature or moisture in the motor housing, utilizing contacts in the pump motor housing. If either event should occur, the motor starter will drop out and a mechanical indicator visible on the door shall indicate that the pump motor has been shut down. The pump motor and the mechanical indicator shall require manual reset. Dry contacts, wired to terminal blocks, shall be furnished for each pump for thermal/moisture shutdown.
2. The control circuit shall be protected by a normal duty thermal magnetic air circuit breaker which shall be connected in such a manner as to allow control power to be disconnected from all control circuits.
3. Pump mode selector switches shall be connected to permit manual start and manual stop for each pump individually, and to select automatic operation of each pump under control of the liquid level control system. Manual operation shall override the liquid level control system. Selector switches shall be heavy duty, oil tight design, with contacts rated NEMA A300 minimum.

4. Pump alternation shall be integral to the liquid level controller. Provisions for automatic alternation or manual selection shall also be integral to the liquid level controller.
5. Control panel shall be equipped with one oil tight pilot light for each pump motor. Light shall be wired in parallel with the related pump motor starter to indicate that the motor is on or should be running.
6. Six-digit elapsed time indicators (non reset type) shall be connected to each motor starter to indicate the total running time of each pump in "hours" and "tenth of hours".
7. A switch shall be provided to permit the station operator to select automatic alternation of the pumps, to select pump number one to be the lead pump for each pumping cycle or to select pump number two to be the lead pump for each pumping cycle. Selector switch shall be oil tight design, with contacts rated NEMA A300 minimum.
8. A duplex ground fault indicating utility receptacle providing 115 VAC, 60 Hertz, single phase current, shall be mounted on the door panel of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal magnetic circuit breaker.
9. Auxiliary Power Transformer:
    a. The lift station shall be equipped with a 7.5 KVA stepdown transformer to supply 115 volt, AC, single phase for the control and auxiliary equipment. The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door. and a padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.
10. The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, voltage unbalance, high voltage, and low voltage. An adjustable time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart, following an adjustable time delay, when power conditions return to normal.
11. Panel Heater:
    a. The control panel shall be equipped with a panel heater to minimize the effects of humidity and condensation. The heater shall include a thermostat.

I. Supervisory Control And Data Acquisition (SCADA) Device:
1. Furnish a remote monitoring and alarming SCADA device.
    a. Mission Communications, MyDro 150 or approved equal.
2. SCADA Device shall utilize cellular communications via Verizon Wireless.
3. Power:
    a. Primary: 12 vac, supplied by 120 vac to 12 vac Control Transformer.
    b. Backup: 12 vdc Battery Backup. Minimum uptime of 24 hours upon power failure.
    c. Auxiliary: 12-24 vdc power shall be available to power Analog Devices.
4. All I/O Points shall be Hard-Wired to SCADA Device, or expansion module(s), without the requirement of a Local Network Connection to an external devices such as a PLC (Programmable Logic Controller).
5. I/O Requirements, Minimum:
    a. 8 Discrete Inputs. Dry Contact Type with built-in circuit Fault Monitoring.
    b. 3 Relay Outputs. Form C Type.
    c. 2 Analog Inputs: Configurable for 4-20mA or 0-10 VDC.
    d. High Speed “Pulse” Counters: Available via expansion modules.
    e. Additional I/O of each type shall be available via expansion modules.

6. Local Network Communications shall be available via built-in RJ45 port. Communication protocols must include Ethernet/IP and MODBUS.
7. SCADA Device shall automatically record the status of all I/O points, control power, backup battery, and enclosure temperature. All recorded data shall automatically save backup records to a cloud server, managed by service provider.
8. SCADA Device shall include a local touchscreen operator interface. Interface shall allow the operator to view the current status of all available recorded data. Operator shall be able to temporarily place device offline and/or change device configurations upon use of access key provided by SCADA Device manufacturer.
9. Operator shall have remote access to SCADA Device(s) via Web Browser, Mobile Web Browser, and Smart Device App (Apple and Android). Remote access shall require a Login and Password.
10. SCADA Device shall have a built-in MicroSD card reader for Firmware/Software Configuration updates and saving capabilities.
11. Contractor shall pre-pay the first year of active service for SCADA Device.

J. Wiring;
   1. The control panel, as furnished by the manufacturer, shall be completely wired. The contractor shall field connect the power feeder lines to the main terminal block, final connections to the remote alarm devices, and the connections between the pump and the pump motor control. All wiring, workmanship, and schematic wiring diagrams shall be in compliance with applicable standards and specifications set forth by the National Electric Code (NEC).
   2. All user serviceable wiring shall be type MTW or THW, 600 volts, and shall be color coded as follows:
      a. Line and load circuits, AC or DC power.....Black
      b. AC control circuit less than line voltage.....Red
      c. DC control circuit.....Blue
      d. Interlock control circuit, from external source……Yellow
      e. Equipment grounding conductor.....Green
      f. Current carrying ground.....White
      g. Hot with circuit breaker open.....Orange
   3. Control circuit wiring inside the panel, with the exception of internal wiring of individual components, shall be of 16 gauge minimum, type MTW or THW, 600 volts. Power wiring shall be 14 gauge minimum.
   4. Motor branch and other power conductors shall not be loaded above the temperature rating of the connected termination. Wires shall be clearly numbered at each end in accordance with the electrical diagrams. All wires on the sub plate shall be bundled and tied.
   5. Wires connected to components mounted on the enclosure door shall be bundled and tied in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall be provided to allow the door to swing to its full open position without undue stress or abrasion on the wire or insulation. Bundles shall be held in place on each side of the hinge by mechanical fastening devices.

K. Conduit requirements are as follows:
   1. All conduit and fittings shall be UL listed.
   2. Liquid tight flexible metal conduit shall be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight, polyvinyl chloride cover.
   3. Conduit shall be supported in accordance with articles 346, 347, and 350 of the National Electrical Code.
   4. Conduit shall be sized according to National Electric Code.

L. Grounding:
   1. The pump control manufacturer shall provide a common ground bar mounted on the enclosure back plate. The mounting surface of the ground bar shall have any paint removed before making final connections.
   2. The contractor shall make the field connections to the main ground lug and each pump motor in accordance with the National Electric Code.

M. Identification:
   1. A permanent corrosion resistant name plate(s) shall be attached to the control and include the following information:
      a. Equipment serial number
      b. Control panel short circuit rating
      c. Supply voltage, phase and frequency
      d. Current rating of the minimum main conductor
      e. Electrical wiring diagram number
      f. Motor horsepower and full load current
      g. Motor overload heater element
      h. Motor circuit breaker trip current rating
      i. Name and location of equipment manufacturer
   2. Control components shall be permanently marked using the same identification shown on the electrical diagram. Identification label shall be mounted adjacent to the device.
   3. Switches, indicators, and instruments shall be plainly marked to indicate function, position, etc. Marking shall be mounted adjacent to and above the device.

2.10 LIQUID LEVEL CONTROL

A. The manufacturer of the liquid level control system must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.

B. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.

C. The level control system shall be utilize a submersible transducer type system.

D. The level control system shall utilize alternation to select first one pump, then the second pump, then the third pump (if required), to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.

E. The level control system shall utilize a level indicating controller which shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the level indicating controller shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the level indicating controller shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the level indicating controller shall start the second and/or third pump (if required) when the liquid reaches the "lag pump start level", or “standby pump start level” so that all pumps are operating. These levels shall be adjustable as described below.
   1. The level indicating controller shall be capable of operating on a supply voltage of 12VDC in an ambient temperature range of 100C (14 degrees F) through 55 degrees C (131 degrees F). Control range shall be 0 to 12.0 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water.

2. The level indicating controller shall consist of the following integral components: DC power supply, display, and output relays.
    a. The level indicating controller shall incorporate a digital back lighted LCD or LED panel display which, upon operator selection, shall indicate liquid level in the wet well, and the preset start and stop level for both lead and lag pump. The display shall include 0.19" high alpha numeric characters calibrated to read out directly in feet of water, accurate to within one tenth foot (0.1 foot), with a full scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.
    b. The lead and lag pumps start and stop set points shall be easily adjustable and accessible to the operator without opening any cover panel on the level indicating controller. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or external communication devices.
    c. Each output relay in the level indicating controller shall be solid state. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. The "ON" state of each relay shall be indicated on the display. The output of each relay shall be individually fused providing overload and short circuit protection. Each output relay shall have an inductive load rating equivalent to one NEMA size 4 contactor. A pilot relay shall be incorporated for loads greater than a size 4 contactor.
3. The level indicating controller shall be equipped with pump start delays. Delays shall be adjustable and preset at five (5) seconds.
4. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.
5. The level indicating controller shall be equipped with a simulator system capable of performing system cycle testing functions.
6. The level indicating controller shall be capable of controlling liquid levels in either a pump up or pump down application
7. The level indicating controller shall have internal capability of providing automatic alternation, manual selection of pump sequence operation, and alternation in the event of 1-199 hours excessive run time.
8. The level indicating controller shall be equipped with a security access code to prevent accidental set up changes and provide liquid level set point lock out.
9. The level indicating controller shall be equipped with at least one (1) scalable analog input of 4-20mA, and one (1) scalable 4-20mA output. Output is powered by 10-24VDC supply. Load resistance for 4-20mA output shall be 100-1000 ohms.
10. The level indicating controller shall be capable of providing 12-24VDC power for Analog Inputs and Outputs.
11. The level indicating controller shall be equipped with a solid state output relay to alert maintenance personnel to a high liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.
12. The level indicating controller shall be equipped with a solid state output relay to alert maintenance personnel to a low liquid level in the wet well. An indicator, visible on the front of the control panel, shall indicate that a low wet well level exists. The alarm signal shall be maintained until the cause for the low wet well level has been corrected and the circuit has been manually reset. A low liquid level condition shall disable both pump

motors. When the wet well rises above the low level point, both pump motors shall be automatically enabled. Low water alarm shall be furnished with a dry contact wired to terminal blocks.

F. Submersible Transducer System:
   1. The level control system shall utilize a submersible transducer. It shall be a strain gauge transducer with a pressure sensor housed in a 316 SST or Titanium case designed to extend into the wet well. The pressure transducer shall provide a proportional signal for distribution to the level controller display and Monitoring and Alarm system. Sensor range shall be 0-12 ft. W.C. (0-5 PSI) minimum with an over-pressure rating 3 times full scale. The transducer shall have output capability of 4-20mA. The transducer's polyurethane jacketed shielded cable shall be of suitable length for proper installation into the wet well without splicing.
   2. An intrinsically safe repeater shall be supplied in the control enclosure. Repeater must be recognized and listed as intrinsically safe by a nationally recognized testing laboratory. Station manufacturer shall make all connections from repeater to feeder lines and motor controls. Installing contractor shall make connections from repeater to transducer.

G. Independent Redundant Float Control System, Intrinsically Safe (Backup Level Control)
   1. Provide five (5) non-mercury float switches for a redundant station level control system that is independent from the primary station level control system. The independent redundant float control system consists of five (5) non-mercury float switches, a stainless steel float chain with anchor, intrinsically safe relays, and shall utilize Relay Logic. PLC control will not be permitted for Backup Level Controls. The Low Level float is positioned below all primary pump-off setpoints. When the wet well level reaches the low level float, a 'Low Level Alarm' will be triggered. If the Low Level Float is activated all pump(s) will shut off. The High Level Float is positioned above all primary pump-on setpoints. If the High Level Float switch is triggered, a 'High Level Alarm' will be triggered. If the level reaches the Lead Pump On Float the lead pump shall run until the wet well level reaches the Pump Off Float. If the level reaches the Lag Pump On Float the lag pump shall run until the wet well reaches the Pump Off Float. The independent redundant float control system includes automatic pump alternation. Dry contacts wired to terminal blocks will be provided for the float control active alarm circuit. The independent redundant float control system will remain latched until manually reset at the control panel.

H. Alarm Light:
   1. Station manufacturer will supply one LED alarm light fixture with vapor-tight red globe, guard, conduit box, mounting base, and match control voltage. The design must prevent rain water from collecting in the gasketed area of the fixture, between the base and globe. The alarm light shall be mounted on the station enclosure, installed after delivery to site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Station manufacturer shall provide written instruction for proper handling. Immediately after off-loading, contractor shall inspect complete pump station and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all station serial

numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.2 INSTALLATION

A. Install, level, align, and lubricate pump station as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.

C. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

3.3 FIELD QUALITY CONTROL

A. Operational Test
   1. Prior to acceptance by owner, an operational test of all pumps, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
   2. After construction debris and foreign material has been removed form the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

B. Manufacturer’s Start-up Services
   1. Coordinate station start-up with manufacturer's technical representative. The representative or factory service technician will inspect the completed installation. Calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

3.4 CLEANING

A. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Remove from the job site all tools, surplus materials, scrap and debris.

3.5 PROTECTION

A. The pump station should be placed into service immediately. If operation is delayed, station is to be stored and maintained per manufacturer's written instructions.

END OF SECTION

SECTION 33 34 00
SANITARY SEWERAGE FORCE MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Force mains.
   2. Bedding and cover materials.

B. Related Requirements:
   1. Section 03 30 00 - Cast-in-Place Concrete: Concrete material requirements.
   2. Section 31 05 13 - Soils for Earthwork: Soil backfill from above pipe to finish grade.
   3. Section 31 23 17 - Trenching: Excavation, backfilling, compacting, and fill pipe.
   4. Section 31 23 23 - Fill: Requirements for fill over underground pipe markers.
   5. Section 33 01 30.13 - Sewer and Manhole Testing: Pressure testing.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. American Water Works Association:
   1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
   3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   4. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
   5. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 12 In., for Water Transmission and Distribution.

C. ASTM International:
   1. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   3. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   4. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   5. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   6. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   7. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. Ductile Iron Pipe Research Association (DIPRA):
   1. Thrust Restraint Design for Ductile Iron Pipe.

1.3 COORDINATION

A. Coordinate Work of this Section with connection to existing sewer utility service.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer information indicating pipe material used, pipe accessories, valves, restrained joint details and materials.

B. Shop Drawings:
   1. Indicate piping piece numbers and locations.
   2. Indicate restrained joint locations.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for restrained joints, including establishing lengths of restrained joint piping required.

E. Manufacturer Instructions: Indicate special procedures required to install specified products.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record invert elevations and actual location of pipe runs and connections.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Design ductile-iron pipe restrained joints according to DIPRA standards.

B. Perform Work according to Municipal, State, and Federal standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Storage:
   1. Store materials according to manufacturer instructions.
   2. Do not place materials on private property without written permission of property owner.
   3. Do not stack pipe higher than recommended by pipe manufacturer.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.
   3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 FORCE MAIN

A. Ductile-Iron Pipe:
   1. Comply with AWWA C151 and AWWA C104. Class 53 (exposed) and Class 52 (buried), cement lined, asphalt dipped (buried) or red oxide primer (exposed), inside nominal diameters as indicated on the drawings.

B. Ductile-Iron Fittings:
   1. Comply with AWWA C110.
   2. Pressure Rating: 250 psig.
   3. Cement mortar lined and outside coated as for ductile-iron pipe.

C. Joints:
   1. Comply with AWWA C111.
   2. Type: Flanged in exposed settings.

D. Rubber Gaskets, Lubricants, Glands, Bolts, and Nuts: Comply with AWWA C111.

2.2 MATERIALS

A. Bedding and Cover:
   1. Bedding: Fill Type A4, as specified in Section 31 05 16 - Aggregates for Earthwork.
   2. Cover: Soil Type A4, as specified in Section 31 05 16 - Aggregates for Earthwork.
   3. Soil Backfill from above Pipe to Finish Grade: Soil Type S1, as specified in Section 31 05 13 - Soils for Earthwork.

4. Subsoil: No rocks more than 6 inches in diameter, frozen earth, or foreign matter.

2.3 MIXES

A. Concrete: As specified in Section 03 30 00 - Cast-in-Place Concrete.

2.4 ACCESSORIES

A. Fittings to connect to existing asbestos cement forcemain.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that trench cut is ready to receive Work.

B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Correct over-excavation with fine aggregate.

B. Remove large stones or other hard matter capable of damaging pipe or of impeding consistent backfilling or compaction.

3.3 INSTALLATION

A. Bedding:
   1. Excavate pipe trench as specified in Section 31 23 17 - Trenching.
   2. Place bedding material at trench bottom.
   3. Level materials in continuous layers not exceeding 6 inches in depth.
   4. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:
   1. Install pipe, fittings, and accessories as indicated on Drawings.
   2. Route piping in straight line.
   3. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
   4. Backfilling and Compacting:
      a. As specified in Section 31 23 17 - Trenching.
      b. Do not displace or damage pipe while compacting.
   5. Connect to sewer system.
   6. Pipe Markers and tracer wire as specified herein.

C. Thrust Restraints:
   1. Provide pressure pipeline with restrained joints or concrete thrust blocking at bends, tees, and changes in direction, and connection of HDPE to DI, per the detail on the Drawings.
   2. Construct concrete thrust blocking as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Testing:
   1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
   2. Pipe Testing:
      a. Pressure Test: As specified in Section 33 01 30.13 - Sewer and Manhole Testing.
   3. Compaction Testing:
      a. Comply with ASTM D6938.
      b. Testing Frequency: once every 3 feet of compaction using a Hoe Pack, once every 6 inches using walk behind plate compactors.

3.5 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 41 11
LEAK DETECTION VENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
1. Solid core geo-composite, prefabricated, liquid and gas collection system (collection system) and the associated transport system (transport pipe).
2. Bedding and cover materials.

B. RELATED SECTIONS
1. Section 31 05 13 – Soils for Earthwork
2. Section 31 05 16 – Aggregates for Earthwork
3. Section 31 23 17 - Trenching
4. Section 31 23 23 - Fill
5. Section 33 05 13 – Manholes and Structures

1.2 SUBMITTALS

A. Product Data: Submit data for Multi-Flow Leak Detection Vent System and all appurtenances including fittings, connection manifolds, venting stacks, HDPE drain piping, etc.

B. Shop Drawings:
1. Indicate all feature locations and elevations.
2. Indicate sizes and elevations of piping penetrations.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Qualifications Statements:
1. Submit qualifications for manufacturer and installer.
2. Submit manufacturer's approval of installer.

1.3 QUALITY ASSURANCE

A. Perform Work according to specified standards.

B. Maintain a copy of each standard affecting Work of this Section on Site.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years documented experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Comply with manufacturer's instructions for unloading and storing products.

PART 2 - PRODUCTS

2.1 LEAK DETECTION AND VENTING SYSTEM

A. Manufacturers:
1. Varicore Technologies, Inc.
2. Or Equal

2.2 DESCRIPTION

A. This work shall consist of providing and placing a Multi-Flow LDVS (leak detection and venting system) comprised of a solid core geo-composite, prefabricated, liquid and gas collection system (collection system) and the associated transport system (transport pipe) as described in the plans. The system shall be installed in accordance with these specifications and in close conformity with the locations and dimensions as shown on the plans or specified by the engineer. The quantities of materials as shown on the plans may be increased or decreased at the discretion of the engineer based on actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

2.3 MATERIALS

A. The collection system shall be of a flexible, prefabricated, rounded rectangular shaped, composite product, consisting of an inner core described in 2.2.A.1 and an outer geotextile wrap described in 2.2.A.2. The outer wrap shall function only as a filter and shall not be a structural component of the core.
1. The collection system core shall be made of a high-density polyethylene. The core shall be constructed using interconnected corrugated pipes that define and provide the flow channels and structural integrity of the collection system. Perforations shall be evenly distributed on both faces of the core. The core of the collection system shall conform to the following physical property requirements.

Thickness, inches	ASTM D-1777	1.0
Outflow Rate, gpm/ft*	ASTM D-4716	29
Compressive Strength, psf	ASTM D-1621 (modified sand method)	6000
Inlet Area / sq. ft.	Cross Sectional Flow Area	>50%

* At gradient = 0.1, pressure = 10 psi for 100 hours.

2. The collection system shall be wrapped with a non-woven geotextile. The non-woven wrap shall be of a needle-punched construction consisting of long-chain polymeric fibers composed of polypropylene, polyethylene or polyamide. The fibers shall be oriented into a multi-directional stable network whereby they retain their positions relative with each other and allow the passage of water as specified. The fabric shall be free of any chemical treatment or coating, which reduces permeability and it shall be inert to chemicals commonly found in soil. The geotextile shall conform to the following minimum average roll values.

Weight	ASTM D-3776	4.0
Tensile Strength	ASTM D-4632	100
Elongation %	ASTM D-4632	50
Puncture, lb	ASTM D-751	50
Mullen Burst, psi	ASTM D-3786	200
Trapezoidal Tear, lb	ASTM D-4533	42
Coefficient of Permeability	ASTM D-4491	.1 cm/sec
Flow Rate, gpm/ft2	ASTM D-4491	100
Permittivity, 1/sec	ASTM D-4491	1.8
Apparent Opening Size	ASTM D-4751	70 Max US Std Sieve Opening
Seam Strength, lb/ft	ASTM D-4595	100
Fungus	ASTM G-21	No Growth

3. Multi-Flow meets or exceed these specifications.

B. The connectors used with the collection system shall be of a snap together design. In no case shall any product be joined without the use of the manufacturer's connector designed specifically for the purpose.

C. Transport pipe shall be either PVC Pipe meeting the requirements of ASTM D-2729 or ASTM F-949, or high-density polyethylene pipe meeting the requirements of ASSHTO M252.2.4.

2.4 CONSTRUCTION REQUREMENTS

A. The collection system shall be installed in an orientation and placed directly below the liner or as directed by the engineer.

B. The collection system and the transport pipe shall be to the line sand grades shown on the plans.

C. The collection system shall be securely connected to the transport pipes using connectors approved by the manufacturer.

D. Connectors shall be installed in accordance with the manufacturer's recommendations.

E. Any damaged collection system or transport pipe shall be replaced or repaired by slicing in an undamaged section of like material.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of Multi-Flow LDVS Geocomposite Panel:
   1. Process – Typically, Multi-Flow LDVS is installed immediately before the placement of a geosynthetic liner, membrane, and textile per engineered specification.
      a. Note – installation may occur directly on compacted base, geosynthetics material and/or both as per engineered specification.
   2. Multi-Flow LDVS 150 ft. roll shall be unbound from packing materials and uncoiled directly upon surface to be positioned, per the location and spacing specified by the engineered drawings.
   3. Multi-Flow LDVS shall be installed to lay flat upon the surface and if necessary, weighted incrementally while the installation takes place, to avoid the product not making contact with the grade it is placed upon, in all areas.
   4. Unless specified, DO NOT FASTEN the Multi-Flow LDVS panel to the base using nails, pins, staples, etc. (sharps).
   5. Allowing for contraction and/or expansion:
      a. If installing in temperatures above 90 degrees Fahrenheit, allow for <1% contraction upon cooler ambient temps, before making final connections to supplied connectors and/or drains/vents.
      b. In the event contraction takes place, cut excess Multi-Flow LDVS to fit.
   6. Cutting Multi-Flow LDVS
      a. The best method to cut the geo-composite product and surrounding geotextile is with a sharp utility knife/blade. Saws with teeth do not provide a clean cut through both the textile and/or HDPE core.

B. Installation of Fittings and Connectors
   1. Install all fittings and connectors according to engineers specifications.
      a. Locate and place appropriate connector at the area according to site plan specified by the engineered drawings.
      b. Cut Multi-Flow LDVS panel to fit min. 4” of the corrugations into the female opening in the connector.
      c. Spread opening in the connector to allow Multi-Flow LDVS to snap into place.
      d. Fold geotextile back from end of geo-composite core 4”-6”.
      e. Snap into place and overlap textile onto outside of connector.
      f. If necessary, secure connection between Multi-Flow LDVS and connector using PVC tape.
      g. DO NOT secure connector with screws or fasteners (sharps) of any type.
      h. DO NOT secure connectors using glues, adhesives or solvents.
      i. In rare instances, connectors are secured via HDPE weld. When specified, use method for welding approved by engineer, making contact ONLY between the connector and the “web” in between Multi-Flow LDVS corrugated flow channels.

C. Hard Connections to Drain or Vent Outlets
   1. Make hard connections using method approved and specified on drawings per engineer.
   2. When specified, use connectors suitable and compatible with like-kinds of materials.
      a. Example – PVC to PVC, HDPE to HDPE, etc.
      b. If PVC – Use approved PVC or compatible adhesive, as per spec.
      c. If HDPE – Use approved snap and lock fittings, as per spec.

d. If using another method (lap-over, abutting, etc.), follow specified practice per engineer.

3. Allow for backfill to be filled and compacted, as per spec, appropriately under voids, as per spec.

D. Cover
   1. Multi-Flow LDVS may be covered by geosynthetics layer or by selected aggregate, as per engineered specification.
   2. It is advised that NO VEHICLE traffic occur directly on the Multi-Flow LDVS itself.
      a. When covered with a backfill medium/aggregate:
         1) Min. 2”-4” cover before track-vehicles may cross.
         2) Min. 6”-8” cover before wheeled vehicles may cross.
         3) Avoid ANY single/tandem axel vehicle traffic if loaded.

END OF SECTION

SECTION 33 47 15
LINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Impermeable geomembrane liners:
a. High Density Polyethylene (HDPE) Liner.
2. Geosynthetic Clay Liner.
3. Accessories: Prefabricated Pipe Boots

B. Related Requirements:
1. Division 31 - Earthwork
2. Section 31 05 19 - Geotextiles for Earthwork

1.2 REFERENCE STANDARDS

A. ASTM International:
1. ASTM D413 - Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
2. ASTM D471 - Standard Test Method for Rubber Property-Effect of Liquids.
3. ASTM D751 - Standard Test Methods for Coated Fabrics.
4. ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
5. ASTM D1693 - Standard Test Method for Environmental Stress Cracking of Ethylene Plastics.
6. ASTM D2136 - Standard Test Method for Coated Fabrics - Low-Temperature Bend Test.
7. ASTM D5596 - Measuring Anionic Contaminants in High-Purity Water by On-Line Ion Chromatography
8. ASTM D5884 - Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes.
9. GRI GM13 - High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
10. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. South Coast Air Quality Management District:
1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

1.3 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer specifications and other data required to demonstrate compliance with the specific requirements.

B. Shop Drawings: Indicate joining details and special details.

C. Samples: Submit liner material sample, 6x6 inches in size.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, panel configuration, general locations of field seams, and information for storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of seams and pipe penetrations.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum 5 years' documented experience and approved by manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle liner with equipment designed to protect liner from damage.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Adhesives: Store adhesives between 60 and 80 degrees F.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Furnish 10-year manufacturer's warranty for repair or replacement of liners that leak or fail in materials and workmanship or that deteriorate under conditions of normal weather.

PART 2 - PRODUCTS

2.1 HDPE LINERS

A. Manufacturers:
   1. GSE Lining Technology, or equal.

B. Physical Material Properties (minimum).
   1. Thickness: 60 mils
   2. Density: 0.940 g/cm^3
   3. Carbon Black Content: 2%
   4. Carbon Black Dispersion: 9 of 10 views from Category 1 or 2, and no more than 1 view Category 3.
   5. Strength at Yield: 126 lb/in - width
   6. Strength at Break: 228 lb/in - width
   7. Elongation at Yield: 12%
   8. Elongation at Break: 700% (2 inch gage or extensometer)
   9. Dimensional Stability: 2.0%
   10. Tear Resistance: 42 lbs
   11. Puncture Resistance: 108 lbs

C. Seam Properties (minimum)
   1. Shear Strength: 121 lb/in - width
   2. Peel Strength: 98 lb/in - width
   3. Peel Strength: 78 lb/in - width
   4. Seam testing shall be the responsibility of the installer.

2.2 GEOSYNTHETIC CLAY LINER

A. The GCL shall be a reinforced liner consisting of a layer of sodium bentonite between a woven and a non-woven geotextiles, which are needle-punched together.

B. Physical Material Properties
   1. Bentonite Swell Index: 24 mL/2g (minimum)
   2. Bentonite Fluid Loss: 18 mL (maximum)
   3. Bentonite Mass/Area: 0.75 lb/ft^2
   4. GCL Grab Strength: 90 lbs
   5. GCL Peel Strength: 15 lbs
   6. GCL Index Flux: 1x10^-8 m^3/m^2/sec

7. GCL Permeability: 5x10^-9 cm/sec
8. GCL Hydrated Internal Shear Strength: 500 psf (typical)

2.3 ACCESSORIES

A. Fabricated Pipe Boots
1. Provide pipe boots with all the necessary accessories and fasteners required at each of the pipe penetrations into the lagoon.

2.4 FABRICATION

A. Fabricate liner panels from sheets in sizes as large as possible, with factory-sealed seams and consistent with limitations of weight and installation procedures.

