IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION II

SITE WORK

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 02110
SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of surface debris.

B. Removal of paving, curbs, and gutters.

C. Clearing site of plant life and grass.

D. Removal of trees and shrubs.

E. Removal of root system of trees and shrubs.

1.2 DEFINITIONS

A. Clearing shall consist of the cutting, removal and satisfactory disposal of all trees, stumps, brush, shrubs, rubbish, pavement, curbs, aggregate surfacing, and any other objectionable material within the designated areas.

B. Grubbing shall consist of the removal and disposal of all stumps larger than 1-½ inches in diameter and other objectionable material to a depth of at least 18 inches below the ground surface.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT

A. This work shall be incidental to construction and separate payment will not be made for site clearing unless it is included as a specific bid item.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable state and local codes for disposal of debris, burning debris on site, and use of herbicides.

B. Coordinate clearing Work with utility companies.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that existing plant life designated to remain, is tagged or identified.

3.2 PROTECTION

A. The Contractor shall protect areas shown on the Drawings or designated by the Engineer to remain protected from damage by construction operations by erecting suitable barriers or other acceptable means. Areas outside the limits of construction as shown on the

Drawings shall be protected and no equipment or materials shall be stored or allowed to damage these areas.

B. Locate, identify, and protect utilities that remain, from damage.

C. Protect trees, plant growth, and features designated to remain, as final landscaping.

D. Protect bench marks, survey control points and existing structures from damage or displacement.

3.3 CLEARING AND GRUBBING

A. Clear areas required for access to site and execution of Work.

B. Remove paving, curbs, and sidewalks as indicated on drawings or as required to install work, but limited to the specified pay limits.

C. The site of the work shall be cleared of all trash and debris found on the site.

D. Grass and weeds shall be mowed to a height of not more than three inches and rakes into windrows or piles.

E. Trees noted to be removed shall be removed to a minimum depth of 2 feet 0 inches below the surface of the finished grade. Apply herbicide to remaining stumps to inhibit growth.

F. All materials accumulated by clearing and grubbing operations shall be disposed of at an offsite location to be provided by the Contractor.

G. Backfill all excavated depressions with approved material and grade to drain.

3.4 STRIPPING

A. Scrape areas clean of all brush, grass, weeds, roots, and other materials.

B. Strip to a depth of approximately 6 inches or to a sufficient depth to remove excessive roots in heavy vegetation or brush areas and as required to segregate topsoil.

C. Strip topsoil to a depth of not less than four inches from all areas to be covered by buildings, pavement, curb and gutter or other construction.

D. Material obtained by stripping shall be stockpiled for use in finish grading or areas not covered by construction. Do not mix with foreign materials.

E. Stockpile topsoil in areas designated where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, debris, and stones larger than 2-inch diameter.

F. Do not excavate wet topsoil.

3.5 GRADE AROUND TREES

A. Trenching: Where trenching is required around trees which are to remain, avoid cutting the tree roots by careful hand tunneling under or around the roots. Avoid injury to or prolonged exposure of roots.

B. Raising Grades: Where existing grade at a tree is below the new finished grade and fill not exceeding 16 inches is required, place 1 to 2 inches of clean, washed gravel directly around the tree trunk. Extend gravel out from trunk on all sides of at least 18 inches and finish 2 inches above finished grade at tree. Install gravel before earth fill is placed. Do not leave new earth fill in contact with any tree trunks.

C. Lowering Grades: Regrade by hand to elevation required around existing trees in areas where new finished grade is to be lower. As required, cut the roots cleanly 3 inches below finished grade and cover scars with tree paint.

3.6 DISPOSAL

A. All roots, vegetation and other removals shall be removed from the site and disposed of by the Contractor. Burning of any material on the site will be allowed only with the proper permits.

END OF SECTION 02110

SECTION 02200
EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Striping and replacement of topsoil.

B. Excavation and filling.

C. Preparing of subgrade.

D. Grading.

1.2 RELATED SECTIONS

A. Section 02110 - Site Clearing

B. Section 02990 - Restoration and Cleanup

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. D 698 Moisture-Density Relations of Soils Using 5.5 lb. (2.5 kg) Rammer and a 12 inch (304.8 mm) Drop.
2. D 1556 Density of Soil In Place by the Sand-Cone Method.
3. D 2167 Density of Soil In Place by the Rubber Balloon Method.
4. D 2729 Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
5. D 2852 Styrene-Rubber Plastic Drain and Building Sewer Pipe and Fittings.
6. D 2922 Test Methods for Density of Soil and Soil Aggregate In Place by Nuclear Methods (Shallow Depth).
7. D4318 Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
8. D4546 Test Method for One-Dimensional Swell/Settlement Potential of Cohesive Soils.

B. Federal Register - Occupational Safety and Health Administration (OSHA)
1. 29CFR Part 1926 Occupation Safety and Health Standards - Excavations.

C. Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001 (IDOT).

1.4 DEFINITIONS

A. Earthwork is defined as all excavation, trenching, fill, backfill, site preparation, subgrade preparation and other appurtenant work.

B. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

C. Classification: Excavation shall be unclassified, and the term "excavation" shall include all material encountered without regard to its physical properties, characteristics or composition.

D. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Engineer.
2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

E. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer, who will make an inspection of conditions. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Engineer. The Contract Sum may be adjusted by an appropriate Contract Modification.
1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.

F. Subgrade: The undisturbed earth or the compacted soil layer immediately below pavements, subbase or topsoil materials.

G. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

1.5 SUBMITTALS

A. Test Reports: Contractor shall submit the following reports from the testing services.
1. Test reports on borrow material.
2. Verification of suitability of each subgrade and borrow material, in accordance with specified requirements.
3. Field reports; in-place soil density tests.
4. One optimum moisture-maximum density curve for each type of soil encountered.
5. Report of actual unconfined compressive strength and/or results of specified tests of each stratum tested.

1.6 LIMITS OF THE WORK

A. Earthwork shall not extend beyond the areas of excavation, embankment or other construction shown on the drawings.

B. Excavations for new construction shall not undercut existing footings and foundations.

1.7 SAFETY AND PROTECTION:

A. Shoring, sheeting and bracing shall be provided as required to protect the work and workmen from damage or injury by caving or sloughing.

B. Laws and ordinances regulating health and safety measures shall be strictly observed.

1.8 JOB CONDITIONS

A. The Contractor shall satisfy himself as to the character and amount of different soil materials, groundwater and the subsurface conditions to be encountered in the work to be performed. Information and data, when furnished, are for the Contractor's general information. However, it is expressly understood that any interpretation or conclusion drawn there from is totally the responsibility of the Contractor. Engineer and Owner assume no liability for the accurateness of the data reported or the materials used.

B. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.9 TESTING

A. Testing for density and moisture content shall be completed by an authorized independent testing laboratory. Arranging for and coordination of testing shall be the responsibility of the Contractor. All costs for testing shall be paid for by the Contractor, incidental to excavation. Testing result reports shall be submitted to the Engineer. These tests are for the sole purpose of assisting the Engineer in determining that the specified density is being obtained. The density testing shall be performed using Standard Soil Proctor Curves provided by the Contractor. The Engineer has the authority and right to not accept backfill based on the results of these tests, but the results of the tests do not waive the responsibilities of the Contractor to ultimately guarantee the density and stability of the fill material. When test results indicate that compaction is not as specified, the material shall be removed, replaced, and recompacted to meet specification requirements at no expense to the Owner. Subsequent tests on recompacted areas shall be performed to determine conformance with specification requirements at the Contractor's expense. Density tests shall be made as specified or as directed by the Engineer. The Engineer shall determine the exact location of all tests.

1.10 PROTECTION AND REMOVAL OF UTILITY LINES

A. Existing utilities that are shown on the Drawings or the locations of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation and backfilling, and if damaged shall be repaired by the Utility company at Contractor's expense.

1.11 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

1.12 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
   1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
   2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
      a. Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.
   3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

B. Use of Explosives: Use of explosives is not permitted unless allowed by Engineer.

C. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
   1. Operate warning lights as recommended by authorities having jurisdiction.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

4. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2 PRODUCTS

2.1 EARTH FILL MATERIALS

A. Fill material used for compacted impervious material shall consist of excess suitable impervious material obtained from on-site suitable excavations or suitable imported clay or silt material. Excess suitable material obtained from structure and trench excavation shall be used for the construction of fills and embankments. Additional material shall be provided as required.

B. All material placed in fills and embankments shall be free from rocks, stones, or shale particles larger than 4 inches, frozen matter, brush, stumps, vegetation, logs, roots, debris, and organic or other deleterious materials. The material for fill shall have a liquid limit less than 45 percent and a plasticity index less than 25 as determined by ASTM D4318. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit, incorporated in the remainder of fills and embankments, shall be distributed so that they do not congregate or interfere with proper compaction.

2.2 EXCAVATED MATERIALS

A. Topsoil obtained by stripping and suitable for finish grading where arable soil is required shall be stockpiled in a location approved by the Engineer.

B. Excavated material approved for embankment, fill or backfill shall be placed in areas receiving embankment or stored for future use in a location approved by the Engineer.

C. If the Contractor deems it necessary to obtain additional area for stockpiling materials, it shall be obtained at no additional cost to the Owner.

2.3 BORROW MATERIAL

A. Where suitable materials, including topsoil, are not available in sufficient quantity from all required excavations under this contract, approved materials shall be obtained from approved sources on and off site at the Contractor's responsibility and expense. The necessary clearing and grubbing of borrow areas, disposal and removing of debris therefrom, the developing of sources including any access roads for hauling, the necessary right-of-way, and the satisfactory drainage of the borrow areas shall be considered as incidental items to borrow excavation.

B. Material obtained for fill shall be approved by the Engineer. Fill material shall be limited to materials specified in Section 2.01 - Earth Fill Materials.

2.4 DUST CONTROL

A. Calcium Chloride: Meet requirements of IDOT 4194.01.

B. Lignosulfonates (Tree sap): Lignosulfonate 58A. Other commercially available Lignosulfonate products intended for dust control may be allowed upon approval of Engineer.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

A. Topsoil shall be stripped to a minimum depth of 6 inches in all areas of cut or fill and stockpiled on the site at a location approved by the Engineer.

3.2 PRESERVATION OF TREES AND SHRUBS

A. Trees and shrubs to be preserved shall be thoroughly protected from scarring or other injury during grading operations. Excavation operations shall not disturb the original ground around trees within a distance of one foot or twice the diameter of the tree, whichever is greater. Exposed roots resulting from excavation shall be cut cleanly and covered with humus-bearing soil.

B. When necessary or required by the Contract Documents, trees or shrubs around which embankment is placed shall be protected by tree wells built in accordance with Detailed Drawings or as laid out in the field by the Owner or Engineer.

3.3 EXCAVATION

A. Excavation is unclassified. Perform excavation regardless of the type, nature, or condition of the material encountered to accomplish the construction.

3.4 STORAGE OF EXCAVATED MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
   1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
   2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill as directed by Engineer.

3.5 EXCAVATION FOR STRUCTURES

A. The structures have been designed to be constructed by open cut and constructed in a dry condition. All dewatering shall be provided at the Contractor's expense.

B. The entire area to be covered by the structures shall be excavated as shown by details on the drawings to elevations of the footings, foundations and floor slabs.

C. Footings, foundations and floor slabs shall be excavated to neat lines as shown on drawings, and shall be formed as required by site conditions.

D. Sheet piling may be used in lieu of open cut. If sheet piling is utilized, the piling must be removed as the backfill is replaced. In no event shall it be left in place permanently.

3.6 EXCAVATION FOR PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.
   1. Reworking subgrades involves scarification of the upper 12 inches of the subgrade, moisture adjustment of the soils as required, and recompaction.
   2. In areas to receive new fill, exposed subgrades, after stripping, shall be scarified to a minimum depth of 6", adjusted in moisture content as needed, and compacted prior to placing new fill.

B. All areas where existing rock/gravel subgrade has a required cut of less than three inches shall be proof rolled with no scarification required.

3.7 FILL WITHIN STRUCTURES

A. Approved fill shall be placed at optimum moisture content in lifts of not more than 8 inches loose lift and compacted to at least 95 percent of Laboratory Maximum Density. Fill shall be placed up to the bottom of the structural floor slabs, with allowance for capillary water barrier (gravel sub-base) and/or concrete mud mat as specified or shown on the drawings, to the elevations shown.

3.8 BACKFILL FOR STRUCTURE FOUNDATION WALLS, GRADE BEAMS AND FOOTINGS

A. Backfill shall be brought up on each side of the foundation wall concurrently. After foundation walls, grade beams and footings have cured, forms have been removed, and all trash has been removed, backfill shall be placed at optimum moisture content in lifts of not more than 6 inches loose lifts and compacted to at least 95 percent of Laboratory Maximum Density.

B. Backfill for areas not to be paved shall be placed to within 6 inches of the finished grade. The top 6 inches shall be topsoil.

3.9 PLACEMENT AND COMPACTION

A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

B. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. No frozen material can be placed.

C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Engineer if soil density tests indicate inadequate compaction.
   1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D-698 Standard Proctor:
      a. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
      b. Under paving, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
   2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
      a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.10 GRADING

A. General: Uniformly grade areas within limits of grading, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes.

C. After construction is completed, areas requiring finish grading shall be cleared of all building materials, equipment and debris and a minimum depth of 6 inches of topsoil placed. The 6 inches of topsoil is included in and not added to the final grade indicated on the plans. Surfaces shall be smooth and suitable for planting or sodding.

D. Under pavement, pads and sidewalks, excavate and fill to grades and contours shown on the Drawings, making allowance for thickness of pavement, pads and sidewalks.

E. General Fill:
1. Excavate and fill to grades and contours shown on the Drawings making allowance for the placing of a minimum of 6 inches of topsoil.
2. Areas receiving embankment or topsoil shall be scarified to a depth of 6 inches and recompacted at optimum moisture content to at least 90 percent of Laboratory Maximum Density.
3. Fill material shall be approved earth free of stones larger than 4 inches diameter and suitable for compaction. Fill material shall be placed at optimum moisture content in lifts not to exceed 8 inches loose lift and compacted to at least 90 percent of Laboratory Maximum Density.
4. Topsoil shall be placed in a 6 inch lift and not compacted.

3.11 SUBGRADE PREPARATION FOR PAVEMENT, PADS, SIDEWALKS AND CURBS

A. Subgrade preparation shall extend two (2) feet beyond the back of curb line or edge of pavement, which ever is appropriate. Sidewalk subgrade preparation shall be limited to width of sidewalk and form limits.

B. The subgrade shall be free of organic material, trash and debris, and rocks larger than 3" inches in diameter. Subgrade shall not be frozen while construction is in progress.

C. The preparation of the subgrade shall consist of bringing the area to be paved to a subgrade conforming to the required grade and cross section, of uniform density, ready to receive the sub-base or pavement. This is to be accomplished by excavating or backfilling as needed, shaping, watering as required, or permitting to dry to proper consistency, and rolling the entire area with an approved self-propelled roller weighing not less than 8 tons. Shaping and rolling shall be continued until the subgrade has been properly prepared and shows that no further compaction of any practical benefit would result from continued compaction. The subgrade shall be tested as to cross section, crown and elevation. After being properly prepared, it shall be so maintained until the base course is constructed. A completed subgrade shall be maintained sufficiently in advance of the base course operations to permit proper control. Any part of the subgrade area not accessible to a roller shall be thoroughly compacted by hand or mechanical compaction in a manner acceptable to the Engineer.

D. Disk, scarify, mix and recompact the top 12 inches of subgrade with moisture and density control.

1. Disks (approximately 36 inches in diameter) and rollers (approximately 60" in diameter) to be adequately sized to insure moisture and density control at 12 inches.
2. If equipment is not sized to perform moisture and density requirements at minus 12 inches, then excavate top 6 inches of subgrade, scarify, mix, and recompact next 6 inches of subgrade with moisture and density control. Pulverize, mix, and replace top 6 inches of subgrade and compact.

E. Compact to not less than 95% Maximum Standard Proctor Density; moisture content not less than optimum or more than 4% above optimum moisture content.

F. The subgrade material shall be properly worked and installed to provide a stable road base, absent of shrinkage or swell potential. The subgrade shall be maintained within the proper moisture content limits until the curb & gutter and / or pavement is placed. Mechanical tamping may be utilized or required for certain areas. If the subgrade contains excess moisture the subgrade shall be aerated or removed and replaced with new material so that moisture limits fall within limits of the standard proctor. The prepared subgrade shall support the weight of vehicles and equipment without producing ruts in the surface, and shall be maintained until pavement has been placed thereon. The Engineer may require proof rolling of the subgrade surface. Proof rolling shall be provided at no additional cost to the Owner.

G. The elevations and cross sections of the subgrade surface shall be thoroughly checked immediately prior to the pavement placement. All high and low places shall be removed and filled with suitable material and mechanically tamped. All subgrades shall be checked not less than 100 feet in advance of paving operation. Any damage or irregularities to the subgrade during paving operations shall be repaired prior to placing of additional pavement.

3.12 SUBGRADE TREATMENT (ONLY IF REQUIRED AND APPROVED BY ENGINEER):

A. Lime or Fly Ash: Upon review of a Soil Engineer, lime or fly ash stabilization may be used as subgrade treatment.
1. Construct in 6 inch layers.
2. Scarify to the proper depth.
3. Incorporate the stabilizing material uniformly.
4. Test for support.

B. Polymer Grid: Upon review of the Engineer, a polymer grid may be used to stabilize the subgrade or reinforce the pavement section.
1. A minimum of 6 inches of well graded granular backfill will be placed on the polymer grid.
2. Largest particle size of backfill will not exceed 1-1/2 inches with less than 10% passing the No. 200 sieve.
3. Installation shall adhere to the guidelines set forth by the polymer grid manufacturer.

3.13 UNSTABLE SUBBASE/EXCAVATION BELOW SUBGRADE

A. Deposits of frost-heave material, unstable soils, topsoil containing considerable amounts of organic matter, or other undesirable foundation material shall be removed from the area and shall be replaced as directed by the Engineer in the field.

B. Contractor shall notify the Engineer of any questionable material. .

3.14 CONTROL OF WATER

A. Surface Water:
   1. Surface water shall be diverted to prevent entry to trenches and excavations for structures.
   2. In the event surface water does accumulate in trenches and other excavations, the excavations shall be dewatered as necessary to permit the proper execution of the work. Dewatering shall be provided at no additional cost to the Owner.

B. During construction, ditches and channels shall be drained at all times by keeping the excavation areas and embankments sloped to the approximate section of the final earth grade. If existing surface drainage must be interrupted, temporary drainage shall be provided.

C. Construction in and adjacent to flowing streams shall be performed to avoid washing, sloughing or deposition of materials into the channel which may obstruct or impair stream flow, or which may result in contamination and/or silting of the stream.

D. Precautions shall be taken to preserve, protect, and continue service of all existing tile drains, sewers, and other subsurface utilities; repair any damage to drains, sewers and utilities.

E. Ground Water: Where ground water is encountered, trenches and other excavations shall be dewatered as necessary to permit the proper execution of the work.

3.15 PROTECTION

A. Subgrade shall be repaired from action of the elements or others. Any settlement or erosion that occurs prior to the placing of the pavement thereon, shall be repaired and the specific lines, grades and cross section re-established. Any subgrade that has become unacceptable shall be reworked as necessary to restore the subgrade to shape, tolerance, density, and moisture content range for such density, immediately prior to the placing of the pavement. The Contractor shall protect all existing improvements from damage resulting from his subgrade operation. Any improvements damaged shall be repaired or replaced at no additional expense to the Owner.

B. Protect excavation bottoms against freezing when anticipated atmospheric temperature is less than 35 degrees F.

3.16 FIELD QUALITY CONTROL

A. Compaction Testing: Contractor to arrange and pay for compaction testing by independent testing laboratory.

B. Density: Obtain required compaction not less than 95% of maximum Standard Proctor Density.

C. Moisture Range: Obtain required compaction within a soil moisture range of optimum moisture to 4 percentage points above optimum moisture content.

D. Testing:
   1. Lab Test: Determine laboratory density of material in accordance with ASTM D 698 (Standard Proctor Density) or ASTM D 4253 and D 4254 (Maximum and Minimum Index Density for Cohesionless Soils). Provide at least one analysis for each material type used as backfill unless provided by Jurisdictional Engineer.
   2. Field Test: Perform in-place field density and moisture testing in accordance with ASTM D 2922 and D 3017 (nuclear) or ASTM D 1556 (sand cone) and D 2216 (moisture content).
   3. Frequency:
      a. Urban Section: Provide one test per lift per 150 feet. If section is less than 300 feet, a minimum of two tests per lift will be required.

b. Rural Section: Provide one test for each 500 cubic yards of material placed with a minimum of two tests per lift.

4. Show compliance with specifications.
5. Locations to be tested will be selected by Engineer.
6. Additional testing may be required by Engineer if noncompliance or change in conditions occurs.

E. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the embankment.

3.17 EROSION CONTROL

A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction.

3.18 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off Owner's property. No prearranged disposal site or related permits have been determined or secured by the Owner. Contractor to obtain all required permits and pay all fees. Provide written verification that proper permits have been acquired or provide agreements with private parties for all disposal sites. Cost for removal and disposal of materials shall be incidental and no separate payment shall be made for this work.

END OF SECTION 02200

SECTION 02202
ROCK EXCAVATION

PART 1 GENERAL

1.1 WORK INCLUDED

A. Excavation, removal, transportation and disposal of rock encountered during excavation operations.

B. Blasting will not be allowed for this project.

1.2 REFERENCES

A. NFPA 495 – Code for the Manufacture, Transportation, Storage, and Use of Explosive Material.

1.3 QUALITY ASSURANCE

A. Contractor shall provide evidence of sufficient experience, equipment and personnel to perform rock removal operations.