B. Minimize field seaming.

PART 3 - EXECUTION

3.1 PREPARATION

A. Conduct operations as not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

B. Side Slopes:
1. Prepare slopes to receive liner.
2. Shape slopes to even surface and to required depth and section, as indicated on Drawings and according to liner manufacturer instructions.

C. Remove sharp sticks, stones, and trash from bottom and sides of excavation subgrade that may puncture liner.

D. Prepare perimeter anchoring trench as indicated on Drawings.

3.2 EXAMINATION

A. Verify that the basin has been constructed according to the Drawings and is ready to accept the liner system.

B. Field verify dimensions and provide necessary piping modifications prior to installation.

C. Verify that anchor trench excavation, where liner is to be secured, is in correct location and configuration.

D. Verify that subgrade and anchor trench excavation is free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, groundwater, and other conditions that may affect liner performance.

E. Beginning of installation means acceptance of existing conditions.

3.3 INSTALLATION – HDPE LINER

A. Install in accordance with manufacturer's instructions.

B. Excavation and Bedding:
   1. Excavate as indicated on Drawings as specified in Section 31 23 16 - Excavation.
   2. Place bedding material at bottom of excavation.
   3. Excavate anchor trenches to the lines and widths shown on the Drawings prior to liner placement.
   4. Slightly round corners in the anchor trench where the liner adjoins the trench to minimize sharp bends in the liner.

C. Orient seams parallel to the slope. Whenever possible, locate horizontal seams on the base of the cell, not less than five feet from the toe of the slope.

D. Number each seam made in the field.

E. Position liner on berm such that one edge can be buried in anchoring trench before remainder is opened down slope.

F. Stretch liner to its full width along entire length of liner, with slack to allow for typical thermal expansion.

G. If field jointing of sections is required, position second section adjacent to first section and unfold such that edges to be joined are overlapped minimum 4 inches.

H. Clean seam area of dust, dirt, and moisture.

I. Smooth out wrinkles and airspaces. Mark and repair any area of a panel seriously damaged (torn, twisted, or crimped).

J. Seal seam with welding according to liner manufacturer instructions.
   1. All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam.
   2. No field seaming is to be done in weather conditions that would adversely affect the integrity of the seam.
   3. Seal liner to concrete structures and pipe projections through liner as indicated on Drawings and according to liner manufacturer instructions.

K. Seam Preparation
   1. Fusion Welding
      a. Overlap the panels of the geomembrane approximately four to six inches prior to welding.
      b. Clean the seam area prior to seaming to assure the area is free of moisture, dust, dirt, or debris of any kind.
      c. Adjust the panels so that seams are aligned with the fewest possible number of wrinkles.
      d. A moveable protective layer may be used directly below the overlap of the geomembrane that is to be seamed to prevent build-up of dirt or moisture

between panels, at the discretion of the superintendent of the manufacturer's installer.

2. Extrusion Fillet Welding
   a. Whenever possible, the sheet will be beveled prior to heat-tacking into place.
   b. Overlap the panels of the geomembrane a minimum of three inches.
   c. Using a hot-air device, temporarily tack the panels of the geomembrane to be welded, taking care not to damage the geomembrane.
   d. Clean the seam area prior to seaming to assure the area is free of moisture, dust, dirt, and debris of any kind.
   e. Grind seam overlap prior to welding within one hour of the welding operation in a manner that does not damage the geomembrane.
   f. Cover grind marks with extrudate whenever possible. In all cases, grinding should not extend more than 1/4 inch past the edge of the area covered by the extrudate during welding.
   g. Keep the welding rod clean and dry.

L. General Seaming Procedures
1. Extend seaming into the anchor trench.
2. Monitor and maintain the proper overlap during seam welding.
3. Align wrinkles at the seam overlap to allow welding through the wrinkle.
4. Wrinkles at seam overlaps that cannot be welded through, shall be cut along the ridge in order to achieve a flat overlap. The cut wrinkle shall be heat tacked flat and extruded or patched with an oval or round patch of the same geomembrane, extending a minimum of three inches beyond the cut in all directions.
5. All cross/butt seams between two rows of seamed panels shall be welded during the coolest time of the day when practical, to allow for typical thermal expansion of the geomembrane.
6. Prior to welding cross/butt seams, trim the top and bottom overlap of the intersecting fusion welded seams to six inches. Grind intersecting extrusion fillet welded seams to flatten the extrusion bead prior to welding butt seams.
7. All "T" joints produced as a result of cross/butt seams shall be extrusion fillet welded. Trim back the overlap on each "leg" of the "T" joint, six inches. Then grind three inches minimum on each of the three legs of the "T" and extrusion weld all of the area prepared by grinding.
8. Whenever possible, cut a one inch peel specimen at the end of every seam. Prior to welding the next seam the specimen shall be tested for peel.
9. In the event of non-complying seam test strips are encountered, the welding machine will be taken out of service until a passing trial weld is obtained, and additional peel specimens will be taken to localize the flaw.

M. Seam Testing
1. Test fusion welds by non-destructive air-pressure testing in accordance with the manufacturer's procedures and by Geosynthetic Research Institute Test Method GM-13.
2. Test extrusion welds by non-destructive vacuum testing in accordance with the manufacturer's procedures and by Geosynthetic Research Institute Test Method GM-13.
3. Vacuum testing may also be used on sections/areas when the geometry of the fusion weld makes air pressure testing impossible or impractical.

4. Vacuum testing may also be used to locate the precise location of the defect believed to exist after air pressure testing.

N. Defects and Repairs
1. Replace or repair any portion of the liner or liner seam showing a flaw, having non-destructive test in non-compliance, showing injury due to scuffing, penetration by sharp objects, or distress from rough subgrade, or as directed by Owner/Engineer.
2. Repair liner by covering damaged area with additional layer of liner material, extending minimum 12 inches beyond damaged area and round the corners of all patches.
3. Use grinding and welding to repair sections of extruded fillet seams.
4. Use spot welding or seaming to repair small tears, pinholes, or other minor localized flaws.
5. Use capping to repair lengths of extrusion or fusion welded seams.
6. Extrude overlap along the length of fusion welded seams.
7. Remove defective seams and replace with a strip of new material, seamed into place.
8. Non-destructively test every repair. Repairs which pass the non-destructive test shall be deemed acceptable.

3.4 INSTALLATION - GEOSYNTHETIC CLAY LINERS

A. Handling and Placement
1. Install in accordance with manufacturer's instructions.
2. Always store geosynthetic clay liner rolls in a location where they will not be exposed to moisture.
3. On slopes, place geosynthetic clay liners with overlap oriented parallel to the maximum slope.
4. Overlap adjoining panels of geosynthetic clay liners a minimum of six inches.
5. Never install geosynthetic clay liners in standing water or when there is precipitation.
6. Always install geosynthetic clay liners with the appropriate side up.
7. Pull rolls tight to smooth out creases or irregularities.
8. Take precautions to avoid damage to any underlying geosynthetic materials while placing the geosynthetic clay liners.
9. Cover geosynthetic clay liners with geomembrane or other cover material after placement, to avoid damage from precipitation.

B. Seams
1. Roll the GCL into place, creating a 6 inch overlap between rows.
2. Apply a bentonite mat in each seam, between the two layers of the GCL.

C. Repairs
1. Repairs to cuts or tears in installed rolls should extend a minimum of six inches beyond the area in need of repair.
2. Hold repair pieces in place until cover material has been placed

3.5 FIELD QUALITY CONTROL

A. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 1 day on Site **per cell** for installation, inspection, field testing, and instructing Owner's personnel in maintenance of liner.

B. Equipment Acceptance:
   1. Before initial filling of pond, or placement of earth or other cover, inspect seams and repaired areas to ensure tight and continuously bonded installation.
   2. Repair damaged liner and seams and reinspect repaired Work.
   3. Make final adjustments to liners under direction of manufacturer's representative.

C. Furnish installation certificate from equipment manufacturer's representative attesting that liner has been properly installed and is ready for startup and testing.

3.6 PROTECTION

A. Protect installed liner according to liner manufacturer instructions.

END OF SECTION

SECTION 40 05 13
COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe penetrations.
2. Restrained joints.
3. Flexible connections.
4. Expansion joints.
5. Sleeve-type couplings.
6. Air release and vacuum breakers.
7. Strainers.
8. Identification for process piping.

B. Related Requirements:
1. Section 40 05 13.53 - Ductile Iron Process Piping.
2. Section 40 05 23 - Common Work Results for Process Valves.
3. Section 40 05 29 - Hangers and Supports for Process Piping and Equipment.

1.2 DEFINITIONS

A. FM: Factory Mutual Insurance Company. "FM Global" is the communicative name of the company.

B. WH: Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.
2. ASME B31.3 - Process Piping.
3. ASME B31.9 - Building Services Piping.
4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

B. American Society of Sanitary Engineering:
1. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
2. ASSE 1020 - Performance Requirements for Pressure Vacuum Breaker Assembly.

C. ASTM International:
1. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

3. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
4. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
6. ASTM F1199 - Standard Specification for Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum).
7. ASTM F1200 - Standard Specification for Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F).

D. American Water Works Association:
1. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.

E. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

F. Expansion Joint Manufacturers Association, Inc.:
1. EJMA Standards.

G. NSF International:
1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

H. UL:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 1479 - Fire Tests of Through-Penetration Firestops.
3. UL 2079 - Tests for Fire Resistance of Building Joint Systems.

1.4 COORDINATION

A. Coordinate installation of specified items with installation of valves and equipment.

B. The drawings indicate the general arrangement of the piping. Details of proposed departures due to actual field conditions or other causes shall be submitted to the Engineer for review. The Contractor shall carefully examine the drawings and shall be responsible for the proper fitting of materials and equipment in each structure as indicated, without substantial alteration.

C. The Pipe Schedule included in this specification or shown on the plans lists materials, joints, and coatings which shall be used for each service. Specialty items including couplings, flange adapters, taps, insulating couplings, expansion joints, etc., are not included in the schedule but shall be incorporated in the work in accordance with the plans and specifications.

D. All piping connections to drive, rotating, or vibrating equipment shall include a flange adapter, coupling, expansion pipe, or other approved device to minimize transmission of vibration to the piping system.

E. All equipment connections shall have isolation valves and shall be made with the use of a union, flange, coupling, or other approved device to allow for equipment removal with minimum pipe disturbance.

1.5 SUBMITTALS

A. Product Data:
   1. Submit manufacturer catalog information for each product specified.
   2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   3. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.

B. Shop Drawings:
   1. Identification:
      a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
      b. Comply with ASME A13.1.
   2. Indicate restrained joint details and materials.
   3. Submit layout drawings showing piece numbers and location, indicating restrained joint locations.
   4. Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets, and swing joints.
   5. Drawings may be "one line" showing size, length, materials, connections, special taps, coatings, supports, joint restraints, and centerline elevations.
   6. Drawings shall be prepared, including designation of valves and items of equipment; and using the actual dimensions of equipment, valves, etc., proposed by the Contractor to be included in the project.
   7. Drawings shall clearly indicate the location and centerline elevation of all sleeves, inserts, etc., to be placed in concrete walls or slabs. Details of all joint restraint shall be included in the shop drawing and are subject to approval by the Engineer.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

E. Manufacturer Instructions: Submit special procedures and setting dimensions.

F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Certify that sound isolation installation is complete and according to instructions.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.
   3. Welder Certificates: Submit welder certification of compliance with AWS D1.1.

1.6 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of piping appurtenances.

B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

B. Perform Work according to ASME B31.9 for installation of piping systems, and according to AWS D1.1 for welding materials and procedures.

C. Perform Work according to applicable code for installation of piping systems.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
   3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 All nuts, bolts, connector rods, brackets, etc. are required to be 316 S.S. in the wet wells and lagoon structures.

2.2 PIPE PENETRATIONS

A. Wall Castings / Wall Pipes for Ductile Iron Pipe:
   1. As specified in Section 40 05 13.53 – Ductile Iron Process Piping.

B. Flashing:
   1. Metal Flashing:
      a. Material: Galvanized steel.
      b. Thickness: 26 gauge.
   2. Metal Counterflashing:
      a. Material: Galvanized steel.
      b. Thickness: 22 gauge.
   3. Lead Flashing:
      a. Material: Sheet lead.
      b. Weight:
         1) Waterproofing: 5 psf.
         2) Soundproofing: 1 psf.
   4. Flexible Flashing Materials:
      a. Material: Butyl sheet Compatible with service conditions.
      b. Thickness: 47 mils.
   5. Caps:
      a. Material: Steel.
      b. Minimum Thickness: 22 gage, and 16 gauge at fire-resistant elements.

C. Sleeves:
   1. Material: Steel pipe or rolled plate.
   2. Size: Suitable for seal installation as recommended by manufacturer.
   3. Thickness:
      a. Sch. 40 pipe for diameters through six (6) inch.
      b. 0.250-inch for diameters above six (6) inch.
   4. Collar: Steel waterstop collar
      a. 2-inch by 0.250-inch minimum
      b. Continuously welded to the sleeve
   5. Painting:
      a. The ends and interior of the sleeve as specified in Section 09 96 00.
      b. The exterior and collar surfaces of the sleeve in contact with concrete are to be left uncoated.
   6. Sealant:
      a. Type: Acrylic.

D. Mechanical Sleeve Seals:
   1. Manufacturers:
      a. GPT Industries (formerly Pipeline Seal & Insulator, Inc.), or equal.

   2. Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve,

connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

3. Material:
   a. Standard Service
      1) Rubber seals: EPDM
      2) Pressure Plates: Delrin or cast iron
      3) Bolts and nuts: Zinc phosphate-low carbon steel
   b. Buried, Submerged, or Corrosive Service
      1) Rubber seals: EPDM or Nitrile rubber as recommended by manufacturer
      2) Pressure Plates: Delrin
      3) Bolts and nuts: Type 18-8 stainless steel
   c. Fire Resistant Service
      1) UL and FM approved.

2.3 JOINT RESTRAINTS

A. All pipe joints shall be designed to restrain the pipe for excessive movement at the pipe test pressure.

B. Details of all joint restraints shall be included on the shop drawings and are subject to approval by the Engineer.

C. Steel pipe joint harness details shall conform to AWWA M11, Section 19.8.

D. Underground pumped or pressurized piping shall be restrained utilizing concrete thrust blocks unless otherwise approved by the Engineer.

1. Thrust Block: shall be made of cast-in-place concrete and placed at all bends noted below. Area in square feet of concrete thrusting against undisturbed earth shall be computed by dividing the total thrust by the safe bearing load of the soil as approved by the Engineer. Thrust and safe bearing loads for soils are shown in the following tables.
   a. Thrust table: Shall be used for sized noted. For larger sizes, detail will be shown on the Drawings.

Thrust Main Size	90 deg. Bend, Tee	45 deg. Bend	22-1/2 deg. Bend	11-1/4 deg. Bend
4"	4,000 lbs.	2,100 lbs.	1,100 lbs.	600 lbs.
6"	8,200 lbs.	4,300 lbs.	2,300 lbs.	1,100 lbs.
8"	14,000 lbs.	7,400 lbs.	3,900 lbs.	2,000 lbs.
10"	21,000 lbs.	11,000 lbs.	5,800 lbs.	2,900 lbs.
12"	30,000 lbs.	15,500 lbs.	8,200 lbs.	4,100 lbs.
14"	40,000 lbs.	21,000 lbs.	11,000 lbs.	5,500 lbs.
16"	51,000 lbs.	27,000 lbs.	14,200 lbs.	7,100 lbs.
18"	64,000 lbs.	34,000 lbs.	17,800 lbs.	8,900 lbs.
20"	79,000 lbs.	37,500 lbs.	21,000 lbs.	11,000 lbs.

   b. Safe bearing loads for soils (horizontal thrust).

Soil	Safe Bearing Load, psf
Muck, Peat, etc.	0

Soft clay	1,000
Sand	2,000
Sand and gravel	3,000
Sand and gravel cemented with clay	4,000
Hard compacted clay	5,000

2.4 FLEXIBLE CONNECTIONS

A. Manufacturers:
1. Metraflex Metrasphere.
2. Proco Series 240.
3. Masonflex.

B. Body Construction
1. For temperatures to 230 deg F: Neoprene
2. For temperatures above 230 deg F: EPDM
3. For process blower connections: EPDM
4. For compressor connections: EPDM

2.5 SLEEVE-TYPE COUPLINGS

A. Ductile Iron Pipe Couplings
1. Manufacturers:
a. For pipe sizes up to and including 16-inch diameter
1) Material: Ductile iron
2) Dresser Style 253
3) Smith-Blair 441
b. For pipe sizes greater than 16-inch diameter
1) Material: Steel
2) Dresser Style 38
3) Smith-Blair 411
2. Minimum sleeve thickness: 0.375 inches.

B. Steel Pipe Couplings
1. Manufacturers:
a. Dresser Style 38
b. Smith-Blair 441
2. Middle ring dimensions:
a. For pipe sizes up to and including 4-inch diameter: ¼" x 5" minimum
b. For pipe sizes greater than 4-inch diameter: ¼" x 7" minimum

C. Flanged Coupling Adapters
1. Manufacturers:
a. For pipe sizes up to and including 12-inch diameter
1) Material: Cast iron
2) Dresser Style 227
3) Smith-Blair 912
b. For pipe sizes greater than 12-inch diameter
1) Material: Steel
2) Dresser Style 128
2. Minimum body thickness: 0.375 inches.

D. Buried, Mechanical Joint Ductile Iron Pipe Couplings: Solid Sleeve

E. Pipe Couplings shall be assembled in a manner to insure permanently tight joints under all reasonable conditions of expansion, contraction, or unavoidable variations and misalignment of piping. Pipe ends shall be smooth and round for a distance equal to the coupling length, and the nominal outside diameter shall conform to AWWA tolerances for plain end pipe.

2.6 AIR RELEASE AND VACUUM BREAKERS

A. Manufacturers:
   1. APCO.
   2. Val-Matic
   3. A.R.I. SAAR

B. Air and Vacuum Valves:
   1. Clean Water Service:
      a. APCO Series 140 or 150
      b. Val-Matic Model 100 series
   2. Sewage Service:
      a. APCO Sereis 401 SAVV
      b. Val-Matic Model 300 series
   3. Comply with AWWA C-512.
   4. Furnish blowoff valve, quick-disconnect couplings, and minimum 6 feet of hose.
   5. Body and Cover: Cast iron.
   6. Float, Seat, and Trim: Type 316 stainless steel.
   7. Working Pressure: 150 psig.
   8. Size: As indicated on Shop Drawings.
   9. End Connections:
      a. Size 1/2 to 3 inches: Threaded.
      b. Size 4 inches and Larger: Flanged.
   10. Valves shall be designed to allow large quantities of air to escape out the orifice and to close water tight when the liquid enters the valve.
   11. Valves shall permit large quantities of air to enter thru the orifice when the vessel is being drained to break the vacuum.
   12. The discharge orifice area shall be equal or greater than the inlet of the valve.
   13. The seat shall be fastened into the valve cover without distortion and shall be easily removed in necessary.
   14. The float shall be center guided for positive seating.

C. Air Release Valves:
   1. Clean Water Service:
      a. APCO Model 200A
      b. Val-Matic Model 38 series
   2. Sewage Service:
      a. APCO Series 450 SARV
      b. Val-Matic Model 48 sereis
   3. Comply with AWWA C-512.
   4. Furnish blowoff valve, quick-disconnect couplings, and minimum 6 feet of hose.
   5. Body and Cover: Cast iron.
   6. Float and Trim: Type 316 stainless steel.

7. Seat: Buna-N
8. Suitable for corrosive service.
9. Working Pressure: 150 psig.
10. Size: As indicated on Shop Drawings.
11. End Connections:
    a. Size 1/2 to 3 inches: Threaded.
    b. Size 4 inches and Larger: Flanged.

D. Dual Body Combination Air Release Valves:
1. Clean Water Service:
    a. APCO Series 1800
    b. Val-Matic Model 100 series
2. Sewage Service:
    a. APCO Series 440
    b. Val-Matic Model 48/304 series
3. Stems and Bodies: Long-float type to minimize clogging.
4. Furnish blowoff valve, inlet shutoff valve, water inlet valve, quick-disconnect couplings, and minimum 6 feet of hose.
5. Body and Cover: Cast iron.
6. Float, Seat, and Trim: Type 316 stainless steel.
7. Working Pressure: 150 psig.
8. Size: As indicated on Shop Drawings.
9. End Connections:
    a. Size 1/2 to 3 inches: Threaded.
    b. Size 4 inches and Larger: Flanged.
10. Combination air release valves shall consist of one air and vacuum valve to permit exhaust or intake of large quantities of air during filling period or startup of pump and one air release valve to exhaust small quantities of air during pump operation.

E. Single Body Combination Air Release Valves:
1. Clean Water Service:
    a. APCO Series 140 C
    b. Val-Matic Model 200 series
2. Sewage Service:
    a. APCO Series 440 SCAV
    b. Val-Matic Model 800 series
3. Stems and Bodies: Long-float type to minimize clogging.
4. Furnish blowoff valve, inlet shutoff valve, water inlet valve, quick-disconnect couplings, and minimum 6 feet of hose.
5. Body and Cover: Cast iron.
6. Float, Seat, and Trim: Type 316 stainless steel.
7. Working Pressure: 150 psig.
8. Size: As indicated on Shop Drawings.
9. End Connections:
    a. Size 1/2 to 3 inches: Threaded.
    b. Size 4 inches and Larger: Flanged.
10. Combination air release valves shall consist of one air and vacuum valve to permit exhaust or intake of large quantities of air during filling period or startup of pump and one air release valve to exhaust small quantities of air during pump operation.

2.7 STRAINERS

A. Manufacturers:
   1. Hayward Flow Control, or equal.

B. Description:
   1. Type: Duplex, basket.
   2. Comply with ASTM F1199.
   3. Body: Cast iron.
   4. End Connections: Flanged.
   5. Minimum Pressure Rating: 150 psig.
   6. Screen:
      a. Material: Heavy gage Type 316 stainless steel.
      b. Size: 30 mesh.
      c. Free Area: Minimum three times pipe cross-sectional area.

2.8 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00.

2.9 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

B. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field dimensions are as indicated on Shop Drawings.

B. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

C. Verify that openings are ready to receive sleeves.

D. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 inches from pipe ends and that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Thoroughly clean end connections before installation.

B. Close pipe and equipment openings with caps or plugs during installation.

C. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Install Work according to ASME B31.3.

B. Coating: Finish piping appurtenances as specified in Section 09 96 00 - Painting and Coating for service conditions.

C. Pipe Penetrations:
   1. Flashing:
      a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
      b. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
      c. Fasten flashing to drain clamp device.
   2. Sleeves:
      a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
      b. Set sleeves in position in forms and provide reinforcing around sleeves.
      c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
      d. Extend sleeves through floors 2 inch above finished floor level and calk sleeves.
      e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with stuffing insulation and calk airtight.

D. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.

E. Expansion Joints:
   1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Shop Drawings.
   2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

F. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment as indicated on Shop Drawings.

G. Backflow Preventers:
   1. Install with nameplate and test cock accessible.
   2. Install according to local code requirements.
   3. Do not install in vertical position.

H. Install insulation as specified in Section 40 42 13 - Process Piping Insulation.

I. Install pipe identification as specified in Section 40 05 53 - Identification for Process Piping.

J. Disinfection: Disinfect potable water piping as specified in Section 33 13 00 - Disinfecting of Water Utility Distribution.

3.4 FIELD QUALITY CONTROL

A. After installation, inspect for proper supports and interferences.

B. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Keep equipment interior clean as installation progresses.

END OF SECTION

SECTION 40 05 13.53
DUCTILE IRON PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ductile iron pipe and fittings.
2. Accessories.
3. Pressure gauges.

B. Related Requirements:
1. Section 09 96 00 - High-Performance Coatings.
2. Section 33 01 30.13 - Sewer and Manhole Testing
3. Section 40 05 13 - Common Work Results for Process Piping
4. Section 40 05 29 - Supports for Process Piping and Equipment
5. Section 40 05 23 - Common Work Results for Process Valves

1.2 REFERENCE STANDARDS

A. ANSI: American National Standards Institute
1. ANSI B16.1

B. ASME: American Society of Mechanical Engineers
1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B31.3 - Process Piping Design.

C. ASTM International
1. ASTM A48 - Standard Specification for Gray Iron Castings.

D. American Water Works Association
1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe.
6. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
7. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
8. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
9. AWWA C606 – Standard for Grooved and Shouldered Joints

1.3 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.

B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and materials lists.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Tools: Furnish special wrenches and other devices required for Owner to maintain fittings and appurtenances.

1.6 QUALITY ASSURANCE

A. Perform Work according to State of Michigan and municipality standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's packaging, including handling instructions.

B. Inspection: Accept piping and appurtenances on-Site. Inspect for damage.

C. Store piping and appurtenances according to manufacturer's instructions.

D. Protect piping and appurtenances from oxidation by storing off the ground.

E. All piping, coating and accessories shall be visually inspected prior to installation. Any defective piece shall be immediately removed from the Site.

1.9 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS

A. Manufacturers:
   1. Clow Water Systems
   2. Tyler Union

3. U.S. Pipe
4. American Ductile Iron Pipe

B. Piping:
   1. ANSI/AWWA C151/A21.51
   2. Wall thickness:
      a. ANSI/AWWA C150/A21.50
      b. Buried Pipe shall be ANSI/AWWA thickness class 52.
      c. Exposed Pipe shall be ANSI/AWWA thickness class 53.
   3. Cement-mortar lining:
      a. ANSI/AWWA C104/A21.4.
      b. Double thickness with seal coat.
      c. Air piping for the blowers shall be unlined.
   4. Outside Coating:
      a. Buried Service: Asphaltic; 0.04 in thick.
      b. Exposed Service: As specified in Section 09 96 00 - High-Performance Coatings.
   5. All nuts, bolts, connector rods, brackets, etc. are required to be 316 S.S. when exposed to sewage.

C. Joints:
   1. Minimum Pressure Rating: Same as that of connecting piping.
   2. Gaskets:
      a. AWWA C111/A21.11.
      b. Gaskets for the air piping for the blowers shall be Viton.
   3. Mechanical Joints:
      a. ANSI/AWWA C110/A21.10.
      b. Glands: Ductile iron with asphaltic coating.
   4. Push-on Joints:
      a. ANSI/AWWA C111/A21.11.
   5. Restrained Joints:
      a. ANSI/AWWA C111/A21.11.
   6. Flanged Joints:
      a. ANSI/AWWA C115/A21.15.
      b. ASME/ANSI B16.1-125 pound template.
         1) Flanged pipe and fitting shall not be flanged in the field.
         2) Threaded flanges shall meet current CIPRA wall thickness.

      c. Gaskets:
         1) ANSI B16.21.
         2) Ring type, 1/16” thick, compression type.
         3) Material suitable for the service intended.
      d. Galvanized hardware shall be used for flanges that are submerged or intermittently submerged.

D. Fittings:
   1. ANSI/AWWA C110/A21.10.
   2. Buried fittings shall be mechanical joint (MJ).
   3. Compact fittings:
      a. AWWA C153/A21.53
   4. Cement-mortar lining:
      a. ANSI/AWWA C104/A21.4

b. Double thickness with seal coat.

5. Outside Coating:
   a. Buried Service: Asphaltic; 0.04 in thick.
   b. Exposed Service: As specified in Section 09 96 00 - High-Performance Coatings.
6. Minimum Pressure Rating:
   a. Fittings through 12-inch: 250 psig.
   b. Fittings greater than 12-inch: 150 psig.
7. Flanged Fittings:
   a. Ductile iron or cast iron.
   b. AWWA C110
   c. ASME/ANSI B16.1-125 pound template.
8. Wall Castings/ Wall Pipes:
   a. Statically cast of cast or ductile iron.
   b. Fabricated wall pipes are not acceptable.
   c. Provide a continuous anchor flange centered on the wall for pipes 3-inch and greater.
   d. Minimum Pressure Rating:
      1) Same as connecting piping.
   e. When flanges or MJ bells are flush with the wall, they shall be tapped for studs.
   f. Lining:
      1) Same as connecting piping.
   g. Coating:
      1) Same as connecting piping.