1.4 PAYMENT

A. Rock excavation and removal will not be considered a pay item but shall be subsidiary to other project bid items. The quantity of rock excavation has not been determined. The Contractor shall perform any borings, surveys or tests prior to preparing the bid to determine the amount of rock excavation and removal and include this work in the bid.

PART 2 PRODUCTS

2.1 ROCK

A. Definition: Solid mineral material consisting of Igneous, Metamorphic and Sedimentary Rock that cannot be removed from the trench by excavation equipment alone, and that requires the use of rock hammers, rippers or explosives for efficient removal shall be classified as rock.

B. Rock Quantities: Quantities are not listed on the bid form. The Contractor is responsible for estimating the amount of rock he anticipates encountering. ALL excavated materials are unclassified and payment will be made in accordance with Section 01250 - Measurement and Basis of Payment.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify site conditions and note irregularities affecting work of this Section.

B. Beginning work of this Section means acceptance of existing conditions.

3.2 ROCK EXCAVATION - MECHANICAL METHOD

A. Excavate and remove rock by the mechanical method.

B. Cut away rock at excavation bottom to form level bearing.

C. Remove shaled layers to provide sound and unshattered base for footings, foundations, or pipeline bedding material as detailed.

D. In utility trenches, excavate to 6 inches (150 mm) below invert elevation of pipe.

E. Remove from site and properly dispose of excavated material.

3.3 FIELD QUALITY CONTROL

A. Provide for visual inspection of bearing surfaces and cavities formed by removed rock.

3.4 ROCK EXCAVATION - EXPLOSIVES METHODS

A. Blasting will not be permitted.

END OF SECTION 02202

SECTION 02225
TRENCHING, BACKFILLING & COMPACTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Trenching, backfilling and compacting for piping and appurtenances.

1.2 RELATED SECTIONS

A. Section 02200 - Earthwork

B. Section 02990 - Restoration and Cleanup

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. D 698 Moisture-Density Relations of Soils Using 5.5 lb. (2.5 kg) Rammer and a 12 inch (304.8 mm) Drop.
2. D 1556 Density of Soil In Place by the Sand-Cone Method.
3. D 2167 Density of Soil In Place by the Rubber Balloon Method.
4. D 2729 Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
5. D 2852 Styrene-Rubber Plastic Drain and Building Sewer Pipe and Fittings.
6. D 2922 Test Methods for Density of Soil and Soil Aggregate In Place by Nuclear Methods (Shallow Depth).
7. D4318 Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
8. D4546 Test Method for One-Dimensional Swell/Settlement Potential of Cohesive Soils.

B. Federal Register - Occupational Safety and Health Administration (OSHA)
1. 29CFR Part 1926 Occupation Safety and Health Standards - Excavations.

C. Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001 (IDOT).

1.4 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Separate payment will not be made for trenching, backfilling and compacting. This work shall be incidental to pipe installed.

1.5 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.6 FIELD MEASUREMENTS

A. Verify that survey bench mark, control point, and intended elevations for the Work are as shown on drawings.

1.7 SUBMITTALS

A. Test Reports: Contractor shall submit the following reports from the testing services.
1. Test reports on backfill.

2. Verification of suitability of each backfill material, in accordance with specified requirements.
3. Field reports; in-place soil density tests.
4. One optimum moisture-maximum density curve for each type of soil encountered.
5. Report of actual unconfined compressive strength and/or results of specified tests of each stratum tested.

1.8 SAFETY AND PROTECTION:

A. Shoring, sheeting and bracing shall be provided as required to protect the work and workmen from damage or injury by caving or sloughing.

B. Laws and ordinances regulating health and safety measures shall be strictly observed.

1.9 JOB CONDITIONS

A. The Contractor shall satisfy himself as to the character and amount of different soil materials, groundwater and the subsurface conditions to be encountered in the work to be performed. Information and data, when furnished, are for the Contractor's general information. However, it is expressly understood that any interpretation or conclusion drawn there from is totally the responsibility of the Contractor. Engineer and Owner assume no liability for the accurateness of the data reported or the materials used.

B. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.10 TESTING

A. Testing for density and moisture content shall be completed by an authorized independent testing laboratory. Arranging for and coordination of testing shall be the responsibility of the Contractor. All costs for testing shall be paid for by the Contractor, incidental to pipe or structure installation. Testing result reports shall be submitted to the Engineer. These tests are for the sole purpose of assisting the Engineer in determining that the specified density is being obtained. The density testing shall be performed using Standard Soil Proctor Curves provided by the Contractor. The Engineer has the authority and right to not accept backfill based on the results of these tests, but the results of the tests do not waive the responsibilities of the Contractor to ultimately guarantee the density and stability of the backfill material. When test results indicate that compaction is not as specified, the material shall be removed, replaced, and recompacted to meet specification requirements at no expense to the Owner. Subsequent tests on recompacted areas shall be performed to determine conformance with specification requirements at the Contractor's expense. Density tests shall be made as specified or as directed by the Engineer. The Engineer shall determine the exact location of all tests.

1.11 PROTECTION AND REMOVAL OF UTILITY LINES

A. Existing utilities that are shown on the Drawings or the locations of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation and backfilling, and if damaged shall be repaired by the Utility company at Contractor's expense.

1.12 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

1.13 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during excavation operations.
   1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
   2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
      a. Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.
   3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

B. Use of Explosives: Use of explosives is not permitted unless allowed by Engineer.

C. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
   1. Operate warning lights as recommended by authorities having jurisdiction.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
   4. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout. Maintain moist condition for root system and cover exposed roots with moistened burlap.

1.14 COORDINATION

A. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 BEDDING MATERIAL

A. Crushed stone meeting requirements of IDOT 4120.04 Class A.

2.2 GRANULAR BACKFILL

A. Crushed stone as specified for bedding material.

2.3 STABILIZING MATERIAL (ONLY IF APPROVED BY ENGINEER)

A. Sharp, clean crushed stone complying with the following gradation:

Sieve	% Passing
3"	100
2 1/2"	90-100
2"	35-70
1 1/2"	0-15
3/4"	0-5

2.4 BACKFILL MATERIALS

A. General: Backfill material shall be that material excavated from the trench, providing that the material does not contain any unacceptable material and can be effectively compacted by mechanical or pneumatic compaction equipment to the specified density.

B. Acceptable Backfill Materials:
   1. Provide soil materials free from organic matter and deleterious substances, containing no rocks or lumps over 6 inches in greatest dimension, frozen materials, rubbish, or unsuitable materials.
   2. Backfill material is subject to approval of the Engineer.
   3. Rocks having a dimension greater than 2 inches shall not be permitted within 12 inches of new piping, nor in the upper 12 inches of backfill.

2.5 STEEL CASING PIPE MATERIAL:

A. Pipe used for casing on pipe borings shall be smooth wall welded steel pipe meeting ASTM A139. All joints shall be continuous welded to full strength. Bevel or space ends of pipe to ensure penetration of weld for full thickness of the pipe wall. The following minimum wall thicknesses shall be used:

WALL THICKNESS (INCHES)

OUTSIDE DIAMETER	UNDER HIGHWAY	UNDER RAILROAD
12" & under	0.188	0.250
16"	0.250	0.250
18"	0.250	0.312
20"	0.250	0.312
24"	0.250	0.375
30"	0.312	0.500
36"	0.344	0.531

PART 3 EXECUTION

3.1 PREPARATION

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

B. Protect plant life, lawns, and other features remaining as a portion of final landscaping.

C. Protection of Persons and Property:
   1. Barricade open holes and depressions occurring as part of the work, and post warning lights on property adjacent to or with public access.
   2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

D. Protection of Utilities:
   1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to trenching. If damaged, repair or replace at no additional cost to the Owner.
   2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.

3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineer and secure instructions.
5. Do not proceed with permanent relocation of utilities until written instructions are received from the Engineer.

E. Dewatering:
1. Remove all water, including rainwater, encountered during trench and substructure work to an approved location by pumps, drains, or other approved methods.
2. Keep trenches and site construction area free from water.
3. Do all work in the dry. Lay no pipe in or pour no concrete on excessively wet soil.
4. Prevent surface water from flowing into excavation.

3.2 TRENCH EXCAVATION

A. Safety: The work shall be in accordance with the codes and standards of the Occupational Safety and Health Act of 1970, as amended, and the Iowa Occupational Safety and Health requirements. Nothing indicated in these specifications and the plans shall relieve the Contractor from complying with any appropriate safety regulations.

B. Excavate to the minimum width necessary for proper installation of the piping providing adequate room for backfill and jointing operations. Depth of trench excavation shall be to the dimension below the pipe as shown on the Standard Drawing on the plans.

C. Keep sides of trench as nearly vertical as practicable within the limits of excavating and safety codes. Maintain vertical walls of excavation below top of pipe or top of bedding as specified.

D. Dimension B, shown on the applicable Standard Drawing on the plans shall be considered maximum trench width limitation of "Pipe Envelope" unless specified otherwise.

E. Provide sheeting and shoring necessary for protection of the work and for the safety of personnel.
1. Prior to backfilling, remove all sheeting.
2. Do not permit sheeting to remain in the trench except when, in the opinion of the Engineer, field conditions or the type of sheeting or methods of construction are as such to make removal impracticable. In such cases, the Engineer may permit portions of the sheeting to be cut off and remain in the trench.

F. Excavate for new water pipe installation by open cut or by trenching.

G. Short sections of trench may be tunneled if, in the opinion of the Engineer, the conductor can be installed safely and backfill can be compacted properly.

H. New service lines to be installed beneath streets shall be bored unless open trench construction is allowed by Jurisdiction.

I. Remove boulders and other interfering objects and backfill voids left by such removals at no additional cost to the Owner.

J. Excavating for appurtenances:
1. Excavate for manholes, intakes and similar structures to a distance sufficient to leave at least 12 inches clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
2. Overdepth excavation beyond such appurtenances that has not been authorized by the Engineer will be at no additional cost to the Owner.

K. Accurately grade the trench bottom and place bedding to provide uniform bearing for the piping. Hand trim for bell and spigot pipe joints. Remove loose matter.

L. When unstable soil material is encountered which may not provide a suitable foundation for pipe, remove and replace with Extra Foundation Rock as specified below. Stabilizing material is to be located below pipe bedding material. Payment shall be at negotiated unit price. Notify Engineer of unsuitable foundation encountered prior to removal and replacement.

3.3 BEDDING

A. Place bedding as specified in applicable sections, or as shown on the applicable Standard Drawings on the plans.

3.4 BORING AND CASING PIPE

A. At locations indicated on the drawings the Contractor shall install the pipe by means of boring and casing.

B. This work shall include installing a pipe of the specified diameter and type of pipe in a steel casing of the type and thickness specified herein by the method of boring or auguring as specified herein or as approved in writing by the Engineer.

C. The operation shall be carried out without encroachment upon the traveled way by either the excavation or by the storage of equipment or materials. Suitable warning signs and lights shall be furnished and maintained by the Contractor. The restrictions and safety requirements of the highway agency or railway company with authority over the traveled way shall be observed.

D. Adequate sheeting and bracing shall be provided as necessary to protect the Contractor, the public and the integrity of the surrounding soil profile. A front shield shall be provided as necessary to control unstable or fluid soil conditions. The Contractor shall provide all equipment and materials required to install the specified pipe by the boring and casing method.

E. Casing Pipe: A casing pipe meeting Section 2.5.A shall be installed using equipment which encases the hole as the earth is removed. Boring without the concurrent installation of a casing pipe will not be permitted. Casing shall extend continuously through the entire bored length as indicated on the plans or as required. All joints shall be continuous welded.

F. Before boring and casing is started, the initial casing pipe section shall be carefully aligned on a prolongation of the line and grade shown on the plans or as staked by the Engineer and shall be held by guideways and other devices so as to deviate from these lines and grades as little as possible as it progresses through the embankment. Deviations from design grade and alignment of the following magnitudes shall be cause for rejection:
   1. Deviation of more than 0.1 foot in elevation or location at the initial point.
   2. A grade deviation of more that 0.2 percent.
   3. A grade deviation which causes reverse fall.
   4. An alignment deviation of more than 0.2 percent.

G. Casing Chocks: Casing chocks shall be installed to support the carrier pipe inside of the casing pipe. Chocks shall be the center-restrained type. Provide a minimum of two chocks per carrier pipe length, or as recommended by the chock manufacturer.
   1. Casing chocks shall be as manufactured by Powerseal, Model 4810, or approved equal.

H. Bulkheads: The annular space between the carrier pipe and casing shall be sealed with a block and Portland cement mortar bulkhead at the ends of the casing.

I. Obstructions: If the progress of the boring is stopped by an obstruction which will not allow completion of the conduit, the casing shall be withdrawn and the cavity filled with sand blown in or flowable mortar.

3.5 HORIZONTAL DIRECTIONAL DRILLING PIPE

A. At locations indicated on the drawings the Contractor shall install the pipe by means of horizontal directional drilling as specified in Section 02230.

3.6 TRENCH BACKFILLING

A. Backfill trench immediately after locations of connections and appurtenances have been recorded and inspection and testing has been completed.

B. Use no large stones, large clods, organic matter, rubbish, frozen or unsuitable materials in backfill.

C. Place bedding material simultaneously on both sides of pipe to prevent displacement.

D. After the specified bedding has been placed and compacted to specified density, acceptable backfill material shall be placed in evenly distributed layers not to exceed 6 inches in depth to 1 foot above top of bell of pipe or top of bedding, whichever is higher. Each layer shall be thoroughly compacted to 90 percent standard proctor by mechanical or pneumatic tampers before the succeeding layer is placed. Care shall be exercised in placing and tamping the backfill so as not to disturb the alignment and grade of the pipe or to cause excessive deflection in the pipe.

E. The remainder of the trench above the backfill specified in Section 3.5.D. above shall be backfilled with acceptable materials and compacted to the following densities:
   1. 95 percent standard proctor throughout for trenches within 2 feet of existing or proposed streets, drives, walks or other pavement.
   2. 90 percent standard proctor throughout for all other locations.

F. Hydraulic compaction or compaction using a backhoe bucket will not be allowed.

G. The Contractor shall exercise care during backfilling to not damage the pipe, adjacent utilities, or adjacent structures.

H. In trenches not below pavement or traveled ways, top 6 inches of backfill shall be topsoil.

I. Excavated materials used for backfill shall be well mixed.

J. If removal of sheeting disturbs compacted backfill, recompact backfill to comply with specifications.

K. Remove surplus fill materials from site and dispose of properly.

L. Leave fill material stockpile areas completely free of excess fill materials.

M. The length of the trench to be opened or the area of surface to be disturbed or uncovered at any time shall be limited by the Engineer. All trenches shall be backfilled as soon as practical after the pipe is in place, or as ordered by the Engineer. New trenches shall not be excavated when, in the opinion of the Engineer, the Contractor is negligent in performing backfill and restoration operations.

3.7 BACKFILL OF STRUCTURES

A. All poured-in-place concrete or masonry shall cure a minimum of 5 days before the structure is backfilled.

B. Structures shall be backfilled with the material specified in this section following the procedures and density requirements for the adjacent pipe. The backfill shall be placed on all sides of the structure simultaneously.

3.8 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

B. Top Surface of General Backfilling: Plus or minus 4 inches from required elevations.

3.9 FIELD QUALITY CONTROL

A. Compaction Testing: Contractor to arrange and pay for compaction testing by independent testing laboratory.

B. Density: Obtain required compaction not less than 95% of maximum Standard Proctor Density.

C. Moisture Range: Obtain required compaction within a soil moisture range of optimum moisture to 4 percentage points above optimum moisture content.

D. Testing:
   1. Lab Test: Determine laboratory density of material in accordance with ASTM D 698 (Standard Proctor Density) or ASTM D 4253 and D 4254 (Maximum and Minimum Index Density for Cohesionless Soils). Provide at least one analysis for each material type used as backfill unless provided by Jurisdictional Engineer.
   2. Field Test: Perform in-place field density and moisture testing in accordance with ASTM D 2922 and D 3017 (nuclear) or ASTM D 1556 (sand cone) and D 2216 (moisture content).
   3. Frequency:
      a. One test per each 3 feet of depth for each pipe segment beneath streets or roadways.
      b. One test for every 400 feet of pipe installed in all other areas.
   4. Show compliance with specifications.
   5. Locations to be tested will be selected by Engineer.
   6. Additional testing may be required by Engineer if noncompliance or change in conditions occurs.

E. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the embankment.

3.10 PROTECTION OF FINISHED WORK

A. Protect finished Work from damage.

B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.11 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off Owner's property. Contractor to obtain all required permits and pay all fees. Provide written verification that proper permits have been acquired or provide agreements with private parties for all disposal sites. Cost for removal and disposal of materials is incidental and no separate payment will be made this work.

END OF SECTION 02225

SECTION 02230
HORIZONTAL DIRECTIONAL DRILLING (HDD)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Installation of pressure and gravity piping using the horizontal directional drilling (HDD) method.

1.2 RELATED SECTIONS

A. Section 02225 - Trenching, Backfilling and Compacting

B. Section 02730 - Sanitary Sewer Systems

C. Section 02667 – Water Distribution System

D. Section 02990 - Restoration and Cleanup

1.3 FIELD MEASUREMENTS

A. Verify that survey bench mark, control point, and intended elevations for the Work are as shown on drawings.

1.4 COORDINATION

A. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

1.5 SCOPE

A. The Contractor shall furnish all labor, materials, tools, and equipment as necessary to drill horizontally and install the specified pipe in the locations as shown on the Drawings and described herein.

1.6 UTILITIES

A. Before work is started, Contractor shall locate utilities and other subsurface structures which may be affected by or interfere with the proposed construction.

1.7 SUBMITTALS

A. Shop Drawings are required for the following:
   1. Instructions for installation of piping by applicable supplier.
   2. Graph plotting in plan and profile of pilot drilling hole.

PART 2 PRODUCTS

2.1 BACKFILL MATERIALS

A. General: Backfill material shall be that material excavated from the trench, providing that the material does not contain any unacceptable material and can be effectively compacted by mechanical or pneumatic compaction equipment to the specified density.

B. Acceptable Backfill Materials:
   1. Provide soil materials free from organic matter and deleterious substances, containing no rocks or lumps over 6 inches in greatest dimension, frozen materials, rubbish, or unsuitable materials.

2.2 MATERIALS

A. Excavation, fill, pipe and fittings, and concrete materials shall be as specified in Related Work Sections.

2.3 PIPE MATERIALS

A. Refer to Specifications Section 02730 – Sanitary Sewer Systems.

2.4 APPURTENANCES

A. Repair couplings (pressure applications):
   1. Mechanical fittings meeting requirements of pressure application; bolted couplings, Smith-Blair 441LR, or approved equal.
      a. Sleeve: Ductile iron ASTM A536.
      b. Gaskets: Grade 30 compounded rubber of new materials.
      c. Follower flanges: Ductile iron ASTM A536.
      d. Bolts and Nuts: 304 stainless steel.
      e. Coating: Shop coat enamel.
   2. Sleeve fittings meeting pressure requirements of PVC pipe and designed to slide completely over pipe ends.

B. Flexible Couplings (non-pressure applications):
   1. Flexible couplings designed to connect spigot ends of similar or dissimilar pipe and provide positive seal against infiltration and exfiltration; Fernco Flexible Coupling or equal.
      a. Flexible elastomeric body conforming to applicable requirements of ASTM C443, C425, C564 and D1869; series 304 stainless steel bands and housings.
      b. Furnish with shear rings designed to provide extra strength and rigidity to construction; series 304 stainless steel bolts, nuts and housing.
   2. Sleeve fitting meeting pressure requirements of PVC pipe and designed to slide completely over pipe ends.

C. Service Saddles for directional drilled sewer:
   1. Saddle tee or wye in compliance with ASTM F1336 with gasketed branch and rubber seal to main.
   2. Mounting clamps series 304 stainless steel; adjustable compression type; 2 per saddle.

PART 3 EXECUTION

3.1 GENERAL

A. The pipe shall be installed in the location to the line and grade designated on the Drawings by horizontal directional drilling.

B. All materials delivered to the project for work on the project shall be neatly piled. Excavated material which is not removed from the immediate site of the work shall be kept trimmed up so as to cause as little inconvenience to the owners of neighboring property and to the public, as possible.

C. Excavated material, including but not limited to, pipe, pavement, concrete, and concrete rubble, and masonry units, which is unsuitable for backfill and all excavated material which has not been used for backfill shall, upon completion of the project, be removed from the site of the work by the Contractor at his own cost and expense.

D. The drill staging area shall be kept neat and orderly and disturb as little area as possible. The pipe staging area shall be set up on the opposite side of the crossing, disturbing as little area as needed to accommodate workers, equipment, and to string, join and inspect the pipe.

3.2 PRESSURE PIPE

A. Assemble and install pipe as specified herein, as shown on Standard Drawings and in accordance with the manufacturer's recommendations and guidelines.

B. Protect pipe and joints during handling against impact, shocks, freefall and gouging.

C. Make joints with equipment and methods recommended by pipe manufacturer.
   1. Clean joint contact surfaces immediately prior to jointing; use lubricants, primers, cement or adhesives as recommended by pipe manufacturer.
   2. Protect solvent weld joints from damage during cement cure; do not disturb pipe joint until fully cured; maintain joint at required temperature until fully cured.

D. Examine pipe for defects and specification compliance prior to installation; damaged or unsound pipe or pipes with defective joints will be rejected.

E. Remove debris from piping.

F. Prior to beginning each directional bore:
   1. Inspect and calibrate steering control system and drill head field locator.
   2. Verify that that there is adequate time, equipment, and materials necessary to complete the bore.
   3. Review field staking of path and construction plans; provide additional staking of directional bore path at no additional cost to the Owner.
   4. Verify location of all utilities; contact the Engineer before proceeding if directional bore path is in conflict with existing utilities or if specified separation distances will not be maintained.
   5. Determine drilling fluid mixture to be used based on subsurface soil conditions; additional soil testing will be performed at no additional cost to the Owner.