E. Corrosion Protection Coating
   1. To be applied to buried nuts, bolts, and threaded rod including those used for mechanical and restrained joints.
   2. Manufacturers:
      a. Sanchem, Inc. – NO-OX-ID GG-2
      b. Or equal

2.2 MATERIALS

A. Materials utilized shall be suitable for the service intended.

B. Free of all defects and imperfections that might affect the serviceability of the finished product.

C. All pipe, fittings, and appurtenances shall be new. Salvaged, refurbished, or recycled materials are not acceptable.

2.3 ACCESSORIES

A. Dielectric Fittings: Provide between dissimilar metals.

B. Jackets:
   1. AWWA C105, polyethylene jacket.
   2. Jackets required only when indicated on the pipe schedule.

2.4 PRESSURE GAUGES

A. Packaged Wastewater Pumping Stations
   1. Provide Ashcroft or Trerice gauges, 4-inch stainless steel case, ring, socket and movement, liquid glycerin filled, and range as appropriate.
      a. Gauges shall be of the combination type (pressure and vacuum).
      b. Gauges shall be mounted to a stainless steel gauge isolator with Buna-N diaphragm.
   2. A shut off valve shall be provided for the gauge so it can be isolated from the system when not in use
   3. Gauges shall be graduated in feet water column and rated accuracy shall be 1 percent of full scale reading.
   4. Gauge kit shall be mounted and complete with all hoses and stainless steel fittings and shall include a shutoff valve installed in each connection to discharge piping and a three way valve to monitor either pump.

B. Pump Station With Separate Valve Vault
   1. Manufacturer: Red Valve Series 40 pressure sensor ring, or equal.
   2. Full flange design, to be retained between standard ANSI B16.1 Class 125/6.5 Class 150 pipeline flanges. Flange bolts shall pass through sensor body and flanges. The outside diameter of the sensor shall match the outside diameter of the mating flange. Face to face of the entire sensor shall be no longer than specifications MSS-SP67.
   3. Sensor shall be flow through design with flexible elastomer sensing ring around the full circumference. The elastomer sensing ring shall be rigidly clamped between metal end clover flanges, and no part of the elastomeric sensing ring shall be exposed to the external face of the sensor. There shall be no dead ends or crevices and flow passage shall make the sensor self-cleaning.
   4. The pressure sensing ring shall measure pressure for 360-degrees around the full inside circumference of the pipeline. Flexible sensing ring shall have a cavity behind the ring filled with fluid to transfer pressure to gauge. Sensor shall be manufactured in the USA.
   5. Provide Ashcroft or Trerice gauge, 4-inch stainless steel case, ring, socket and movement, liquid glycerin filled, and range as appropriate.
      a. Gauge shall be of the combination type (pressure and vacuum).
      b. Gauges shall be mounted to a stainless steel gauge isolator with Buna-N diaphragm.
   6. A shut off valve shall be provided for the gauge so it can be isolated from the system when not in use.

2.5 SOURCE QUALITY CONTROL

A. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field dimensions are as indicated on Shop Drawings.

B. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Thoroughly clean pipe and fittings before installation.

B. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 - High-Performance Coatings.
   2. Solvent-clean surfaces that are not shop primed.
   3. Prime surface as specified in Section 09 96 00 - High-Performance Coatings.

3.3 INSTALLATION

A. Buried Service:
   1. Sanitary Sewers:
      a. Install pipe as specified in Section 33 31 13 – Public Sanitary Sewerage Piping.

B. Exposed Service:
   1. Run piping straight along alignment indicated on Shop Drawings with minimum number of joints.
   2. Install according to ASME B31.3.
   3. Fittings:
      a. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
      b. Install fittings according to manufacturer's instructions.
      c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer's recommendations.
   4. Provide required upstream and downstream clearances from devices as indicated.
   5. Grooved End Pipe:
      a. Installed in accordance with manufacturer’s recommendations.
   6. Pipe Supports:
      a. Install supports as specified in Section 40 05 29 –Supports for Process Piping and Equipment

C. Make taps to ductile iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.
   1. Taps shall conform to ANSI A21.51
   2. Sidewall taps shall not be used unless approved by the Engineer.

D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

E. Pipe Drains and Air Vents:
   1. Valved drains and vents shall be installed at all low points and high points in the piping system.
   2. Air vents shall be installed at the downstream end of the piping system.
   3. Minimum size of air vents and valves shall be one inch.
   4. Minimum size of stop cocks, drain cocks, and drain valves shall be 2 inch.
   5. Drain valves shall be gate or plug valves.

6. Extend air release and drain piping to within one foot of the finished floor unless otherwise directed by the Engineer.

F. Gas Piping:
   1. All sewage gas piping shall be sloped to drain to drip traps.
   2. All gas piping shall be installed with dirt legs at equipment connections.

G. Air Piping:
   1. All low points and trapped lines shall be equipped with ½-inch drain cock, a union, or a screwed cap or plug.

H. Chemical Feed Piping:
   1. Where indicated on the Drawings or Pipe Schedule, chemical feed piping shall be completely encased in PVC pipe.

I. Flushing Connections:
   1. As detailed on the Drawings.

J. Support piping as specified in Section 40 05 29 - Supports for Process Piping and Equipment.

K. Provide expansion joints as specified in Section 40 05 13 - Common Work Results for Process Piping and pipe guides as specified in Section 40 05 29 - Supports for Process Piping and Equipment to compensate for pipe expansion due to temperature differences.

L. Field Cuts:
   1. According to pipe manufacturer's recommendations.
   2. Shall be done in a neat and workmanlike manner without damage to the pipe or coating.

M. Pipe Insulation:
   1. Piping system shall be insulated as indicated on the Drawings or Pipe Schedule.
   2. In conformance with Section 40 42 13 – Process Piping Insulation.

N. All branches, and connections shall be made using standard fittings.

O. Change in Pipe Size:
   1. Made with standard reducing fittings.

P. Finish primed surfaces according to Section 09 96 00.

Q. Install pressure sensor rings and pressure gauges in accordance with manufacturer’s instructions.
   1. Install all sensors at verified locations, in accordance with drawings, and in a manner that shall permit them to function as designed.

3.4 TOLERANCES

A. No pipe joint shall be deflected greater than the manufacturer’s published allowable angle.

3.5 FIELD QUALITY CONTROL

A. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by the Engineer. Repair damaged piping or provide new undamaged pipe.

B. Pressure Testing in accordance with Section 33 01 30.13-Sewer and Manhole Testing.

C. After installation, inspect for proper supports and interferences.

3.6 CLEANING

A. Keep pipe interior clean as installation progresses.

B. Clean pipe interior of soil, grit, loose mortar, and other debris after pipe installation.

END OF SECTION

SECTION 40 05 23
COMMON WORK RESULTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Valves.
   2. Identification for process valves.

B. Related Requirements:
   1. Section 40 05 13 - Common Work Results for Process Piping
   2. Section 40 05 23.21 - Plug Valves
   3. Section 40 05 23.24 - Check Valves
   4. Section 40 05 29 - Supports for Process Piping and Equipment

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
   3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:
   1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
   2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

D. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:
   1. Equipment Directory.

1.3 COORDINATION

A. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS

A. Product Data:
   1. Submit manufacturer data for valves.
   2. Submit valve cavitation limits.

B. Shop Drawings:
   1. Provide assembly drawings indicating parts list, materials, and size.

C. Valve-Labeling Schedule: Indicate valve locations and nametag text.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Certification of Valves Larger than 12 inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

F. Manufacturer Instructions: Submit installation instructions and special requirements.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

H. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:
   1. Furnish one set of manufacturer's recommended spare parts.

B. Tools:
   1. Furnish one operator wrench required for Owner to maintain equipment. Height to be specified by Owner/Operator during shop drawing process.

1.7 QUALITY ASSURANCE

A. Maintain clearances as indicated on Shop Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Perform Work according to State of Michigan and Municipality standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
   3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operating nut, extension stem, worm and gear operator, wrench, and other accessories as required.

B. Operation:
   1. Cast directional arrow on valve with OPEN and CLOSE cast on valve in appropriate location.

C. Valve Marking and Labeling:
   1. Provide buried valves with valve boxes, covers marked “Sewer”, and extensions to bring operating nut up within 4 inches of final grade.

D. Valve Construction:
   1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
   2. Bonnets:
      a. Bolted to body and of same material and pressure rating as body.
      b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
   3. Stems and Stem Guides:
      a. Materials and Seals: As specified in valve Sections.
      b. Bronze Valve Stems: According to ASTM B62.
      c. Space stem guides 10 feet o.c.
      d. Buried Stem Guides: Type 304 stainless steel.
   4. Nuts and Bolts: Type 304 stainless steel.

2.2 FINISHES

A. Valve Lining and Coating: Comply with AWWA C550.

B. Exposed Valves: As specified in the valve specifications.

C. Do not coat flange faces of valves unless otherwise specified.

2.3 SOURCE QUALITY CONTROL

A. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

B. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Install valves with stems upright or horizontal, not inverted.

E. Install valve in horizontal piping with the stem at or above the center of the pipe.

F. Install brass male adapters on each side of valves in copper-piped system. Solder adapters to pipe.

G. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

H. Install valves with clearance for installation of insulation and allowing access.

I. Provide access where valves and fittings are not accessible.

J. Comply with Section 40 05 29 - Supports for Process Piping and Equipment for pipe supports.

K. Valve Applications:
   1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.
   2. Install shutoff and isolation valves.
   3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.
   4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Valve Field Testing:
   1. Test for proper alignment.
   2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
   3. Engineer will witness field testing.

END OF SECTION

SECTION 40 05 23.21
PLUG VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Eccentric plug valves.

B. Related Requirement:
1. Section 40 05 23 - Common Work Results for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.
3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

B. ASTM International:
1. ASTM A536 - Standard Specification for Ductile Iron Castings.
2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. American Water Works Association:
1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.3 SUBMITTALS

A. Product Data:
1. Submit catalog information, indicating materials of construction and compliance with indicated standards.

B. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

PART 2 PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:
1. DeZurik, GA Industries, Henry Pratt, Val-Matic, or equal.

B. Description:
1. Type: Non-lubricated, eccentric.
2. Ports: Rectangular; minimum port area 80 percent of nominal pipe area.
3. Plugs:
a. Cylindrical seating surface eccentrically offset from the centerline of the plug shaft.
b. Provide drip-tight shutoff up to the valve pressure in either direction.

c. Interface between the plug face and the body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in line and under pressure.

4. Valve Seats:
   a. 1/8-inch thick raised weld-in overlay.
   b. On all body seat surfaces in contact with the plug face.
5. Stem Bearings:
   a. Replaceable sleeve type.
   b. Oil impregnated, self-lubricating.
6. Stem Seals: Grit seals on upper and lower bearing journals.
7. Packing and Gland:
   a. Accessible and externally adjustable without disassembly of valve or operator.
   b. Adjustable bolted follower.
   c. Stuffing box with sufficient depth to accept four rings of v-shaped packing.
8. End Connections: As indicated on the Drawings.

C. Operation:
1. As indicated on the Drawings or Valve Schedule.
2. Furnish gear operators for valves 8 inches and larger,
3. Furnish chainwheel operators for manually operated valves mounted over 7 feet above floor.
4. Furnish floor stands as indicated on the Drawings.

D. Materials:
1. Body: AWWA C517, cast iron, lined with elastomer as recommended by valve manufacturer for service conditions.
2. Plug: AWWA C517, cast iron, lined with NBR (Acrylonitrile-butadine).
3. Seats: 90 percent nickel.
4. Stem: Type 316 stainless steel.
5. Stem Bearings: Stainless steel.
6. Seals: PTFE (Teflon).
7. Packing: NBR (Acrylonitrile-Butadine)
8. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 23 - Common Work Results for Process Valves.

2.2 SOURCE QUALITY CONTROL

A. Valve operators shall be furnished, installed, adjusted and tested by the valve manufacturer.

B. Performance Testing:
1. Operate each valve and actuator from fully CLOSED to fully OPEN to fully CLOSED under no-flow conditions.

C. Leakage Testing:
1. Test at indicated working pressure to ensure valves are drip-tight. Test with pressure in both directions for five minutes each way.

D. Hydrostatic Testing:
1. Perform test at twice rated pressure. Test for at least one minute to ensure no leakage.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves according to AWWA C517 and as recommended by manufacturer.

B. Horizontal Piping: Install plug valves with the valve stem horizontal and the plug opening upwards.

C. Vertical Piping: Install plug valves with the plug at top when closed.

D. On lines containing solids, install plug valves with the seat upstream.

E. On lines not containing solids, install plug valve with the seat downstream.

F. Install such that plugs are on top when OPEN and on pressure side when CLOSED.

END OF SECTION

SECTION 40 05 23.24
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Swing check valves

B. Related Requirements:
   1. Section 09 96 00 - High Performance Coatings
   2. Section 40 05 23 - Common Work Results for Process Valves.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
   2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
   3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings.

B. ASTM International:
   1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. ASTM A536 - Standard Specification for Ductile Iron Castings.
   3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
   4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.
   5. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   6. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   7. ASTM D3222 - Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
   8. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

C. American Water Works Association:
   1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

1.3 SUBMITTALS

A. Product Data:
   1. Submit catalog information, indicating materials of construction and compliance with indicated standards.

B. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES

A. Manufacturers:
   1. GA Industries, APCO, Val-Matic, Crispin, or equal.

B. Description:
   1. AWWA C508.
   2. Type: Swing, resilient-seated, with outside lever and adjustable weight.
   3. Flow Area: Full open, equal to connecting nominal pipe diameter.
   4. Provide check valves 6 inches and larger with adjustable air cushion chambers.
   5. Mounting: Rated for use in horizontal or vertical position to match its installed location.
   6. End Connections: As indicated on the Drawings or Valve Schedule.
   7. Capable of passing a 3-inch solid sphere.

C. Materials:
   1. Body and Cover: ASTM A126 cast iron, or ASTM A536 ductile iron.
   2. Disc: ASTM A536 ductile iron.
   3. Seat: Field-replaceable, Type 304 stainless steel.
   4. Resilient Disk Seat: Buna-N.
   5. Chamber and Plunger: ASTM B62, bronze.
   6. Hinge Pin and Key: Stainless steel.
   7. Packing and O-Ring: Buna-N.
   8. Rubber Components: Buna-N.
   9. Connecting Hardware: Type 304 stainless steel.

D. Finishes: High strength epoxy coating from manufacturer.

2.2 SOURCE QUALITY CONTROL

A. Testing:
   1. Hydrostatically test check valves at twice rated pressure, in conformance with requirements of AWWA C508.
   2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install check valves according to AWWA C508 and as recommended by manufacturer.
   1. Verify direction of flow.
   2. Install in horizontal position with hinge pin level, per manufacturers recommendations.
   3. Install in vertical position per manufacturer’s recommendations.

END OF SECTION

SECTION 40 05 29
SUPPORTS FOR PROCESS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe supports.
   2. Structural attachments.

B. Related Requirements:
   1. Section 03 10 00 - Concrete Forming and Accessories
   2. Section 03 30 00 - Cast-in-Place Concrete
   3. Section 09 96 00 - High-Performance Coatings.
   4. Section 40 05 13 - Common Work Results for Process Piping
   5. Section 40 05 13.53 - Ductile Iron Process Piping
   6. Section 40 05 23 - Common Work Results for Process Valves

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   1. ASME B31.1 - Power Piping.
   2. ASME B31.9 - Building Services Piping.

B. ASTM International:
   1. ASTM A36 - Standard Specification for Carbon Structural Steel.
   2. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
   3. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   4. ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code Steel - Reference Manual.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation.

E. MSS: Valve and Fittings Industry, Inc. - Manufacturers Standardization Society
   1. SP-58-2002 Pipe Hangers and Supports - Materials, Design, and Manufacture.
   2. SP-69-2003 ANSI/MSS Edition Pipe Hangers and Supports - Selection and Application.
   3. SP-89-2003 Pipe Hangers and Supports -Fabrication and Installation Practices.
   4. SP-90-2000 Guidelines on Terminology for Pipe Hangers and Supports.

F. AWWA: American Water Works Association
   1. AWWA M11: Steel Water Pipe: A Guide for Design and Installation
   2. AWWA M23: PVC Pipe – Design and Installation
   3. AWWA M41: Ductile-Iron Pipe and Fittings

4. AWWA M45: Fiberglass Pipe Design
5. AWWA M55: PE Pipe- Design and Installation

1.3 COORDINATION

A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's catalog data including load capacity.

B. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX, verifying qualification within previous 12 months.

E. Design Submittals:
1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
3. Submit calculations sealed by a registered professional engineer.

F. Manufacturers' Instructions: Submit special procedures and assembly of components.

G. Qualifications Statements:
1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:
1. Furnish one set of manufacturer's recommended spare parts.

B. Tools: Furnish special wrenches and other devices required for Owner to maintain.

1.7 QUALITY ASSURANCE

A. Perform Work according to State of Michigan and municipality standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.

B. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.10 AMBIENT CONDITIONS

1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Furnish 1-year manufacturer's warranty for pipe supports.

PART 2 - PRODUCTS

2.1 PIPE SUPPORTS

A. Manufacturers:
1. Piping Technology & Products
2. Osland Piping Supply
3. Carpenter & Patterson
4. Empire Industries

B. Description:
1. Conform to MSS SP58.
2. Layout to be approved by the Engineer.
3. Provide means of vertical adjustment after erection.
4. All metal pipe supports, hangers, clamps, rods and accessories inside tanks containing water, wastewater, or sludge shall be stainless steel.

C. Performance and Design Criteria:
1. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
2. Provide linkage to permit lateral or axial movement where anticipated.
3. Adequate to maintain all piping and equipment in the correct position and alignment with due allowance for expansion and contraction with a load safety factor of 5 to 1.

4. Where horizontal pipe movement is greater than 1/2 in, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.
5. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
6. Piping shall not be supported from other piping.
7. Dissimilar Materials:
    a. Whenever pipe supports are made of dissimilar metal than the piping, they shall be plated, coated, or lined to prevent contact between the dissimilar metals.
8. Point loading hangers, chains, straps, perforated bar, or wire hangers are not acceptable.

2.2 FLOOR SUPPORTS

A. Floor Supports:
1. Adjustable saddle type with pipe riser and grouted base flange.
    a. Normal Service: wrought iron or malleable iron.
    b. Inside tanks containing water, wastewater, or sludge: Stainless steel.
2. Concrete supports shall be used when shown on the Drawings or directed by the Engineer.

2.3 VERTICAL RISER SUPPORTS

A. Vertical Riser Supports:
1. Shall consist of a combination of structural steel, pipe clamps, and a supported base elbow or tee.
2. System shall be rated for all loads imposed with a safety factor of 5 to 1.
3. Normal Service: ASTM A576, steel
4. Inside tanks containing water, wastewater, or sludge: Stainless steel.

2.4 PIPE HANGERS

A. Pipe Hangers:
1. Heavy duty.
2. Split type adjustable pipe rings and clamps.
3. Normal Service: wrought iron or malleable iron.
4. Inside tanks containing water, wastewater, or sludge: Stainless steel.

2.5 HANGER RODS

A. Hanger Rods:
1. Normal Service: ASTM A576, steel
2. Inside tanks containing water, wastewater, or sludge: Stainless steel.
3. All-thread.
4. Diameter: ASME B31.1

2.6 CLIPS

A. Clips and Hardware:
1. For supporting smaller pipes.
2. Normal Service: Similar material to the pipe.
3. Inside tanks containing water, wastewater, or sludge: Stainless steel.

4. Fastened to structural members.

2.7 STRUCTURAL ATTACHMENTS

A. Concrete Inserts
   1. Manufacturers:
      a. Piping Technology & Products
      b. Osland Piping Supply
      c. Carpenter & Patterson
      d. Unistrut U.S.
   2. Description:
      a. Shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
      b. Size inserts to suit threaded hanger rods.
      c. Normal Service: Malleable iron.
      d. Inside tanks containing water, wastewater, or sludge: Stainless steel.

B. Mounting Brackets:
   1. Normal Service: ASTM A36, welded steel.
   2. Inside tanks containing water, wastewater, or sludge: Stainless steel.

C. Beam Clamps:
   1. MSS SP-58.
   2. Clamp Size:
      a. Based on load to be supported and load configuration.
      b. Rated for the imposed load with a safety factor of 5 to 1.
   3. Bottom center type.
   4. Shall not impose an eccentric load on the beam.
   5. Normal Service: ASTM A36, welded steel.
   6. Inside tanks containing water, wastewater, or sludge: Stainless steel.

D. Riser Clamps:
   1. Normal Service: ASTM A36, welded steel.
   2. Inside tanks containing water, wastewater, or sludge: Stainless steel.
   3. Support of Copper Tubing: Provide copper-plated clamps.

E. Offset Clamps:
   1. Double leg, two-piece.
   2. Normal Service: ASTM A36, welded steel.
   3. Inside tanks containing water, wastewater, or sludge: Stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field dimensions as indicated on Shop Drawings.

3.2 INSTALLATION

A. Anchors: Stainless Steel expansion or epoxy as shown on the Drawings or directed by the Engineer.

B. Do not drill or cut structural members.

C. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in and larger.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

D. Pipe Hangers and Supports:
   1. Install according to: MSS SP 58.
   2. Support horizontal piping as indicated on Shop Drawings.
   3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
   4. Place hangers within 12 in of each horizontal elbow.
   5. Use hangers with 1-1/2 in minimum vertical adjustment.
   6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
   7. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
   8. Support riser piping independently of connected horizontal piping.
   9. Vertical Risers: Maximum spacing of structural steel supports and clamps shall be 10 feet.
   10. Provide copper-plated hangers and supports for copper piping.
   11. Design hangers for pipe movement without disengagement of supported pipe.
   12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
   13. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
   14. Use beam clamps where piping is to be suspended from building steel.
   15. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
   16. Use offset clamps where pipes are indicated as offset from wall surfaces.

E. Insulation:
   1. Provide clearance in hangers and from structure and other equipment for installation of insulation.

F. Equipment Bases and Supports:
   1. Provide housekeeping pads as detailed on Drawings or as required by the equipment manufacturer.
   2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
   3. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with Section 40 05 13 - Common Work Results for Process Piping.

G. Coatings:
   1. Conform to Section 09 96 00 – High-Performance Coatings.

END OF SECTION

SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Fifth Street Pump Station's pump control system including power disconnect, pump alternation, intrinsically safe control, lightning protection, push buttons, indicating lights, and control relays.

B. Related Sections:
1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
3. Section 26 05 83 - Wiring Connections.
4. Section 43 21 29 - Submersible Sewage Pumps

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters' Laboratories
1. UL 508 - Industrial Control Equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Sequence of Operation: Duplex Station
1. Level Control Method:
a. Primary: Submersible Pressure Transducer.
b. Secondary: Float Switch Array.
2. Operate two pumps in lead/lag mode.
3. Control pumps by individual Hand-Off-Auto selector switches located on pump control panel. Provide manual start-stop control of pumps using "hand" and "off" positions of each Hand-Off-Auto switch. Automatically control pumps in "auto" position as follows:
a. When liquid level in wet well rises to elevation of "lead pump start" setpoint, start lead pump. When lead pump is started, run pump until liquid level in wet well is drawn down to "lead pump stop" setpoint, and then shut down lead pump.
b. When lead pump cannot keep up with influent flow, liquid level in wet well rises to "lag pump start" setpoint that starts lag pump. When lag pump is started, run pump until liquid level in wet well is pumped down to "lag pump stop" setpoint and shut down lag pump, and lead pump if still running.
c. Automatically alternate lead and lag status of pumps after each pumping cycle. Provide manual selection of lead pump.
4. When liquid level in wet well rises to elevation of "wet well high level" float switch, energize "Wet Well High Level" alarm light located on pump control

panel and the secondary control method shall be activated. The secondary controls shall remain active until reset by pressing the “Alarm Reset” button.

5. When liquid level in wet well is pumped down to elevation of "wet well low level" float switch, energize "Wet Well Low Level" alarm light located on pump control panel and shut down pumps.
6. Each setpoint listed above shall have a float switch provided at the same elevation, unless otherwise indicated.
7. A two-position selector switch shall allow the operator to force the secondary control method (float switches) into primary control, deactivating the primary control (pressure transducer). The secondary control shall remain active until the selector switch is returned to its normal position.
8. When thermal switches are provided in motor windings to detect high temperature in motor, wire switch to relay located in pump control panel. Provide normally open contact on relay wired in series with pump starter, and normally closed contact on relay wired to "Motor High Temperature" alarm light located on control panel. When high temperature occurs in motor windings, shut down pump and energize high temperature alarm light.
9. When pump seal leak sensor is provided and located in pump housing, wire sensor to seal failure relay located in pump control panel. Wire normally open contact on relay to "Seal Failure" alarm light located on control panel. When seal leak occurs, energize seal failure alarm light.
10. Provide dry contacts in pump control panel for each of following:
    a. Power Failure / Phase Monitor.
    b. Pump No. 1 Motor High Temperature/Seal Failure.
    c. Pump No. 2 Motor High Temperature/Seal Failure.
    d. Wet Well Level High.
    e. Wet Well Level Low.
    f. Pump No. 1 Running.
    g. Pump No. 2 Running.
11. Wire these contacts to terminal strip in panel for wiring to SCADA Device.

1.4 SUBMITTALS

A. Shop Drawings: Submit complete bill of materials, wiring diagrams and panel layout drawings showing dimensions to devices.

B. Product Data: Submit catalog information and descriptive literature for components.

C. Test Reports: Submit certified factory test report indicating control panel successfully performs functions specified.

D. Manufacturer's Installation Instructions: Submit instructions on installation and field wiring connections.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

F. Manufacturer's Field Reports: Submit certification after installation that control panel has been installed in accordance with manufacturer's instructions and has been successfully field tested.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of control panel and final wiring diagrams and connections.

B. Operation and Maintenance Data: Submit operation and maintenance instructions for components and devices.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with UL 508.

B. Provide components compatible with functions required to form complete working system.

C. Provide UL 508 label on complete assembly.

D. Perform Work in accordance with all applicable codes and standards.

A. Maintain a minimum of one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer and Fabricator: Company specializing in manufacturing and assembling products specified in this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspect for damage.

B. Store in areas protected from weather, moisture, or possible damage; do not store directly on ground; handle to prevent damage to wiring and components.

1.10 COORDINATION

A. Coordinate work and component requirements with controlled pumps.

1.11 EXTRA MATERIALS

A. Furnish the following spare parts:
   1. 1 pilot light assembly for each type utilized.
   2. 1 24-volt DC power supply for each size utilized.
   3. 4 fuses for each type and size utilized.
   4. 1 general purpose relay for each type utilized.
   5. 1 intrinsically safe relay of each type utilized.
   6. 1 intrinsically safe barrier of each type utilized.

PART 2 - PRODUCTS

2.1 PUMP CONTROL PANEL

A. Manufacturers:
1. Kennedy Industries.
2. Primex.
3. StaCon.
4. PumpCon.
5. USEMCO.

2.2 COMPONENTS

A. Control Panel Enclosure:
1. Furnish NEMA 250, Type 4X, Stainless Steel enclosure fabricated of 10 gage steel with continuously welded seams.
a. Enclosure door gasketed with neoprene.
b. Heavy-duty three-point latching mechanism.
c. Power: 277/480 volt, 3 phase service.
2. Identify control panel components with engraved nameplate mounted on inside of panel.
3. Mount components, not mounted on front of panel, on removable back panel secured to enclosure with collar studs.
4. Install wiring in neat, workmanlike manner and group, bundle, support and route horizontally and vertically for neat appearance.
5. Terminate wires leaving panel at terminal strips inside enclosure.
6. Identify terminals and wires in accordance with panel wiring diagrams.
7. Furnish copper grounding plate inside control panel for terminating ground wires.
8. All enclosure penetrations from underground conduits, or other conduits connected to underground locations (such as Wet Wells, Valve Vaults, Metering Pits) shall be sealed to create a vapor-tight transition.

B. Transient Voltage Surge Suppressor: Furnish three phase transient voltage surge suppressor, mounted to exterior of pump control panel, to protect panel components from potential damage from transient voltages caused by lightning or surges on incoming power line. Furnish indication light to indicate unit is functioning.

C. Phase Monitor:
1. Furnish phase monitor in pump control panel to monitor incoming power and sense loss of any phase(s).
a. Voltage and Phase Configuration shall match incoming electrical service.
b. Inhibit pump operation when phase loss occurs.
c. Surface mounted.

D. Motor Circuit Protector Type Circuit Breakers:
1. Furnish properly sized motor circuit protector type molded case circuit breaker for each pump motor starter.
a. Type: Quick-make, quick-break, individually mounted.
b. Minimum Interrupting Capacity: 22,000 amperes rms symmetrical at 240 volts.

E. Pump Motor Starters:
   1. Furnish across-the-line magnetic type rated in accordance with NEMA standards, sizes and horsepower ratings. Size for pump motor horsepower.
   2. Furnish each motor starter with three pole overload relay. Furnish heater element in each phase of relay, sized for motor nameplate full load amps.
   3. Furnish overload reset button for each motor starter.

F. Control Transformer:
   1. Furnish 480 volt to 120/240 volt control transformer in pump control panel to provide 120 VAC control power. Size transformer to power connected devices and protect with primary and secondary fusing.

G. Circuit Breakers:
   1. Furnish quick-make, quick-break thermal-magnetic molded case type, individually mounted and identified.
   2. Furnish individual circuit breakers as indicated on Drawings.