G. Directional boring and installation of pipe:
   1. Select ground entry and exit locations and angles needed to accommodate the installation of the pipe at the horizontal alignment, vertical profile, and to depths shown on the plans; do not exceed the allowable pipe bending limits established by the manufacturer; excavate bore pit as needed.
   2. Locate and install pressure relief pits as needed to relieve excessive drilling fluid pressure.
   3. Complete boring of pilot hole to alignment and depth necessary to assure that final location of pipe is in general compliance with plans; utilizing the drill head field locator collect and record horizontal alignment and depth of bury at 100 foot intervals.
   4. Backream the pilot hole to a diameter between 125% (minimum) and 150% (maximum) of the maximum outside diameter of the pipe material to be installed; 'slugging' of pilot hole is prohibited; exercise care not to 'hump' ground surface or surface of roads, drives, or sidewalks.
   5. Before installing pipe, verify all measurements at site; make necessary field measurements to accurately determine piping make-up length.
   6. Pull assembled pipe and tracer wire into borehole during last pass by reamer; continuously monitor pullback forces during pullback; limit pull forces so as to prevent damage to pipe; pushing of pipe into borehole to aid with insertion is prohibited; Provide

adequate support of pipe during installation; do not allow twisting or binding of pipe in excess of manufacturer's recommendations

7. Connect directionally bored pipe with pipe or appurtenance installed by conventional trench excavation.
8. Clean up and dispose of cuttings and excess drilling fluids in a manner consistent with local, State and Federal requirements.
9. Back-fill excavated bore pit as appropriate. ,
10. Repair damage to ground surface or surface of roads, drives, or sidewalks along path of bore at no additional cost to Owner; remove mounded soils and or surfacing and repair as specified.
11. Length of bore will be equal to pipe length installed between points of connection to appurtenances or to piping installed by other methods, including not more than 20 feet of open trench excavation per bore,

3.3 GRAVITY PIPE

A. Assemble and install pipe as specified herein, as shown on Standard Drawings and in accordance with the manufacturer's recommendations and guidelines.

B. Protect pipe and joints during handling against impact, shocks, freefall and gouging.

C. Make joints with equipment and methods recommended by pipe manufacturer.
   1. Clean joint contact surfaces immediately prior to jointing; use lubricants, primers, cement or adhesives as recommended by pipe manufacturer.
   2. Protect solvent weld joints from damage during cement cure; do not disturb pipe joint until fully cured; maintain joint at required temperature until fully cured.

D. Examine pipe for defects and specification compliance prior to installation; damaged or unsound pipe or pipes with defective joints will be rejected.

E. Remove debris from piping.

F. Prior to beginning each directional bore:
   1. Inspect and calibrate steering control system and drill head field locator.
   2. Verify that that there is adequate time, equipment, and materials necessary to complete the bore.
   3. Review field staking of path and construction plans; provide additional staking of directional bore path at no additional cost to the Owner.
      a. Update staking to reflect elevation of pilot hole that is needed to accomplish the installation of piping at the flow line elevation shown on the plans.
   4. Verify location of all utilities; contact the Engineer before proceeding if directional bore path is in conflict with existing utilities or if specified separation distances will not be maintained.
   5. Determine drilling fluid mixture to be used based on subsurface soil conditions; additional soil testing will be performed at no additional cost to the Owner.

G. Directional boring and installation of pipe:
   1. Select ground entry and exit locations and angles needed to accommodate the installation of the pipe at the horizontal alignment and vertical alignment shown on the plans; do not exceed the allowable pipe bending limits established by the manufacturer; excavate bore pit as needed.
   2. Locate and install pressure relief pits as needed to relieve excessive drilling fluid pressure.
   3. Complete boring of pilot hole to alignments and depth necessary to assure that final location of pipe is within allowable tolerance of compliance with plans; utilizing the drill head field locator and other methods, collect and record horizontal alignment and vertical alignment at 50 foot intervals.
   4. Allowable tolerance of horizontal and vertical alignment deviation from piping system design as shown on .the plans:

a. Horizontal alignment of pilot hole shall be within +/- 2 inches at 50 foot intervals.
b. Vertical alignment of pilot hole shall be within +/- 0.1 feet at 50 foot intervals.
c. Retract and repeat directional drilling attempts, until horizontal and vertical alignments are within allowable tolerances, or install gravity sewer piping in accordance with Specification Section 02730.

5. Back-ream the pilot hole to a diameter between 125% (minimum) and 150% (maximum) of the maximum outside diameter of the pipe material to be installed; 'slugging' of pilot hole is prohibited; exercise care not to 'hump' ground surface or surface of roads, drives, or sidewalks.
6. Before installing pipe, verify all measurements at site; make necessary field measurements to accurately determine piping make-up length.
7. Pull assembled pipe into borehole during last pass by reamer; continuously monitor pullback forces during pullback; limit pull forces so as to prevent damage to pipe; pushing of pipe into borehole to aid with insertion is prohibited; provide adequate support of pipe during installation; do not allow twisting or binding of pipe in excess of manufacturer's recommendations.
8. Connect directionally bored pipe with pipe or appurtenance installed by conventional trench excavation.
9. Provide sufficient length of pipe to extend past termination point to allow connection to other pipe sections.
10. Allow minimum of 24 hours for stabilization after installing pipe before making connections to pipe.
11. Mark location and depth of bore with spray paint on paved surfaces, and wooden stakes on non-paved surfaces at each end bores and at 25-foot intervals along bore.
12. Backfill excavated bore pit as appropriate.
13. Clean up and dispose of cuttings and excess drilling fluids in a manner consistent with local, State and Federal requirements.
14. Repair damage to ground surface or surface of roads, drives, or sidewalks along path of bore at no additional cost to Owner; remove mounded soils and or surfacing and repair as specified.
15. Length of bore will be equal to pipe length installed measured from point of connection to piping or manholes, for each size of pipe and type of pipe material along centerline of pipe with no deductions for manholes.

3.4 SERVICE CONNECTIONS

A. Conform to details shown on Drawings.

B. Install saddle wyes; use standard saddle tee and riser in lieu of saddle wye where invert of sewer is 10' or more below ground surface; see Standard Drawing.

C. Place stopper in end of service pipe:
1. Provide weather tight joint on stopper to match that on pipe spigot; block plug to undisturbed earth with 2" x 4" strut.
2. Mark location of sewer service connection with magnetic tape; connect to end of service.

D. Install as recommended by manufacturer.

E. Backfill excavated area after recording exact location of service connection.

3.5 CONNECTIONS BETWEEN DISSIMILAR PIPE

A. Provide and install suitable couplings for joining dissimilar materials.

B. Install compacted granular bedding and backfill on stable trench for 12 inches either side of repair coupling.

3.6 PROTECTION OF WATER SUPPLIES

A. There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenances thereto, which would permit the passage of any wastewater of polluted water into the potable water supply.

B. Wells: Sewers constructed of standard sewer materials shall not be laid within 75 feet of a public well or 50 feet of a private well. Sewers constructed of water main materials may Jl~e laid within 75 feet of a public well and within 50 feet of a private well, but not closer than 25 feet to either.
   1. Where above separation is not met, notify Engineer immediately; Engineer will authorize relocation of sewer as required.

C. Horizontal separation of gravity sewers from water mains:
   1. Gravity sewer should be separated from water mains by a horizontal distance of at least 10 feet unless:
      a. The top of sewer main is at least 18 inches below the bottom of water main and,
      b. The sewer is placed in a separate trench or in the same trench on a bench of undisturbed earth at a minimum horizontal separation of 3 feet from water main.
   2. Where required clearances between sewer and water main cannot be maintained: Use ductile iron pipe as specified for pressure pipe; pressure test and leakage test pipe as specified herein.

D. Separation of sewer and water main crossovers:
   1. Where new sewer crosses over water main or service where top .of sewer is within 18" of bottom of water main or service; provide 20' length of ductile iron pipe for sewer centered on the water main.
   2. Support water and sewer pipes and backfill with low permeability soil.

E. Force mains shall be separated at least 4 feet horizontally from water main.
   1. Where specified horizontal distance canaot be maintained; notify Engineer immediately; Engineer will authorize relocation of force main or water main as required.

F. Provide all necessary shut-down, repair and relocation of water mains, sanitary sewer or force main where conflicts occur; furnish labor, equipment, pipe and fittings; repair and relocation will be paid for as Extra Work; when broken due to carelessness of Contractor, repair is incidental to construction.

3.7 FIELD TESTS

A. Perform testing in compliance with requirements of Specifications Sections 02730 – Sanitary Sewer Systems and 15042 – Cleaning and Pressure Testing of Pipelines.

END OF SECTION 02230

SECTION 02275
REVETMENT AND EROSION STONE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Revetment and erosion stone for slope protection and erosion control.

1.2 RELATED SECTIONS

A. Section 02200 - Earthwork.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Standard Specifications for Highway and Bridge Construction, IDOT, 2001 Series, Section 4130 - Revetment Stone and Erosion Stone

PART 2 PRODUCTS

2.1 MATERIALS

A. Riprap or revetment stone: Provide Class D Revetment Stone (Riprap), where indicated on the drawings, meeting the requirements of IDOT Standard Specification Section 4130 for gradation shown and which when subjected to the freezing and thawing test of the IDOT Laboratory, Method 211, Method C, shall not loose more than 10% for stones crushed to 1-1/2" to 3/4" (nominal). In addition the percentage of abrasion loss when tested in accordance to AASHTO T96 shall not exceed 50. Do not use material which split in layers less than 4-inches thick, when exposed to natural weathering regardless of the above tests results.

1. Class "D" Revetment Stone: Provide sound, well graded, and durable broken limestone, dolomite or quartzite, taken from blasted rocks, making any additional processing unnecessary.
2. Provide following size limitations with no more than 5 percent passing the ½ " sieve:

Stone Weight, Lbs.	Minimum % Larger Than
90	50
5	90

B. Erosion stone: Provide stone consisting on a nominal 6 inch mixture, by visual examination. The stone shall meet the requirement of IDOT 4130.01, Gradation No. 34 of the Aggregate Gradation Table referenced in IDOT 4109, and not more than 5% maximum mud balls.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B. Do not place riprap over frozen or spongy subgrade surfaces.

3.2 PREPARATION

A. Surface Preparation: Shape and dress the slope to be protected so that the revetment surface will be in compliance with the lines and grades shown on the Drawings. The Engineer will inspect the prepared base directly prior to placement of revetment.

B. Installed Thickness: As indicated on drawings.

3.3 PLACEMENT

A. Special Techniques: Spot loads and distribute over the surface. Do not place any material until prepared base has been accepted by the Engineer.

B. Place stone riprap to produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids and in full course thickness in one operation.
   1. Distribute the largest stones so that the entire mass of conforms approximately to the gradation specified in IDOT Section 4130.
   2. Where necessary, allow some roughness in surface to decrease the velocity, keep the mass fairly compact with all sizes of material in proper proportions.
   3. Hand place or rearrange individual stones with mechanical equipment as necessary to secure results as specified.

C. Tolerances: Control distribution based on the assumed density of 100 lbs. per cubic feet and the actual weights delivered.

END OF SECTION 02275

SECTION 02370
EROSION CONTROL

PART 1 GENERAL

1.1 RELATED SECTIONS

A. Section 01011 – Special Conditions.

B. Section 02200 – Earthwork.

C. Section 02275 – Revetment and Erosion Stone.

1.2 APPLICABLE PUBLICATIONS

A. Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, 2001 Edition (IDOT).

1.3 SUMMARY

A. The work under this section shall cover furnishing the equipment, materials, equipment and labor necessary to control erosion by the methods specified herein. If no specific quantities are shown on the contract drawings, the Contractor shall use whatever quantities are necessary to prevent sediment transport off the job site or into any storm water conveyances or streams.

1.4 SHOP DRAWINGS

A. The Contractor shall submit for approval by the Engineer a Storm Water Pollution Prevention Plan as required by the NPDES Stormwater Permit for accomplishing temporary and permanent erosion control, prior to beginning any construction on the project. Information shall be in conformance with requirements of submittals - Division 1 of these specifications.

1.5 NPDES STORMWATER PERMIT

A. This project is subject to Section 402(b) of the Clean Water Act and Iowa Code Section 455B.174 and 567 IAC 64.4 (projects disturbing 1 or more total acres) and requires issuance of a National Pollution Discharge Elimination System (NPDES) General Permit No. 2, or an individual NPDES Permit for Stormwater Discharge Associated with Industrial Activity for Construction Activities.

B. The Contractor shall be the responsible party for applying for implementing and complying with a NPDES Stormwater discharge permit for the construction activities with this project. The Contractor shall be the permittee and solely responsible for compliance and costs associated therewith, including those specifically referenced herein. The Contractor shall be responsible for preparation of the Storm Water Pollution Prevention Plan and shall be responsible to retain or engage persons knowledgeable in the preparation of said plan. The Storm Water Pollution Prevention Plan shall be prepared in a manner that complies with all applicable requirements.

C. The Contractor shall be the responsible party for publishing Notice of Intent as required for the NPDES Storm Water permit as well as for paying for fees associated with said Notice.

D. The Contractor shall pay all fees and costs associated with preparation of and implementation of the Storm Water Pollution Prevention Plan. Payment of all fines and penalties associated with the permit and any permit violations shall be the responsibility of the Contractor.

E. All subcontractors must sign the NPDES certification statement before conducting any work at the site. The certifications must be signed in accordance with the signatory requirements found in the permit and must be incorporated in the Storm Water Pollution Prevention Plan.

F. In the event that the Iowa Department of Natural Resources considers the Owner to be a co-permitte, the Contractor agrees to indemnify and hold harmless the Owner for all issues and activities relating to the Storm Water Pollution Prevention Plan and permit including, but not limited to, fines and penalties.

G. References to silt fences and other erosion control devices or measures, if any, in the specifications or on the plans are intended to illustrate typical erosion control measures to be implemented by the Contractor. References in the plans or specifications shall not be considered a part of the Storm Water Pollution Prevention Plan. The occasion that erosion control measures of devices are not indicated on the plans or in the specifications does not waive the Contractor's responsibilities associated with the NPDES Storm Water permit nor the Storm Water Pollution Prevention Plan.

H. The Contractor shall be responsible for maintenance and inspection, and all associated costs thereof, of all erosion control facilities or other activities or devices identified under the Storm Water Pollution Prevention Plan.

I. Include all costs associated with applying for and obtaining the necessary NPDES permit(s) as well as for preparation, implementation and monitoring of the Storm Water Pollution Prevention Plan and all necessary pollution control measures to be constructed and maintained by the Contractor, including indemnification of the Owner, in the lump sum price for erosion control.

PART 2 PRODUCTS AND MATERIALS

2.1 EROSION CONTROL

A. All erosion control products and materials, including permanent seed and sod, shall be in accordance with IDOT Sections 2601 and 4169 or as otherwise indicated on Drawings or as specified elsewhere.

2.2 EROSION STONE

A. Erosion stone shall be requirements specified in Specifications Section 02275 – Revetment and Erosion Stone.

PART 3 CONSTRUCTION METHODS

3.1 PERMITS AND APPROVALS

A. An Iowa National Pollutant Discharge Elimination System (NPDES) Permit No. 2 is required for construction activities that disturb a total of 1 acres of land or more. The contractor is responsible for all activities associated with this permit.

3.2 EROSION CONTROL CONSTRUCTION

A. The Contractor shall comply with all requirements of the NPDES Storm Water Permit as well as local jurisdiction requirements.

B. Construct or install erosion control in accordance with NPDES Storm Water Permit and the Storm Water Pollution Prevention Plan.

C. If an NPDES Storm Water Permit is not applicable to this project, Contractor shall construct and install erosion control measures in accordance with IDOT Sections 2601 and 4169 or as otherwise indicated on Drawings or as specified elsewhere.

END OF SECTION 02370

SECTION 02609
PIPE CULVERTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe culvert, joints and accessories.

1.2 RELATED SECTIONS

A. Section 02220 - Earthwork

B. Section 02225 - Trenching, Backfilling and Compacting

1.3 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.

B. Product Data: Provide data on pipe, fittings and accessories.

1.4 SUBMITTALS FOR INFORMATION

A. Section 01300 - Submittals: Procedures for submittals.

B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Section 01700 - Contract Closeout: Procedures for submittals.

B. Accurately record actual locations of pipe runs, connections, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 CORRUGATED METAL PIPE (CMP)

A. Conform to AASHTO M 36, Type I.

B. Zinc coating: Conform to AASHTO M 218.

C. Corrugated steel circular section with annular (circumferential) or helical corrugations.

D. Minimum thickness: Gauge of pipe conforming to Iowa DOT Standard Road Plans RF-32 and RF-33 or as indicated on the plans.

E. Coupling bands: Annular corrugations or helical corrugations to match pipe ends.

2.2 SPIRAL RIB PIPE

A. Conform to ASTM A 760 Type 1R.

B. Use a corrugation profile of 3/4 inch by 3/4 inch by 7-1/2 inches.

C. Aluminized steel Type 2: Conform to ASTM A 929.

D. Use a minimum thickness of 0.064 inch: Gage of pipe conforming to manufacturer's requirements or as shown on plans.

E. Coupling bands conforming to manufacturer's recommendations.

2.3 CORRUGATED METAL ARCH PIPE (CMAP)

A. Conform to AASHTO M 36, Type II.

B. Zinc coating: Conform to AASHTO M 218.

C. Corrugated steel Type I pipe reformed into a pipe-arch having an approximately flat bottom.

D. Coupling bands: Annular corrugations or helical corrugations to match pipe ends.

E. Minimum thickness: Gage of pipe conforming to Iowa DOT Standard Road Plan RF-33.

2.4 SPIRAL RIB PIPE ARCH

A. Conform to ASTM A 760 Type IIR.

B. Corrugation profile to be 3/4 inch by 3/4 inch by 7-1/2 inch.

C. Aluminized steel Type 2: Conform to ASTM A 929.

D. Use a minimum thickness of 0.064 inch: Gage of pipe conforming to manufacturer's requirements or as shown on plans.

E. Coupling bands conforming to the manufacturer's recommendations.

2.5 STRUCTURAL PLATES

A. Use a galvanized steel structural plate conforming to AASHTO M 167.

B. Use bolts and nuts meeting ASTM A 449 and galvanized per ASTM A 153, Class C.

C. Assemble the structure according to the shop drawings provided by the manufacturer and per the manufacturer’s recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.

D. Install the structure according to the plans and specifications, the manufacturer´s recommendations, and AASHTO Standard Specifications for Highway Bridges, Division II, Section 26.

E. Conform the gage of the structure to Iowa DOT Standard Road Plan RF-33 or as indicated on the plans.

2.6 COATED CORRUGATED METAL PIPE

A. Use in corrosive soil or effluent conditions or where indicated on plans or required by Engineer.

B. Conform to AASHTO M 274 steel sheet, aluminum-coated (Type 2).

2.7 ALUMINUM STRUCTURAL PLATE

A. Conform to AASHTO M 219

B. Use a corrugation profile of 9 inches by 2-1/2 inches.

C. Aluminum: Conform to ASTM B 209.

D. Use a minimum thickness of 0.100 inch: Gage of structure conforming to manufacturer's requirements or as shown on the plans.

E. Use bolts and nuts meeting ASTM A 307 or ASTM A 449 and galvanize per ASTM A 153

F. Assemble the structure according to the shop drawings provided by the manufacturer and per the manufacturer's recommendations. Tighten the bolts using an applied torque of between 100 and 300 foot-pounds.

G. Install the structure according to the plans and specifications, the manufacturer's recommendations, and AASHTO Standard Specifications for Highway Bridges, Division III, Section 26.

H. Meet or exceed the AASHTO Standard Specifications for Highway Bridges, Section 12.8 for HS 20 loading.

2.8 PIPE APRONS AND BEVELED ENDS

A. Use where indicated on plans.

PART 3 EXECUTION

Not Used

END OF SECTION 02609

SECTION 02661

FLEXIBLE MEMBRANE LAGOON LINER

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work under this section shall cover materials, installation, and testing of a flexible membrane liner for installation in earthfill Wastewater Lagoon as shown on the Contract Drawings and specified herein.

1.2 RELATED SECTIONS

A. Section 02200 - Earthwork

B. Section 02225 – Trenching, Backfilling and Compacting

C. Section 02370 – Erosion Control

D. Section 02730 – Sanitary Sewer Systems

E. Section 02740 – Wastewater Lagoon Construction

F. Section 03300 – Cast in Place concrete

1.3 REFERENCES

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
   1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
   2. American National Standards Institute (ANSI), Standards, Current Edition.
   3. National Sanitation Foundation (NSF), Standard 54, Current Edition.

1.4 SHOP DRAWINGS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 1 of these specifications.

B. Contractor shall submit such Shop Drawings and details required for the construction and installation of the materials. Shop drawings and details shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and intricate or detailed construction requirements.

1.5 INSTALLER REQUIREMENTS

A. The flexible membrane liner installer shall be approved in writing by the manufacturer prior to installing the liner material. Manufacturer shall submit written approval to Owner prior to the commencement of any work on the liner.

PART 2 PRDUCTS AND MATERIALS

2.1 MANUFACTURE

A. The flexible membrane liner shall be manufactured by Poly-Flex, Inc., GSE, National Seal Co., Schlegel Lining Technology, or equal.

2.2 MATERIALS

A. Flexible membrane liners shall be 60mil High-Density Polyethylene (HDPE).

B. Gasket material shall be neoprene, closed cell medium, 1/4-inch thick, 2 inches wide with adhesive on one side, or other compatible gasket materials as required.