H. Selector Switches:
   1. NEMA Type 4X, 30.5 mm, heavy-duty, non-illuminated, maintained contact type with double-break silver contacts.
   2. Substituting Selector Switches with objects on a graphical interface (ie. Touchscreen or computer screen) shall only be allowed when given prior approval by engineer and owner.

I. Push Buttons:
   1. NEMA Type 4X, 30.5 mm, heavy-duty, non-illuminated, momentary contact type with double-break silver contacts.
   2. Substituting Push Buttons with objects on a graphical interface (ie. Touchscreen or computer screen) shall only be allowed when given prior approval by engineer and owner.

J. Pilot Lights:
   1. NEMA Type 4X, 30.5 mm, heavy-duty, transformer type.
      a. Voltage Rating: Match control voltage.
      b. Color Caps: Green for "run" and red for "alarm."
   2. Furnish "run" pilot light for each pump. Energize each light through auxiliary contact on pump motor starter.
   3. Furnish "motor high temperature" and "seal failure" alarm pilot light for each pump.
   4. Furnish wet well "high level" and "low level" alarm pilot lights.
   5. Substituting Pilot Lights with objects on a graphical interface (ie. Touchscreen or computer screen) shall only be allowed when given prior approval by engineer and owner.

K. Legend Plates for Pilot Devices:
   1. Furnish 2-1/4 inch (60 mm) square plastic legend plate for each selector switch, push button and pilot light.
   2. Color: Gray with white lettering.

L. Relays:
   1. Heavy-duty, general purpose type, with 10 amp contacts.

a. Blade type terminals that plug-in to socket.
b. DIN rail mounted to inside of panel enclosure.
c. Contact Configuration: As required for proper operation of control logic.
d. Operating Power: As required to match voltage of control signals.
e. Furnish indicator light to indicate relay coil is energized.

M. Alternator:
1. Solid state, plug-in type, with coil matching control voltage and 10 amp contacts.
a. Furnish alternator relay plugged into socket, mounted to inside of panel enclosure.
b. SPDT, suitable for continuous operation, and furnished with integral selector switch to allow operator to select automatic alternation of pumps or to select Pump No. 1 or Pump No. 2 as lead pump.

N. Seal Failure Relays:
1. Provide seal failure relay in pump control panel for each pump. Coordinate seal failure relays with controlled pump.

O. Intrinsically Safe Relays:
1. Furnish intrinsically safe relay in pump control panel for each wet well float switch.

P. Intrinsically Safe Barriers:
1. Furnish intrinsically safe barrier in pump control panel for each submersible pressure transducer in wet well.

Q. Elapsed Time Meters:
1. Resettable, time totalizer type.
a. Furnish synchronous motor to drive set of digit readout wheels to indicate total time pump motor starter is energized.
b. Readout: Six-digit including 1/10 digit.
c. Range: 0 to 99999.9 hours.
d. Voltage Rating: Match control voltage.
2. Furnish elapsed time meter for each pump. Energize each elapsed time meter through auxiliary contact on pump motor starter.
3. Substituting Elapsed Time Meters with objects on a graphical interface (ie. Touchscreen or computer screen) shall only be allowed when given prior approval by engineer and owner.

R. Terminal Blocks:
1. Furnish terminal blocks in control panel for field wiring.
a. NEMA type, rated for 600 volts AC.
b. Identify with permanent machine printed marking in accordance with terminal numbers shown on panel wiring diagrams.
c. Furnish twenty five percent spare terminal blocks in control panel for each voltage and configuration utilized.

S. Wiring:
1. Furnish pump control panel completely wired by manufacturer.

2. Furnish wiring, workmanship, and schematic wiring diagrams in compliance with UL 508. Isolate wiring and terminal blocks by voltage levels to greatest extent possible.
3. Wiring: Stranded copper, Type MTW or THW, 600 volts, color coded as follows:
    a. Line and Load Circuits, AC Power: Black.
    b. AC Control Circuit Less than Line Voltage: Red.
    c. DC Control Circuit: Blue.
    d. Interlock Control Circuits from External Source: Yellow.
    e. Equipment Grounding Conductor: Green.
    f. Current Carrying Ground: White.
4. Minimum Size of Control Wiring: Number 16.
5. Tag control wiring at both ends in control panel with legible permanent coded wire marking sleeve. Mark with white embossed adhesive tape with machine printed black marking. Mark in accordance with wire numbers shown on control wiring diagrams and terminal strip numbers.

T. Nameplates:
1. Furnish laminated phenolic nameplates on front of pump control panel.
2. Color: White with black engraved letters.
3. Minimum Size of Engraving: 1/4 inch (6 mm).

U. Environmental Condition Management:
1. Furnish anti-condensation heater with adjustable temperature switch to prevent moisture formation and maintain temperature above 35 degrees Fahrenheit within enclosure.
2. Furnish cooling fan with adjustable temperature switch to maintain safe operational temperatures within enclosure.
3. Furnish inhibiting measures to prevent rust and corrosion within enclosure.

V. Supervisory Control And Data Acquisition (SCADA) Device:
1. Furnish a remote monitoring and alarming SCADA device.
    a. Mission Communications, MyDro 150 or approved equal.
2. SCADA Device shall utilize cellular communications via Verizon Wireless.
3. Power:
    a. Primary: 12 vac, supplied by 120 vac to 12 vac Control Transformer.
    b. Backup: 12 vdc Battery Backup. Minimum uptime of 24 hours upon power failure.
    c. Auxiliary: 12-24 vdc power shall be available to power Analog Devices.
4. All I/O Points shall be Hard-Wired to SCADA Device, or expansion module(s), without the requirement of a Local Network Connection to an external devices such as a PLC (Programmable Logic Controller).
5. I/O Requirements, Minimum:
    a. 8 Discrete Inputs. Dry Contact Type with built-in circuit Fault Monitoring.
    b. 3 Relay Outputs. Form C Type.
    c. 2 Analog Inputs: Configurable for 4-20mA or 0-10 VDC.
    d. High Speed “Pulse” Counters: Available via expansion modules.
    e. Additional I/O of each type shall be available via expansion modules.
6. Local Network Communications shall be available via built-in RJ45 port. Communication protocols must include Ethernet/IP and MODBUS.

7. SCADA Device shall automatically record the status of all I/O points, control power, backup battery, and enclosure temperature. All recorded data shall automatically save backup records to a cloud server, managed by service provider.
8. SCADA Device shall include a local touchscreen operator interface. Interface shall allow the operator to view the current status of all available recorded data. Operator shall be able to temporarily place device offline and/or change device configurations upon use of access key provided by SCADA Device manufacturer.
9. Operator shall have remote access to SCADA Device(s) via Web Browser, Mobile Web Browser, and Smart Device App (Apple and Android). Remote access shall require a Login and Password.
10. SCADA Device shall have a built-in MicroSD card reader for Firmware/Software Configuration updates and saving capabilities.
11. Contractor shall pre-pay the first year of active service for SCADA Device.

2.3 LIQUID LEVEL CONTROL SYSTEM

A. Furnish liquid level control system to monitor wet well level and start and stop pump motors in response to changes in wet well level as set forth herein.

B. Initiate pump controls (low water level alarm, pump off, lead pump start, lag pump start, and high water level alarm) by level transmitter and individual float switches.

C. Submersible Pressure Transducer: Section 40 72 43 - Level Meters:
1. Furnish one submersible pressure transducer in wet well.
2. Furnish transducer with individual weight and corrosion resistant strain-relief clamp for mounting on 316 stainless steel J-Hook bracket.

D. Float Switches: Section 40 72 76 - Level Switches:
1. Furnish five float switches in wet well.
    a. Type: Single pole, double throw, mechanical switch in corrosion resistant polypropylene housing.
    b. Furnish each float switch with individual weight and corrosion resistant strain-relief clamp for mounting on 316 stainless steel J-Hook bracket.

E. Furnish stainless steel bracket for supporting transducer and float switches.

2.4 SOURCE QUALITY CONTROL AND TESTS

A. Perform a factory test of completed control panel by demonstrating operation of control functions. Provide certified test results.

B. Factory assemble and test each control and alarm function.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify correct power supply is available.

B. Verify pumps are installed.

3.2 INSTALLATION

A. Install control panel at location indicated on Drawings.

B. Install control panel in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Start-up pump control system by energizing system equipment and testing operation of hardware and process control logic under supervision of manufacturer's representative and in presence of Architect/Engineer.

B. Equipment Acceptance:
   1. Adjust, repair, modify or replace system components that fail to perform as specified and rerun tests. Make final adjustments to equipment under direction of manufacturer's representative.
   2. Document adjustments, repairs and replacements in manufacturer's field services certification.

3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish services of manufacturer's representative experienced in installation of products furnished under this specification for not less than 2 work days on-site for installation inspection and field testing, and instructing Owner's personnel in maintenance of equipment.

B. Certify that equipment has been properly installed and is ready for start-up and testing.

3.5 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 72 23
RADAR LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Radar-level measurement devices.
   2. Transmitters.

B. Related Requirements:
   1. Section 26 05 83 - Equipment Wiring Connections: Control power wiring requirements.

1.2 REFERENCE STANDARDS

A. International Electrotechnical Commission:
   1. IEC 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems.
   2. IEC 61511 - Corrigendum 1 - Functional safety - Safety instrumented systems for the process industry sector.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with Site Work.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of shop and factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

H. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work according to all applicable codes and standards.

D. Maintain one copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish 5-year manufacturer's warranty for radar-level measurement devices.

PART 2 - PRODUCTS

2.1 RADAR-LEVEL MEASUREMENT DEVICES

A. Manufacturers:
   1. Vega, Model VEGAPULS WL61
   2. Substitutions: Not Accepted.

B. Description:
   1. Measuring Range: Minimum of 60 feet.
   2. Operating Temperature Range: Minus 40 to plus 150 degrees F.
   3. Operating Pressure: Up to 23 psig.
   4. Accuracy: Plus or minus 0.4 inch.
   5. Certified according to IEC 61508 and IEC 61511.

C. Communications Protocol: HART.
   1. External communication devices will NOT be required for product setup or configuration.

D. Operation: Menu guided.
   1. All device settings and functions shall be configurable via local display using pushbuttons and/or turn-dials.

E. Transmitters:
   1. Selected by sensor manufacturer to match sensor.
   2. Visual Display: Alphanumeric.
      a. Four digit, Minimum.
      b. LED or Backlit LCD.
   3. Output Signal: 4 to 20-mA dc.
   4. Location: As indicated on Drawings.
   5. Control Power:
      a. Wiring: As specified in Section 26 05 83 - Equipment Wiring Connections.
      b. 24-V DC, Loop Powered.
   6. Enclosures: NEMA 250 Type 4, 4X, or as indicated on Drawings.
   7. Mounting:
      a. Remote.
      b. Enclosure.
   8. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

C. Installation Standards: Install Work according to all applicable codes and standards.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 hours (per Device) on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

D. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 72 43
PRESSURE TYPE LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hydrostatic-level measurement devices.
2. Transmitters.

1.2 REFERENCE STANDARDS

A. International Electrotechnical Commission:
1. IEC 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems.
2. IEC 61511 - Corrigendum 1 - Functional safety - Safety instrumented systems for the process industry sector.

B. NSF International:
1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with wet well work.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

B. Shop Drawings:
1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of shop and factory tests and inspections.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

G. Qualifications Statement:
1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

C. Perform Work according to all applicable State and Local Codes and standards.

D. Maintain one copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Furnish **5-year** manufacturer's warranty for hydrostatic level measurement devices.

PART 2 - PRODUCTS

2.1 HYDROSTATIC-LEVEL MEASUREMENT DEVICES

A. Manufacturers:
   1. Endress+Hauser
   2. Siemens
   3. KPSI

B. Sensor:
   1. Description: Pressure sensor, condensate proofed and long-term stable, and incorporating continuous temperature and pressure compensation.
   2. Turndown: 100:1
   3. Certified according to IEC 61508 and IEC 61511.
   4. Measuring Cell:

a. Hermetically sealed.
b. Material: Ceramic.
c. Accuracy: Plus or minus 0.2 percent.
d. Furnish pressure overload resistance to 200 percent of full scale nominal pressure.

C. Range: 0-5 psi.

D. Signal: 4-20mA.

E. Communications Protocol: HART.

F. Operation: Menu guided.

2.2 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 4 hours on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

B. Equipment Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

C. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 72 76
LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Mercury-type level switches.
2. Mechanical-type level switches.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA ICS 1 - Industrial Control and Systems: General Requirements.

B. NSF International:
1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with wet well Work.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

B. Shop Drawings:
1. Indicate system materials and component equipment.
2. Submit installation requirements and other details.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Qualifications Statement:
1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Comply with NSF 61 and NSF 372.

C. Perform Work according to all applicable State and Local Codes and standards.

D. Maintain one copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY

A. Furnish **5-year** manufacturer's warranty for level switches.

PART 2 - PRODUCTS

2.1 LEVEL SWITCHES

A. Mercury-Float Type:
   1. Manufacturers:
      a. Conery Manufacturing
      b. Magnetrol.
      c. Omega Engineering, Inc.
      d. SJE Rhombus.
   2. Switch Description: One normally open (NO) mercury switch.
   3. Relays: Intrinsically safe.
   4. Float Casing: Polypropylene.
   5. Housing: NEMA 250, Type 4X.
   6. Mounting:
      a. Wall bracket.
      b. Rods: Galvanized steel.
      c. Bolts: Stainless steel.
   7. Cable: Oil-resistant thermoplastic.
   8. Rated Voltage: 600 V.

B. Mechanical-Float Type:
   1. Manufacturers:

a. Conery Manufacturing
b. Magnetrol.
c. Omega Engineering, Inc.
d. SJE Rhombus.

2. Contacts: One normally open (NO), one normally closed (NC).
3. Relays: Intrinsically safe.
4. Float Casing: Polypropylene.
5. Housing: NEMA 250, Type 4X.
6. Mounting:
   a. Wall bracket.
   b. Rods: Galvanized steel.
   c. Bolts: Stainless steel.
7. Cable: Oil-resistant thermoplastic.
8. Rated Voltage: 600 V.

C. Operation:
1. Control Power Wiring: As specified in Section 26 05 83 - Wiring Connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of level probe assemblies with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 4 hours on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

B. Equipment Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

C. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 91 23.33
FLOW PROCESS MEASUREMENT DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Magnetic flow meters.
   2. Open-channel laser flow meters.

B. Related Requirements:
   1. Section 33 05 13 – Manholes and Structures
   2. Section 33 32 16 – Packaged Utility Wastewater Pumping Stations

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
   2. ASME PTC 19.5 - Flow Measurement.

B. ASTM International:
   1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.

C. American Water Works Association:
   1. AWWA C704 - Propeller-Type Meters for Waterworks Applications.
   2. AWWA Manual M6 - Water Meters-Selection, Installation, Testing, And Maintenance.

D. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. National Sanitation Foundation:
   1. NSF Standard 61 - Drinking Water System Components - Health Effects.
   2. NSF Standard 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Coordinate Work of this Section with process piping.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's Product Data for system materials and component equipment, including connection requirements.

B. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

F. Manufacturer Reports:
   1. Certify that equipment has been installed according to manufacturer's instructions.
   2. Indicate activities on Site, adverse findings, and recommendations.

G. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:
   1. Furnish one set of manufacturer's recommended spare parts.

B. Tools: Furnish special wrenches and other devices required for Owner to maintain devices.

1.7 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Perform Work according to State of Michigan and municipality standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept equipment on Site in manufacturer's original packaging and inspect for damage.

B. Store equipment according to manufacturer's instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from areas involved in construction operations.
   2. Provide additional protection according to manufacturer's instructions.

PART 2 PRODUCTS

2.1 DESCRIPTION

A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, interconnecting cables, and unit conversions and algorithms as required for application.

2.2 MAGNETIC FLOW METERS

A. Manufacturers:
   1. ABB.
   2. Toshiba
   3. Emerson/Rosemount.
   4. Krohne America, Inc.
   5. Sparling Instruments, LLC.

B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.

C. Flow Rate Range: As specified on the Drawings and in Section 33 32 16.

D. Size: As specified on the Drawings and in Section 33 32 16.

E. Flow Tubes:
   1. Material: Type 304 stainless steel, with polyurethane liner.
   2. End Connections:
      a. Flanged, ASME B16.1, carbon steel.

F. Electrodes:
   1. Hastelloy-C.
   2. Self-cleaning.

G. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.

H. Provide adjustment for zero and span.

I. Accessories:
   1. Provide automatic, non-mechanical electrode cleaning system without taking meter out of service.
   2. Furnish cable between the transmitter and receiver.
   3. Provide flanged spool piece equal to the lay length of the meter.
   4. Grounding ring kit.

2.3 TRANSMITTERS

A. Transmitter Output:
   1. 4 to 20 mA dc analog signal.
   2. Accuracy: Plus or minus 0.5 percent of full scale.

B. Housing Material: Cast aluminum.

C. HMI:
   1. Touch-screen programming, functioning through enclosure window without opening enclosure.
   2. Display:
      a. Size: Four lines by 16 characters.
      b. Type: Backlit LCD.
      c. User-selectable engineering units.
      d. Readout of diagnostic error messages.
      e. Totalizer.
      f. Flow Rate.

D. Accessories:
   1. Current signal output simulation.
   2. Empty pipe detection.
   3. Self-diagnostics.
   4. Automatic zero adjustment.
   5. Stainless-steel sunshield.
   6. Signal Cable: Provided by flow meter manufacturer.

2.4 OPERATION

A. Control Power:
   1. Wiring: As specified by manufacturer.
   2. 120 V ac, single phase, 60 Hz.
   3. Furnish local transformers as required.

B. Enclosures: NEMA 4.

2.5 OPEN CHANNEL LASER FLOW METERS

A. Manufacturers:
   1. Teledyne ISCO, Hach, or equal.

B. Basis of Specification:
   1. Teledyne ISCO Signature® Flow Meter Module with LaserFlow 360 Meter
   2. Manufacturer/Contractor to also provide the following for a complete functioning system:
      a. Totalizer.
      b. USB adaptor cable.
      c. All required battery power source(s).
      d. Sensor retrieval arm tool for removing/re-installing flow meter when not in use.
      e. Stainless steel permanent mounting hardware for manhole installation.
      f. Stainless steel hanger hardware mounted inside manhole for suspending module.

C. The open channel flow monitoring system shall be suitable for installations for enforcement, compliance, and process control.

D. The flow meter shall be able to utilize multiple flow and parameter sensing technologies simultaneously.
   1. Device options for flow measurement technology will include downward looking ultrasonic level measurement, non-contact laser area velocity, and submerged Doppler ultrasonic area velocity.

2. Device options for parameter sensing will include a pH/temperature sensor.
3. The flow meter shall be capable of running up to 9 connected devices simultaneously.

E. The flow meter shall be capable of interfacing with an optional wastewater sampler by means of an optional device. Via the interface device, the flow meter shall be capable of enabling and pacing the sampler based on multiple preprogrammed conditions, as well as receiving sampling data from the sampler.

F. The flow meter shall accept device data from up to two connected devices.

G. The flow meter shall be able to record and transmit data from connected monitoring equipment.

H. The flow meter shall be able to track event data that cannot be altered, in order to ensure that data integrity has not been compromised.

I. The flow meter shall have optional 4-20mA output capability by means of field-installable card(s).

J. The flow meter shall optionally provide field-installable cellular communication for remote communication without physically visiting the monitoring site, for alarm notification, and for transmission of data to a central server.
1. The flow meter shall be capable of remote configuration and data transmission via a dedicated web browser that duplicates flow meter menu and keypad operation.

K. Flow Meter Construction
1. The flow meter electronics and connections will be housed in a PPO Polyphenylene Oxide, Noryl, NEMA4X/IP66, lockable enclosure suitable for conduit connection.
2. Basic construction will consist of a two-piece electronics enclosure, front panel, and door.
3. The enclosure door will have a clear polycarbonate window for viewing the LCD, optional mechanical totalizer, and LED indicator without opening the door.
4. Connections will be accessible for addition and removal of optional devices by unlatching the door and then opening the front panel on the enclosure.
5. The flow meter shall include a stainless steel bracket for wall mounting, and shall also be suitable for mounting on a rack or inside a console enclosure.
6. Operating and storage temperature shall be -20 to 60°C (-4 to 140°F).
7. The flow meter's primary user interface shall include a tactile keypad with audible feedback, and 4-inch, 320x240, backlit liquid crystal display with graphing functionality.
8. The flow meter will have a two-color LED indicator next to the display to indicate activated alarms/events.
9. The flow meter shall optionally include a 7-digit, non-resettable, electromechanical totalizer that can be removed or installed in the field.
10. Input power shall be nominal 12VDC.
    a. The flow meter's internal mains power supply will operate on 100VAC,50/60Hz or 240VAC,50/60Hz line power.
    b. The flow meter shall have the provision to be powered by an external 12VDC source.
    c. The flow meter shall have the option for external, uninterrupted battery backup power lasting a minimum of 4 hours.

d. The power circuit shall include trickle charge for a connected rechargeable lead acid battery.

11. Device connection(s) shall be performed by wiring to easily accessible terminal strips and following simple instructions printed on the circuit board assembly.
    a. The flow meter shall provide nominal 12VDC output power to connected devices.

L. Flow Meter Functionality
1. Communication and User Interface
    a. Primary programming will be directly through the tactile keypad and programming menus on the front panel of the flow meter.
    b. Provide internal GSM or CDMA cellular modem or Ethernet modem to provide capability for future remote communication for configuration and programming, data access, and alarm notifications.
    c. Alarm status/events shall be indicated by the LED next to the display. Detailed information about the alarm/event(s) indicated will be accessed by pressing a key on the keypad.
    d. Manufacturer software shall be able to retrieve stored data from the flow meter, and generate graphs and reports from stored data.
    e. Direct serial connection to a computer or USB flash drive will be through a micro A/B USB port located on the front panel of the flow meter.
        1) Updates to the flow meter and optional device software will be performed by connecting a USB flash drive to the flow meter.
        2) The flow meter's program can be downloaded onto the connected flash drive. The saved program can then be duplicated onto other Signature flow meters via the flash drive.
        3) Data shall be exported from the flow meter in .ddp format to a USB flash drive.
        4) Verifiable text reports shall be exported from the flow meter to a USB flash drive.
        5) The flow meter shall include an adaptor for connecting a USB flash drive.
        6) The flow meter shall optionally include an adaptor cable for connecting to the USB port on a computer.
    f. Direct I.P. interface for local area network access will be through an internal Ethernet connection.
2. Outputs
    a. The flow meter shall be able to activate an optional connected sampler based on multiple user-selected trigger conditions.
    b. The flow meter shall optionally provide industry standard 4-20 mA analog output via a factory- or field-installed internal card, and shall accept up to three such cards, allowing for up to six outputs.
        1) Output range shall be from 4 to 20 mA.
        2) Isolation will be monolithic air core transformer technology.
        3) Maximum load shall be 500Ω.
    c. The flow meter shall act as a slave for Modbus interfacing via RS-485 terminal strip connection, using ASCII or RTU transmission coding.
3. Inputs
    a. The following data shall be received by the flow meter from an optional connected sampler.
        1) Sample event
        2) Bottle number
        3) Sampler voltage

b. The flow meter shall record flow and parameter data from optional connected devices.
c. The flow meter shall record parameter data from up to two optional connected SDI-12 devices.
d. The flow meter shall be capable of separate, simultaneous interfacing with multiple connected devices of the same type, i.e., one or more sampler interfaces, one or more pH/Temperature devices, etc.
e. The flow meter shall be capable of accepting inputs from multiple external devices via optional expansion box(es). For every expansion box, three more devices can be added to the system.

4. Data Storage
   a. The flow meter will store recorded data and program settings on a recoverable, flash-based, secure, non-volatile digital memory card with standard 8M capacity
      1) Interval: 15 or 30 seconds; 1, 2, 5, 15, or 30 minutes; or 1, 2, 4, 12, or 24 hours.
      2) Capacity: 180 days with 5 parameters logged at 1-minute intervals and reports at 24-hour intervals.
   b. The program memory shall be capable of being updated via the USB port on the flow meter without opening the enclosure.
5. Data Integrity
   a. The flow meter shall be capable of collecting and storing event data that cannot be altered, to ensure that data integrity has not been compromised. Event types shall be:
      1) Program Report - Tracks configuration changes to the flow meter.
      2) Two programmable Summary Reports - Tracks measurement summaries.
      3) Diagnostic Report - Tracks occurrences and results from diagnostic tests.
      4) History Report - Tracks user events (such as calibration, etc.)
6. Flow Measurement Options
   a. Ultrasonic: Non-Contact Level Sensor
   b. Area Velocity: Non-Contact Laser Sensor
   c. Area Velocity: Submerged Doppler Ultrasonic Sensor
7. Level-to-Flow Calculation
   a. Measured liquid level readings shall be converted into corresponding flow rate readings using internal conversion algorithms. The flow meter shall contain conversions for V-notch, rectangular and Cipolletti weirs, and Parshall, Palmer-Bowlus, trapezoidal, and H flumes. The flow meter shall accept up to 4 sets of level-flow rate points, with up to 50 pairs of points in each set. The flow meter shall accept a user-defined, one- or two-term, level-flow rate polynomial equation.
8. Level-to-Area Calculation
   a. Measured liquid level readings shall be converted into the area of the flow using internal conversion algorithms. The flow meter shall contain conversion information for round, U-shaped, rectangular trapezoidal and elliptical channels. The flow meter shall accept a silt level measurement and adjust the area of the flow appropriately. The flow meter shall also accept up to 50 pairs of level-area points.

2.6 SOURCE QUALITY CONTROL

A. Provide shop inspection and testing of meters according to AWWA Manual M6.

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

A. Coordinate location and orientation of flow meter with final equipment installations.

B. Ensure that instruments are located to be easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL

A. Testing:
   1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.
   2. Comply with AWWA Manual M6.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 4 hours on Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

C. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Manufacturer’s representative shall demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 43 05 20
COMMON WORK RESULTS FOR LIQUID HANDLING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Lubrication.
2. Pump piping, fittings, and valves.
3. Piping connections.
4. Shaft coupling guards.
5. Accessories.

B. Related Requirements:
1. Section 40 05 13 - Common Work Results for Process Piping: Execution requirements for piping specified by this Section.
2. Section 40 05 13.53 – Ductile Iron Process Piping: Ductile iron piping materials and appurtenances.
3. Section 40 05 23 - Common Work Results for Process Valves: Execution requirements for valves specified by this Section.
4. Section 40 05 23.21 - Plug Valves: Execution requirements for plug valves as required by this Section.
5. Section 40 05 23.24 - Check Valves: Execution requirements for check valves as required by this Section.
6. Section 40 05 29 - Supports for Process Piping and Equipment: Anchors, sleeves, and sealing of piping to adjacent structures.
7. Section 43 21 39 - Submersible Pumps: Submersible pumps and accessories.

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
2. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
3. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

B. NSF International:
1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

C. Occupational Safety and Health Administration (OSHA):
1. 29 CFR 1910 - Occupational Safety and Health Standards.

1.3 COORDINATION

A. Coordinate Work of this Section with location and placement of utilities and piping.

1.4 SUBMITTALS

A. See individual specification equipment Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.6 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide pumping systems designed and constructed for continuous service within specified range of operation, without overheating, cavitation, or excessive vibration.

2.2 LUBRICATION

A. Water-Lubricated Pumps: Provide flow meter and differential pressure switch to de-energize pumping unit in low-water-flow conditions.

B. Ball Bearings and Roller Bearing: Lubricate materials as recommended by pump manufacturer.

C. Lubrication Equipment: Provide pumps, piping, tankage, and filters as required to supply lubrication to pumping units.

2.3 PUMP PIPING, FITTINGS, AND VALVES

A. For piping, fittings, and valves furnished with pumps, comply with relevant Section referenced in this Section under "Related Requirements" Paragraph.

2.4 PIPING CONNECTIONS

A. Flanges:
   1. Comply with ASME B16.1.

B. Fasteners:
   1. Stainless Steel Fasteners.

C. Screwed Fittings: Comply with ASME B1.20.1.

2.5 SHAFT COUPLING GUARDS

A. Comply with OSHA requirements.

2.6 FINISHES

A. As specified in Section 43 21 39 – Submersible Sewage Pumps.

2.7 ACCESSORIES

A. Nameplates:
   1. Identify individual pumps with a stainless-steel nameplate, indicating assigned equipment number, serial number, rated head and flow rate, impeller size, speed, and manufacturer's name and model number.

2.8 SOURCE QUALITY CONTROL

A. Drive Units:
   1. Test electric drive motors and furnish test results to pump manufacturer prior to pump testing.

B. Hydrostatic Testing:
   1. Hydrostatically test each pump.
   2. Provide Architect/Engineer minimum two weeks' notification prior to testing.
   3. Tests of pumps of same model, speed, head, and capacity rating are acceptable if drive unit is rated at 5 hp or less.
   4. Perform witnessed hydrostatic and performance tests on pumps where specified and on pumping systems rated at 125 hp or greater.
   5. Test Pressure:
      a. Centrifugal Pumps: Minimum 150 percent of shutoff head.
      b. Positive Displacement Pumps: Minimum 150 percent of maximum head.

C. Performance Testing (Non-positive-displacement Pumps):
   1. Test over entire operating range of pump; obtain measurements of head, flow rate, power demand, NPSH required, and pump efficiency.
   2. Obtain measurements of head, maximum and minimum flow rates, power demand, and overall efficiency at design.
   3. For variable-frequency-driven pumps, test pumps at intervals of 100 rpm from minimum to maximum speed.
   4. Demonstrate that pump is free from overheating, cavitation, and excessive vibration over flow rate range.
   5. For centrifugal pumps, demonstrate no contact between impeller ring and casing ring over flow rate range.

D. Performance Testing (Positive-Displacement Pumps):

1. Operate pump at least 30 minutes for each specified speed and capacity to demonstrate compliance with specified requirements and to establish that pumping unit is free from overheating and excess vibration.
2. Test pump at maximum rated speed and at minimum, rated, and maximum flow rates, and measure respective head and ampere draw.
3. For pumps with drive unit rated at 5 hp or less, test only for excess current draw.

E. Drive Units:
1. Perform tests using complete pump system to be furnished, including Project motor and variable-frequency drive, if specified.
2. For pumps with motors rated less than 100 hp, manufacturer's certified test motor is acceptable.

F. NPSH:
1. Perform test of NPSH required as required by specific pump Section.

G. Do not ship equipment until test data have been accepted by Architect/Engineer.

H. Include one or both of following Paragraphs to require Owner's inspection or witnessing of test at factory.

I. Owner Inspection:
1. Make completed pumping system available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

J. Owner Witnessing:
1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

K. Certificate of Compliance:
1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

3.2 PREPARATION

A. Disconnect electrical systems scheduled for removal.

B. Provide temporary wiring and connections to maintain existing systems in service during construction.

C. Remove, relocate, and extend existing installations as necessary to accommodate new construction.

3.3 INSTALLATION

A. According to manufacturer instructions.

B. Ensure that equipment is secure in position.

C. Equipment Bases and Supports:
   1. Install anchor bolts and accessories for mounting and anchoring equipment.
   2. Supports:
      a. Provide stainless pipe supports.
      b. Brace and fasten with flanges bolted to equipment structure.
      c. Provide flexible connections as required to isolate equipment from piping.
   3. Gauges:
      a. Provide pressure gages at pump discharge piping as shown on the Drawings.
   4. If subject to shock or vibrations, wall-mount gages or attach gages to galvanized channel floor stands and connect with flexible connectors.

D. Lubricants: Provide necessary oil and grease for initial operation.

E. Coat materials and equipment as specified in individual specification Sections.

3.4 FIELD QUALITY CONTROL

A. Testing:
   1. Test for proper alignment and freedom from binding, scraping, shaft runout, or other defects.
   2. Where specified by individual Specification Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
   3. Engineer will witness field testing.
   4. Start control system by energizing system equipment and testing operation of hardware and process control logic under supervision of manufacturer's representative and in presence of Engineer.
   5. Field-test each pump system after installation in order to demonstrate:
      a. Satisfactory operation without excessive noise and vibration over flow rate range; if pump driven by variable-frequency drive, test at 100-rpm increments.
      b. Required head, flow rate, and efficiency at design point.
   6. Certify in writing that pump system has been satisfactorily tested.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.

C. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 DEMONSTRATION

A. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 43 21 29
SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes submersible sewage pumps for Fifth St. Pump Station.

B. Related Requirements:
   1. Section 40 05 13 - Common Work Results for Process Piping.
   2. Section 40 67 00 - Control System Equipment Panels and Racks
   3. Section 43 05 20 - Common Work Results for Liquid Handling Systems.

1.2 REFERENCE STANDARDS

A. ASTM International:
   1. ASTM A48 - Standard Specification for Gray Iron Castings.
   2. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SCHEDULING

A. Schedule Work of this Section prior to connecting piping work.

1.4 SUBMITTALS

A. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

B. Shop Drawings:
   1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   1. Certify installation is completed according to manufacturer's instructions.

D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Hydrostatically test and test run pumps before shipping.
   1. Produce non-witnessed certified test curves for each pump.
   2. Test curves shall show head, capacity, and brake horsepower over a range covering the specified duty points.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.5 DELIVERY AND HANDLING

A. Deliver products to site in original factory packaging.

B. Handle in accordance with manufacturer's written instructions. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SEWAGE PUMPS

A. Manufacturer:
   1. Flygt, Gorman Rupp, Hydromatic, ABS, KSB, Grundfos, or equal.

B. Design Criteria:

Number of Pumps	2
Capacity (gpm)	100
Total Dynamic Head (feet)	29
Power Supply	480/3/60
VFD Compatible	Not Required

C. Description:
   1. Submersible non-clog pumps, each equipped with submersible electric motor.
   2. The pump and motor unit shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged or totally non-submerged. The use of shower systems, secondary pumps or cooling fans to cool the motor shall not be acceptable.
   3. The pump, mechanical seals and motor units provided under this specification shall be from the same manufacturer.
   4. Suitable for use in a Class 1, Division 1, Group D location
   5. Designed for handling raw, unscreened sewage, wipes, rags and wastewater and shall be fully guaranteed for this use.
   6. Connection: Automatic to discharge connection elbows when lowered into place, and easily removed for inspection or service.
   7. Capable of continuous submergence underwater without loss of watertight integrity to depth of 65 feet.

2.2 PUMP DESIGN

A. Impeller and Volute:
   1. Impeller:
      a. Close-grained cast iron, ASTM A48 Class 30 or stainless steel.
      b. Dynamically balanced.
      c. Non-clogging design having long throughlet without acute turns.
      d. Capable of passing minimum 3-inch solid sphere.
      e. Capable of handling solids, fibrous materials, sludge, and other matter found in normal sewage applications.
      f. Impeller and Shaft Fit: Sliding fit with one key.
   2. Volute:
      a. Gray cast iron, ASTM A48, Class 35B.
      b. Single piece.
      c. Non-concentric design.
      d. Smooth fluid passages capable of passing solids through impeller.
   3. Wear Ring:
      a. Use for sealing between volute and impeller.
      b. Stationary ring composed of nitrile rubber, molded with steel ring insert drive-fitted to volute inlet.
      c. Rotating ASTM A276, Type 304 stainless-steel ring drive-fitted to impeller skirt.

B. Mechanical Seal System:
   1. Shaft:
      a. ASTM A276, Type 420 stainless steel.
      b. Continuous pump and motor shaft.
      c. Completely isolated from the pumped liquid.
   2. Shaft Seal: Tandem mechanical type.
      a. Upper Tandem Set of Seals:
         1) Operating in oil chamber located just below stator housing.
         2) One stationary tungsten-carbide ring and one positively driven rotating carbon ring.
      b. Lower Tandem Set of Seals: Stationary tungsten-carbide ring and positively driven rotating tungsten-carbide ring.
   3. Oil Chamber for Shaft-Sealing System: Drain and inspection plug, with positive anti-leak seal, accessible from outside.

C. Bearings:
   1. Rotate shaft on two permanently lubricated bearings.
   2. Upper Bearing: Single-row roller bearing.
   3. Lower Bearings:
      a. At least one roller bearing.
      b. At least one angular-contact ball bearing.
   4. Minimum L10 bearing life: 100,000 hours.

D. Cable Entry Seal:
   1. Single or dual cylindrical elastomer grommet, flanked by stainless-steel washers with close tolerance fit against cable outside diameter and entry inside diameter, and compressed by entry body containing strain-relief function, separate from function of sealing cable.
   2. Bear assembly against shoulder in pump top.

3. Separate cable entry junction chamber and motor by stator-lead sealing gland or terminal board, which isolates motor interior from foreign material gaining access through pump top.

E. Operation:
   1. Electrical Characteristics: As specified in Section 26 05 03 - Equipment Wiring Connections and as shown on the Drawings.
   2. Controls: As specified in Section 40 67 00 - Control System Equipment Panels and Racks.
   3. Pump Motor:
      a. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.
      b. Inverter duty rated, capable of being operated with variable frequency drive if indicated in the project description and drawings.
      c. Non-overloading throughout entire pump performance range based on 1.0 service factor.
      d. Continuous duty, capable of sustaining minimum of 15 starts per hour.
      e. Indefinite operation without overheating when unsubmerged and operating in air.
      f. Stators:
         1) Dipped and baked three times in Class F varnish.
         2) Heat-shrink-fitted into stator housings.
         3) Thermal sensors to monitor stator temperatures.
      g. Include three thermal switches embedded in end coils of stator winding, for one switch in each stator phase.
      h. Stator Windings and Leads: Insulated with moisture-resistant Class F insulation capable of resisting temperature of 311 degrees F.
      i. Each unit shall be provided with an integral motor cooling system above 10 hp.
         1) Water jacket encircling stator housing.
         2) Furnish cooling media channels.
      j. Combined service factor: 1.15
   4. Power Cable:
      a. Sized according to NEC and ICEA standards.
      b. Sufficient length to reach the junction box without the need of any splices.
      c. Outer Jacket: oil resistant chloroprene rubber.
   5. Protection
      a. Provide manufacturer's standard motor thermal and seal leak monitoring relay, and be tied to activate an alarm.

F. Materials:
   1. Exposed Nuts, Bolts, and Washers: ASTM A276, Type 304 stainless-steel construction.
   2. Finishes: Spray exterior with PVC epoxy primer and chloric rubber paint finish.

G. Accessories:
   1. Pump Base/Discharge Connection Elbow.
      a. Permanently installed in wet well, fixed to the floor.
      b. Firmly connected to the discharge piping.
      c. Material: Mating cast iron.
   2. Pump Removal System
      a. Sliding guide bracket integral to pumping unit.
      b. Machined connecting flange to the pump casing.

c. Stainless steel pipe guide rails.
   1) Complete with intermediate stainless-steel support brackets.
d. Entire weight of pump unit guided by not less than two guide bars, and pressed tightly against discharge connection elbow with a watertight, metal-to-metal contact interface seal. No portion of the pump shall be supported directly on the bottom of the wet well, guide rails, or lifting cable.
e. Upper guide rail holders.
f. Level sensor cable holders.
g. Power and pilot cable supports.
h. Lifting cable shall consist of a stainless-steel braided wire cable attached to the pump lifting bail. Stainless Steel fasteners. A crimped ball end shall be provided at the upper end of this cable for attaching to the wet well access frame.

3. All bolts, machine screws, nuts, washers, and lockwashers for complete assembly of access cover, guide rails, and discharge elbow shall be stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION AND INSTALLATION

A. Verify layout and orientation of pumps, accessories, and piping connections.

B. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

C. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational, ready for startup.

D. Flush piping with clean water.

3.2 MANUFACTURER SERVICES:

A. A factory authorized start up technician with a minimum of 5 years' experience shall be provided to visit the site for a minimum of 8 hours on-site and confirm pump/s and controls operation meets or exceeds the specifications. The name of the technician along with the qualifications shall be submitted prior to start up upon Engineer/Owner request.

B. The service technician shall be outfitted with a service crane truck capable of pulling the pumps to verify rotation and perform a visual check of the pump/s along with the following items at a minimum:
1. Megger stator and power cables.
2. Inspect pump/s cables for damage.
3. Verify proper base and rail installation.
4. Check seal lubrication.
5. Check for proper rotation.
6. Check power supply voltage.
7. Measure motor operating amperage load and no load amperage.
8. Perform shut off head test and draw down flow test.
9. Check level control operation, sequence and alarm call out of telemetry.

C. The factory start-up form shall be submitted for approval prior to start up and approved by the Engineer/Owner. The Engineer/Owner, at their discretion, may add items to be completed at start up that they feel proves compliance with all project requirement and will notify the Contractor of these items prior to start up.

D. During this initial inspection, the manufacturer's service representative shall review recommended operation and maintenance procedures with the Owner's personnel. The Owner shall be provided with (1) additional training day that can be used at no cost to the Owner within the first year of startup. This 8-hour training day is to allow time for the Owners personnel to utilize the equipment and become familiar with the operation

3.3 FIELD QUALITY CONTROL

A. Pre-operational Checks:
   1. Check pump and motor alignment.
   2. Check for proper motor rotation.
   3. Check pump and drive units for proper lubrication.

B. Startup and Performance Testing:
   1. Operate pump using clean water at design point for continuous period of two hours, under supervision of manufacturer's representative and in presence of Engineer.

C. Verify pump performance by performing time-drawdown test or time-fill test.

D. Check pump and motor for high bearing temperature and excessive vibration.

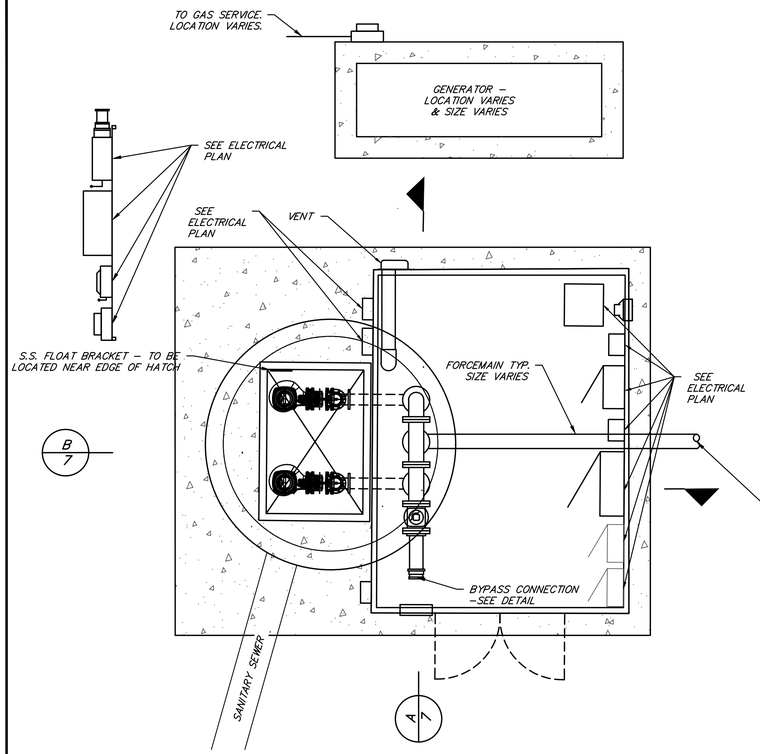
E. Check for motor overload by taking ampere readings.

F. Equipment Acceptance:
   1. Contractor shall adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
   2. Contractor shall make final adjustments to equipment under direction of manufacturer's representative.
   3. Contractor shall document adjustments, repairs, and replacements in manufacturer's field services certification.

3.4 DEMONSTRATION

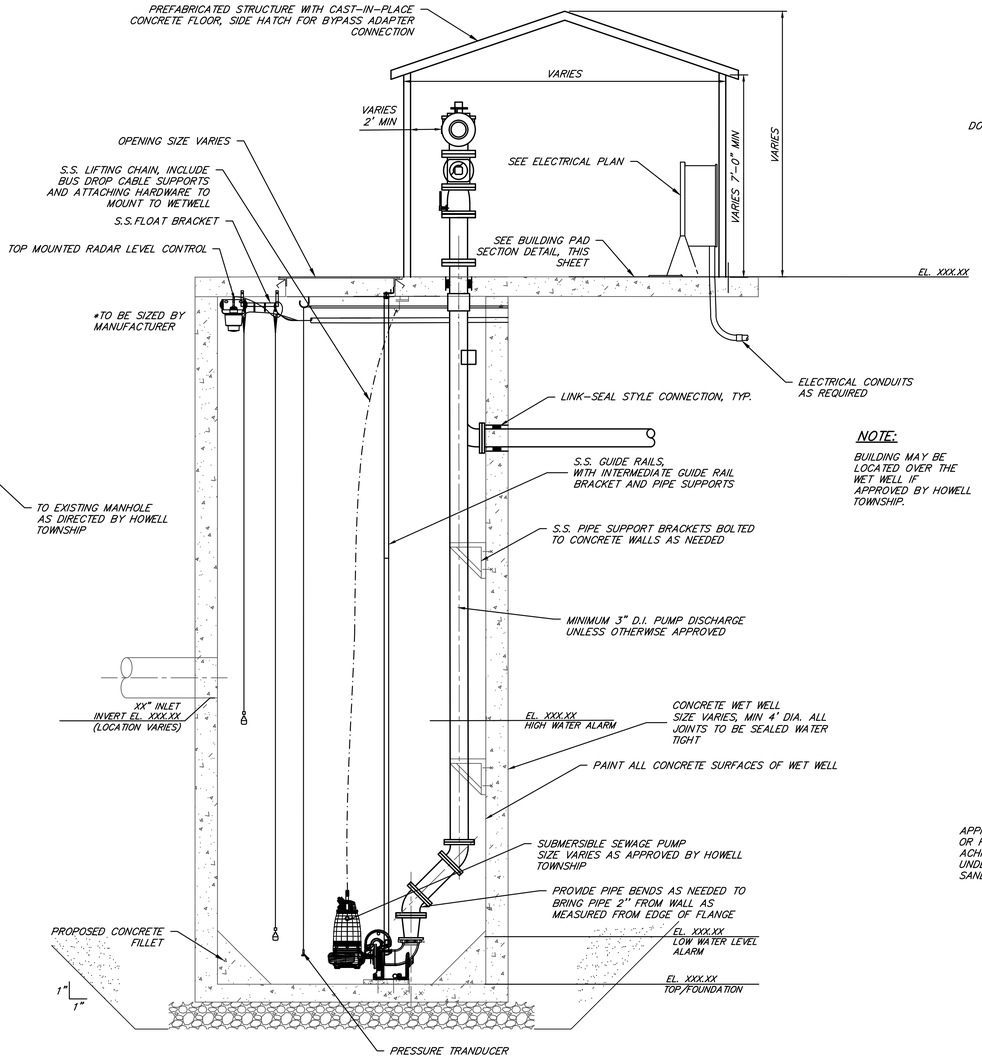
A. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION



TYPICAL PUMP STATION PLAN

SCALE: 1" = 4'

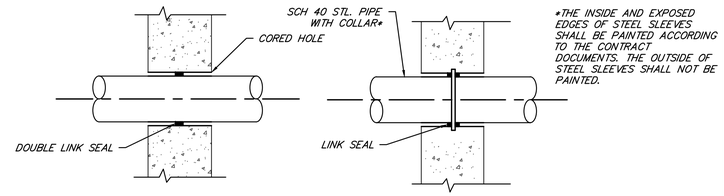


B 7 **TYPICAL PUMP STATION SECTION**

SCALE: 3/8"=1'-0"

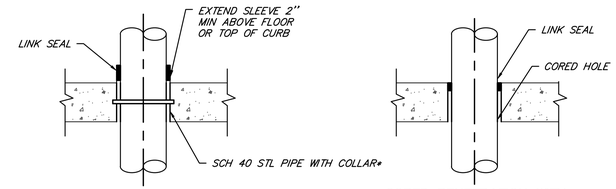
NOTE:

BUILDING MAY BE LOCATED OVER THE WET WELL IF APPROVED BY HOWELL TOWNSHIP.



CORED PENETRATION WITH LINK SEAL THROUGH CONCRETE WALL

STEEL SLEEVE WITH LINK SEAL THROUGH CONCRETE WALL

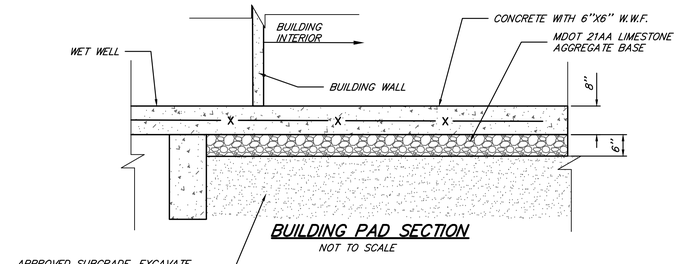


STEEL SLEEVE WITH LINK SEAL THROUGH FLOOR

CORED PENETRATION WITH LINK SEAL THROUGH FLOOR

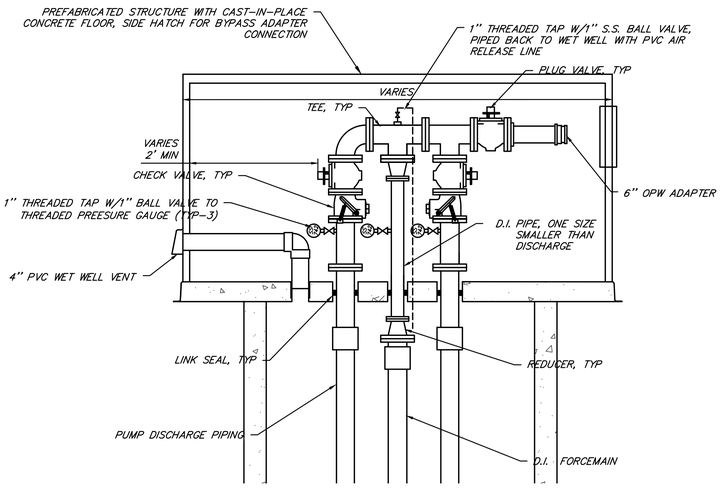
STEEL SLEEVE AND CORE PENETRATION DETAILS

NOT TO SCALE



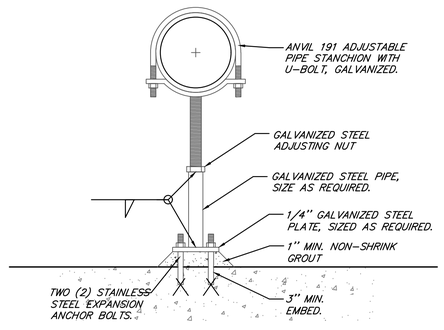
BUILDING PAD SECTION

NOT TO SCALE



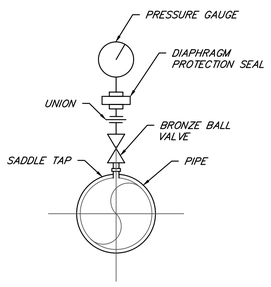
A 7 **TYPICAL PUMP STATION SECTION**

SCALE: 3/8"=1'-0"



ADJUSTABLE PIPE STANCHION SADDLE DETAIL

NOT TO SCALE



PIPE PRESSURE GAUGE DETAIL

NOT TO SCALE

NOTES

1. PIPE DIAMETER WILL VARY PER PUMP SIZE.
2. ALL HARDWARE TO BE 316 STAINLESS STEEL.
3. ELECTRICAL CONTROL PANELS AND JUNCTION BOXES TO BE MOUNTED ON STRUTS OR BUILDING WALLS, AS NOTED.
4. SEE ELECTRICAL PLANS FOR INTERIOR LIGHTING.
5. ALL MECHANICAL JOINT FITTINGS TO BE MEGA-LUG AND THRUST BLOCK.
6. VARIATION TO BUILDING PER HOWELL TOWNSHIP APPROVAL.
7. LANDSCAPING AROUND PUMP STATION TO BE APPROVED BY HOWELL TOWNSHIP.
8. SEE STANDARDS FOR GENERATOR SIZING AND REQUIREMENTS.
9. BUILDING TO BE EASI-SET WORLDWIDE, EASI-BRICK FINISH OR APPROVED EQUAL. COLOR TO MATCH SURROUNDING AREA AND BE APPROVED BY TOWNSHIP.

BY	MARK	REVISIONS	DATE
ACJ		UPDATED PER HOWELL TWP AND MHOG COMMENTS	03-25-25

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

PUMP STATION PLAN GREATER THAN 250 GPM

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www.SpicerGroup.com

DE. BY: TCA	CH. BY: TCA	PROJECT NO.	
DR. BY: EMJ	APP. BY: PAW	131763SG2021	
STDS.		SHEET 4 OF 7	DS 03
DATE JUNE, 2022		FILE NO.	
SCALE AS SHOWN		DS-5156-7	

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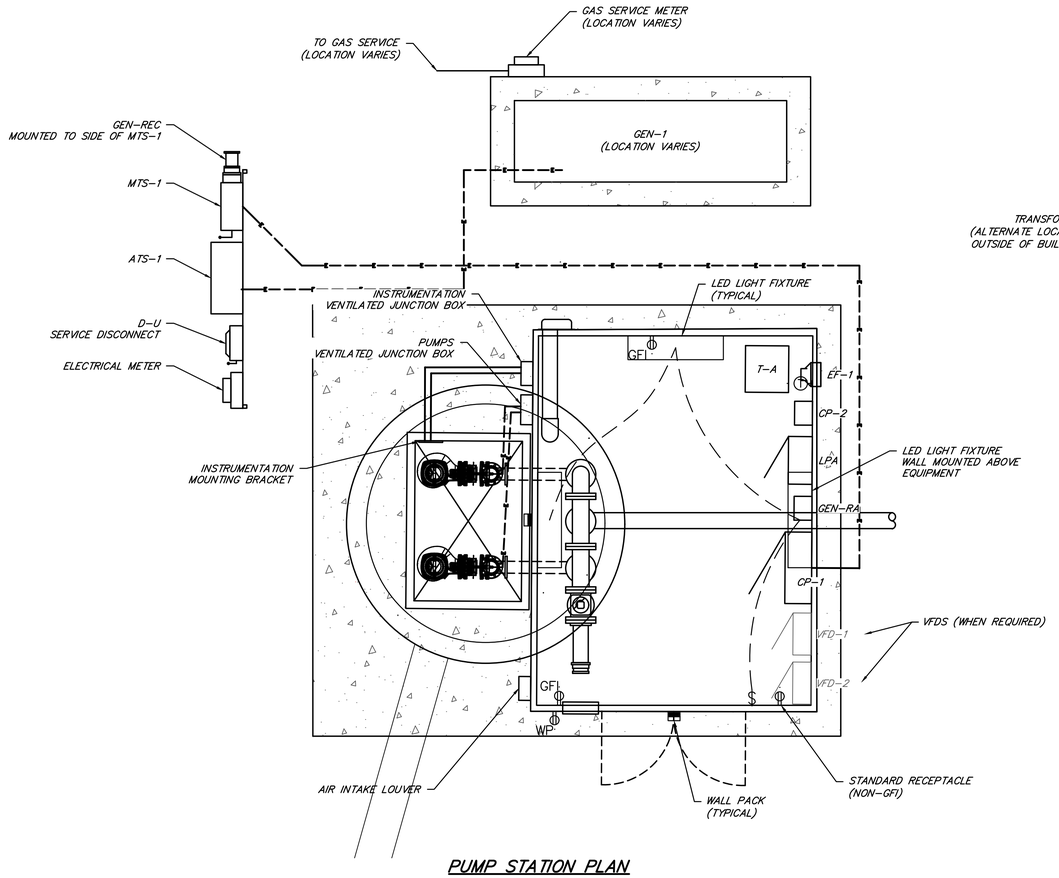
LINE TYPE:

PROPOSED ELECTRICAL POWER

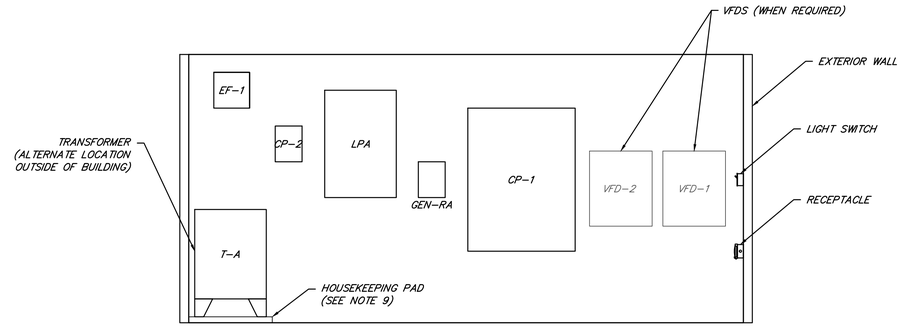
PROPOSED INSTRUMENTATION & CONTROL

LIGHTING CIRCUIT



PUMP STATION PLAN

SCALE: 1" = 2'-0"