C. Metal battens or banding and hardware shall be stainless steel.

D. Water cut-off mastic shall be Neoprene Flashing.

E. Sealant shall be General Electric Silicone, RTV 103, or equal.

2.3 RAW MATERIALS

A. The membrane liner shall be manufactured of polyethylene resins produced in the United States and shall be compounded and manufactured specifically for the intended purpose. The resin manufacturer shall certify each lot for the following properties.

The natural polyethylene resin without the carbon black shall meet the following requirements:

Property	Test Method	HDPE Requirements
Density, g/cc	ASTM D 1505 or ASTM D 792	0.935 - 0.940
Melt Index, g/10 min.	ASTM D 1238 Condition E	<0.4

2.4 ROLLS

A. The membrane shall be supplied in rolls, minimum 23 foot seamless width.

B. Carbon black shall be added to the resin if the resin is not compounded for ultra-violet resistance.

C. The surface of membrane shall not have striations, roughness, pinholes, or bubbles.

D. The membrane rolls shall have labels identifying the material thickness, length, width, lot and roll numbers, and name of the manufacturer.

E. The manufacturer shall provide a minimum twenty (20) year guarantee that the lining will not be degraded because of exposure to the elements present in this installation. Certification test results showing that the sheeting meets the specifications shall be supplied on request.

2.5 PHYSICAL CHARACTERISTICS

A. The membrane materials shall have the following physical characteristics:

Property	Test Method	Value
Thickness, mils	ASTM D374	60 ±10%
Sheet Density, g/cc	ASTM D 1505/D 792	0.940
Tensile Properties		
1. Yield Strength, lb/in	ASTM D638 Type IV	140
2. Break Strength, lb/in	Dumb-Bell at 2 ipm	240
3. Yield Elongation, %		10
4. Break Elongation, %		700
Modulus of elasticity, psi	ASTM D638	80,000
Tear Resistance, lb	ASTM D 1004	42
Puncture Resistance, lb	ASTM D 4833	108
Stress Crack Resistance, hrs	ASTM D 5397 (App.)	300
Carbon Black Content, %	ASTM D 1603	2.0 - 3.0
Dimensional stability (each direction, maximum percent)	ASTM D1204	±2
Brittleness temperature (Maximum ˚C)	ASTM D746 Procedure B	-40
Water absorption (Percent weight change maximum)	ASTM D 570	0.1
Oxidative Induction Time (OIT) Standard OIT, minutes	ASTM D 3895	100
Oven Aging at 85℃ High Pressure OIT - % retained after 90 days	ASTM D 5721 ASTM D 5885	80
UV Resistance High Pressure OIT - % retained after 1600 hrs	GRI GM11 ASTM D 5885	50
Weld shear testing, psi	ASTM D638 Type IV Dumb-Bell at 2 ipm	2,700 (sheet must fail before weld)
Weld peel testing, psi, stress the top sheet in relation to the overlapped edge of the lower sheet	ASTM D413 Machine Method 180-degree peel	Sheet fails before weld

PART 3 CONSTRUCTION METHODS

3.1 SURFACE PREPARATION

A. The surface upon which the flexible membrane liner will be placed shall be graded smooth and free from sharp rocks, roots, holes, clods and other debris. A firm substrata is required for the entire bottom and inside slopes of the lagoon; therefore, all boils, heaves, and soft material shall be removed. These areas along with any unintentional excess excavation shall be filled with sand and compacted. Final surface of bottoms and inside slopes shall be left free of any protruding material. The bottom shall be uniformly

graded to the finish grades shown on the Contract Documents and as called for in Section 02740 – Wastewater Lagoon Construction.

B. The area to be covered shall be rolled to effect compaction and smoothing so as to reduce local stresses on the flexible membrane liner. The Contractor shall give 48 hours advance notice to the Engineer prior to installing the liner. Prior to the installation of the liner, all grades and measurements shall be checked by the Engineer and the surface of the bottoms and dike slopes inspected for irregularities and material which could puncture the lining. Any damage to the liner resulting from improper preparation of the subgrade will be the responsibility of the Contractor and it shall be his responsibility to repair same.

C. A soil sterilizer-herbicide equal to Dupont Hyvar X or CIBA-Geiby Pramitol 25E or Pennwalt Hydrothal 47 shall be applied to all surfaces receiving flexible membrane liner as per manufacturer's recommendations. The sterilizer-herbicide shall be compatible with HDPE membrane liner.

3.2 LINER INSTALLATION

A. General. Installation shall be performed by a Contractor that has previously, satisfactorily installed a minimum of 300,000 square feet of this material or by a Contractor that has a manufacturer's field representative in attendance. The surface (substrate) to receive the liner shall be smooth, and free of sharp objects that could puncture the lining. Standing water or excessive moisture shall not be allowed. All vegetation shall be removed.

1. The liner rolls shall be shipped by flatbed trailer to the job site. The liner shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface (not wooden pallets) and should not be stacked more than two rolls high.
2. The rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the Engineer. The Contractor shall be responsible for the following:
   a. Equipment and tools shall not damage the liner during handling, transporting, and deployment.
   b. Personnel working on the liner shall not smoke or wear damaging shoes.
   c. The method used to unroll the liner shall not cause scratches or crimps in the liner and shall not damage the supporting soil.
   d. Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).
3. The lining shall be sealed to all concrete structures and other openings through the lining in accordance with the contract drawings or details shown on the Shop Drawings submitted by the Contractor and reviewed by the Engineer. The lining shall be closely fitted and sealed around inlets, outlets and other projections through the lining.
4. Any portion of lining damaged during installation shall be removed or repaired by using an additional piece of lining as specified hereinafter.

B. Weather Conditions. Liner deployment shall proceed between ambient temperatures of 32° F and 104° F. Liner placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, rain, dew) or in the presence of excessive winds.

C. Field Joints. Approved seaming processes are fusion and extrusion welding. On side slopes, seams shall be oriented in the general direction of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

No base T-seam shall be closer than 5 feet from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and “fishmouths”. If a fishmouth or wrinkle is found, it shall be relieved and cap-stripped.

1. No jointing shall be performed during wet and inclement weather conditions or when the temperature is less than 50□ F.
2. Field made splices shall have a strength of 80 percent of the specified sheet strength.

D. Joints to Structures. Joining of flexible membrane liner to concrete shall be made using mechanical a fastening device in accordance with drawing details and the manufacturer’s recommendations. Joints to pipe protrusions shall be made using a manufactured “boot” all in accordance with the drawing details and the manufacturer’s recommendations.

E. Burial Trench. The Contractor shall cut a burial trench at the top of the dike as shown on the contract drawings prior to liner system placement. The trench shall be continuous around the entire perimeter of the dike. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the liner.

F. Quality of Workmanship. All joints, on completion of the work, shall be tightly bonded. Any lining surface showing injury due to scuffing, penetration by foreign objects or distress from rough subgrade shall, as directed by the Engineer.

3.3 FIELD SEAMING

A. Approved seaming processes are fusion and extrusion welding. On side slopes, seams shall be oriented in the general direction of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

B. No base T-seam shall be closer than 5 feet from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and “fishmouths”. If a fishmouth or wrinkle is found, it shall be relieved and cap-stripped.

C. Seam Overlap. Liner panels must have a finished minimum overlap of 4 inches for fusion welding and 6 inches for extrusion welding. Cleaning solvents may not be used unless the product is approved by the liner manufacturer.

D. Test Seams. Field test seams shall be conducted on the liner to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period and at least once every 4 hours, for each seaming apparatus and personnel used that day. All test seams shall be made in contact with the subgrade. Welding rod used for extrusion welding shall have the same properties as the resin used to manufacture the liner. The test seam samples shall be 10 feet long for fusion welding and 3 feet long for extrusion welding with the seam centered lengthwise. Three specimens shall be cut from each end of the test seams by the inspector. The inspector shall use a tensiometer to test 3 specimens for shear and 3 specimens for peel. Each specimen shall be one inch wide with a grip separation of 4 inches plus the width of the seam. The seam shall be centered between the clamps. The rate of grip separation shall be 2 inches per minute.

E. Assessment of Seam Test Results. For both smooth and textured seams the strength of two out of three 1.0 inch (25 mm) wide strip specimens should meet or exceed values given in this specification. The third must meet or exceed 80% of the given values. The shear percent elongation should exceed 50%. The assumed gauge length is considered to be the unseamed sheet material on either side of the welded area. Elongation measurements should be omitted for field testing. In addition, the peel separation should not exceed 25% based on the proportion of area of separated bond to the area of the original bonding. Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in the ASTM D 6392. In this regard, SIP is an acceptable break code.

Unacceptable Break Codes
Hot Wedge: AD and AD-BRK > 25%
Extrusion Fillet: AD1, AD2 and AD-Weld (unless strength is achieved)

F. Non-Destructive Seam Testing. The installer shall non-destructively test all field seams over their full length.

1. Vacuum Box Testing: Equipment for testing extrusion seams shall be comprised of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.
   b. Soapy solution in a plastic bucket with a mop.
   c. The following procedures shall be followed by the installer:
      - Excess sheet overlap shall be trimmed away.
      - Wet a strip of geomembrane approximately 12 inches wide by the length of box with the soapy solution.
      - Place the box over the wetted area and compress.
      - Create a vacuum of 3 - 5 psi.
      - Ensure that a leak tight seal is created.
      - For a period of approximately 10 seconds, examine the geomembrane through the viewing window for the presence of animated soap bubbles.
      - If no animated bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap and repeat the process.
      - All areas where animated soap bubbles appear shall be marked, repaired and then retested.
   d. The following procedures shall apply to locations where seams cannot be non-destructively tested.
      - If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.
      - If the seam cannot be tested prior to final installation, the seams shall be spark tested according to the spark tester manufacturer's procedures.

G. Destructive Seam Testing. Destructive seam testing should be minimized to preserve the integrity of the liner. The installer shall provide the inspector with one destructive test sample per project specifications (usually once per 500 feet of seam length) from a location specified by the inspector.

1. Sampling Procedure: In order to obtain test results prior to completion of liner installation, samples shall be cut by the installer as the seaming progresses. The installer shall also record the date, location, and pass or fail description. All holes in the liner resulting from obtaining the seam samples shall be immediately patched and vacuum tested.
2. Size and Disposition of Samples: The samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into three equal-length pieces, one to be given to the inspector, one to be given to the owner and one to the installer.
3. Field Laboratory Testing: The inspector shall test ten 1-inch wide specimens from his sample, five specimens for shear strength and five for peel strength.
4. Independent Laboratory Testing: The owner, at his discretion and expense, may send seam samples to a laboratory for testing. The test method and procedures

to be used by the independent laboratory shall be the same as used in field testing.

5. Procedures for Destructive Test Failure: The following procedures shall apply whenever a sample fails the field destructive test:
   a. The installer shall cap strip the seam between the failed location and any passed test locations.
   b. The installer can retrace the welding path to an intermediate location (usually 10 feet from the location of the failed test), and take a sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, then the process is repeated.
   c. Over the length of seam failure, the installer shall either cut out the old seam, reposition the panel and reseam, or add a cap strip.

H. Upon satisfactory completion of the testing, the Contractor shall provide three (3) copies of a bound, typewritten report containing at a minimum the following information:
   1. Date and time tests were performed.
   2. Test procedure performed.
   3. Name and title of person performing tests and qualifications.
   4. Descriptive narrative of test including any pertinent information regarding procedures utilized, lining failure found and repaired, equipment failures, and procedural problems.
   5. Name and title of all in attendance during testing.
   6. Name and title of representative accepting tests conducted, if other than the Engineer.

I. Defects and Repairs. All seams and non-seam areas of the liner shall be inspected by the inspector for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the liner shall be clean at the time of inspection.
   1. Evaluation: Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the inspector. Each location that fails the non-destructive testing shall be marked by the inspector, and repaired accordingly.
   2. Repair Procedures:
      a. Defective seams shall be cap stripped or replaced.
      b. Small holes shall be repaired by extrusion welding a bead of extrudate over the hole. If the hole is larger than $^{1}/4$ inch, it shall be patched.
      c. Tears shall be repaired by patching. If the tear is on a slope or an area susceptible to stress and has a sharp end it must be rounded prior to patching.
      e. Blisters, large cuts and undispersed raw materials shall be repaired by patches.
      e. Patches shall be completed by extrusion welding. The weld area shall be ground no more than 10 minutes prior to welding. No more than 10% of the thickness shall be removed by grinding. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted. The welding shall restart by grinding the existing seam and rewelding a new seam. Patches shall be round or oval in shape, made of the same liner, and extend a minimum of 6 inches beyond the edge of defects.
   3. Verification of Repairs: Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. The inspector shall keep daily documentation of all non-destructive and destructive testing. This documentation shall identify all

seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

END OF SECTION 02661

SECTION 02667

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. This section describes the general requirements of materials, testing, and installation of the water distribution system:

1.2 APPLICABLE PROVISIONS

A. Drawings, General and Supplementary Conditions of the Contract, and Division 1 shall govern the work of this section.

1.3 RELATED SECTIONS

A. 02225 - Trenching, Backfilling and Compacting.

B. 15041 - Disinfection of Piping and Structures.

C. 15042 - Cleaning and Pressure Testing of Water Pipelines.

1.4 DEFINITIONS

A. “Buried piping” is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Piping enchased in concrete is considered to be buried. Do not coat encased pipe.

B. “Exposed piping” is piping that is located above ground; inside buildings, vaults, or other structures; or in underground concrete trenches or galleries.

1.5 SUBMITTALS

A. Submit the following in accordance with General Conditions, Special Conditions, and Section 01300:

1. Product Data.
   a) Submit manufacturer’s data sheet for each type of piping.
   b) Submit manufacturer’s data sheet for gaskets supplied, showing dimensions and bolting recommendations.
   c) Submit manufacturer’s data sheet for insulating unions, showing recommended installation procedures.
2. Certificates.
   a) Submit affidavits of compliance that proposed pipe, fittings, and appurtenances meet the referenced standards.
   b) Submit certification that cement lining complies with referenced standards.
   c) Submit certification that gaskets comply with referenced standards.
   d) Submit certification that O-Rings in chemical service are chemically compatible.
   e) Submit certification that the polyethylene encasement complies with referenced standards.
   f) Submit certification that all piping materials that come into contact with drinking water (including raw and process waters), drinking water chemicals, or both comply with NSF 61.

g) Submit certification that bolts and nuts comply with referenced standard, including coatings if specified.

1.6 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS INTERNATIONAL (ASTM)

ASTM D 1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2680	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2855	Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F 437	Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 439	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	(2002) Standard Specification for Chlorinated Poly(Vinyl
ASTM F 441M	Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442	(1999) Standard Specification for Chlorinated Poly(Vinyl
ASTM F 442M	Chloride) (CPVC) Plastic Pipe (SDR-PR)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

NATIONAL SANITATION FOUNDATION INTERNATIONAL NSF

NSF 61 (2007) Drinking Water System Components -- Health Effects

PART 2 - MATERIALS

2.1 DUCTILE IRON (DI) PIPE AND FITTINGS

A. Pipe

Pipe shall be ductile iron, conforming to AWWA C151.

B. Lining

Cement-mortar-lined pipe and fittings shall conform to AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Lining material shall conform to ASTM C150, Type II. Cement-mortar-lining shall be given a seal-coat of asphaltic material per AWWA C104; the solvents used for such seal-coat shall be NSF approved for use for potable water and shall not contain perchloroethylene (PCE) or trichloroethylene (TCE).

C. Pipe Wall Thickness

1. Pipe with threaded flanges shall be Class 53.
2. Buried pipe with push-on, mechanical joints, or plain end:

Pipe Size (in.)	Wall Thickness
4 to 12	Class 350

3. Pipe having grooved-end joints:

Pipe Size (in.)	Wall Thickness
4 to 16	Class 53

D. Flanges

1. Flanges shall be Class 125 per AWWA C115. Flanges on pipe shall be either cast or threaded.
2. It shall be the responsibility of the contractor to verify the compatibility of all flanges and appurtenances.

E. Joints

1. Joints in piping located in vaults and structures shall be flanged, flexible or rigid grooved end, or restrained flexible coupling as shown on the drawings. Joints in buried piping shall be of the push-on or mechanical-joint type per AWWA C111/ANSI A21.11.
2. Buried restrained push-on joints with test pressure of 150 psi or less shall be as per AWWA C111/ANSI A21.11 and shall be capable of transmitting the full longitudinal thrust developed at design pressure with a 1.5 factor of safety. Restrained joints shall be American Lok-Ring or Flex-Ring Joint pipe or equal. Pipe 12" and smaller may alternately utilize mechanical joints with retaining wedges such as EBAA Iron Series 1100, Ford Series 1400 or equal, for applications where the test pressure is 150 psi, or less.
3. All welding of retainer rings shall be done in the pipe manufacturers shop except for necessary restrained closure pieces. A maximum of one field cut closure pipe piece between each pair of fixed pipe sections (i.e. end points, fittings, etc.) may have the retainer ring field welded. Field welding shall be done by methods and qualified welders approved by the pipe manufacturer.

F. Fittings
1. Class 125 fittings shall conform to AWWA C110 or C153 with a minimum pressure rating of 250 psi. Flanges shall be flat faced for Class 125.
2. Fittings shall be cement-mortar-lined with single thickness as specified in AWWA C104, Section 4.8.
3. Grooved-end fittings shall conform to AWWA C110 and ANSI B16.1 with grooved ends conforming to AWWA C606. Joints shall be cut or shouldered as applicable. It shall be the responsibility of the contractor to verify compatibility of all grooved end connections and appurtenances.

2.3 PVC PIPE AND FITTINGS (SCHEDULE 80 PVC)

A. Materials shall conform to ASTM D 1784, Type I Grade 1 (Cell Classification 12454-B) and meet the requirements of NSF 61.

B. Pipe shall be PVC plastic pipe conforming to ASTM D 1785, Schedule 80. Use Material Designation Code PVC 1120 or PVC 1220.

C. Fittings and Couplings:
1. Threaded-type fittings and couplings shall be PVC plastic pipe fittings conforming to ASTM D 2464, Schedule 80.
2. Schedule 80 socket-type fittings and couplings shall be PVC plastic pipe fittings conforming to ASTM D 2467.
3. PVC flanges shall be made of the same material as the pipe. Flanges, including two-piece Van Stone style flanges, shall match the dimensions of ANSI B16.5, Class 150, steel flanges.
4. Unions shall have socket-type ends, fluorocarbon elastomer (Viton® or equal) O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D 1784. O-Rings in chemical service shall be verified for chemical compatibility by manufacture.
5. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

D. Solvent Cement shall conform to ASTM D 2564.

2.4 PRESSURE CLASS PVC PIPE

A. Materials shall conform to ASTM D 1784 (Cell Classification 12454-B) PVC 1120.

B. Pipe shall be PVC plastic conforming to ASTM D 2241, Class 160 (SDR 26), or Class 200 (SDR 21) as shown on the project Drawings. Pipe shall be iron pipe size.

C. Restrained pipe shall be by Class 250, shall use a gasketed, spline inter-lock system, and shall be as manufacture by CertainTeed “Yellowmine”, Victaulic “Aquamine” or equal.

D. Pipe joints should be single gasketed with integral bell joints in conformance with ASTM D 3139. Gasket material shall be per ASTM F477.

E. Fittings. Push joint or mechanical joint ductile iron fittings meeting AWWA C110 or C153 can be used.

F. Lining and Coating for Fittings. Provide cement-mortar lined fittings per AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Cement for lining shall conform to ASTM C150, Type II.

G. Restrained PVC pipe joints and fittings. For mechanical joint applications the restraint device shall use wedge feature, not set screws. EBAA Iron Series 2000, Ford Series 1500, or equal. For push joint applications the restraint device shall use a serrated ring. EBAA Iron Series 6500 , Ford Series 1390, or equal.

2.5 AWWA PVC PIPE

A. Pipe shall be in conformance with AWWA C900, rubber-ring gasket bell end or plain end with elastomeric gasket coupling. Class 150 cast iron pipe O.D.

B. Materials shall be ASTM D1784 cell classification 12454-B.

C. Fittings shall be ductile iron conforming to AWWA C110 or C153 with a minimum pressure rating of 250 psi. Size bells specifically for OD of cast iron equivalent PVC pipe including rubber-ring retaining groove.

D. Flanges on outlets of fittings shall be Class 125 per ANSI B16.1.

E. Lining and Coating for Fittings. Provide cement-mortar lined fittings per AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Cement for lining shall conform to ASTM C150, Type II.

F. Restrained pipe, 4” through 12” shall use a gasketed, spline inter-lock system, and shall be as manufacture by CertainTeed “Certa-Lock”, or equal. Class shall match adjacent PVC pipe class.

G. Restrained PVC pipe joints and fittings. For mechanical joint applications the restraint device shall use wedge feature, not set screws. EBAA Iron Series 2000, Ford Series 1500, or equal. For push joint applications the restraint device shall use a serrated ring. EBAA Iron Series 1600 , Ford Series 1390, or equal.

2.6 STEEL PIPE AND FITTINGS (3-INCHES AND SMALLER)

A. Pipe shall be black or hot-dipped, zinc-coated welded or seamless steel pipe conforming to ASTM A53, Types E, F, and S, or ASTM A135 as shown on drawings. Use threaded Schedule 40 or 80 as shown on the drawings per ANSI B36.10.

B. Fittings, couplings, and unions shall be black or hot-dipped zinc-coated malleable iron threaded fittings conforming to ANSI B16.3, (ASTM A 47, Grade 35018), Class 150 or 300. Use Class 150 except where required for an anticipated working pressure of 200 psi or above.

C. Threading shall conform to ANSI B1.20.1. Jointing lubricant shall be polytetrafluoroethylene (PTFE, Teflon®) or PTFE tape.

2.7 STAINLESS STEEL PIPE AND FITTINGS (3-INCHES AND SMALLER)

A. Stainless steel pipe shall be Type 304, unless shown to be Type 316 on drawings. Pipe shall conform to ASTM A312, Schedule 40.

B. Fittings, couplings, and unions shall be Type 304, unless shown to be Type 316 on drawings. Fittings shall conform to ASTM A403 and shall have a minimum working pressure rating of 150 psi.

C. Threading shall conform to ANSI B1.20.1. Jointing lubricant shall be polytetrafluoroethylene (PTFE, Teflon®) or PTFE tape.

2.8 WATER SERVICE AND DOMESTIC WATER PIPE

A. Copper tubing pipe: ASTM B88, seamless, Type K.

B. Polyethylene tubing pipe: AWWA C901, pressure class 160 psi or greater. Copper pipe sized.

C. Polybutylene tubing pipe: AWWA C902, pressure class 160 psi or greater. Copper pipe sized.

D. PVC Schedule 80 conforming to 02667.2.3.

2.9 CURB STOP WITH DRAIN

A. For copper pipes both end: Mueller M-15210, Ford 222-SW, A.Y. McDonald 4714, or approved equal.

B. For copper and plastic pipes: Mueller 110 compression connection, A.Y. McDonald 4714-T, Ford or approved equal.

2.10 CORPORATION STOPS

A. Copper service thread connection outlet: Mueller H-1500, A.Y. McDonald 4701, Ford F600.

B. For copper and plastic pipes: Mueller compression connection outlet, A.Y. McDonald 4714T, Ford F 1001, F 1002, or equal.

2.11 SERVICE SADDLES

A. Rockwell, Mueller Company, A.Y. McDonald or approved equal.

2.12 SERVICE BOXES

A. Mueller H-10306, A.Y. McDonald 5601, Ford EA1-50-40-45R, or approved equal.

2.13 YARD HYDRANTS

A. Woodford Iowa Model Y2 freeze-less yard hydrant, or approved equal. Set for three feet burying depth.

2.14 FLUSHING HYDRANTS

A. Anti-freezing Kupferle Model 77 blow-off hydrant or approved equal, with 2” FIP side inlet. The hydrant outlet shall be sized and of a configuration to prevent the attachment of fire hoses

B. Provide lower hydrant barrel length suitable for six feet of trench depth.

C. Furnish two operating wrenches for project.

2.15 RESILIENT WEDGE GATE VALVES

A. Valves shall comply with AWWA C509 and the following:

B. The minimum rated working pressure shall be 200 psi. Valves shall have nonrising stems. Valve stems shall be cast integral with stem collar and furnished of cast, forged, or rolled bronze. Stem nuts shall be independent of the wedge and shall be made of solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and aluminum of 10% elongation in 2-inches (ASTM B584 or B783, Alloy C87600 or C99500). All body bolts shall be 316 stainless steel. Cast-iron wedge shall have sealing surfaces of the wedge permanently bonded with resilient materials to meet ASTM tests for rubber to metal bond, ASTM D429.

C. Provide reduction thrust bearings both above and below the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

D. Flanges shall be Class 125 per ANSI B16.1, mechanical joint ends shall comply with ANSI A21.11.

E. Valve shall be Clow R/W, American Darling CRS-80, Waterous Series 500, Kennedy Ken-Seal, Mueller, or equal.

2.16 VALVE BOXES FOR BURIED VALVES

A. 5 ¼" inside diameter, cast iron, slide type, with cast iron drop cover.

2.17 EXTENSION STEMS FUR BURIED VALVE ACTUATORS

A. Provide operating extension stems to bring the operating nut to a point 6-inches below the surface of the ground and/or box cover. Extension stems shall be steel and shall be complete with 2-inch-square operating nuts and to the valves shall withstand without damage an input torque of 300 foot-pounds.

B. Extension stem diameters shall be 7/8" diameter minimum.

2.18 COMBINATION AIR RELEASE VALVE

A. Valve Design and Operation

1. The valve shall include a large orifice to vent large quantities of air during pipeline filling. The same orifice shall also function to allow large quantities of air to enter the pipeline in event a negative pressure were to occur inside the pipeline. The valve shall also include a small orifice to automatically vent small quantities of air, while the pipeline is functioning under pressure.
2. Valve shall consist of a single body design, with a flanged top to allow access to the inside of the valve. The valve shall be float activated. Float shall be unconditionally guaranteed. The valve inlet shall be baffled to protect the lower float from the direct forces of rushing air and water to prevent premature shut-off. Valve shall include a 1/2" threaded drain outlet near the bottom with a bronze plug.

B. Materials of Construction

Item	Material	Specification
Body and Cover	Cast iron	ASTM A 48, Class 30, ASTM A126, Class B
Float and Linkage	Stainless Steel	AISI Type 304, 303
Seat	Buna-N	----

2.19 AIR AND VACUUM VALVES

A. Valve design and operation.

1. Air and vacuum valves for water service shall have a float assembly and large venting orifice to exhaust large quantities of air from pipelines when being filled and to admit large quantities of air when pipelines are being drained. Valve shall have a body with a flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat. Float shall be

unconditionally guaranteed. Do not use designs having levers and weights attached to the floats. Float shall have a one-piece guide rod extending out of the bottom end to engage the guide bushings in the valve body at all times. Air and vacuum valves shall include a throttling device to control air output but allow full air input to the pipeline.

2. Air and vacuum valves 4-inches and larger shall have 1/2-inch threaded outlets with bronze plugs near the top and bottom of the valve body. Air and vacuum valves shall include a throttling device to control air output but allow full air input to the pipeline. The valve assembly shall incorporate a perforated baffle on the inlet to prevent the water column entering the valve from slamming the float shut, and an isolation butterfly valve.

B. Materials of Construction:

Item	Material	Specification
Body and Cover and Baffle	Cast iron	ASTM A 48, Class 35 or ASTM A126, Grade B
	Ductile iron	ASTM A 536, 65-45-12
Float, guide rod guide bushings	Stainless Steel	AISI Type 304, 303
Seat	Buna-N	---
Water Diffuser (Surge Check Plug)	Bronze	ASTM B584 C83600
Throttling Device	Malleable Iron	---

C. Valves with cast iron body and cover shall have an operating pressure of 150 psi. Valves constructed with ductile iron body and cover shall have an operating pressure of 300 psi.

2.20 AIR RELEASE VALVE

A. Valve Design and Operation

1. Air-release valves for water service shall function to slowly release pockets of air which accumulate at high points in piping systems. Valves shall have a float-actuated compound lever with linkage mechanism to release air. Float shall be unconditionally guaranteed.

B. Materials of Construction

Item	Material	Specification
Body and Cover	Cast iron	ASTM A 126, Class B
Float and seat	Stainless Steel	AISI Type 304, 303
Linkage, orifice air-release mechanism	Stainless Steel	AISI Type 304, 303
Needle	Buna-N	---

2.21 BURIED PIPE WARNING / LOCATING TAPE

A. Buried pipe warning / locating tape shall be preprinted polyethylene and metallic tape, 6-inch minimum width. Tape shall be suitable for use with common metal detectors. Tape wording shall be "Caution – Pipeline Buried Below." Tape shall be Seton Name Plate Company or equal.

2.22 THRUST BLOCKS

A. Provide concrete thrust blocks where piping changes direction or dead ends.

B. Concrete shall be 3,000 psi 28-day strength per section 03300 - Cast-in-place Concrete.

C. Thrust blocks shall bear on undisturbed earth at the edge of the excavation.

D. Place thrust blocking so that fitting joints are accessible and so that hydrant drain holes are not blocked.

E. Protect bolts and joints from concrete with a sheet of plastic.

F. Bearing area of thrust blocks, Square Feet:

Pipe Size	90° Bend	45° Bend	Tee or Dead End
2	2	2	2
4	4	2	3
6	6	3	4
8	11	6	8
10	17	9	12
12	24	13	17
14	33	18	23
16	43	23	31

G. Refer to Standard Drawing for general arrangement of thrust blocks.

2.23 PAINTING AND COATING

A. Provide asphaltic coating on buried ductile iron pipe and fittings per AWWA C151. Wrap buried pipe, fittings, and joints with 8-mil polyethylene or 4 mil high density cross laminated tubing per AWWA C 105. Wrap tubing joints with 2-inch-wide adhesive tape, PolyKen 900, Scotch Wrap 50, or equal.

B. Coat buried flexible pipe couplings (including joint harness assemblies), transition couplings and flanged coupling adapters per Section 09900, System No. 10. Then wrap the couplings with polyethylene wrap per as described above.

C. Coat ductile iron, and black steel pipe and fittings exposed in structures per Section 09900, System No. 29. Apply prime coat in factory.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify existing conditions.

B. Correct conditions detrimental to timely and proper completion of the work.

C. Do not proceed until satisfactory conditions have been corrected.

D. Make necessary measurements in the field to assume precise fit of items in accordance with the approved design.

3.2 PREPARATION

A. Handle pipe accessories so as to ensure delivery to the trench in sound, undamaged condition:

B. Carry pipe into position; do not drag.

C. Use pinch bars or tongs for aligning or turning the pipe only on the bare end of the pipe.

D. Thoroughly clean interior of pipe and accessories before lowering pipe into trench.

E. Keep clean during laying operations by plugging or other method approved by the Engineer.

F. Before installation, inspect each piece of pipe and each fitting for defects:

G. Replace material found to be defective before or after laying, with sound material meeting the specified requirements, and without additional cost to the Owner.

H. Rubber gaskets: Store in a cool, dark place until just prior to time of installation.

3.3 INSTALLATION - PIPE

A. Lay pipe in dry; minimum earth cover as indicated on drawings; install water main and appurtenances in accordance with AWWA C600; use applicable portions of AWWA C600 for PVC pipe installation.
   1. Make iron pipe joints in accordance with AWWA C600 and as recommended by manufacturer; use minimum amount of gasket lubricant; apply to gasket only; do not apply to inside of bell.
   2. Make PVC pipe joints in accordance with manufacturer's recommendations.

B. Clean pipe interior of foreign material before lowering into trench; keep clean at all times; when pipe laying is not in progress, including lunch breaks, nights, weekends and other non-working periods, securely close open ends of pipe and fittings with watertight plug.

C. Place in trench in sound, undamaged condition; do not injure pipe coating or lining; use web slings to install or move pipe; use of end hooks prohibited; dropping or rolling pipe will not be permitted.

D. Cut pipe in neat and workmanlike manner without damage to pipe; bevel cut ends of push-on type pipe.
   1. Completely coat damaged ends of cut iron pipe with bituminous sealer; use spray-on type sealer which will adhere to lining at any temperature; do not install pipe and fittings showing blisters or holes.

E. Before installation, tap iron pipe lightly with light hammer to detect cracks; visually inspect pipe lining for defects; do not install defective, damaged or unsound pipe.

F. Deflect pipe joints as required in accordance with recommendations of pipe manufacturer except pipe deflection shall not exceed 3°; use suitable fittings where grade or alignment requires offsets of more than 1" per foot.

G. Minimum horizontal separation from sanitary sewers, storm sewers or sewer manholes: 10’ from edge of sewer or manhole to edge of water main.
   1. If conditions prevent 10' separation, minimum may be reduced to 3' by placing bottom of water main at least 18" above top of sewer in separate trench or in same trench on bench of undisturbed earth.
   2. If impossible to obtain 18" clearance, replace sanitary sewer with ductile iron pipe; pressure test pipe as specified herein; replace storm sewer with gasketed joint pipe.

H. Minimum vertical clearance for water main crossing sewer service, sanitary sewer, storm sewer or drainage tile: 18" vertical clearance from bottom of water main to top of sewer.

1. If above clearance cannot be obtained, replace sewer service or sanitary sewer with 20' length of ductile iron pipe centered on water main; replace storm sewer or drainage tile with gasketed joint pipe.
2. If water main must pass under sewer service or sanitary sewer, replace with 20' length of ductile iron; provide at least 18" vertical clearance between bottom of sewer and top of water main; center 20' length of water main at point of crossing; replace storm sewer or drainage tile with gasketed joint pipe.
3. Adequately support sewer line to prevent settling or breaking of water main or sewer.
4. Backfill trench with low permeability soil for 20' length centered on crossing.
5. Pressure test cast iron sewer pipe as specified herein.

I. Plug or cap and block all pipe ends or fittings left for future connections.

3.4 INSTALLATION - VALVES

J. Install with stems vertical and centered in manhole or box, as shown on Standard Drawing.

K. Check all valve bolts when installed; tighten as necessary after valves are in operation and up to operating pressure.

L. Support valves in manholes or boxes as required.

M. Carefully tamp earth around each valve box or manhole to distance of 4' on all sides of box or manhole or to undisturbed trench face, if less than 4'; install as shown on Standard Drawing.

3.5 INSTALLATION - HYDRANTS

A. Install plumb; set at elevation so that cover will not be less than for adjacent main; set grade mark on hydrant barrel at finished ground level; install as shown on Standard Drawing.

B. Set on concrete foundation.

C. Carefully tamp backfill around hydrant to a distance of 4' on all sides of hydrant or to undisturbed trench face, if less than 4'.

D. Tighten all stuffing boxes as hydrant is installed; operate hydrant in open and closed position to assure all parts are in working condition.

E. Block hydrant in place.

3.6 STREET/PAVEMENT CROSSINGS

C. Auger service pipe under paved streets, driveways and sidewalks; no casing pipe required.

3.7 TESTING AND DISINFECTION

A. Clean and test all water piping appurtenances after installation in accordance with Specifications Section 15042.

D. Disinfection all water piping and appurtenances after installation in accordance with Specifications Section 15041.

3.8 FIELD QUALITY CONTROL

A. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

END OF SECTION 02667

SECTION 02671

WELL PUMP AND PITLESS UNIT

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers materials, testing, and work required for placing into operation the necessary submersible pumps and pitless unit system included in the project. Contractor shall supply all necessary materials, equipment, tools, labor, and superintendence necessary for completion of the work. Some pumps may operate in conjunction with Variable Frequency Controllers (VFDs). Those pumps and motors utilizing VFDs shall be designed to operate from 60% to 100% speed for extended periods of time.

This section does not include installation of pump controls

1.2 REFERENCES

A. ANSI B1.20.1: NPT American Tap Pipe Thread

B. ANSI B16.5: Pipe Flanges and Flanged Fittings.

C. ASTM D-1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

D. ASTM D-2464: Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

E. ASTM D-2467: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

F. AWWA A100: Standard for Water Wells.

G. Great Lakes – Upper Mississippi River Board of State Sanitary Engineers, Recommended Standards for Water Works.

H. Location Specific References:
1. Iowa Administrative Code 567 Chapter 43: Water Supplies – Design and Operation.
2. Iowa Administrative Code 567 Chapter 82: Well Contractor Certification.
3. Iowa Water Supply Facilities Design Standards, Chapter 3: Source Development.

1.3 SUBMITTALS

A. Submit dimensional drawings, showing materials of construction by ASTM reference and grade.

B. Submit manufacturer's certified pump performance curves for review by the Engineer. Pumps will not be shipped prior to approval of the pump curves by the Engineer. Show pump total head, torque, brake horsepower, pump efficiency, and required NPSH with pump and system operating point plotted.

C. Submit data to indicate compliance with type of materials specified.

1.4 QUALITY CONTROL

A. Owner and/or Owner's Representative will be on-site during the entire installation and testing of the first well pump. It is most likely that Owner and/or Owner's Representative will be on-site during installation and testing of remaining pumps.

1.5 MANUFACTURER'S SERVICES

A. Equipment manufacturer's services at the jobsite shall not be required.

PART 2 PRODUCTS

2.1 GENERAL

A. All equipment for the pumps, including motors and installation appurtenances, shall be provided as a complete unit by the pump manufacturer, who shall assume full responsibility for the proper operation of the pumps and associated equipment. For pumps utilizing VFDs, coordinate with VFD manufacturer as necessary to assure proper pump, motor, and VFD operation.

2.2 MANUFACTURERS

A. Pump selections were made based on Grundfos Pumps. Other manufacturers may be acceptable provided the pump is to be supplied has an efficiency no lower than 5 percent from that specified for the primary design point. Flow at the secondary points shall be ±10% gpm, head shall be ±10 feet, and efficiency is no lower than 8 percent of those specified.

B. Other pre-approved manufacturers include Paco, Goulds, Fairbanks, and Peerless. Other manufacturers must be approved by the Engineer a minimum of ten (10) days prior to bid opening to be considered. Submit pump curves with primary and secondary points indicated and list any exceptions to the specification that may be taken during submittals.

2.3 NAMEPLATE

A. Corrosion resistant nameplate by W.H. Brady, or approved equal, securely fastened to pump with the following data engraved or stamped in black letters (1/2" high) on a light contrasting background:
   1. Name of pump manufacturer
   2. Pump serial number
   3. Year built
   4. Number of stages
   5. Design head and discharge
   6. Pump speed (rpm)

2.4 WELL PUMPS

A. Type: Pumps shall be submersible axial-flow or mixed-flow centrifugals. Statically and dynamically balanced rotating parts. Pump shall be equipped with a spring loaded, stainless steel (Type 304) check valve; built-in (preferred) or attached on the pump column immediately above the pump. Pumps installed in angled wells shall have nitrile (Buna-N, NBR) intermediate bearings supporting the shaft between each stage.

B. Materials of Construction: All stainless steel construction with nitrile (Buna-N, NBR) seals, gaskets, and o-rings.

C. Pump Conditions
   a. 75 gpm at 240-ft TDH, 3” NPT discharge (Grandfoss 85 S 75-6, 7.5hp)

2.5 COLUMN PIPE

A. Material
   1. Certa-Lok™ PVC Drop Pipe, and stainless steel drop pipe adapters or equal. (Schedule 80 PVC pipe utilizing a locking groove-and-spline restrained joint system with torque screws for submersible pump installations.)

B. Column Pipe Adapter: Use a stainless steel column pipe adapter to connect column pipeing to pumps, check valves, pitless adapters, or other appurtenances. Column pipe shall not be directly connected to the discharge chamber of the pump.

C. Column Pipe Centralizers
   1. Centralizers shall position column pipe in a centered and restrained position utilizing equal runner lengths with a minimum clearance of 1.0” between runner tops and casing inner diameter.
   2. Products:
      a. Stainless steel (Type 304) casing spacer system with glass reinforced polymer runners and all stainless steel hardware: Pipeline Seal and Insulator, Inc. (PSI) or equal.
      b. Kwik-Zip® centralizers shall not be used.

2.7 SUBMERSIBLE MOTOR

A. Motor shall be a Type 304 stainless steel, vertical, submersible motor. Motor shall be designed for drinking water application.

B. NEMA Code "F" starting current range or better.

C. Power Cable
   1. Provide 3-Conductor cable assembly, synthetic rubber insulation, jacketed, for submerged applications. Size conductor cable so voltage drop in the power cable does not exceed 5% at the motor rated full load current and voltage. Cable shall be approved for drinking water application. Cable length shall extend 25 feet beyond top of well.
   2. Provide stainless steel cable straps at intervals not to exceed 20 feet. Secure cable splicing with a strap above each joint.
   3. Provide steel guard in area of the bowl assembly to protect against damage of cable from contact with well casing.

D. Motor Conditions
   a. 4”, 7.5 HP, 240 V, 1 phase, 60 Hz, inverter duty rated.

E. Flow Inducer Sleeve (Pump Shroud):
   1. Flow inducer sleeve shall be sized to provide sufficient flow past the motor for proper cooling, as per manufacturer’s specifications. Sleeves for motors p[eratomg om cpmkictopm wotj VFDs shall be sized for operation at 60% to 100% speed.
   2. Flow inducer sleeve shall be constructed wither from PVC or stainless steel.

3. For vertical wells, submersible moter manufacturer shall provide flow inducer sleeve. For angled wells, a protective PVC pump sled shall be sized to act as a flow inducer sleeve.

F. Provide five-year warranty for motors.

G. Each motor shall have sufficient brake horsepower to operate the pump at any point on the pump head-capacity curve without overloading the nameplate horsepower rating of the motor. Operating in the service factor of the motor will not be acceptable.

H. In the opinion of the Engineer, if a pump or motor fails to meet any of the specified requirements, the contractor/manufacturer shall, at no expense to the Owner, make such modifications and perform tests as may be necessary to comply with these specifications.

2.8 WATER LEVEL MEASUREMENT

A. Contractor shall furnish conduit for a pressure transducer at each well. Conduit shall be 1" nominal diameter Schedule 80 PVC pipe of sufficient length to extend from the base of pump to the top of pitless unit, accounting for any pipe stretch. Transducer shall be provided by Owner's Systems Integrator.

2.9 PITLESS UNIT SYSTEM

A. The system shall be furnished and installed with a watertight well cap with protected screen well vent, lift-out bail, depth test fitting, hold down hooks, sealed conduit, airline, lift out pipe, discharge body with support ring, and pressure equalizing passage. The Pitless Unit System shall be Baker Manufacturing Company, Monitor Division, Custom Pitless Unit for submersible pumps, or equal. The recommended model is Baker/Monitor Model #5PS810WBE24F4S.

B. The cast iron well cap shall be watertight and be secured to the pitless casing with a compression gasket. The well cap shall have a separate protected, downward facing screened well vent with pipe nipple.

C. The upper casing shall be factory assembled to the discharge body; the lift out and hold down mechanisms factory assembled to the spool. Upper casing weight and thickness must conform to the Recommended Standards for Water Works. Upper casing shall be coated with a rust protective coating.

D. The discharge port centerline shall be below the regional frost line, and the pitless upper casing shall extend above grade, as shown on plans. The discharge connection shall be flanged (150 lb. per ANSI B16.5).

E. The spool shall be constructed of lead-free galvanized cast iron, ductile iron, or steel with lead-free galvanized plating on the wetted surface of over 0.010-inches thick. O-ring grooves shall be machined into the spool. O-ring seals shall be constructed of neoprene or equivalent. Spool shall be designed to accommodate probe tubes or water samplers and NPT ports for discharge pressure taps. Spool shall include NPT male drop pipe connection, per ANSI B 1.20.1, sized as specified in Part 2.4 of this section.