BUILDING INTERIOR WALL ELEVATION VIEW

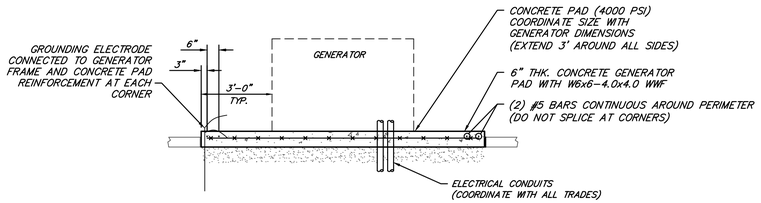
NOT TO SCALE

KEY

	120 VAC, 20 AMP, DUPLEX RECEPTACLE WP: WEATHERPROOF GFI: GROUND FAULT CIRCUIT INTERRUPT, WITH LED INDICATOR
	SURFACE MOUNT LIGHT FIXTURE 12" X 48" LED, VAPOR-TIGHT, WET LOCATION 120V, 3000 LUMEN (MIN), 4000K COLOR TEMP
	WALL PACK LIGHTING LED, FULL CUTOFF FIXTURE 1000 LUMEN (MIN.), 50K COLOR TEMP, WITH PHOTOCELL AND MOTION SENSOR
	THERMOSTAT SWITCH (EXHAUST FAN CONTROL) REVERSE ACTING SWITCH WITH ADJUSTABLE DEADBAND
$	TOGGLE SWITCH 120-277V, 15A, SINGLE POLE
EF-1	EXHAUST FAN 120V, THRU-WALL FAN WITH REMOTE INTAKE LOUVER CAPABLE OF A MINIMUM OF 6 AIR CHANGED PER HOUR.
EH-1	ELECTRIC HEATER 1500 WATT ADJUSTABLE OUTPUT, 120V, PORTABLE, FAN FORCED CONVECTION HEATER, WITH INTEGRAL THERMOSTAT DAYTON MODEL 3VU33B, OR APPROVED EQUAL
D-U	UTILITY SERVICE DISCONNECT SWITCH SERVICE RATED, NON-FUSIBLE SAFETY SWITCH 480V, 3ϕ, 200A, 3-POLE
ATS-1	AUTOMATIC TRANSFER SWITCH 480V, 3ϕ, 200A, 3-POLE
GEN-1	STANDBY GENERATOR *KW/*KVA, 480V, 3ϕ WITH LEVEL 2 SOUND ATTENUATED ENCLOSURE NATURAL GAS (WHERE AVAILABLE) CUMMINS (OR APPROVED EQUAL)
GEN-REC	PORTABLE GENERATOR RECEPTACLE 480V, 3ϕ, 200A, 3-WIRE, 4-POLE, PIN AND SLEEVE TYPE CROUSE-HINDS, MODEL AREAL20427, OR APPROVED EQUAL
GEN-RA	GENERATOR, REMOTE ANNUNCIATOR PANEL
MTS-1	MANUAL TRANSFER SWITCH 480V, 3ϕ, 200A, 3-POLE
VFD	VARIABLE FREQUENCY DRIVE
T	TRANSFORMER 25KVA, 1ϕ, 480V-IN, 120/240V-OUT, NEMA 3R ENCLOSURE
LP	LIGHTING PANEL 120/240V, 1ϕ, 100A, NEMA 3R ENCLOSURE 24 SPACES (MIN)
LE-1	LEVEL ELEMENT WEIGHTED, SUBMERSIBLE PRESSURE TRANSDUCER 24VDC, LOOP POWERED, 0 TO 10 PSI RANGE
LE-2	LEVEL ELEMENT FREE-AIR RADAR TRANSMITTER 24VDC, LOOP POWERED, 0 TO 30 FT RANGE (MIN)
LIT-#	LEVEL INDICATING TRANSMITTER LEVEL ELEMENT INTERFACE (MATCH LE-# MANUFACTURER)
LS	LEVEL SWITCH WEIGHTED MECHANICAL FLOAT SWITCH, 3-WIRE, DPDT CONTACTS AH : ALARM HIGH / START PUMPS AL : ALARM LOW / STOP PUMPS
CP	CONTROL PANEL CP-1 : MAIN CONTROL PANEL CP-2 : SCADA SYSTEM CONTROL PANEL
SCADA	SUPERVISORY CONTROL ALARMING AND DATA ACQUISITION
PMU-1	POWER MONITORING UNIT PANEL MOUNTED WITHIN CP-1 SCHNEIDER ELECTRIC, POWERLOGIC PM5560, OR APPROVED EQUAL

NOTES:

1. ALL 120 VOLT RECEPTACLES SHALL BE 20 AMP RATED, AND BE INSTALLED WITH METALLIC, LOCKABLE, WEATHERPROOF "WHILE-IN-USE" ENCLOSURES.
   1.1. PROVIDE AND INSTALL A MINIMUM OF 1 EXTERIOR RECEPTACLE NEAR DOOR, 2 INTERIOR RECEPTACLES ON OPPOSITE WALLS, AND 1 NON-GFI TYPE RECEPTACLE.
2. PROVIDE AND INSTALL A MINIMUM OF 2 VAPOR-TIGHT, LED, SURFACE MOUNT LIGHT FIXTURES, TO PROVIDE A MINIMUM AVERAGE ILLUMINATION OF 20 FOOTCANDLES. IF REQUIRED, DUE TO BUILDING DIMENSIONS, ADDITIONAL FIXTURES SHALL BE PROVIDED.
3. EXTERIOR LIGHTING SHALL INCLUDE A MINIMUM OF 2 FIXTURES (TOTAL) AND SHALL BE INSTALLED TO ILLUMINATE THE FOLLOWING AREAS.
   3.1. ENTRY/ACCESS DOOR
   3.2. WET WELL AND VENTILATED JUNCTION BOXES
   3.3. EQUIPMENT MOUNTED TO BUILDING EXTERIOR
4. CONTROL PANEL "CP-1" SHALL BE SUPPLIED WITH A PROGRAMMING RECEPTACLE, ALONG WITH ALL REQUIRED PROGRAMMING LOGIC AND CONFIGURATIONS.
   4.1. ALL REQUIRED SOFTWARE DEVELOPMENT AND/OR RUNTIME PACKAGES AND ASSOCIATED LICENSES SHALL BE SUPPLIED TO OWNER. LICENSES REQUIRING ANNUAL SUBSCRIPTION FEES SHALL NOT BE ALLOWED.
   4.2. ALL LOGIC AND CONFIGURATION FILES SHALL BE PROVIDED TO ENGINEER AND OWNER AS PART OF O&M MANUAL, IN ORIGINAL ELECTRONIC FORMAT.
5. CONDUIT AND WIRE ROUTING SHOWN IS APPROXIMATE, FOR REFERENCE ONLY. CONTRACTOR SHALL DETERMINE EXACT ROUTING AND PROVIDE FIELD MARK-UPS FOR AS-BUILT DOCUMENTATION.
   5.1. INDOOR CONDUIT ROUTES NOT SHOWN. CONTRACTOR SHALL DETERMINE BEST ROUTES AND DOCUMENT FOR AS-BUILT PLANS.
6. AIR INTAKE LOUVER AND EXHAUST FAN TO BE SUPPLIED AND INSTALLED BY CONTRACTOR. CONTRACTOR TO COORDINATE LOCATION WITH BUILDING MANUFACTURER.
7. ALL OUTDOOR CONDUIT PENETRATIONS SHALL HAVE VAPOR-TIGHT SEALS FOR ODOR CONTROL AND TO PREVENT INTRUSION OF HAZARDOUS GASES.
8. CONTRACTOR SHALL PROVIDE A STATION HEATER, DAYTON MODEL 3VU33B, OR APPROVED EQUAL. STATION HEATER IS SUBJECT TO CHANGE BASED ON BUILDING SIZE AND REQUIREMENTS.
   8.1. STATION HEATER SHALL UTILIZE A STANDARD 120V, 20A RECEPTACLE FOR POWER, UNLESS STATED OTHERWISE.
9. ALL HOUSEKEEPING PADS SHALL BE POURED CONCRETE, A MINIMUM OF 2 INCHES THICK, AND EXTEND 4 INCHES BEYOND ALL SIDES OF EQUIPMENT.



- ATTACH GENERATOR TO CONCRETE PAD WITH STAINLESS STEEL ANCHORS PER MANUFACTURERS RECOMMENDATIONS
- CONTRACTOR SHALL COORDINATE AND INSTALL CONDUIT PENETRATIONS FOR WIRING AS NECESSARY

GENERATOR PAD DETAIL

SCALE: 1" = 3'-0"

BY	MARK	REVISIONS	DATE

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

GREATER THAN 250 GPM ELECTRICAL SITE & BUILDING PLANS

DUNDEE OFFICE
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www.SpicerGroup.com

DE. BY: LAM	CH. BY: TCA	PROJECT NO.	
DR. BY: LAM	APP. BY: DWH	13176JSG2021	
STDS. –	SHEET 5 OF 7		E
DATE MARCH, 2025	FILE NO.		03
SCALE AS SHOWN	DS-5156-5		

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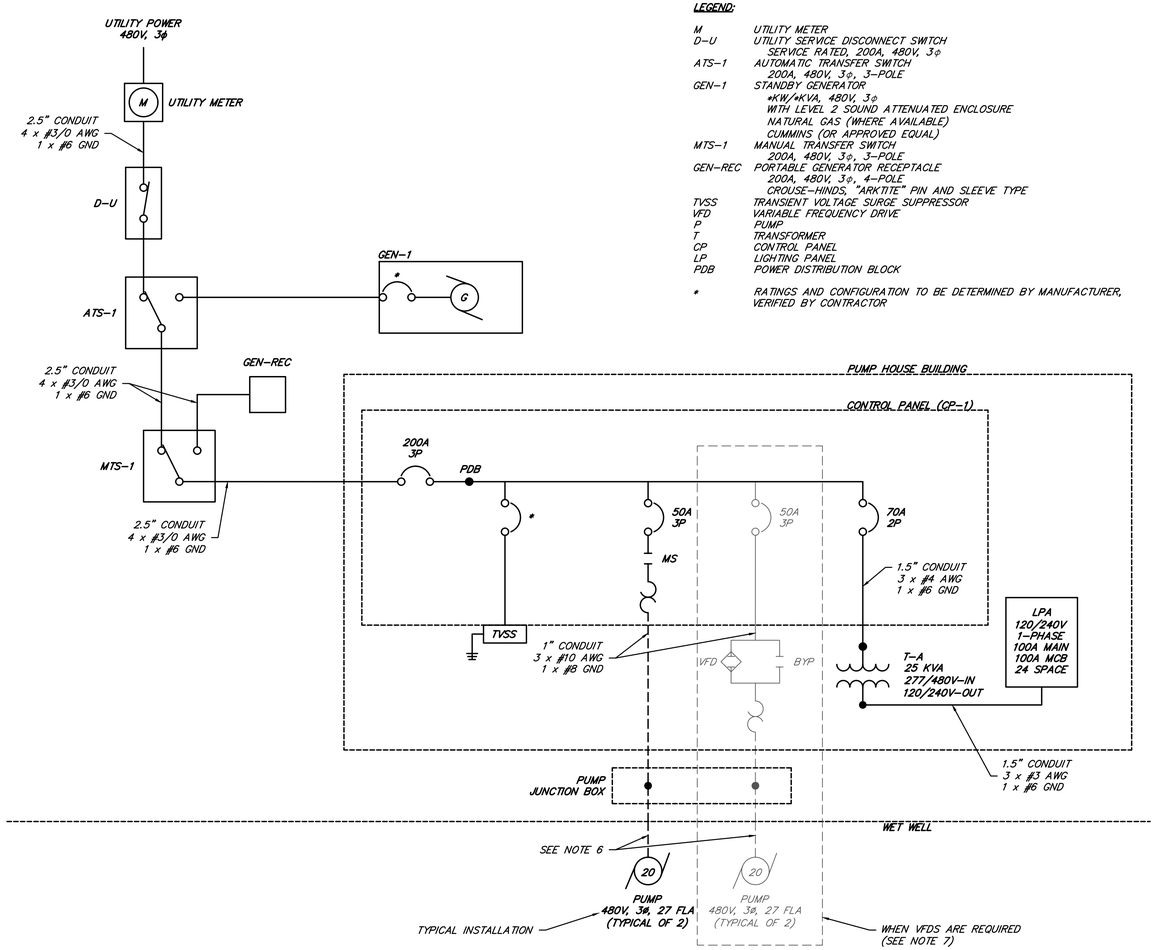


LEGEND:

M	UTILITY METER
D-U	UTILITY SERVICE DISCONNECT SWITCH SERVICE RATED, 200A, 480V, 3ϕ
ATS-1	AUTOMATIC TRANSFER SWITCH 200A, 480V, 3ϕ, 3-POLE
GEN-1	STANDBY GENERATOR *KW/*KVA, 480V, 3ϕ WITH LEVEL 2 SOUND ATTENUATED ENCLOSURE NATURAL GAS (WHERE AVAILABLE) CUMMINS (OR APPROVED EQUAL)
MTS-1	MANUAL TRANSFER SWITCH 200A, 480V, 3ϕ, 3-POLE
GEN-REC	PORTABLE GENERATOR RECEPTACLE 200A, 480V, 3ϕ, 4-POLE CROUSE-HINDS, "ARKTITE" PIN AND SLEEVE TYPE
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
T	TRANSFORMER
CP	CONTROL PANEL
LP	LIGHTING PANEL
PDB	POWER DISTRIBUTION BLOCK
*	RATINGS AND CONFIGURATION TO BE DETERMINED BY MANUFACTURER, VERIFIED BY CONTRACTOR

PROPOSED ONELINE: 480V SERVICE

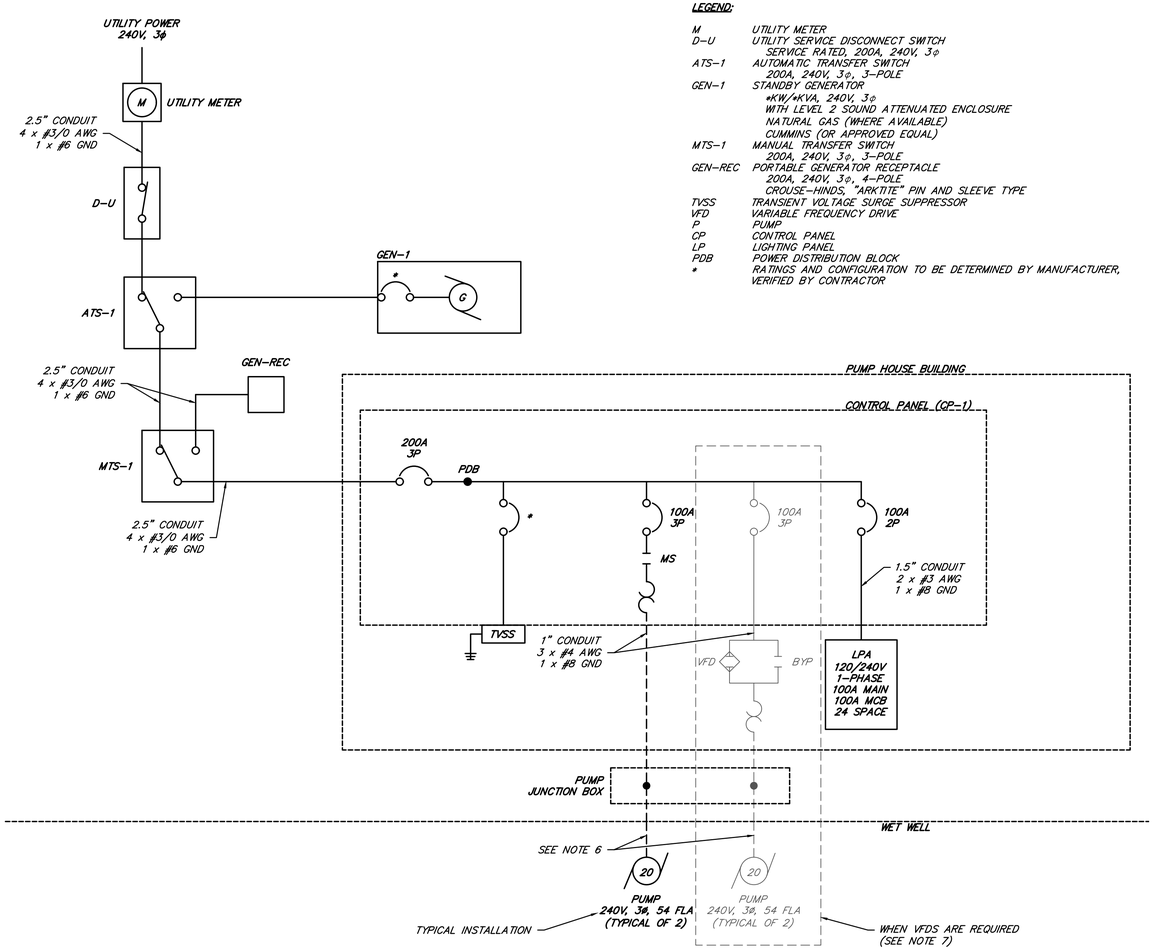
SCALE: N/A

PANEL BOARD SCHEDULE									
									PANEL: LPA - LIGHTING PANEL A
									LOCATION: PUMP STATION CONTROL ROOM
									FED FROM: *VARIES
									VOLTAGE: 120/240V, 1-PH, 3-WIRE
									RATINGS: 100A MAIN, 100A MAIN CB
									SPACES: 24 (MIN.)
LOAD DESCRIPTION	LOAD (W)	CB (A)	CKT #	100A MAIN CB A	100A MAIN CB B	CKT #	CB (A)	LOAD (W)	LOAD DESCRIPTION
LIGHTS : INTERIOR	384	20	1			2	20	1,800	CP-1 : CONTROL POWER
LIGHTS : EXTERIOR	234	20	3			4	15	0	SPARE
RECS : EXTERIOR	540	20	5			6	20	1,500	CP-2 : SCADA PANEL
RECS : INTERIOR	1,500	20	7			8	20	600	PM-1 : POWER MONITOR
RECS : INTERIOR	1,500	20	9			10	20	0	SPARE
EH-1 : ELECTRIC HEATER RECEPTACLE	1,500	20	11			12	20	600	GEN-BATT : GENERATOR BATTERY CHARGER
EF-1 : EXHAUST FAN	300	20	13			14	20	1,440	GEN-HTR : GENERATOR BLOCK HEATER
SPARE	0	20	15			16	20	0	SPARE
SPARE	0	20	17			18	20	180	REC-G : GENERATOR CONVENIENCE RECEPTACLE
SPARE	0	20	19			20	20	0	SPARE
SPARE	0	20	21			22	20	0	SPARE
SPARE	0	20	23			24	20	0	SPARE
TOTALS	5,958			7,644	4,434			6,120	
CONNECTED AMPS PER PHASE				63.70	36.95				
CONNECTED LOAD				12,078 WATTS,		50.33 AMPS			
TOTAL SERVICE DEMAND (CONNECTED LOAD * 125%)				15,098 WATTS,		62.91 AMPS			

TYPICAL PANEL SCHEDULE

SCALE: N/A

NOTE: PANEL SCHEDULE SUBJECT TO CHANGE BASED ON PROJECT SPECIFIC REQUIREMENTS, SUCH AS BUILDING SIZE, ADDITION/REMOVAL OF A BACKUP GENERATOR, OR OTHER EQUIPMENT.



LEGEND:

M	UTILITY METER
D-U	UTILITY SERVICE DISCONNECT SWITCH SERVICE RATED, 200A, 240V, 3ϕ
ATS-1	AUTOMATIC TRANSFER SWITCH 200A, 240V, 3ϕ, 3-POLE
GEN-1	STANDBY GENERATOR *KW/*KVA, 240V, 3ϕ WITH LEVEL 2 SOUND ATTENUATED ENCLOSURE NATURAL GAS (WHERE AVAILABLE) CUMMINS (OR APPROVED EQUAL)
MTS-1	MANUAL TRANSFER SWITCH 200A, 240V, 3ϕ, 3-POLE
GEN-REC	PORTABLE GENERATOR RECEPTACLE 200A, 240V, 3ϕ, 4-POLE CROUSE-HINDS, "ARKTITE" PIN AND SLEEVE TYPE
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
CP	CONTROL PANEL
LP	LIGHTING PANEL
PDB	POWER DISTRIBUTION BLOCK
*	RATINGS AND CONFIGURATION TO BE DETERMINED BY MANUFACTURER, VERIFIED BY CONTRACTOR

PROPOSED ONELINE: 240V SERVICE (ALTERNATE)

SCALE: N/A

NOTES:

1. 20 HP PUMPS USED AS DESIGN BASIS FOR SERVICE SIZING REQUIREMENTS.
2. CONTRACTOR SHALL PROVIDE NEW CABLES AND WIRE FOR ALL PROPOSED EQUIPMENT TO BE INSTALLED.
   - 2.1. ALL CONDUCTORS SHALL BE STRANDED COPPER, WITH THHN INSULATION, UNLESS OTHERWISE NOTED OR APPROVED.
3. CONTRACTOR SHALL SUPPLY REQUIRED RACEWAY, CABLING, AND MOUNTING HARDWARE FOR ALL EQUIPMENT INSTALLED.
4. CONTRACTOR SHALL COORDINATE TRANSFORMER AND ELECTRIC METER REPLACEMENT SCHEDULING WITH UTILITY COMPANY.
5. SEE SITE AND PUMP STATION PLANS FOR ADDITIONAL DETAILS.
6. PUMP CABLES SHALL BE SUPPLIED BY MANUFACTURER, AT SUFFICIENT LENGTH TO CONTROL CABINET WITHOUT THE NEED FOR SPLICING.
7. VFDS MAY BE REQUIRED BY HOWELL TOWNSHIP, DEPENDANT ON PUMPS' SIZE AND OPERATIONAL REQUIREMENTS.
   - 7.1. ALL VFDS SHALL BE PROVIDED WITH BYPASS CONTACTORS/MOTOR STARTERS.
8. THE FOLLOWING CIRCUIT BREAKERS SHALL BE OPERABLE THROUGH PANEL'S "DEAD-FRONT" DOOR CUTOUTS.
   - 8.1. CONTROL PANEL MAIN FEED
   - 8.2. PUMP MOTOR FEED
   - 8.3. TRANSFORMER FEED (LINE)
9. GENERATOR SHALL BE NATURAL GAS UP TO 100KW (WHERE AVAILABLE). ANY GENERATOR LARGER THAN 100KW SHALL BE DIESEL, UNLESS OTHERWISE INDICATED.
10. GENERATOR SIZE SHALL BE BASED ON ELECTRICAL LOAD. FINAL SELECTION TO BE APPROVED BY TOWNSHIP ENGINEER.

* CONTRACTOR SHALL VERIFY EQUIPMENT'S POWER REQUIREMENTS AND CONFIGURATIONS WITH MANUFACTURER, AND SUPPLY REQUIRED CIRCUIT PROTECTION. THIS INCLUDES, BUT IS NOT LIMITED TO, CIRCUIT BREAKERS, FUSE BLOCKS, AND FUSES.

BY	MARK	REVISIONS	DATE

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

GREATER THAN 250 GPM ONE-LINE & PANEL SCHEDULE

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DE. BY: LAM	CH. BY: TCA	PROJECT NO.	
DR. BY: LAM	APP. BY: DWH	131763SG2021	
STDS.	SHEET 6 OF 7		E
DATE MARCH, 2025	FILE NO.		04
SCALE AS SHOWN	DS-5156-6		

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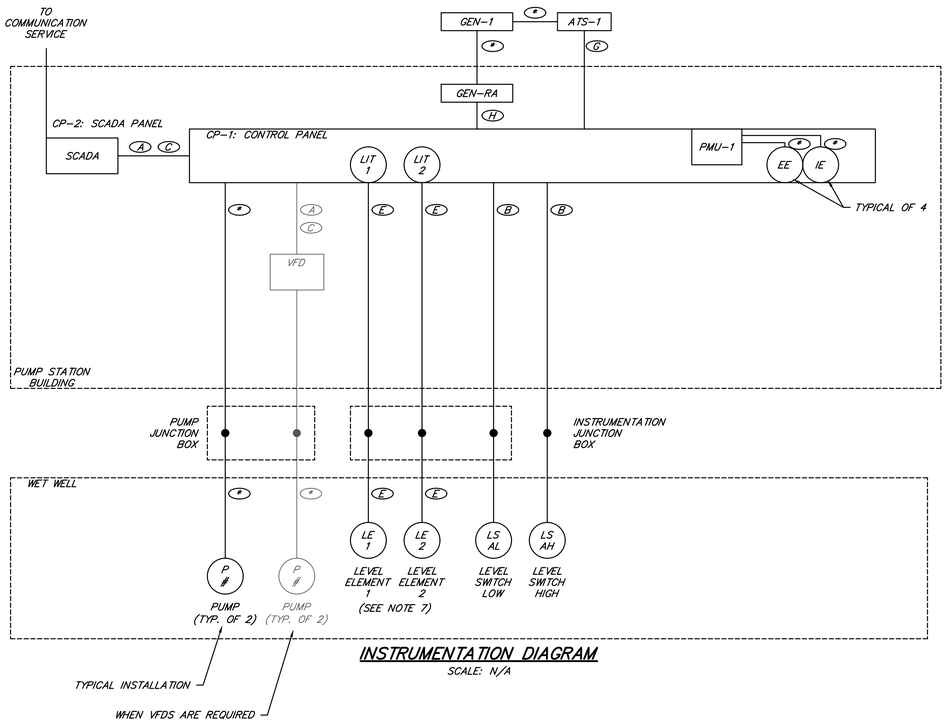


INSTRUMENTATION DIAGRAM

SCALE: N/A

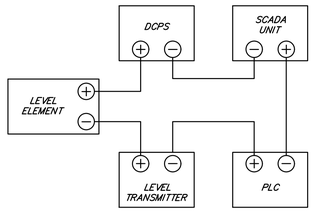
INSTRUMENTATION & CONTROL WIRING					
(X)	CONTENTS	TYPE			NOTE
		DATA	DISCRETE I/O	ANALOG I/O	
*	AS REQUIRED BY EQUIPMENT MFR.				TBD
A	1 x CATEGORY 6A	ENET			
B	3 x #14 AWG		2		
C	12 x #14 AWG, 2 x 2/C-#18 AWG (w/ SHLD)		6	2	
D	1 x 5/C-#18 AWG (w/ SHLD)		1	1	
E	1 x 6/C-#18 AWG (w/ SHLD)		1	1	
F	8 x #14 AWG		4		
G	6 x #14 AWG		3		
H	6 x #14 AWG		3		
I	4 x #14 AWG, 1 x 2/C-#18 AWG (w/ SHLD)		2	1	

NOTES:

1. CONTRACTOR SHALL VERIFY INSTRUMENTATION GROUNDING REQUIREMENTS AND INSTALL ALL NECESSARY ADDITIONAL GROUNDING COMPONENTS.
2. CONDUCTOR QUANTITIES AND SIZES LISTED ARE THE MINIMUM ACCEPTABLE. CONTRACTOR SHALL PROVIDE ALL ADDITIONAL CONDUCTORS AND TERMINATIONS REQUIRED FOR A COMPLETE AND OPERABLE SYSTEM.
3. ALL INSTRUMENTATION AND CONTROL WIRING SHALL BE RUN IN CONDUIT, UNLESS OTHERWISE STATED.
4. MULTIPLE WIRES AND CABLES MAY BE SUBSTITUTED WITH MULTI-CONDUCTOR CABLE ASSEMBLIES ONLY UPON APPROVAL BY ENGINEER.