F. The spool shall have a hold down mechanism, factory assembled to spool and capable of preventing rotation of the pitless spool relative to the discharge body, at full rated locked rotor torque of the submersible pump motor. The spool must also have a factory assembled lift out pipe and bail, or spider capable lifting a water filled drop pipe and pump out to the well for service.

G. The discharge body shall be constructed of lead-free, galvanized ductile iron or lead-free, galvanized steel. Minimum I.D. of the discharge body to be equal to or greater than I.D. of the inner well casing for ease in well servicing. O-ring seat shall be made of similar metal to prevent crevice and galvanic corrosion.

PART 3 EXECUTION

3.1 INSTALLATION

A. Disinfect pump assembly immediately prior to setting the pump. Spray pump assembly with 200 mg/l chlorine solution.

B. Bump pump motors to ensure that rotation of motor and pump is correct.

C. Install column pipe to adapter, then install adapter to the pump discharge.

D. The column pipe shall be supported every 10 feet by flange or by column pipe centralizer.

E. If using plastic or flexible pipe for column pipe, compensate for stretching when establishing pump depth and attaching downhole conduit or cables to the column pipe. Contractor shall check with the column pipe manufacturer to determine pipe stretch compensation for accurate pump depth setting. Leave 3 to 4 inches of slack between downhole conduit or cable straps to allow for stretching.

F. Upon startup, measure head, flow and amperage to ensure that the pump is operating along the pump curve and the motor is not being overloaded.

3.2 PAINT

A. Paint exposed portions of pitless and with two coats Tnemec Senes 66 or equal, top coat Tnemec Senes 73 or equal. Surface preparation SSPC SP6.

END OF SECTION 02671

SECTION 02730
SANITARY SEWER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials and installation procedures for piping, structures and appurtenances for sanitary sewer construction.

1.2 RELATED SECTIONS

A. Section 02225 - Trenching, Backfilling and Compacting

B. Section 02230 – Horizontal Direction Drilling

C. Section 02990 - Restoration and Cleanup

PART 2 PART PRODUCTS

2.1 SANITARY SEWER PIPE MATERIALS – 6” GRAVITY PIPE AND LARGER – OPEN TRENCH INSTALLATION

A. Solid Wall Polyvinyl Chloride Pipe (PVC) 6" - 15":
   1. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe, SDR 35.
   2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
   3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

B. Solid Wall Polyvinyl Chloride Pipe (PVC) 18"-27":
   1. Conform to ASTM F 679 (SDR 35 or equivalent) with T-1 minimum wall thickness; minimum pipe stiffness, 46 psi as per ASTM D 2412.
   2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
   3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

C. Corrugated Polyvinyl Chloride Pipe (PVC) 6"-36":
   1. Conform to ASTM F 949, 46 psi stiffness, smooth interior, corrugated exterior.
   2. PVC resin meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
   3. Integral bell and spigot rubber gasket joint conforming to ASTM D 3212 and ASTM F 477. Double wide gaskets required (index into two valleys).

D. Closed Profile Polyvinyl Chloride Pipe (PVC) 21"-36":
   1. Conform to ASTM F 1803 (Closed Profile), minimum pipe stiffness 46 psi.
   2. PVC plastic meeting ASTM D 1784, Cell Classification 12364. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot with elastomeric seals conforming to ASTM D 3212 and ASTM F 477.

E. Polyvinyl Chloride Composite Pipe (PVC Truss) 6"-15":
1. Composite pipe constructed with truss type structure between inner and outer PVC walls with voids filled with lightweight concrete.
2. Conform to ASTM D 2680, minimum pipe stiffness, 200 psi.
3. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.
4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and F 477.

F. Reinforced Concrete Pipe (RCP) 18”-144":
1. Conform to ASTM C 76.
2. Minimum Class IV, Wall B.
3. Tongue and groove joints.
4. Rubber O-ring flexible joint conforming to ASTM C 443.
5. Coat interior pipe barrel and entire joint surfaces with two-component coal-tar epoxy-polyamide black paint or approved equal.
6. Lining Material: Steel Structures Painting Council (SSPC) Specification No. 16, Table 1.
   a. Minimum epoxy resin content 34 to 35% by dry film weight.
   b. Minimum sag resistance 40 mils.
   c. Minimum solids 80% by volume.
7. Cure pipe, sand blast and thoroughly clean surfaces, and remove all loose materials.
8. Apply lining by airless spray to pipe barrel in multiple coats.
   a. Prime with thinned coating.
   b. Apply top coats.
   c. Provide recommended curing time between coats.
   d. Dry film thickness: Not less than 25 mils or more than 30 mils.
9. Apply lining by brushing all joint surfaces.
   a. Prime with thinned coating.
   b. Apply top coat or coats.
   c. Provide recommended curing time between coats.
   d. Minimum dry film thickness: 8 mils.
10. Cure pipe lining according to the manufacturer´s recommendations, 5 days minimum.

G. Ductile Iron Pipe (DIP) 6"-54":
1. Conform to AWWA C 151/ANSI A 21.51.
2. Minimum pressure class: Class 52.
3. Interior linings
   a. Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.
   b. Use linings specifically designed for sanitary sewer applications, which may include calcium aluminate, polyethylene, ceramic epoxy, and coal tar epoxy. Other lining types may be allowed upon approval of the Jurisdictional Engineer.
   c. Apply lining to interior of unlined ductile iron pipe and fittings according to published specifications from manufacturer.
   d. Seal all cut ends and repair field damaged areas according to the manufacturer’s recommendations.
4. Exterior coating: Asphaltic.
5. Push on joint: AWWA C111/ANSI A 21.11.
6. Fittings: Mechanical joint AWWA C 110/ANSI A 21.10.

7. Polyethylene encasement:
   a. Conform to AWWA C 105/ANSI A 21.5.
   b. Minimum thickness: 8 mils.
   c. Use for all ductile iron pipe and fittings in buried service.

2.2 SANITARY SEWER FORCE/PRESSURE MAIN – 4" DIAMETER AND LARGER – OPEN TRENCH INSTALLATION

A. Ductile Iron Pipe (DIP) 4" - 54": See Section 2.1.G.

B. Polyvinyl Chloride Pipe (PVC):
   1. Conform to AWWA C 900 for pipe sizes 4 to 12 inches; conform to AWWA C 905 for pipe sizes 16 to 30 inches.
   2. Minimum DR 18.
   3. Integral bell and spigot joint with elastomeric gasket.

2.3 SANITARY SEWER FORCE/PRESSURE MAIN – 3" DIAMETER AND SMALLER – OPEN TRENCH INSTALLATION

A. Polyvinyl Chloride Pipe (PVC): ASTM D2241. SDR 26 (160 psi) Pressure Rated Pipe.
   1. Elastomeric gasket (ASTM F 477) joints.

B. HDPE pipe meeting the following specifications also may be used for the pressure mains for both open trench and horizontal directional drill (HDD) method of installation.
   1. High Density Polyethylene (HDPE) Pipe conforming to ASTM D3350 with cell classification 345434C. All HDPE pipe material shall meet the requirements of ASTM D1248 for a Type III, Class C, Category 5, Grade P34 material. Pipe shall be manufactured in accordance with ASTM F-714.
   2. All pipe size dimensions shall be inside measurements.
   3. Minimum pipe class shall be DR 11, 160 psi.
   4. HDPE pipe shall have butt-fused joints.
   5. HDPE fittings and adaptors shall be butt-fused, EHMW-HDPE, PE3408 meeting the same resin requirements as specified for the pipeline. In addition, the fittings shall meet the applicable requirements of ASTM D2513 and ASTM D3261.

2.4 SANITARY SEWER PIPE MATERIALS – HORIZONTAL DIRECTIONAL DRILL (HDD) INSTALLATION

A. The following pipe materials shall be allowed for use in horizontal directional drill (HDD) installation of sewer piping. Materials shall apply to both gravity and pressure sewer applications.
   1. Polyvinyl chloride (PVC) pipe, SDR rated: meeting requirements of ASTM D2241 with solvent cement joint and manufactured from PVC compounds meeting ASTM D1784 for cell classification 12454B (PVC 1120) and testing requirements of ASTM D2241; minimum pressure class 160 psi based on SDR 26.
      a. Joints for piping and fittings shall be deep socket type
   2. Restrained Joint Pipe: Polyvinyl chloride (PVC) restrained joint pipe, SDR rated, RJ-PVC. Pipe shall be as manufactured by CertainTeed, Certa-Lok Yelomine, C900/RJ, Class 160 psi based on SDR 26, or approved equal.
      a. Pipes shall be joined by restrained joint couplings with flexible elastomeric o-ring seals. Jointing shall be in accordance with manufacturer's recommendations.

B. Piping installed using the horizontal directional drill technique shall be installed in accordance with Specifications Section 02230 – Horizontal Direction Drilling.

2.5 SEWAGE AIR RELEASE VALVE:

A. Consists of an elongated tapered or conical body with outward-slanting walls and a float to operate (open and close) under pressure without spillage. Use a float with a flexible connection to the seal plug assembly to prevent irregular air release and protect the connecting rod. The bottom of the valve shall be sloped or funnel-shaped to encourage the accumulated sewage and solids to drain from the valve. Preserve a volume of air at all times between the liquid sewage and the seal plug assembly.

B. Materials:
   1. Body and cover: Stainless steel, fiberglass-reinforced nylon, or other corrosion-resistant materials
   2. Internal Linkage, Stem: Stainless Steel
   3. Float: Stainless Steel, ASTM A 240, ASTM T 304, or foamed polypropylene
   4. Seal Plug Assembly: Stainless steel, foamed polypropylene, EPDM rubber, reinforced nylon

C. Tapping saddle: Stainless steel or nylon

D. Pit: See Details in Drawings.

2.6 SANITARY SEWER SERVICES (GRAVITY)

A. Polyvinyl Chloride Pipe (PVC) and fittings meeting or exceeding requirements of ASTM D3034.
   1. Minimum SDR: 23.5
   2. Preformed saddle wye or saddle tee for service tap conforming to ASTM D 3034 or ASTM F 949.
   3. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
   4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212.

2.7 GATE VALVES AND BOXES

A. Resilient Seated Gate Valves:
   1. Valves shall be of the iron-body resilient-wedge type with non-rising stems for all sizes required on the project.
   2. All valves by the same manufacturer.
   3. Specification Standard: ANSI/AWWA C509.
   4. Body, Bonnet, Stuffing Box: Cast iron or ductile iron.
   5. Bolts and Nuts: Stainless steel.
   6. Valve Ends: Mechanical joint or push-on ends.
   7. Wedge: Cast iron or ductile iron, resilient coated.
   8. Stem: Manganese bronze, non-rising stem.
   9. Seals: Synthetic rubber 0-rings.
   10. Stem Extensions: Steel, noted on the Drawings if required.
   11. Operator: 2" square nut.
   12. Coating: ANSI/AWWA C550 epoxy coating, both inside and outside of body, bonnet, and stuffing box.
   13. Pressure Rating: 200 psi, bubble-tight closure.
   14. Direction of Operation: Counterclockwise to open.
   15. Smooth, unobstructed waterway with a diameter not less than the full nominal diameter of the valve.
   16. Wrap buried valves with polyethylene encasement.
   17. Approved Manufacturers:
      a. American Flow Control Model: Series 2500
      b. Clow Model: F-6100
      c. Kennedy Model: Fig. 1571-X

d. M & H Model: Style 3067-01
e. Mueller Model: Resilient Wedge
f. US Pipe Model: Metroseal
g. Waterous Model: Series 500
h. Owner approved equivalent

B. Valve Boxes:
1. 6" PVC SDR 35 gravity sewer pipe with 6" PVC solvent weld cap. Cap shall not be glued to end of pipe.
2. Height:
a. Rural Areas: Extend from valve body at main to two feet above finished ground elevation.
b. Urban Areas: Extend from valve body at main to flush with finished ground elevation.
3. Wrap with polyethylene encasement to prevent soil from entering valve box.
4. Furnish for all buried valves.

2.8 CORPORATION AND CURB STOPS

A. Corporation Stops:
1. Brass or bronze body.
2. AWWA Taper MIP X PVC Pack Joint.
3. Size: as shown on Drawings.
4. Ford, Mueller, A.Y. McDonald, or Owner approved equal.

B. Curb Stops:
1. General:
a. Brass or Bronze.
b. Ball valve type.
c. 150 psi minimum working pressure.
d. Size: as shown on Drawings.

C. Curb Boxes:
1. For service lines.
a. Extendable two-piece type.
b. Cast iron arch pattern base section
c. Steel pipe upper section
d. Lid selected by Owner.
e. Height required to extend from valve body at service line to finished grade.
f. Locations as shown on Drawings
g. Ford, Mueller, A.Y. McDonald, or Owner approved equal.

2.4 BURIED PIPE WARNING / LOCATING TAPE

A. Buried pipe warning / locating tape shall be preprinted polyethylene and metallic tape, 6-inch minimum width. Tape shall be suitable for use with common metal detectors. Tape wording shall be “Caution – Pipeline Buried Below.” Tape shall be Seton Name Plate Company or equal.

2.9 MANUFACTURER'S CERTIFICATION

A. Prior to installing pipe, the Contractor shall submit to the Engineer a certification from the pipe manufacturer that the pipe intended for use on this project meets these specifications and applicable specified standards.

2.10 ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.11 MANHOLES

A. All manholes shall be made of cast-in-place concrete or precast concrete sections meeting the requirements of ASTM C478 as indicated on the standard details, and shall have a minimum internal diameter of 48 inches. Manhole construction shall be free of voids and exposed reinforcing at pipe openings shall be cut off and grouted.

B. Grout: Non-shrink, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

C. Manhole bottoms shall be cast-in-place or precast integrally with the bottom section. The inverts of channels through the structure shall be formed as indicated on the Drawings.

D. Adjusting rings: ASTM C478 precast concrete adjusting rings shall be provided on manholes as necessary to place the cover assembly at grade or to the required elevation. Under permanent paving and in finished right-of-way, a maximum of 18 inches of adjusting rings shall be placed. Under asphalt stabilization or any other nonpermanent paving, a minimum of 12 inches of adjusting rings or a maximum of 20 inches of adjusting rings shall be maintained at the manholes.

E. Manhole castings shall be as indicated on the Drawings.

F. Manhole section joints shall be made watertight by use of gaskets (ASTM C443) as shown on the Standard Details.

G. All newly constructed manholes shall have a watertight external rubber seal from the casting to the cone which is composed of: (1) a 3/16 inch minimum thickness, corrugated, multiple fin rubber sleeve conforming to ASTM C923 with a durometer hardness of 45; (2) 1 inch minimum width 16-gauge stainless steel bands conforming to ASTM A240, Type 304 with stainless steel screws, bolts, and nuts conforming to ASTM F593 and F594, Type 304 which has the capacity to develop a watertight seal; (3) a 12 ounce per square yard fiberglass-reinforced PVC fabric extension skirt, where banded extensions are not used.

2.12 BEDDING

A. Provide granular bedding for flexible pipe as shown on standard detail for PVC and ABS pipes. Provide granular bedding for rigid pipes as shown on standard details for all VCP, LRCP, and DIP pipes.

B. Pipe bedding material: Bedding material shall be either porous backfill material meeting IDOT Gradation No. 29 or ASTM D2321 Class I, sharp, clean crushed stone; complying with following gradation, dependent upon pipe diameter:

Sieve	% Passing
1-1/2"	100
1"	100
3/4"	80-95
1/2"	35-60
3/8"	20-40
No. 4	0-5

C. Extra Foundation Rock: Aggregate shall be either crushed limestone or crushed gravel. The rock shall be free from deleterious substances in amounts which the Engineer may determine as being excessive and shall conform to the following gradation:

Sieve	% Passing
3"	100
2-1/2"	90-100
2"	35-70
1-1/2"	0-15
3/4"	0-5

PART 3 PART EXECUTION

3.1 EXAMINATION

A. Verify that excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 REPARATION

A. Excavate and carefully remove existing sewer pipe as indicated on the Plans. Excavate trench for new pipe installation below required grade in accordance with Section 02225 and the Drawings.

B. Correct over excavation with bedding materials specified in 2.7.C of this section at no additional cost to the Owner.

C. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

A. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth.

B. Hand shape bell holes at each pipe joint in pipe bedding; provide access around circumference of pipe for proper jointing.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 LINE AND GRADES

A. The grades set shall be for the sewer pipe inverts. All reference points, stakes, hubs, etc. set shall be carefully preserved. All restaking required as the result of improper protection shall be done at the contractor's expense. The contractor shall utilize batter boards or a laser device to ensure adherence to line and grade during construction. Check grades at each 100 ' of pipe laid.

3.5 INSTALLATION - PIPE

A. Install bedding, pipe, fittings, accessories, and backfill in accordance with manufacturer's instructions and the following standards for each type of pipe material:
   1. Polyvinyl Chloride: ASTM D2321
   2. ABS Composite: ASTM D2321
   3. Except as modified by ASTM D2680

4. VCP, LRCP, DIP: ASTM C12

B. Horizontal Direction Drilled (HDD) pipe shall be installed in accordance with Specifications Section 02230 – Horizontal Directional Drilling.

C. Use no defective pipe. Check each length of pipe for defects and hairline cracks at ends prior to lowering into trench. Handle pipe carefully so as to avoid damage to the pipe.

D. Lay pipe commencing at the lowest point in the line. Lay bell or groove ends pointing upstream.

E. Lay pipe to slope gradients noted on drawings with maximum variation from true slope of 1/4 inch in 10 feet.

F. Uniform bearing along the full length of the pipe barrel shall be maintained at all times. Blocking up the pipe shall not be permitted or acceptable.

G. Backfill with bedding materials as specified in layers not exceeding 6 inches to height shown on the Standard Details. This bedding shall be placed and consolidated by rodding or slicing with a shovel to 90 percent standard proctor density. Care shall be exercised in the placing and tamping of the bedding such that the pipe alignment or grade is not disturbed.

H. The sewer shall be kept clean at all times during construction. At the close of each day, or during periods when the construction is halted and the construction site is unattended, the exposed end of the pipe shall be effectively closed to prevent the entrance of animals, dirt, storm water, or any other objects.

I. Pipe joints shall be laid in a dry trench. Water shall not be allowed to rise in the trench until the joints have had sufficient time to set so as to prevent damage to the joint. Care shall be taken in making the joint to attain a close, uniform joint with the previous pipe and to prevent offsets in the flow line of the pipe. Lubricant shall be applied to the gaskets prior to pushing the pipe home for gasketed joints. Follow the manufacturer's requirements when making joints.

J. Refer to Section 02225 for trenching, backfilling and compacting requirements. Do not displace or damage pipe when compacting.

K. Connection of new pipe to existing pipe: The method for connecting the new pipe to existing pipe shall be as shown on the Standard Drawing on the Plans. Joints shall be watertight and smooth with no uneven or jagged edges exposed to the interior surface of the sewer line. New pipe materials shall be as specified in Section 2.1.

L. Connection to New Structures: Connection of sanitary sewer to structures shall utilize flexible watertight pipe connectors (ASTM C923) which shall be precast into the base section at the line and elevation as indicated on the plans.

M. Connection to Existing Structures: Connection of new sanitary sewers to existing structures shall be at the line and elevation as indicated on the plans and shall be by a watertight pipe connector (ASTM C923) or a waterstop gasket material which shall be grouted into the existing structure wall. Grout shall be as specified in Section 2.5.B.

3.6 RECONNECTION OF EXISTING SANITARY SERVICE LINES

A. All existing active sanitary sewer services as shown on the plans and as discovered during construction shall be reconnected to the new sewer pipe as the work progresses.

B. All active services shall be accounted for and shall be unobstructed. No property shall be left without a sanitary service for more than 36 hours.

C. The reconnection of existing excavated sewer services shall be completed in accordance with the Standard Drawings in the Plans.

D. Utilize the same size of pipe as the existing sewer service.

E. Factory wye branches shall be installed as shown on the plans. Wye branches shall be inclined upward at an angle of 45 degrees from the horizontal, unless otherwise specified. If approved by the Engineer, or shown on the plans, tee branches may be substituted for wye branches.

F. Connect new service piping to the existing piping with a Fernco, or approved equal, type coupling.

3.7 INSTALLATION - MANHOLES

A. Form bottom of excavation clean and smooth to correct elevation.

B. Establish elevations and pipe inverts for inlets and outlets as indicated.

C. All lift holes shall be covered on the outside of the wall with bituminous material and plugged on the inside with mortar to make watertight.

3.8 MAINTAINING SEWAGE FLOW

A. Transportation of sewage shall be maintained at all times, except where stoppage is specifically allowed by the Engineer. In no case shall the Contractor cease operations for the day without restoring sewer flowage.

B. Contractor shall bypass the flow by plugging the line at a point upstream of the pipe to be rehabilitated and pumping the flow to a downstream point or adjacent sanitary sewer system as allowed by the Engineer. The pump and bypass lines shall be of adequate capacity and size to handle the flow. In addition, the Contractor shall provide adequate reserve pumps available on site for emergency use when required.

3.9 CONNECTIONS OF DISSIMILAR PIPE

A. Suitable adapters or couplings approved by the Engineer shall be used for joining dissimilar materials. Where adapters or couplings are not available, the Engineer may authorize a concrete collar as shown on the Standard Drawings.

3.10 SEWER MAIN/WATER MAIN CONFLICTS

A. Horizontal Separation. Sewer mains shall be separated from water mains by a horizontal distance of at least 10 feet unless:
   1. the top of a sewer main is at least 18 inches below the bottom of the water main, and
   2. the sewer is placed in a separate trench or in the same trench of undisturbed earth at a minimum horizontal separation of 3 feet from the water main.