LEGEND:

CP	CONTROL PANEL
	CP-1 : MAIN CONTROL PANEL
	CP-2 : SCADA SYSTEM CONTROL PANEL
SCADA	SUPERVISORY CONTROL, ALARMING, AND DATA ACQUISITION
GEN-1	STANDBY GENERATOR
GEN-RA	GENERATOR REMOTE ANNUNCIATOR
ATS-1	AUTOMATIC TRANSFER SWITCH
PM	POWER MONITORING UNIT
	SCHNEIDER ELECTRIC, POWERLOGIC PM5560, OR APPROVED EQUAL
EE	ENERGY ELEMENT, VOLTAGE SENSOR
IE	CURRENT ELEMENT, AMPERE SENSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
LE-1	LEVEL ELEMENT
	SUBMERSIBLE PRESSURE TRANSDUCER
LE-2	LEVEL ELEMENT
	FREE-AIR RADAR TRANSMITTER
LIT	LEVEL INDICATING TRANSMITTER
LS	LEVEL SWITCH (WEIGHTED FLOAT SWITCH)
	AL : ALARM LOW / STOP ALL PUMPS
	AH : ALARM HIGH / LEAD PUMP START
DCPS	DC POWER SUPPLY
	24VDC, 120W, 5A, UNLESS OTHERWISE NOTED
PLC	PROGRAMMABLE LOGIC CONTROLLER

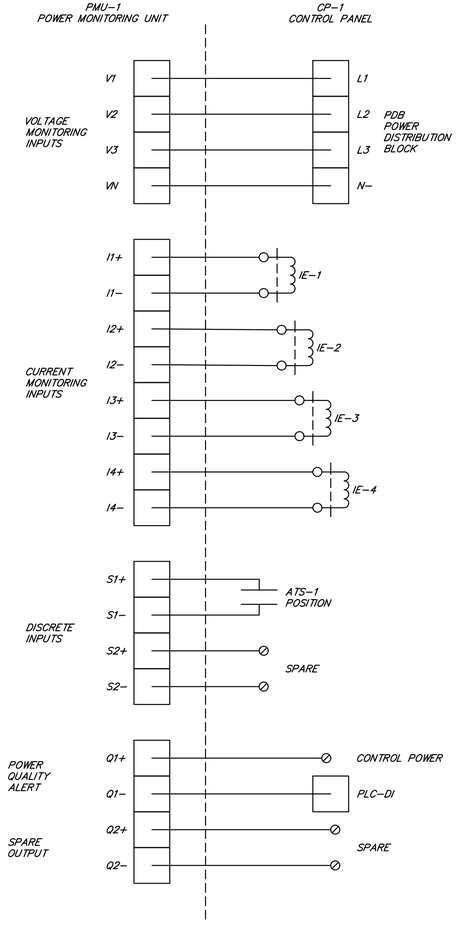


ANALOG LOOP WIRING (TYPICAL)

SCALE: N/A

NOTES:

1. CONTRACTOR TO INSTALL ANALOG SIGNAL LOOP ISOLATORS WHERE NECESSARY TO PROVIDE A COMPLETE OPERATIONAL SYSTEM.

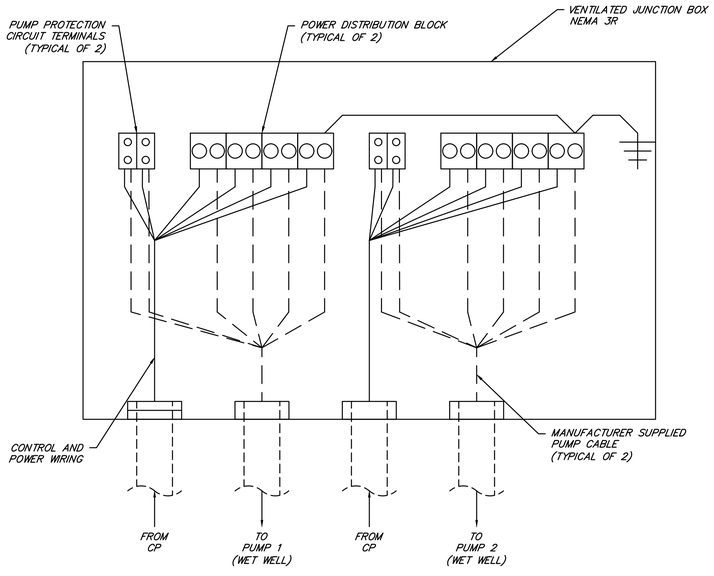


POWER MONITORING UNIT INTERCONNECTION DETAIL

SCALE: N/A

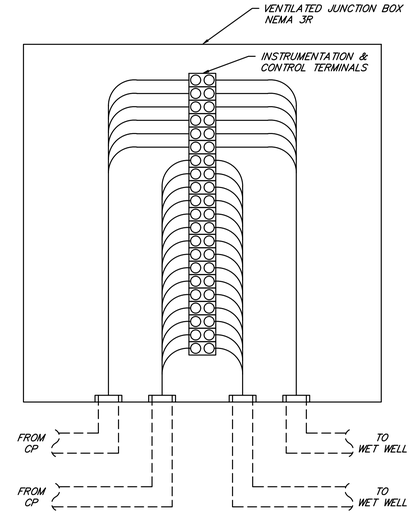
NOTES:

1. CONTRACTOR SHALL PROVIDE NEW CABLES AND WIRE FOR ALL PROPOSED EQUIPMENT TO BE INSTALLED.
   1.1. ALL CONDUCTORS SHALL BE STRANDED COPPER, WITH THHN INSULATION, UNLESS OTHERWISE NOTED OR APPROVED.
2. ALL CONTROL POINTS ON PROPOSED EQUIPMENT SHALL BE CLEARLY LABELED AND WIRED TO TERMINALS IN CONTROL PANEL FOR SYSTEM INTEGRATION. THIS INCLUDES CONTROL SIGNALS NOT UTILIZED IN THE CURRENT CONTROL SCHEME.
3. PUMP PROTECTION RELAYS TO BE MOUNTED THOUGH DOOR AND HAVE INDICATOR LIGHTS AND RESET BUTTON BUILT IN.
4. ALL 480 VAC CIRCUIT BREAKERS TO BE OPERABLE THROUGH PANEL'S "DEAD-FRONT" DOOR CUTOUTS.
5. "BACKUP ON" INDICATOR LIGHT SHALL ILLUMINATE WHEN PUMPS ARE RUNNING IN BACKUP MODE.
6. LEVEL TRANSMITTER DISPLAY SHALL BE INSTALLED INSIDE THE CONTROL PANEL.
7. CONTROL PANEL SHALL HAVE A 2 POSITION SELECTOR SWITCH INSTALLED WHICH ALLOWS OPERATOR TO SELECT THE PRIMARY LEVEL TRANSMITTER; LE-1 / LE-2 (SUBMERSIBLE TRANSDUCER / RADAR TRANSMITTER). PUMPS SHALL OPERATE IN ACCORDANCE TO THE PRIMARY LEVEL TRANSMITTER'S LEVEL READING.



PUMPS JUNCTION BOX DETAIL

SCALE: N/A



INSTRUMENTATION JUNCTION BOX DETAIL

SCALE: N/A

BY	MARK	REVISIONS	DATE

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

GREATER THAN 250 GPM INSTRUMENTATION DIAGRAM & DETAILS

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DE. BY: LAM	CH. BY: TCA	PROJECT NO. 13176.3SG2021
DR. BY: LAM	APP. BY: DWH	
STDS.	SHEET 7 OF 7	E
DATE MARCH, 2025	FILE NO. DS-5156-7	05
SCALE AS SHOWN		

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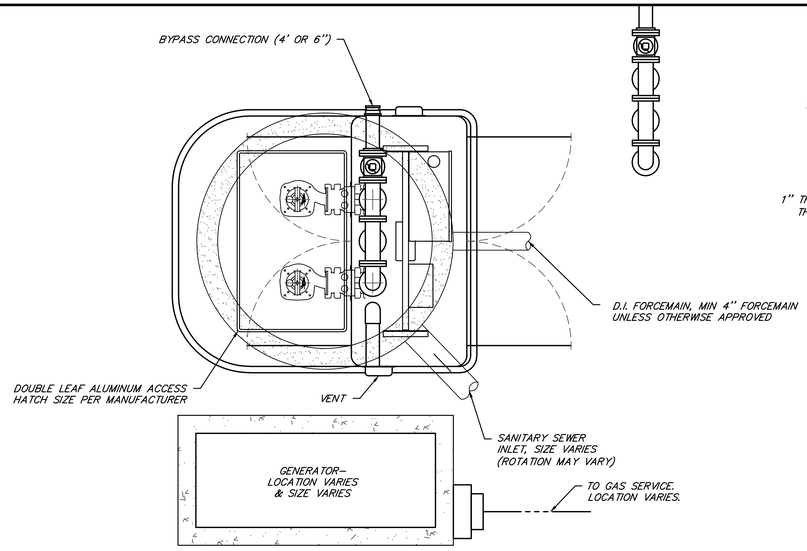
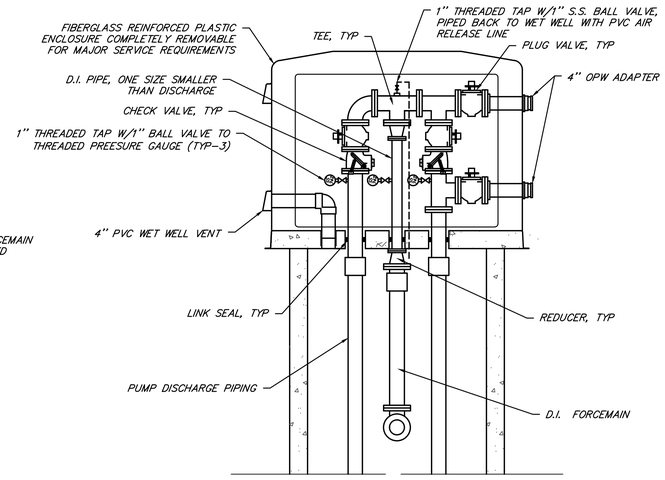
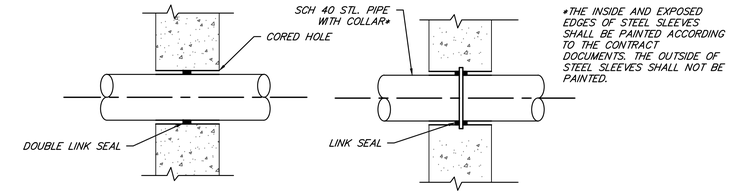


TYP. PUMP STATION PLAN
NOT TO SCALE

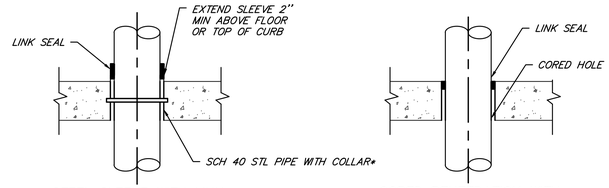


PLASTIC ENCLOSURE SECTION
NOT TO SCALE



CORED PENETRATION WITH LINK SEAL THROUGH CONCRETE WALL

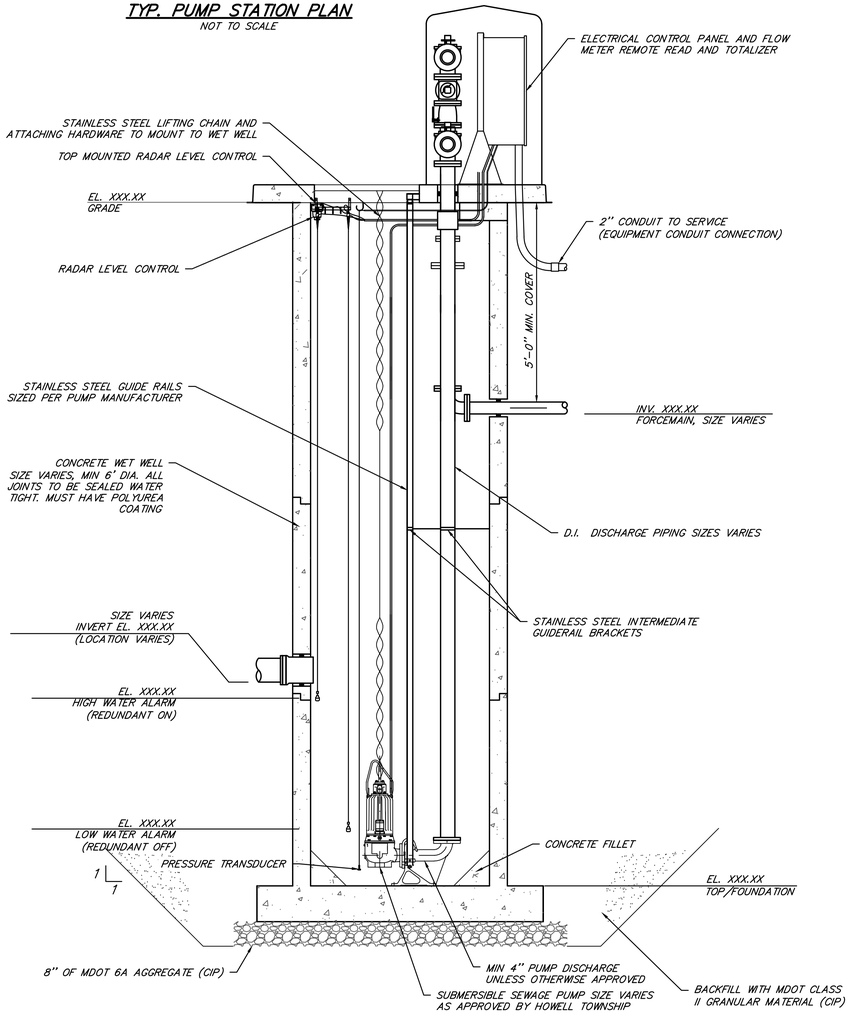
STEEL SLEEVE WITH LINK SEAL THROUGH CONCRETE WALL



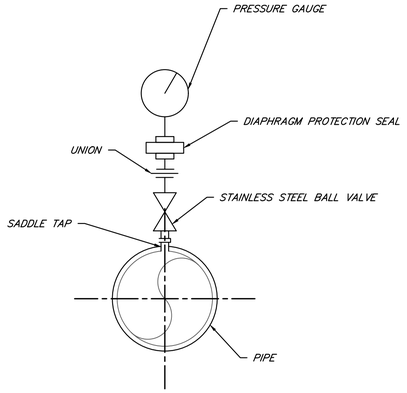
STEEL SLEEVE WITH LINK SEAL THROUGH FLOOR

CORED PENETRATION WITH LINK SEAL THROUGH FLOOR

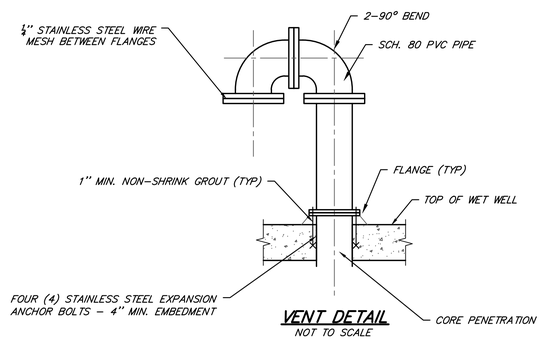
STEEL SLEEVE AND CORE PENETRATION DETAILS
NOT TO SCALE



TYP. PUMP STATION SECTION
NOT TO SCALE



PIPE PRESSURE GAUGE DETAIL
NOT TO SCALE



VENT DETAIL
NOT TO SCALE

NOTES
1. PIPE DIAMETER WILL VARY PER PUMP SIZE.
2. ALL HARDWARE TO BE 316 STAINLESS STEEL.
3. LANDSCAPING AROUND PUMP STATION TO BE APPROVED BY HOWELL TOWNSHIP.
4. ENGINEER SHALL PROVIDE BUOYANCY CALCULATION FOR WET WELL AND DESIGN APPROPRIATE BALLAST CONCRETE.
5. HOWELL TOWNSHIP MAY REQUIRE CONTRACTOR TO INSTALL ODOR REDUCING MEASURES AT DOWNSTREAM DISCHARGE POINT.
6. SEE STANDARDS FOR GENERATOR SIZING AND REQUIREMENTS.

BY	MARK	REVISIONS	DATE
ACJ		UPDATED PER HOWELL TWP AND MHOG COMMENTS	03-03-25

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

PUMP STATION PLAN
10 GPM TO 250 GPM

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DE. BY: TCA	CH. BY: TCA	PROJECT NO.	
DR. BY: EMJ	APP. BY: PAW	13176JSG2021	
STDS.		SHEET 1 OF 7	DS 02
DATE JUNE, 2022		FILE NO.	
SCALE AS SHOWN		DS-5156-4	

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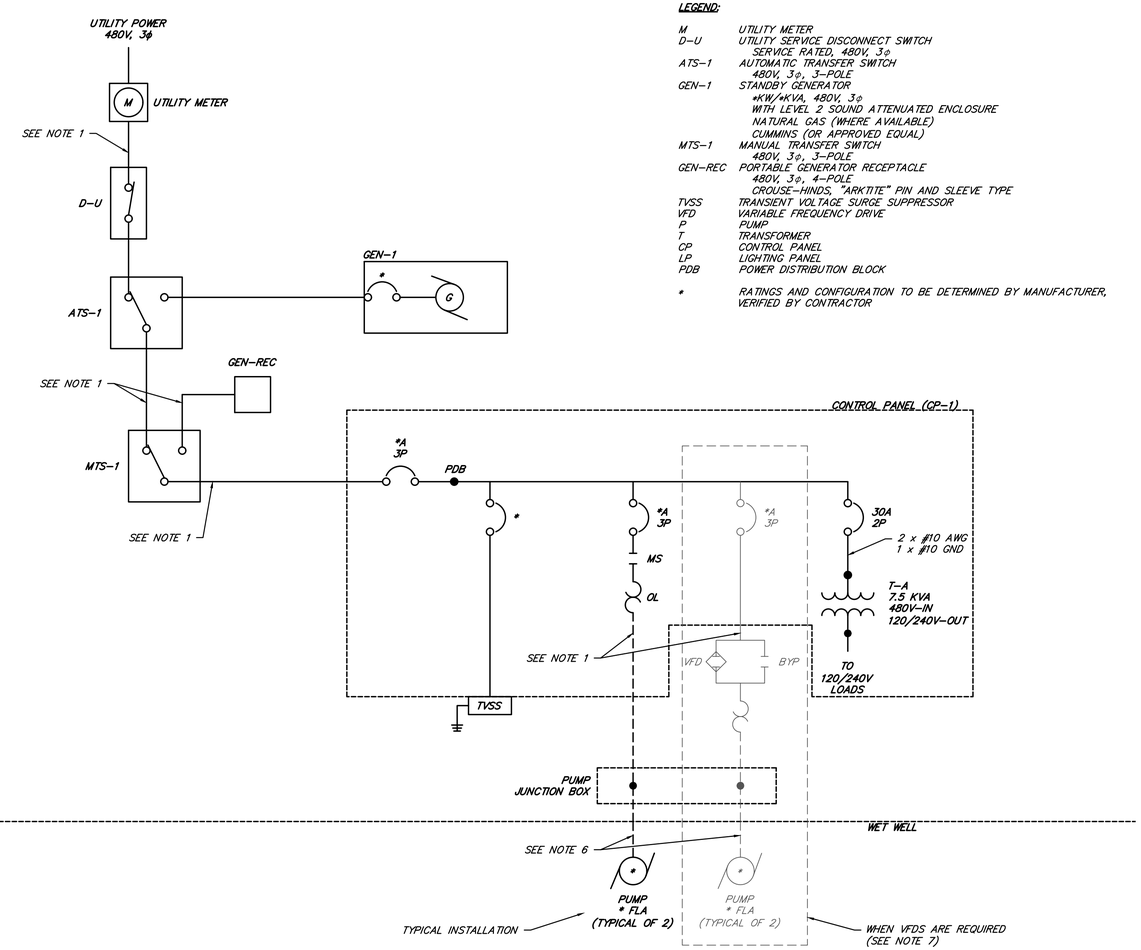
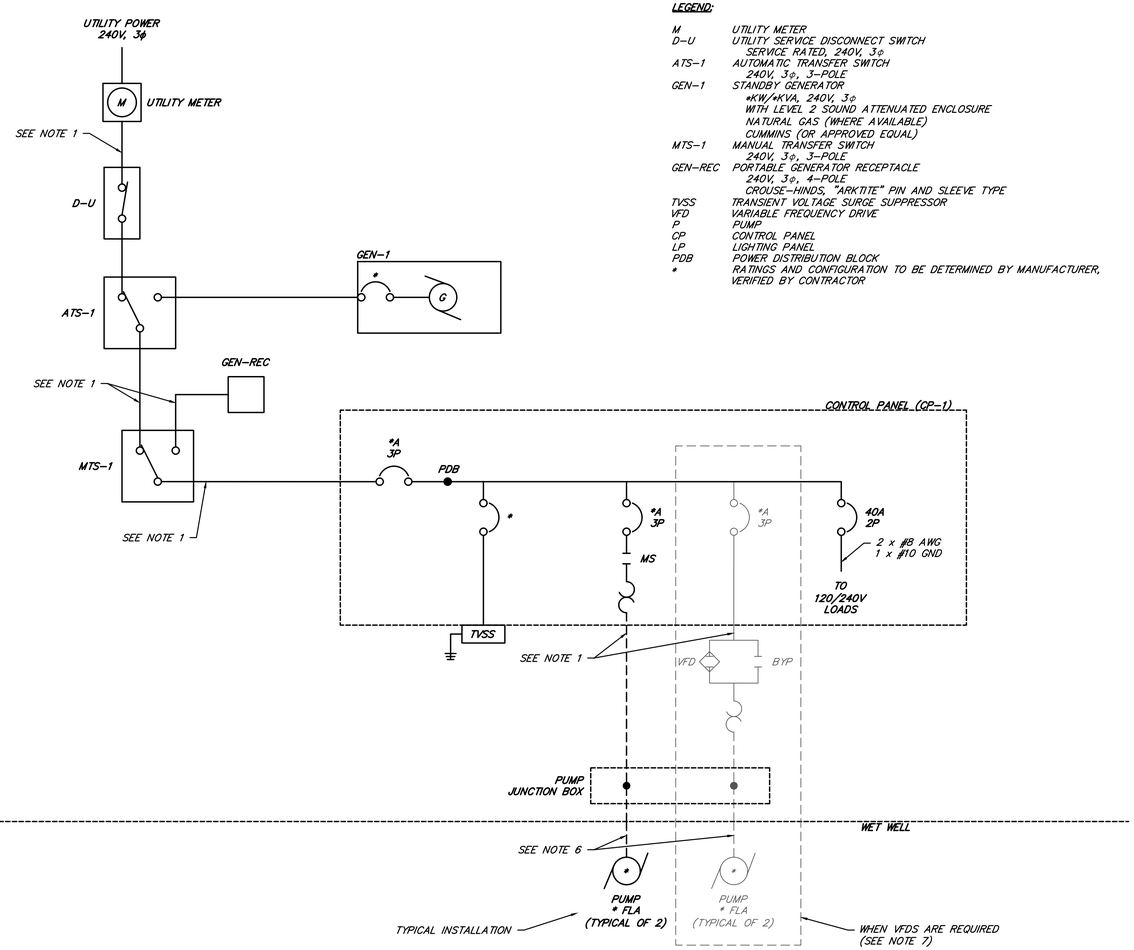


LEGEND:

M	UTILITY METER
D-U	UTILITY SERVICE DISCONNECT SWITCH SERVICE RATED, 480V, 3ϕ
ATS-1	AUTOMATIC TRANSFER SWITCH 480V, 3ϕ, 3-POLE
GEN-1	STANDBY GENERATOR *KW/*KVA, 480V, 3ϕ WITH LEVEL 2 SOUND ATTENUATED ENCLOSURE NATURAL GAS (WHERE AVAILABLE) CUMMINS (OR APPROVED EQUAL)
MTS-1	MANUAL TRANSFER SWITCH 480V, 3ϕ, 3-POLE
GEN-REC	PORTABLE GENERATOR RECEPTACLE 480V, 3ϕ, 4-POLE CROUSE-HINDS, "ARKTITE" PIN AND SLEEVE TYPE
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
T	TRANSFORMER
CP	CONTROL PANEL
LP	LIGHTING PANEL
PDB	POWER DISTRIBUTION BLOCK
*	RATINGS AND CONFIGURATION TO BE DETERMINED BY MANUFACTURER, VERIFIED BY CONTRACTOR

PROPOSED ONELINE: 480V SERVICE

SCALE: N/A



LEGEND:

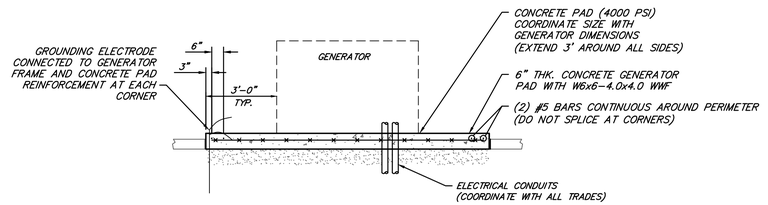
M	UTILITY METER
D-U	UTILITY SERVICE DISCONNECT SWITCH SERVICE RATED, 240V, 3ϕ
ATS-1	AUTOMATIC TRANSFER SWITCH 240V, 3ϕ, 3-POLE
GEN-1	STANDBY GENERATOR *KW/*KVA, 240V, 3ϕ WITH LEVEL 2 SOUND ATTENUATED ENCLOSURE NATURAL GAS (WHERE AVAILABLE) CUMMINS (OR APPROVED EQUAL)
MTS-1	MANUAL TRANSFER SWITCH 240V, 3ϕ, 3-POLE
GEN-REC	PORTABLE GENERATOR RECEPTACLE 240V, 3ϕ, 4-POLE CROUSE-HINDS, "ARKTITE" PIN AND SLEEVE TYPE
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
CP	CONTROL PANEL
LP	LIGHTING PANEL
PDB	POWER DISTRIBUTION BLOCK
*	RATINGS AND CONFIGURATION TO BE DETERMINED BY MANUFACTURER, VERIFIED BY CONTRACTOR

PROPOSED ONELINE: 240V SERVICE (ALTERNATE)

SCALE: N/A

NOTES:

1. ALL 120 VOLT RECEPTACLES SHALL BE 20 AMP RATED.
   1.1. ALL EXTERIOR INSTALLED RECEPTACLES SHALL BE GFCI-TYPE WITH METALLIC, LOCKABLE, WEATHERPROOF "WHILE-IN-USE" ENCLOSURES.
2. CONTROL PANEL "CP-1" SHALL BE SUPPLIED WITH A PROGRAMMING RECEPTACLE, ALONG WITH ALL REQUIRED PROGRAMMING LOGIC AND CONFIGURATIONS.
   2.1. ALL REQUIRED SOFTWARE DEVELOPMENT AND/OR RUNTIME PACKAGES AND ASSOCIATED LICENSES SHALL BE SUPPLIED TO OWNER. LICENSES REQUIRING ANNUAL SUBSCRIPTION FEES SHALL NOT BE ALLOWED.
   2.2. ALL LOGIC AND CONFIGURATION FILES SHALL BE PROVIDED TO ENGINEER AND OWNER AS PART OF O&M MANUAL, IN ORIGINAL ELECTRONIC FORMAT.
3. CONDUIT AND WIRE ROUTING SHOWN IS APPROXIMATE, FOR REFERENCE ONLY. CONTRACTOR SHALL DETERMINE EXACT ROUTING AND PROVIDE FIELD MARK-UPS FOR AS-BUILT DOCUMENTATION.
4. ALL CONDUIT PENETRATIONS SHALL HAVE VAPOR-TIGHT SEALS FOR ODOR CONTROL AND TO PREVENT INTRUSION OF HAZARDOUS GASES.
5. CONTRACTOR SHALL PROVIDE A STATION HEATER, DAYTON MODEL 3VJ33B, OR APPROVED EQUAL. STATION HEATER IS SUBJECT TO CHANGE BASED ON BUILDING SIZE AND REQUIREMENTS.
   5.1. STATION HEATER SHALL UTILIZE A STANDARD 120V, 20A RECEPTACLE FOR POWER, UNLESS STATED OTHERWISE.



- ATTACH GENERATOR TO CONCRETE PAD WITH STAINLESS STEEL ANCHORS PER MANUFACTURERS RECOMMENDATIONS
- CONTRACTOR SHALL COORDINATE AND INSTALL CONDUIT PENETRATIONS FOR WIRING AS NECESSARY

GENERATOR PAD DETAIL

SCALE: 1" = 3'-0"

NOTES:

* SIZE BASED ON LOAD REQUIREMENTS.

1. CONDUIT AND CONDUCTOR SIZING TO BE DETERMINED BY EACH STATION'S TOTAL LOAD CALCULATIONS.
   1.1. LOAD CALCULATION WILL VARY BASED ON PUMPS' ELECTRICAL SPECIFICATIONS.
2. CONTRACTOR SHALL PROVIDE NEW CABLES AND WIRE FOR ALL PROPOSED EQUIPMENT TO BE INSTALLED.
   2.1. ALL CONDUCTORS SHALL BE STRANDED COPPER, WITH THHN INSULATION, UNLESS OTHERWISE NOTED OR APPROVED.
3. CONTRACTOR SHALL SUPPLY REQUIRED RACEWAY, CABLING, AND MOUNTING HARDWARE FOR ALL EQUIPMENT INSTALLED.
4. CONTRACTOR SHALL COORDINATE TRANSFORMER AND ELECTRIC METER REPLACEMENT SCHEDULING WITH UTILITY COMPANY.
5. SEE SITE AND PUMP STATION PLANS FOR ADDITIONAL DETAILS.
6. PUMP CABLES SHALL BE SUPPLIED BY MANUFACTURER, AT SUFFICIENT LENGTH TO CONTROL CABINET WITHOUT THE NEED FOR SPLICING.
7. VFDS MAY BE REQUIRED BY HOWELL TOWNSHIP, DEPENDANT ON PUMPS' SIZE AND OPERATIONAL REQUIREMENTS.
   7.1. ALL VFDS SHALL BE PROVIDED WITH BYPASS CONTACTORS/MOTOR STARTERS.
8. THE FOLLOWING CIRCUIT BREAKERS SHALL BE OPERABLE THROUGH PANEL'S "DEAD-FRONT" DOOR CUTOUTS.
   8.1. CONTROL PANEL MAIN FEED
   8.2. PUMP MOTOR FEED
   8.3. TRANSFORMER FEED (LINE)
9. GENERATOR SHALL BE NATURAL GAS UP TO 100KW (WHERE AVAILABLE). ANY GENERATOR LARGER THAN 100KW SHALL BE DIESEL, UNLESS OTHERWISE INDICATED.
10. GENERATOR SIZE SHALL BE BASED ON ELECTRICAL LOAD. FINAL SELECTION TO BE APPROVED BY TOWNSHIP ENGINEER.