When it is impossible to obtain the required horizontal clearance of three feet and a vertical clearance of 18 inches between sewers and water mains, the sewers must be constructed of water main materials meeting both a minimum pressure rating of 150 psi and the requirements of Sections 8.2 and 8.4 of the "Iowa Standards for Water Supply Distribution Systems". However, a linear separation of at least 2 feet shall be provided.

B. Vertical Separation. Vertical separation of sanitary sewers crossing under any water main should be at least 18 inches when measured from the top of the sewer to the bottom of the water main. If physical conditions prohibit the separation, the sewer may be place not closer than 6 inches below a water main or 18 inches above a water main. The separation distance shall be the maximum feasible in all cases.

Where the sewer crosses over or less than 18 inches below a water main one full length of sewer

pipe of water main material shall be located so both joints are as far as possible from the water main. The sewer and water pipes must be adequately supported and have watertight joints. A low permeability soil shall be used for backfill material within 10 feet of the point of crossing.

3.11 FIELD QUALITY CONTROL AND TESTING

A. Request inspection prior to and immediately after placing aggregate cover over pipe.

B. Compaction testing shall be performed in accordance with ASTM D698 and as specified in Section 02225. If compaction tests indicate Work does not meet specified requirements, remove Work, replace and retest.

C. Pipe Inspection: Prior to being lowered into the trench, each pipe shall be carefully inspected, and those found to be unacceptable or not meeting the specified requirements shall be removed from the site immediately. Rejections may be made for any of the reasons as stated in these specifications or in the referenced ASTM standards for each specific type of pipe. Pipe having minor flaws not serious enough to cause rejection shall be laid so as to bring such flaws in the top half of the sewer. Pipe shall be protected during handling against impact, shocks and free fall.

D. The new sewers and all appurtenances shall be thoroughly cleaned under the direction of and to the satisfaction of the Engineer before final acceptance of this work. Included shall be the removal of all sheeting, bracing, shoring, scaffolding, forms, and all objectionable debris.

E. Testing. The following tests shall be performed by the Contractor in the presence of the Engineer. The Contractor shall be responsible for providing all labor, materials, and equipment for the testing. Testing shall conform to the requirements of Section 12.7 of the Iowa Wastewater Facilities Design Standard (IAWFDS), Current Edition. All equipment required for testing shall be furnished and operated by the Contractor subject to the approval of the Engineer. This equipment shall include all fittings, piping and necessary flushing appurtenances.

1. Infiltration Test. The sanitary sewer and all connections and laterals shall be measured for infiltration at points designated by the Engineer. The tests for infiltration shall be conducted in a manner as approved by and under the direction of the Engineer. Infiltration shall be measured using either the water test or the low pressure air test. The sewer and connections shall have a rate of infiltration less than 200 gallons per inch of pipe diameter per mile per day.
2. Water Test. The test shall be performed using a minimum positive head of 2 feet of water. Maximum allowable exfiltration shall be 200 gallons per inch of pipe diameter per mile per day.
3. Low Pressure Air Test. Sewer lines shall be air tested in accordance with ASTM C828 - Standard Practice for Low Pressure Air Test of Vitrified Clay Pipe Lines or NCPI Bulletin - Low Pressure Air Test for Sanitary Sewers or Cherne Discussion No. 6 - Air Test Specifications. The air test shall be made in the presence of the Engineer. All equipment necessary for said air test shall be provided by the Contractor and approved by the Engineer.
4. Deflection Test. All polyvinyl chloride pipe installations shall be tested for deflection by using a rigid ball or mandrel and shall be performed in accordance with ASTM D2321 and without the use of mechanical pulling devices. Deflection may not exceed 5 percent and shall be tested more than 30 days after final backfill is placed.
5. Alignment. Sewer pipe will be inspected for alignment by the use of mirrors, flashlights or lamps. Sewer lines shall permit a through view of at least half the pipe diameter between manholes.
6. Force (Pressure) Mains: Force mains shall be pressure tested after installation in accordance with ANSI/AWWA C-600, Hydrostatic Testing.

F. Acceptance. If any of the tests are not met, the Contractor shall, at his own expense, determine the source of the problem and repair or replace all defective materials.

G. Collapsed, fractured or pipe whose structural integrity is questionable, as determined by the Engineer, shall be replaced in a manner suitable to the Engineer. The sewer line shall be considered acceptable when all of the above provisions are complied with.

3.12 PROTECTION

A. Protect finished Work from damage.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 02730

SECTION 02740
WASTEWATER LAGOON CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Special construction associated with wastewater lagoon treatment facilities.

B. The work under this section shall cover the construction of the earthen lagoons and appurtenant improvements. It is required that the lagoons be constructed essentially watertight in accordance with Iowa Wastewater Facilities Design Standards Chapter 18C, Section 18C.7.3 – Pond Bottom.

1.2 RELATED SECTIONS

A. Section 02200 – Earthwork.

B. Section 02225 – Trenching, Backfilling and Compacting.

C. Section 02275 – Revetment and Erosion Stone.

D. Section 02370 – Erosion Control.

E. Section 02661 – Flexible Membrane Lagoon Liner.

F. Section 02730 – Sanitary Sewer Systems.

G. Section 02990 – Restoration and Cleanup.

1.3 REFERENCES

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
   1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
   2. American Water Works Association (AWWA) Standards, Current Edition.
   3. American National Standards Institute (ANSI) Standards, Current Edition.
   4. State of Iowa, Department of Transportation, Standard Specifications for Highway and Bridge Construction, 2001 Edition, and current Supplemental Specifications.

PART 2 PRODUCTS AND MATERIALS

2.1 EARTH MATERIALS

A. Earth fill shall consist of suitable soil materials and shall contain no deleterious materials such as logs, stumps, brush or other perishable material.

B. Soils not suitable for dike construction may be placed in the dike backslope beyond a 1:1 slope extending outward from the outer top of dike line.

C. Materials to be incorporated in the top one foot of the dikes shall be free of large stones, broken concrete and the like which would hinder scarifying, compacting, finishing the subgrade or installing the liner.

2.2 LAGOON LINER

A. Due to the shallow bed rock site conditions the lagoon will require a flexible membrane lining system. See Section 02661 – Flexible Membrane Lagoon Liner for details.

2.3 SOIL STERILANT

A. Sterilant: Sodium chlorate, borax, sodium pentaborate, boron trioxide, or similar material.
   1. The addition of 2, 4-D; 2, 3, 6T-BA, or substitute phenylurea herbicide to reduce application rates is recommended.
   2. Soil Sterilant shall be compatible with lagoon liner. See Section 02661 – Flexible Membrane Lagoon Liner.

2.4 LAGOON STRUCTURES, PIPING AND VALVES

A. Structures and piping for installation shall be in accordance with Section 02730 – Sanitary Sewer Systems.

B. All lagoon piping shall be unlined interior class 52 ductile iron pipe (DIP) unless otherwise indicated on the drawings.

2.5 GRANULAR SURFACING

A. Class A crushed stone meeting IDOT Section 4120.04.
   1. Gradation No. 11

2.6 TOPSOIL

A. Topsoil layer shall consist of stockpiled topsoil material that can be readily seeded and will support vegetation.

B. Pulverized and free of large, extraneous material and contaminants.

C. Conform to Section 02990.

2.7 SEED, FERTILIZER AND MULCH

A. Seed shall be in accordance with Specifications Section 02990 – Restoration and Cleanup, Rural Areas Seed Mixture.

B. Fertilizer and mulch shall be in accordance with Specifications Section 02990 – Restoration and Cleanup, Grasses and Lawns.

PART 3 EXECUTION

3.1 LAGOON EARTHWORK

A. The following procedures generally describe special excavation and backfill procedures and requirements shown on plans and detailed in the Subsurface Exploration Report (see Appendix).

B. Preparation of Excavation Site:
   1. Strip topsoil from excavation and borrow area(s) to minimum of 12 inches or as determined by Engineer to obtain suitable foundations; remove all

topsoil, rubbish, vegetable matter, roots, grass and other organic material; stockpile topsoil for restoration of borrow area(s) and excavation area.

2. Stockpile other stripping materials, which are suitable for use as fill in the opinion of the Engineer.
3. Proof roll prior to placement of fill; remove or compact area of soft subgrade conditions.
4. Scarify, harrow and roll embankment foundation areas as necessary to provide proper bond with first layer of new fill.

C. Lagoon Bottom and Dikes (embankment): prepare site as directed above.

1. Where in cut section (excavated to natural soils), over-excavate a minimum of one foot below bottom of finish grade; excavated subgrade shall be scarified an additional 6 inches and compacted to minimum 95% of standard Proctor density; extend over-excavation laterally minimum five (5) feet beyond intersection of lagoon floor and exterior lagoon side slope; place compacted, cohesive soil in over-excavation.
2. Where bedrock is encountered, overexcavate to provide a minimum vertical distance of 4 feet between top of bedrock and bottom of lagoon liner. Replace overexcavated rock materials with suitable fill.
3. Where in fill section, place cohesive soil on prepared site in lifts with loose thickness of 9 inches or less and compact to minimum 95% of standard Proctor density.
4. Construct to line and grade as shown, on plans; provide allowance for settlement: bottom of lagoon to be within 3 inches of elevation shown on plans.
5. Place no roots, brush, grass or organic materials in embankments; place no material on embankment when material or foundation is frozen.
6. Excess sand and silt materials may be used for dike construction if placed in the outer 1/3 of the embankment and covered a minimum of three (3) feet with compacted cohesive fill.
7. Place fill material on scarified surfaces; avoid distinct changes in texture by scarifying and intermingling dissimilar fill materials; place no stones larger than 6 inches in embankment. Lagoon bottom within 2 vertical feet from liner shall be free of stones larger than 1 inch.
8. Allow areas of fill to settle for 3 weeks; check elevation to top of dike and add fill as required.
9. Place topsoil on top and outer surface of dikes in areas not to receive granular surfacing.

D. Other areas receiving fill:

1. Place selected backfill material and compact each horizontal layer with tamping or sheeps-foot roller; place in layer compatible with compaction equipment used, but not to exceed 9 inches.
2. Use roller designed to provide at least 250 psi distributed on one (1) row of knobs.
3. Maintain optimum moisture content of soil within practical limits, uniformly distribute water over each layer to raise moisture content; scarify, harrow or work material to aerate if necessary to reduce moisture content.
4. Place topsoil as appropriate.

E. Grade borrow areas and excavation sites to uniform slope for drainage, place topsoil as appropriate, finish grade and prepare seedbed as appropriate.

F. Cropland and pastureland, within construction easement, compacted by construction equipment, shall be subsoiled prior to preparation of seed bed.

3.2 SURPLUS MATERIAL

A. Unless otherwise specified, dispose of surplus material off site in accordance with applicable ordinances and environmental requirements and in coordination with the Owner/Engineer.
   1. Cost for removal and proper disposal of surplus material off site shall be incidental to lagoon construction and no separate payment will be made for this work.

B. If specified, quantity of surplus material is approximate.

C. Verify that sufficient material is available for completion of embankments before disposing of material off site. Premature disposal of material shall be replaced at the Contractor's expense.

D. Maintain stability of soil adjacent to any excavation.
   1. Do not stockpile material to a depth greater than 5 feet above the finished grade within 25 feet of an excavation or structure.

3.3 BORROW MATERIAL

A. Import quantity of borrow material needed to complete embankments conforming to specified requirements.
   1. Cost for importing borrow materials from off site shall be incidental to lagoon construction and no separate payment will be made for this work.

B. Determination of borrow site(s) and quality of borrow materials shall be by Contractor with approval of the Engineer prior to use on site.

3.4 ACCESS ROAD

A. Construct access road to grade and alignment shown on plans using suitable fill material and procedures specified for excavation and backfill; blade and shape road to shed and drain water.

B. Furnish and install temporary surfacing to provide site access during construction; keep road clear and reshape to maintain access to site during construction at no additional cost to Owner.

C. As last order of construction, grade road and proof roll areas to receive granular surfacing; remove or recompact areas of soft subgrade conditions; place granular surfacing to limits and quantities shown on plans.

3.5 LAGOON BOTTOM AND SLOPES

A. The bottom of the lagoons shall be graded to within the elevations indicated on the contract drawings with a maximum finished tolerance 0.25 feet. The slopes shall be within 0.35 feet of those so indicated similarly.

3.6 LAGOON SEALING

A. The Contractor is required to seal the interior of the lagoons in accordance with Iowa Department of Natural Resources requirements.

3.7 SOIL STERILIZATION

A. Sterilize lagoon inner side dikes up to top erosion stone blanket location with non-selective herbicide weed killer.

B. Soil sterilant shall be applied per manufacturer's instructions at the rates recommended.

C. The herbicide and method of application shall be approved by Engineer prior to application.

D. Apply soil sterilant prior to placement of erosion blanket on inside lagoon dike slopes.

3.8 FINISHING AND TOPSOILING

A. Finish grade all areas of the site which are disturbed. Provide slopes, swales and ditches as required to provide surface drainage and as shown on the contract drawings.

B. Topsoil all areas other than access roads and interior of lagoons below the dike tops. Topsoil thickness shall be a minimum of 4 inches. All remaining stockpiled topsoil shall become the property of the Owner.

3.9 CONTROL STRUCTURES

A. The structures for controlling lagoon water levels and discharge shall be constructed as shown on the contract drawings.

B. Backfill of all piping and structure excavations within dikes or lagoons shall be compacted to 95 percent of the maximum dry density as determined for the materials in accordance with ASTM D1557.

3.10 SEEDING, FERTILIZING AND MULCHING

A. After all excavation and grading operations are completed the Contractor shall seed, fertilize and mulch all areas within the lagoon site and areas disturbed by construction that are not to receive granular or stone surfacing. Work shall be in accordance with Specifications Section 02990 – Restoration and Cleanup, Grasses and Lawns.

B. Seeding, fertilizing and mulching shall be incidental to NPDES Stormwater Permit/Erosion Control. No separate payment shall be made for this work.

END OF SECTION 02740

SECTION 02820
WOVEN WIRE FENCE

PART 1 GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 1 shall govern work of this section.

1.2 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
   1. State of Iowa, Department of Transportation, Standard Specifications for Highway and Bride Construction, Current Edition, and current Standard Road Plans
   2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.

1.3 DESCRIPTION OF WORK

A. The work covered under this section shall consist of providing all materials and labor to construct a fence consisting of woven wire fencing fabric erected on preservative treated wood posts. All fences gates as shown on the contract drawings shall be chain link fence.

1.4 RELATED WORK ELSEWHERE

A. Site Grading - Division 2

B. Cast-in-Place Concrete - Division 3

1.5 SHOP DRAWINGS

A. The Contractor shall submit such shop drawings and/or catalog cuts required for the construction and installation of the equipment. These drawings shall be accurate in every detail and shall contain all information necessary to relate the equipment to the specifications.

PART 2 PRODUCTS

2.1 WOVEN WIRE FABRIC

A. Fabric materials conforming to Subsection 4154.02 of the State of Iowa, Department of Transportation, Standard Specifications.

B. Woven Wire Fabric Fence shall conform to ASTM A116, Class 3 Coating, or ASTM A584.

2.2 GATES

A. Gates shall be fabricated in conformance with Subsection 4154.12 of the State of Iowa, Department of Transportation, Standard Specifications.

B. Fabricate gate perimeter frames of pipe or roll-formed section conforming with ASTM F669 and have a minimum yield strength of 45,000 psi. Sections shall be of structural dimensions as required to provide a minimum bending strength of 15,700 lb/-in and a minimum stiffness of 12.0 x 10^6 lb/-in^2. Provide additional horizontal and vertical members to insure proper gate operation and for attachment of fabric, hardware and accessories. Assemble gate frames by welding or fittings and rivets for rigid connections. Install fabric with stretcher bars at vertical edges, and tie at top and bottom edges. Attach stretcher bars to gate frame at not more than 15 inches O.C. Attach hardware with rivets or by other means which will provide security against removal or breakage.

C. Provide diagonal cross bracing consisting of 3/8 inch diameter adjustable length truss rods on gates where necessary to provide frame rigidity without sag or twist.

2.3 GATE HARDWARE

A. Provide hardware and accessories for each gate, finish heavy galvanized conforming with requirements of ASTM A153:

1. Hinges. Pressed steel or malleable iron to suit gate size, non-lift off type, offset to permit 180E gate opening. Provide one pair of hinges for each leaf.
2. Latch. Forked type to permit operation from either side of gate. Provide padlock eye as integral part of latch.
3. Keeper. Provide keeper which automatically engages the gate leaf and holds it in the open position until manually released.

PART 3 EXECUTION

3.1 WOVEN WIRE FENCE

A. All work performed under this section shall be done in accordance with Subsection 4154 of the State of Iowa, Department of Transportation, Standard Specifications, as well as Standard Road Plans RC-7, RC-8A, RC-8B(1) and RC-8B(2). Refer to Detail Drawings of these specifications.

3.2 GATES

A. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation.

END OF SECTION 02820

SECTION 02990
RESTORATION AND CLEANUP

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work necessary to restore the areas disturbed by construction back to original or better condition.

B. Timely cleanup of construction areas as project progresses.

1.2 REFERENCES

A. Iowa Department of Transportation, Standard Specifications for Highway and Bridge Construction, Series 2001. (IDOT)

1.3 SUBMITTALS FOR REVIEW

A. Product Data: Provide data indicating grass seed mixtures proposed for various areas, proposed asphaltic cement concrete and Portland cement concrete mixtures including cylinder break results, gradation of proposed street surfacing aggregate, and seal coat mixes and proposed construction methods.

PART 2 PRODUCTS

2.1 GRASSES AND LAWNS

A. Urban Areas Seed Mixture: The following seed mixture shall be used for permanent seeding of urban areas. The application rate shall be 4 pounds per 1,000 square feet.

Bluegrass, Kentucky	70%
Ryegrass, Perennial (Fineleaf variety)	10%
Fescue, Creeping Red	20%

B. Rural Areas Seed Mixture: The following seed mixture shall be used for permanent seeding of rural areas.

Fescue, Kentucky 31 or Fawn	25 lbs./acre
Ryegrass (Perennial)	15 lbs./acre
Sideoats Grama (Butte or Trailway)	5 lbs./acre
Switchgrass (Neb. 28, Blackwell, Pathfinder, or Cave-in-Rock)	3 lbs./acre
Birdsfoot Trefoil (Empire)	5 lbs./acre

C. Fertilizer: 750 pounds per acre of commercial 13-13-13.

D. Mulch: Mulch used for seedbed protection shall be reasonably dry material. Materials and rates of application can be either of 1-1/2 tons per acre of dry cereal straw, 2 tons per acre of wood excelsior, or 2 tons per acre of prairie hay.

E. Seedbed: Seedbed shall be a minimum of 6 inches of topsoil, unless otherwise specified, and shall be free of rocks or other deleterious materials.

2.2 STREETS AND ROADWAYS

A. Hot Mix Asphalt (HMA) Pavement: Materials shall conform to IDOT Section 2303, Base and Surface courses.
   1. Type B Base Course: Class 1, 3/4 inch aggregate, AC-5, 6% asphalt cement, minimum of 45% of crushed particles. Base Course thickness shall be 4 inches.
   2. Type A Surface Course: Class 1, 1/2 inch aggregate, AC-10, 6% asphalt cement, minimum of 60% crushed particles. Surface Course thickness shall be 2 inches.
   3. Tack Coat: Emulsified asphalt, Grade CSS-1.

B. Bituminous Seal Coat Street Surfacing: Materials shall conform to IDOT Section 2307. Seal coat street surface restoration for this project shall be the two course type of seal coat with the following applied coats:
   1. First Course:
      Binder Bitumen 0.35 gal/sq. yd.
      Cover Aggregate 30 lbs/sq. yd.
   2. Second Course:
      Binder Bitumen 0.30 gal/sq. yd.
      Cover Aggregate 25 lbs/sq. yd.
   3. Aggregate Size: IDOT Section 4125, 1/2 inch size.
   4. Bituminous Material: Meet IDOT Section 4138, Cut Back Asphalt or Section 4140, Emulsified Asphalt.
   5. Subsurface Material: Meet IDOT Section 4121, Granular Subbase Material, Gradation 12. Subbase thickness shall be 6 inches compacted to 95 percent Standard Proctor.

C. Portland Cement Concrete (PCC) Streets and Roadways: Concrete used for full-depth patching shall be early strength Class M concrete conforming to Section 2301, IDOT.
   1. Aggregates shall be IDOT Class 3 durability.
   2. Joint sealing material shall be hot-poured composed of petropolymers and shall be supplied in solid form. The sealer shall meet ASTM D3405.
   3. Epoxy for bonding dowels and deformed bars: The epoxy shall bond a reinforcing bar or dowel bar in a drilled hole in concrete and provide a 9,000-pound minimum load on a pull-out load test after a 7-day cure. The epoxy shall also have a consistency so that is does not run out of a horizontal hole. Either a pressure injection system or encapsulated chemical anchors shall be used. Epoxy shall have 1-hour cure before concrete is placed.
   4. All dowels and deformed bars shall have an epoxy coating.

D. Portland Cement Drive Approaches and Sidewalks: Concrete used for replacement of PCC drive approaches and sidewalks removed for installation of sewers shall be Class C concrete produced and placed in accordance with IDOT Section 2301. Sidewalks and PCC drive approaches shall be replaced in the following thicknesses:
   1. Sidewalks: 4 inches
   2. PCC drive approaches: 6 inches

E. Gravel Streets and Roadways: Aggregate materials shall conform to IDOT Section 4121, Gradation 12.
   1. Dust Control: 0.5 gal/sq. yd. of diluted emulsified asphalt.
   2. Reuse of existing granular surfacing: Crushed material removed from the line of work prior to excavation, if not rejected by the Engineer, may be reused for resurfacing.
   3. Depth of compacted granular surfacing shall be 6 inches.