* CONTRACTOR SHALL VERIFY EQUIPMENT'S POWER REQUIREMENTS AND CONFIGURATIONS WITH MANUFACTURER, AND SUPPLY REQUIRED CIRCUIT PROTECTION. THIS INCLUDES, BUT IS NOT LIMITED TO, CIRCUIT BREAKERS, FUSE BLOCKS, AND FUSES.

BY	MARK	REVISIONS	DATE

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

10 TO 250 GPM ONE-LINE & PANEL SCHEDULE

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DR. BY: LAM	APP. BY: DWH	131763SG2021	
STDS.	SHEET 2 OF 7		E
DATE MARCH, 2025	FILE NO.		01
SCALE AS SHOWN	DS-5156-2		

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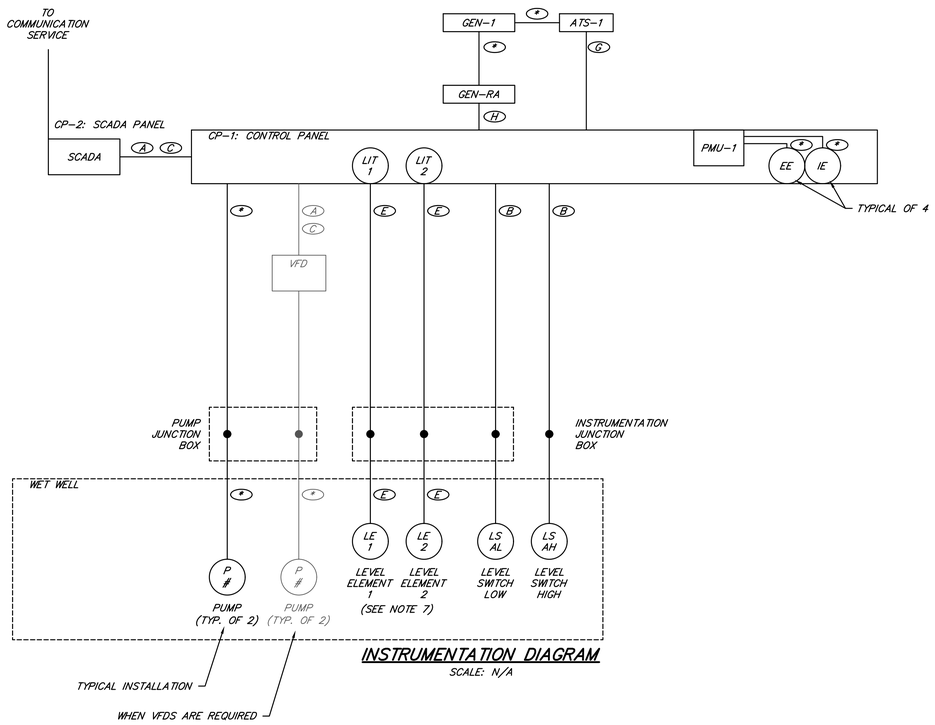


INSTRUMENTATION DIAGRAM

SCALE: N/A

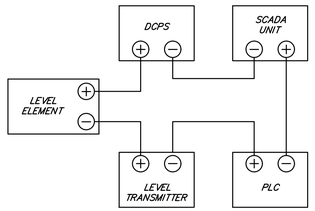
INSTRUMENTATION & CONTROL WIRING					
(X)	CONTENTS	TYPE			NOTE
		DATA	DISCRETE I/O	ANALOG I/O	
*	AS REQUIRED BY EQUIPMENT MFR.				TBD
A	1 x CATEGORY 6A	ENET			
B	3 x #14 AWG		2		
C	12 x #14 AWG, 2 x 2/C-#18 AWG (w/ SHLD)		6	2	
D	1 x 5/C-#18 AWG (w/ SHLD)		1	1	
E	1 x 6/C-#18 AWG (w/ SHLD)		1	1	
F	8 x #14 AWG		4		
G	6 x #14 AWG		3		
H	6 x #14 AWG		3		
I	4 x #14 AWG, 1 x 2/C-#18 AWG (w/ SHLD)		2	1	

NOTES:

1. CONTRACTOR SHALL VERIFY INSTRUMENTATION GROUNDING REQUIREMENTS AND INSTALL ALL NECESSARY ADDITIONAL GROUNDING COMPONENTS.
2. CONDUCTOR QUANTITIES AND SIZES LISTED ARE THE MINIMUM ACCEPTABLE. CONTRACTOR SHALL PROVIDE ALL ADDITIONAL CONDUCTORS AND TERMINATIONS REQUIRED FOR A COMPLETE AND OPERABLE SYSTEM.
3. ALL INSTRUMENTATION AND CONTROL WIRING SHALL BE RUN IN CONDUIT, UNLESS OTHERWISE STATED.
4. MULTIPLE WIRES AND CABLES MAY BE SUBSTITUTED WITH MULTI-CONDUCTOR CABLE ASSEMBLIES ONLY UPON APPROVAL BY ENGINEER.

LEGEND:

CP	CONTROL PANEL
	CP-1 : MAIN CONTROL PANEL
	CP-2 : SCADA SYSTEM CONTROL PANEL
SCADA	SUPERVISORY CONTROL, ALARMING, AND DATA ACQUISITION
GEN-1	STANDBY GENERATOR
GEN-RA	GENERATOR REMOTE ANNUNCIATOR
ATS-1	AUTOMATIC TRANSFER SWITCH
PM	POWER MONITORING UNIT
	SCHNEIDER ELECTRIC, POWERLOGIC PM5560, OR APPROVED EQUAL
EE	ENERGY ELEMENT, VOLTAGE SENSOR
IE	CURRENT ELEMENT, AMPERE SENSOR
VFD	VARIABLE FREQUENCY DRIVE
P	PUMP
LE-1	LEVEL ELEMENT
	SUBMERSIBLE PRESSURE TRANSDUCER
LE-2	LEVEL ELEMENT
	FREE-AIR RADAR TRANSMITTER
LIT	LEVEL INDICATING TRANSMITTER
LS	LEVEL SWITCH (WEIGHTED FLOAT SWITCH)
	AL : ALARM LOW / STOP ALL PUMPS
	AH : ALARM HIGH / LEAD PUMP START
FE-1	FLOW ELEMENT
	ELECTROMAGNETIC FLOW METER
FIT-1	FLOW INDICATING TRANSMITTER
	FLOW METER INTERFACE (MATCH FE-1'S MANUFACTURER)
DCPS	DC POWER SUPPLY
	24VDC, 120W, 5A, UNLESS OTHERWISE NOTED
PLC	PROGRAMMABLE LOGIC CONTROLLER

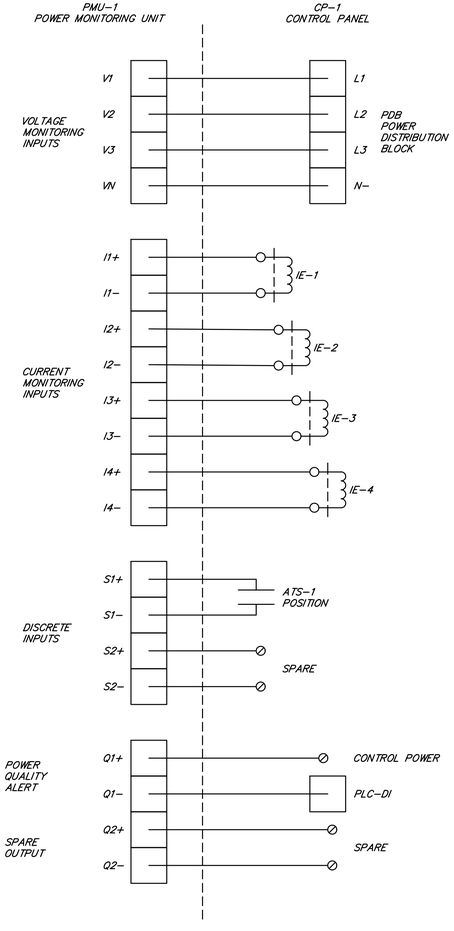


ANALOG LOOP WIRING (TYPICAL)

SCALE: N/A

NOTES:

1. CONTRACTOR TO INSTALL ANALOG SIGNAL LOOP ISOLATORS WHERE NECESSARY TO PROVIDE A COMPLETE OPERATIONAL SYSTEM.

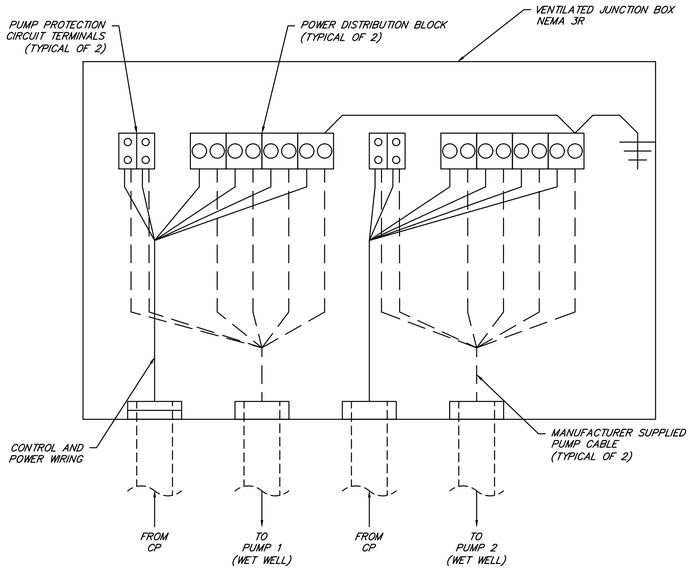


POWER MONITORING UNIT INTERCONNECTION DETAIL

SCALE: N/A

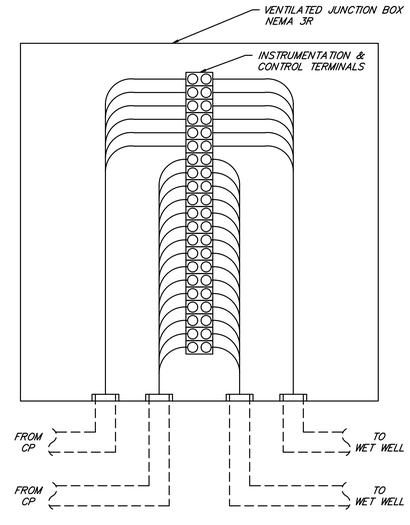
NOTES:

1. CONTRACTOR SHALL PROVIDE NEW CABLES AND WIRE FOR ALL PROPOSED EQUIPMENT TO BE INSTALLED.
   1.1. ALL CONDUCTORS SHALL BE STRANDED COPPER, WITH THHN INSULATION, UNLESS OTHERWISE NOTED OR APPROVED.
2. ALL CONTROL POINTS ON PROPOSED EQUIPMENT SHALL BE CLEARLY LABELED AND WIRED TO TERMINALS IN CONTROL PANEL FOR SYSTEM INTEGRATION. THIS INCLUDES CONTROL SIGNALS NOT UTILIZED IN THE CURRENT CONTROL SCHEME.
3. PUMP PROTECTION RELAYS TO BE MOUNTED THOUGH DOOR AND HAVE INDICATOR LIGHTS AND RESET BUTTON BUILT IN.
4. ALL 480 VAC CIRCUIT BREAKERS TO BE OPERABLE THROUGH PANEL'S "DEAD-FRONT" DOOR CUTOUTS.
5. "BACKUP ON" INDICATOR LIGHT SHALL ILLUMINATE WHEN PUMPS ARE RUNNING IN BACKUP MODE.
6. LEVEL TRANSMITTER DISPLAY SHALL BE INSTALLED INSIDE THE CONTROL PANEL.
7. CONTROL PANEL SHALL HAVE A 2 POSITION SELECTOR SWITCH INSTALLED WHICH ALLOWS OPERATOR TO SELECT THE PRIMARY LEVEL TRANSMITTER; LE-1 / LE-2 (SUBMERSIBLE TRANSDUCER / RADAR TRANSMITTER). PUMPS SHALL OPERATE IN ACCORDANCE TO THE PRIMARY LEVEL TRANSMITTER'S LEVEL READING.



PUMPS JUNCTION BOX DETAIL

SCALE: N/A



INSTRUMENTATION JUNCTION BOX DETAIL

SCALE: N/A

BY	MARK	REVISIONS	DATE

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HOWELL TOWNSHIP
PUMP STATION STANDARDS

10 TO 250 GPM INSTRUMENTATION DIAGRAM & DETAILS

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DE. BY: LAM	CH. BY: TCA	PROJECT NO. 13176.3SG2021
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DATE MARCH, 2025	FILE NO. DS-5156-3	02
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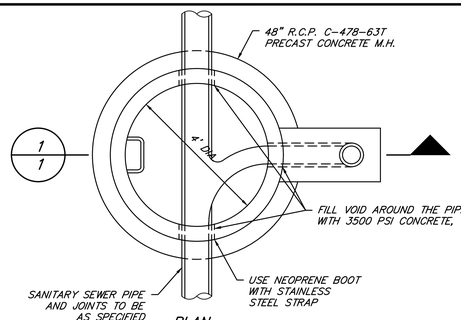
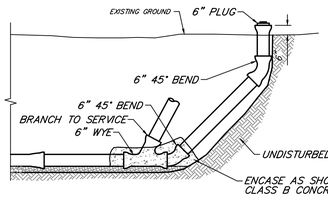
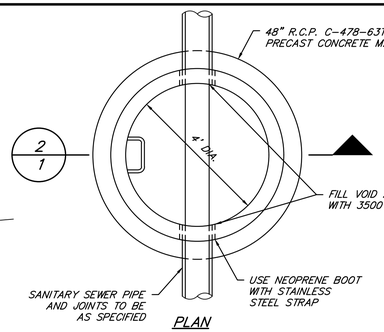


1/1 PLAN

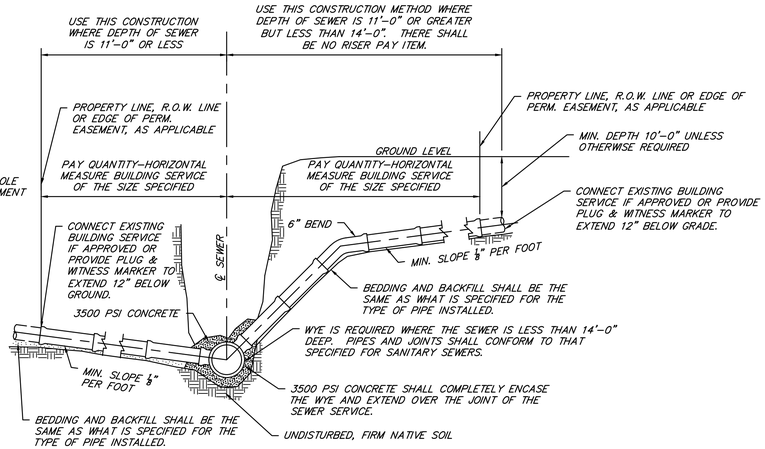
TRENCH WIDTH CHART

PIPE SIZE	MINIMUM	MAXIMUM
8" & 10"	24"	30"
12" & 15"	30"	36"
18"	34"	40"
21"	38"	42"
24"	42"	46"
27"	45"	49"
30"	49"	53"
36"	56"	60"
LARGER THAN 36"	I.D. +20"	I.D. +24"



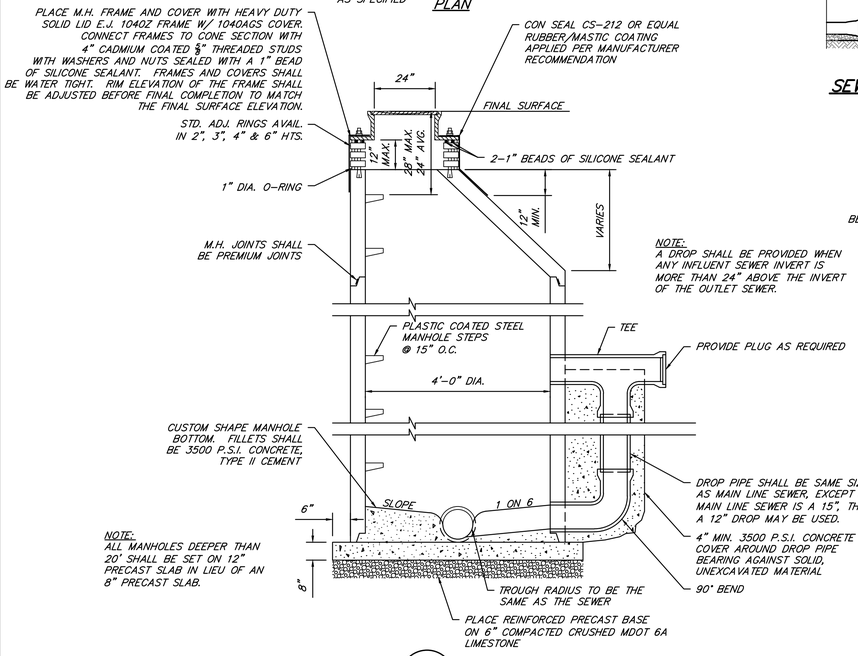


2/1 PLAN



SEWER SHALLOWER THAN 14'-0" SERVICE DETAIL

1/4" = 1'-0"



NOTE: ALL MANHOLES DEEPER THAN 20' SHALL BE SET ON 12" PRECAST SLAB IN LIEU OF AN 8" PRECAST SLAB.

1/1 SECTION

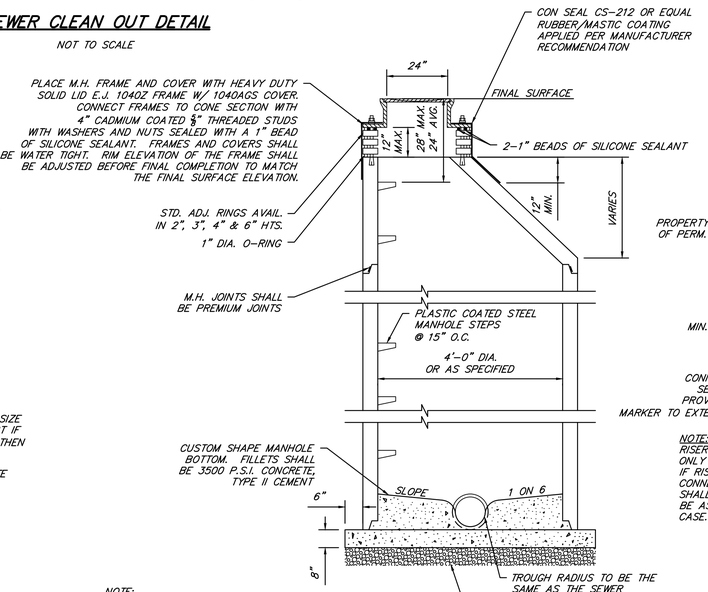
STANDARD DROP MANHOLE

SCALE: 1/2" = 1'-0"

SEWER CLEAN OUT DETAIL

NOT TO SCALE

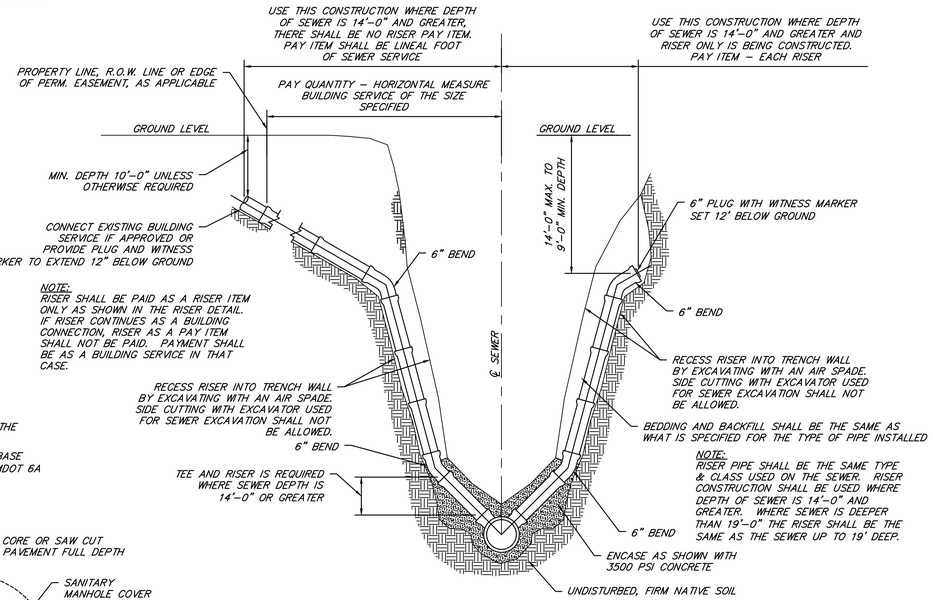
NOTE: A DROP SHALL BE PROVIDED WHEN ANY INFLUENT SEWER INVERT IS MORE THAN 24" ABOVE THE INVERT OF THE OUTLET SEWER.



2/1 SECTION

STANDARD MANHOLE

SCALE: 1/2" = 1'-0"



NOTE: RISER SHALL BE PAID AS A RISER ITEM ONLY AS SHOWN IN THE RISER DETAIL. IF RISER CONTINUES AS A BUILDING CONNECTION, RISER AS A PAY ITEM SHALL NOT BE PAID. PAYMENT SHALL BE AS A BUILDING SERVICE IN THAT CASE.

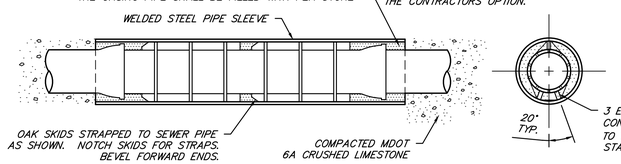
NOTES:
ALL HOUSE OR BUILDING SERVICES CROSSING UNDER IMPROVED ROADS SHALL BE INSTALLED AT, AND TO, THE PROPER GRADE BY BORING, UNLESS OTHER METHOD IS APPROVED IN WRITING. CASINGS, IF REQUIRED BECAUSE OF THE GROUND CONDITION, SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR AT THE BID PRICE PER FOOT OF HOUSE OR BUILDING SERVICE. ALL SEWER SERVICES SHALL END IN AN OPEN CUT. WHERE THE PROPOSED SEWER IS LOCATED WITHIN THE TRAVELED SURFACE OF AN UNIMPROVED ROAD, THE HOUSE OR BUILDING SERVICE SHALL BE INSTALLED IN AN OPEN CUT. SERVICES CONNECTED INTO MANHOLES SHALL ENTER THE MANHOLE 30" OR LESS ABOVE THE INVERT AND SHALL BE CONSTRUCTED AS SHOWN ABOVE. HOUSE AND BUILDING PIPE AND JOINTS SHALL CONFORM TO THAT SPECIFIED OR AS LISTED IN THE PROPOSAL. PAY QUANTITY FOR SERVICES SHALL INCLUDE MAKING CONNECTIONS WHERE NECESSARY, PROVIDING BENDS, PLUGS, WITNESS MARKERS, AND CONCRETE AS SPECIFIED. ALL PIPE, BENDS, AND PLUGS SHALL BE OF THE TYPE REQUIRED IN THE PROPOSAL ITEM FOR RISERS AND SHALL INCLUDE SAND BACKFILL AND CONCRETE AS SPECIFIED WHERE REQUIRED.
ALL MANHOLES DEEPER THAN 20' SHALL BE SET ON 12" PRECAST SLAB IN LIEU OF AN 8' PRECAST SLAB.
MANHOLE FRAME RIM ELEVATIONS LOCATED IN CULTIVATED FIELDS SHALL BE SET 6" BELOW THE MAXIMUM PLOW DEPTH (TYPICAL).
MANHOLE FRAMES SET PRIOR TO ESTABLISHING FINAL GRADES SHALL BE RESET TO FINAL GRADE IF NEEDED AT NO COST TO THE OWNER.

SEWER DEEPER THAN 14'-0" SERVICE AND RISER DETAIL

1/4" = 1'-0"

LEGEND

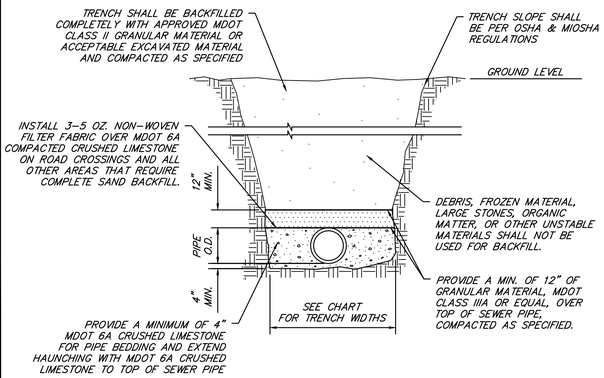
- PROPOSED SANITARY SEWER
- PROPOSED WYE OR TEE
- PROPOSED RISER
- PROPOSED FORCE MAIN



NOTE: PRESSURE TREATED LUMBER MAY BE SUBSTITUTED FOR HARDWOOD SKIDS AT THE CONTRACTORS OPTION.

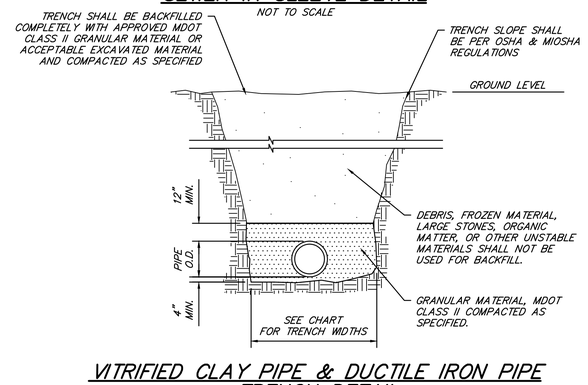
SEWER IN SLEEVE DETAIL

NOT TO SCALE



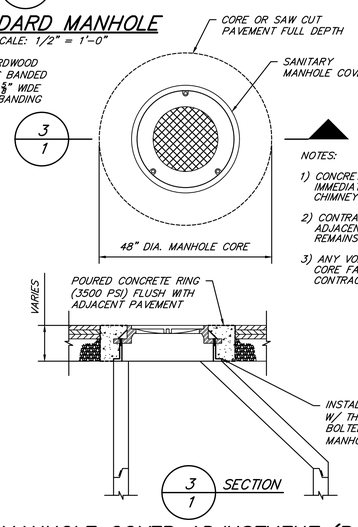
P.V.C. PIPE TRENCH DETAIL

1/4" = 1'-0"



VITRIFIED CLAY PIPE & DUCTILE IRON PIPE TRENCH DETAIL

1/4" = 1'-0"



3/1 SECTION

NOTES:
1) CONCRETE SHALL BE POURED IMMEDIATELY UPON COMPLETION OF CHIMNEY WORK.
2) CONTRACTOR SHALL ENSURE THE ADJACENT AGGREGATE BASE COURSE REMAINS IN PLACE AND UNDISTURBED.
3) ANY VOIDS CREATED OUTSIDE OF THE CORE FACE SHALL BE CORRECTED AT THE CONTRACTOR'S EXPENSE.

MANHOLE COVER ADJUSTMENT (PAVED AREAS)

NOT TO SCALE

BY	MARK	REVISIONS	DATE
ACJ		UPDATED PER HOWELL TWP AND WHOG COMMENTS	03-03-25

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STANDARD DETAILS
SANITARY SEWER PLANS

SANITARY SEWER DETAILS FOR SEWER TRENCH, SERVICES AND MANHOLES

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DE. BY: SGI	CH. BY: SGI	PROJECT NO.	
DR. BY: SGI	APP. BY: SGI		
STDS. DS-1156-2A	SHEET 1 OF 1		
DATE SEPTEMBER 2017	FILE NO. DS-1156-2A		
SCALE NOT TO SCALE			

RET. F.B. PG. ACAD FILE: DS1156ZA
PLOTTING SCALE: 1=1
APPROVED BY: WJS
CHECKED BY: DRS
DRAWN BY: MDR/CJA
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