PART 3 EXECUTION

3.1 GENERAL

A. All restoration work shall be performed by personnel experienced in the work being accomplished.

B. All restoration work shall be completed in a timely manner as the work progresses.

C. Unless otherwise specified or indicated on the plans, all finished surfaces of restored areas shall conform to the grade and cross-section which existed prior to construction.

D. All topsoil, road rock, or other salvageable material encountered in the line of work shall be removed as the work progresses, and such items shall be carefully stored. Upon completion of the work, or portions thereof, these items shall be replaced by the Contractor. Any shortages shall be replaced by the Contractor with material of the same or equal quality so that when restoration is complete, the condition of these items will be to the Engineer's satisfaction.

E. All areas disturbed by construction shall be restored to original or better condition by the Contractor as specified hereinafter.

3.2 RESTORATION OF GRASSED AREAS AND LAWNS

A. Trench excavation backfill below grassed and lawn areas shall be in accordance with Section 02225 of these specifications.

B. Prepare seedbed, seed, fertilize, and mulch in accordance with IDOT Section 2601.04.

C. Seedbed, seed mixture, fertilizer and mulch shall conform to that specified in 2.1 of this specification section.

D. No seeding shall take place until the Engineer has approved the condition of the seed bed.

E. Seeding Season: Between March 1 and May 31 and between August 10 and September 30.

3.3 RESTORATION OF HOT MIX ASPHALT (HMA) STREETS OR ROADWAYS

A. Sawcut edges of pavement to remain in straight lines parallel and perpendicular to centerline of trench. Removal of the pavement shall be conducted in such a way as to not damage pavement that is to remain. Any pavement damaged beyond the removal limits by the Contractor shall be patched in accordance with these specifications at the Contractor's expense.

B. Trench excavation backfill below pavement shall meet requirements of Section 02225 of these specifications.

C. Prior to repaving, the edges of the existing HMA pavement shall be tacked.

D. Submit mix design to the Engineer for approval prior to placing HMA.

E. The HMA mixture meeting 2.2.A. of this section shall be deposited in layers not exceeding 2 inches. Each layer shall be thoroughly compacted while hot, by rolling or compacting with a vibratory compactor, to provide a dense, compacted surface. Succeeding layers may be placed as soon as the preceding layer has been properly compacted. The final layer shall also be smoothed with a steel-tired finish roller and may be a small roller suitable for this type of operation.

F. The final compacted surface shall be level with, or not more than approximately 1/8 inch above, the surrounding pavement and shall have a smooth riding surface. Patch material shall not extend beyond the edge of the pavement; if so constructed, the material shall be cut off.

G. The patch shall not be opened to traffic until the mixture has cooled sufficiently to provide stability. If the patch becomes seriously distorted for any reason, the Contractor shall smooth the surface the next working day, by blading, scraping, filling, or by other approved means.

3.4 RESTORING PORTLAND CEMENT CONCRETE (PCC) STREETS AND ROADWAYS

A. Existing PCC pavement to be removed and replaced for installation of the new piping shall be constructed in accordance with the following IDOT requirements and as further indicated on the Standard Drawings in the Plans:
   1. Pavement Removal: IDOT 2529.04
   2. Restoring Pavement, PCC Finish Patches with Dowels: IDOT 2529.06.B.

B. Sawcut edges of pavement to remain in straight lines parallel and perpendicular to centerline of trench. Conduct removal so that pavement to remain is not damaged. Heavy equipment shall not be used adjacent to new concrete until the specified curing is completed. Any pavement damaged beyond the removal limits by the Contractor shall be patched in accordance with these specifications at the Contractor's expense.

C. Trench excavation backfill below pavement shall meet requirements of Section 02225 of these specifications.

D. Submit mix design including results of cylinder tests on mix design to the Engineer for approval prior to placing PCC.

E. The replacement of the surface shall be carried on in such a manner as to provide, as near as is practicable, a facility equal to or better than that which existed prior to construction.

F. New PCC thickness shall be as indicated on the plans, or shall match existing.

G. Subgrade Compaction: Compact as specified in Section 02225.
   1. When unstable material or excessive moisture is encountered in the subgrade, the Engineer may order subgrade to be removed and replaced with new material. This material shall be clay or sandy clay at or near optimum moisture content compacted in six-inch lifts. Payment for this work will be negotiated in addition to the contract bid unit prices.

3.5 RESTORING PORTLAND CEMENT CONCRETE (PCC) DRIVE APPROACHES AND SIDEWALKS

A. Sawcut edges of pavement to remain in straight lines parallel and perpendicular to centerline of trench.

B. Trench excavation backfill below pavement shall meet requirements of Section 02225 of these specifications.

C. Submit mix design including results of cylinder tests on mix design to the Engineer for approval prior to placing PCC.

D. The replacement of the surface shall be carried on in such a manner as to provide, as near as is practicable, a facility equal to or better than that which existed prior to construction.

E. Restoration of PCC drive approaches and sidewalks shall meet the following IDOT requirements:

1. PCC drive approaches: IDOT Section 2515.04
2. Sidewalks: IDOT Section 2511.05

3.6 RESTORING BITUMINOUS SEAL COAT STREETS AND ROADWAYS

A. Trench excavation backfill below pavement shall meet requirements of Section 02225 of these specification

B. Restoration of existing bituminous seal coat streets and roadways shall be in accordance with IDOT Section 2307.04.

3.7 RESTORATION OF GRAVEL STREETS AND ROADWAYS

A. Trench excavation backfill below pavement shall meet requirements of Section 02225 of these specification

B. The replacement of the surface shall be carried on in such a manner as to provide, as near as is practicable, a facility equal to or better than that which existed prior to construction. Surface restoration shall result in a smooth riding surface.

C. Immediately following gravel surface restoration, the surface shall be treated with the dust control material specified herein.

D. Materials utilized for gravel surface restoration shall be as specified in 2.2.E. of this specifications section.

3.8 TREES AND SHRUBS

A. When trees or shrubs are encountered in the direct line of work, they shall be removed by the Contractor. Unless otherwise indicated on the plans, trees and shrubs shown to be removed will not have to be replaced by the Contractor. The Contractor shall replace or compensate the owner for trees and shrubs not shown to be removed which are damaged during construction.

B. When trees and shrubs are removed, such removal shall include the removal of the stump and sufficient root length to ensure that the plant will not continue to grow. Trees, stumps and roots shall be cleared from the site and disposed of by the Contractor. When large trees are encountered in the line of work, they shall be tunnelled when practicable.

C. Trees found in relative proximity with the work, but which need not be removed, shall be protected from damage. The Contractor shall use every precaution to preserve as many trees as possible along the line of work.

3.9 TRAFFIC CONTROL

A. No streets may be closed without the approval of the City Clerk, Fire Department, and the Police Department.

B. The Contractor shall furnish, erect, maintain and finally remove barricades or fences necessary to prevent vehicles and pedestrians from entering areas of work. Contractor shall be responsible for any damage to new pavement or other construction.

C. Unless the road is closed, traffic shall be permitted to use the pavement during construction operations; and all operations shall be so conducted as to provide a minimum of inconvenience to traffic.

D. During construction, areas to be maintained for traffic shall be kept clear of all hazardous materials, including but not limited to construction debris, dust and mud.

3.10 DISPOSAL OF UNSALVAGED MATERIALS

A. All material removed for construction of this project and not designated for salvage shall be disposed of properly by the Contractor. Cost for disposal shall be incidental to the project.

3.11 CLEANUP

A. All private or public property upon which the Contractor has prosecuted his work shall be left in good condition to the satisfaction of the Engineer.

B. All drainage ditches and culverts shall be cleaned and the drainage shall be restored.

C. Excess soil and materials shall be hauled away or disposed of by the Contractor.

END OF SECTION 02990

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION III

CONCRETE

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete building frame members, floors, shear walls, foundation walls, supported slabs, tanks and other concrete work shown in the drawings.

B. Floors and slabs on grade.

C. Control, expansion and contraction joint devices associated with concrete work, including joint sealants.

D. Equipment pads, thrust blocks, manholes.

1.2 RELATED SECTIONS

A. Section 03100 - Concrete Formwork: Formwork and accessories.

B. Section 03200 - Concrete Reinforcement.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide data on mix design, joint devices, attachment accessories, admixtures.

C. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Accurately record actual locations of embedded utilities and components which are concealed from view.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301.

B. Acquire cement and aggregate from same source for all work.

C. Conform to ACI 305R when concreting during hot weather.

D. Conform to ACI 306R when concreting during cold weather.

1.6 FIELD SAMPLES

A. Provide under provisions of Section 01400. Coordinate with Section 03100.

B. Construct and erect a field sample for tank wall concrete surfaces.

C. Sample Panel: Sufficient size to indicate special treatment or finish required.

D. Locate where directed.

E. Accepted sample panel is considered basis of quality for the finished work. Keep sample panel exposed to view for duration of concrete work.

1.7 COORDINATION

A. Coordinate work under provisions of Section 01039.

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

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I - Normal.

B. Fine and Coarse Aggregates: ASTM C33. Course aggregate shall be crushed rock (IDOT Class 3).

C. Lightweight Aggregate: ASTM C330.

D. Water: Clean and not detrimental to concrete.

2.2 ADMIXTURES

A. Air Entrainment: ASTM C260; All concrete to have 6%.(1) entrained air.

B. Fly Ash: ASTM C618.

2.3 ACCESSORIES

A. Bonding Agent: Latex emulsion.

B. Vapor Barrier: 6 mil thick clear polyethylene film or type recommended for below grade application.

C. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler Type B: ASTM D1752; Closed cell polyvinyl chloride foam, resiliency recovery of 95 percent if not compressed more than 50 percent of original thickness.

B. Sealant and Primer: Sonneborn Kure-N-Seal 0800. Two coats with final coat at completion of job.

2.5 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94.

B. Prepare each type and strength concrete by trial batch methods in ACI 301. Submit mix design and tests to Engineer for approval.

C. Design mixes to provide normal weight concrete with the following properties:
   1. 4,000 psi 28-day compressive strength; 560 lbs. cement per cubic yard minimum; W/C ratio, 0.44 maximum. 6% Entrained air.(1%).

2. 3,000 psi 28-day compressive strength concrete may be used for foundation footings. All other concrete work shall be 4,000 psi.

D. Consistency: Determine the quantity of water required for proper consistency of concrete by slump test in accordance with ANSI/ASTM C 143.
   1. For Vertical Wall Sections, Columns -- Maximum slump, 4 inches, plus or minus one-inch tolerance.
   2. For Footings, Beams, Slabs -- Maximum slump, 3 inches, plus or minus one-inch tolerance.

E. Use accelerating admixtures in cold weather only when approved by Engineer. Use of admixtures will not relax cold weather placement requirements.

F. Use calcium chloride only when approved by Engineer.

G. Use set retarding admixtures during hot weather only when approved by Engineer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

B. Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in.

C. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work.

D. Moisten wood forms immediately before placing concrete where form coatings are not used.

3.2 PREPARATION

A. Drain and pump all water from excavations, forms, and any locations where concrete is to be placed.
   1. Bottom of excavations shall be undisturbed earth free of frost or debris, level and compacted.
   2. Do not place any concrete until the Engineer has inspected and approved forms and soil conditions, and until reinforcing, sleeves, and embedded items have been placed.
   3. Clean all dirt and debris from transporting equipment. Clean reinforcement of all foreign matter. Clean forms and oil or wet (except in freezing conditions) surfaces.
   4. Compact, level, and dampen base fill material under slabs on grade.
   5. Prior to placing concrete, install polyethylene vapor barrier under interior slabs.
   6. Do not puncture or otherwise damage vapor barrier or membrane waterproofing.

B. Transport concrete to prevent separation of materials in accordance with ACI practices.
   1. Do not add water to concrete during transporting.
   2. Handle from mixer to point of placement with carts, buggies, or conveyors.
   3. Do not dump concrete from mixer or from transporting equipment with a free fall of more than three feet.
   4. Clean transporting equipment at frequent intervals during placement.
   5. Do not use partially hardened or contaminated concrete.

3.3 PLACEMENT OF CONCRETE

A. Place concrete in accordance with ACI 304 "Recommended practice for measuring, mixing, transporting and placing concrete" and as herein specified.

B. Place concrete continuously or in layers of such thickness that no fresh concrete will be placed on concrete which as hardened sufficiently to cause the formation of seams or planes of weakness.
   1. If a section cannot be placed continuously, provide construction joints as herein specified.
   2. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Work concrete into corners and around reinforcement.
   1. Machine vibrate sufficiently to insure thorough compaction and complete embedment of reinforcing.
   2. Stop placement at point of no shear, or where directed, and erect tight, plumb dams through forms.
   3. Place concrete between construction joints in one continuous operation.
   4. Locate construction joints in slabs under partitions.
   5. Brush on near cement when pouring against hardened concrete.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints.
   1. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
   2. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping.
      a. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
   3. Do not use vibrators to transport concrete inside forms.
      a. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine.
      b. Place vibrators to rapidly penetrate placed layer and at least six (6) inches into preceding layer.
      c. Do not insert vibrators into lower layers of concrete that have begun to set.
      d. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
   1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Bring slab surfaces to correct level with straight edge and strike off.
   3. Use bull floats or darbies to smooth surface, free of humps or hollows.
   4. Do not disturb slab surfaces prior to beginning finishing operations.
   5. Maintain reinforcing in proper position during concrete placement operations.

F. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306, "Cold Weather Concreting," and as herein specified.
   1. When air temperature has fallen to or is expected to fall below 40□F. (4□C), uniformly hear water and aggregates before mixing to obtain a concrete mixture temperature of not less than 40□F. (4□C), and not more than 80□F. (27□C) at

point of placement, and maintain minimum temperature over the entire work for no less than 72 hours.

a. Do not use frozen materials or materials containing ice or snow.
b. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
c. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

G. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305, "Hot Weather Concreting," and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90□F. (32□C). 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.
2. 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 embedment in concrete.
3. Wet forms thoroughly before placing concrete.
4. Use water-reducing retarding admixture (Type A) when required by high temperatures, low humidity, or other adverse placing conditions.

H. Expansion Joints: Unless otherwise specifically designated on the Drawings, install expansion joint filler where interior slabs abut exterior walls, interior bearing walls and columns, and at perimeter of concrete equipment pads. Omit expansion joint filler and install 15 lb. felt, centered below door, to break bond at exterior doors with concrete platforms, unless otherwise shown on the Drawings.

I. Control Joints: Cut control joints a maximum of 12 feet o.c. each way in all exposed concrete floor slabs on grade.

1. Locate in a uniform pattern within room spaces and centered below partitions separating spaces.
2. Locate at doorways between rooms, at center lines of exposed columns and to divide areas of irregular-shaped rooms.
3. Verify location and cut to depth of one-sixth (1/6) of slab thickness with minimum of three-fourths (3/4) inch.
4. Cut with carborundum saw, approximately six (6) to twenty-four (24) hours after placing concrete and when a minimum amount of raveling occurs in concrete.
5. On exterior walks, score with one-fourth inch by one inch (1/4" x 1") deep control joints.
6. Use straight edge guide when scoring joints.
7. Where required depth of control joint cannot be made by scoring, cut joints with carborundum saw.

3.4 CONCRETE FINISHING

A. Finish on Formed Surfaces: Verify that finished or formed surfaces conform accurately to the shape, alignment, grades and sections shown on the Drawings.

1. Finish surfaces free from fins, bulges, ridges, offsets, honeycombing or roughness, presenting a finished, continuous, hard surface.
2. Round and bevel all sharp angles, where required.
3. In accordance with coating manufacturer's specifications, do not permit the presence of any material detrimental to the specified paint or coating on any formed or finished surface to be painted or otherwise coated.
4. Rough Form Finish:

a. Provide as-cast rough form finish to formed concrete surfaces that are to be concealed in the finish work or by any other construction.
b. Standard rough form finish shall be the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched, and all fins and other projections exceeding one-fourth inch (1/4") in height rubbed down or chipped off.

5. Smooth Form Finish:
a. Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view, or that are to be covered with a coating material other than cement plaster applied directly to the concrete.
b. Produce smooth form finish by selecting form material to impart a smooth, hard uniform texture and arranging them orderly and symmetrically with a minimum of seams.
c. Repair and patch defective areas with all fins and other projections completely removed and smoothed.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a smooth troweled finish.

C. Slab and Floor Finished: Provide an adequate slope to the drains or to suitable points of disposal for all floor and flat roof surfaces and all exterior concrete floor, sidewalk and flat slab surfaces.

1. Provide the direction of slope and the amount of crowning as shown on the Drawings or as prescribed by the Engineer. Do not allow dry topping on any of the finishes.

2. Scratch Finish:
a. Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile and other bonded applied cementitious-finish flooring material.
b. After placing slabs, plane the surface to a tolerance not exceeding one-fourth inch (1/4") in twenty-four inches (24") when tested with a straight edge.
c. Slope surfaces uniformly to drains where required.
d. After leveling, roughen the surface before the final set by using stiff broom brush or rake.

3. Float Finish:
a. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes hereinafter specified, and to slab surfaces which are to be covered with insulation, and as otherwise shown on the Drawings or in the schedules.
b. After placing concrete slabs, do not work the surface further until ready for floating.
c. Begin floating when the surface water has disappeared and when the concrete has stiffened sufficiently to permit operation of a power-driven float, hand float, or both.
d. Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units.
e. Check and level the surface plane to a tolerance not exceeding one-fourth inch (1/4") in ten feet (10"-0") when tested with a ten-foot (10'-0") straight edge placed on the surface at not less than two different angles.
f. Cut down high spots and fill low spots.
g. Uniformly slope surfaces to drains where required.
h. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

4. Trowel Finish:

a. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and to slab surfaces that are to be covered with resilient flooring, carpeting, paint, or other thin-film finish coating system.
b. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
c. Consolidate the concrete surface by the final hand troweling operation, free from trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding one-eighth inch (1/8") in ten feet (10'-0") when tested with a ten-foot (10'-0") straight edge.
d. Grind smooth those surface defects which would telegraph through applied floor covering system.

5. Nonslip Broom Finish:
   a. Apply nonslip broom finish to exterior concrete platforms, steps and ramps, and elsewhere as shown on the Drawings or in the schedules.
   b. Immediately after trowel finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use a fiber bristle broom.
   c. Coordinate the required finish with the Engineer prior to the application.

3.5 CONCRETE CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.
   2. Weather permitting, keep continuously moist for not less than seven (7) days.
   3. Begin final curing procedures immediately following initial curing and before concrete has dried.
   4. Continue final curing for at least seven (7) days in accordance with ACI 308, "Standard Practice for Curing Concrete."
   5. Avoid rapid drying at end of final curing period.

B. Curing Method: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof as herein specified.
   1. Provide moisture curing by the following methods:
      a. Keep concrete surface continuously wet by covering with water.
      b. Continuous water-fog spray.
      c. Covering concrete surface with specified absorbent cover, thoroughly saturating cover with water and keeping continuously wet.
      d. Place absorbent cover to provide coverage of concrete surfaces and edges, with four-inch (4") lap over adjacent absorbent cover.
   2. Provide moisture-cover curing as follows: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least three inches (3") and sealed by waterproof tape or adhesive.
      a. Immediately repair any holes and tears during curing period using cover material and waterproof tape.
   3. Apply curing compounds to slabs as follows:
      a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within two (2) hours).
      b. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions.
      c. Recoat areas subjected to heavy rainfall within three (3) hours after initial application.

d. Maintain continuity of coating and repair damage during curing period.

4. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the coating manufacturer.

3.6 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.
   1. Mix, place, and cure concrete as herein specified to blend with in-place construction.
   2. Provide other miscellaneous concrete filling shown or required to complete work.

B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on the Drawings or required for the machine and equipment actually furnished.
   1. Set anchor bolts for machines and equipment to template, at correct elevations, complying with certified diagrams or templates of the manufacturer furnishing the machines and equipment.
   2. Provide isolation joints surrounding bases where indicated or required

3.7 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 and under provisions of Section 01400.

B. Provide free access to Work and cooperate with appointed firm.

C. Submit proposed mix design to testing firm for review prior to commencement of Work.

D. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

E. Three concrete test cylinders will be taken for every 20 cubic yards or less.

F. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

G. One slump test and air test will be taken for each set of test cylinders taken.

3.8 PATCHING

A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

C. Patch imperfections as directed in accordance with ACI 301.

3.9 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Engineer.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect/Engineer for each individual area.

3.10 SCHEDULE - CONCRETE TYPES AND FINISHES

A. Foundation Footings: 3,000 psi 28 day concrete.

B. Underside of Supported Floors, Tanks and Structure Exposed to View: 4,000 psi 28 day concrete, sack rubbed finish.

END OF SECTION

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION V

METALS

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section covers all items fabricated from metal shapes, plates, sheets, rods, bars, or castings and all other wrought or cast metal except component parts of equipment and items covered by other sections.

B. Fabricated metal items, which are indicated on the drawings, but not mentioned specifically herein, shall be fabricated in accordance with the applicable requirements of this section.

1.2 GENERAL REQUIREMENTS

A. Supplementary parts necessary to complete each item, though such work is not definitely shown or specified, shall be provided. Appropriate trades shall furnish all anchors, sockets or fastenings required for securing metal work to other construction. Details and specifications of items for which standard products are available are representative of the quality required for such items. Standard products, generally meeting such requirements, will be accepted if details of construction and installation are approved by the Engineer.

B. Gages of sheet iron and steel, as specified, shall be U.S. Standard for uncoated sheet and plate. Gages for nonferrous metals are Brown and Sharpe.

C. Welding shall be continuous along the entire area of contact, except where tack welding is permitted. Tack welding will not be permitted on exposed surfaces. All exposed welds shall be ground smooth. All welding shall be done in an approved manner and in accordance with the requirements of the American Welding Society Publication D1.1. The surfaces to be welded shall be cleaned thoroughly of all scale, rust, oil or grease for a distance of not less than 1/2 inch from the welding edge. Welding rods shall be equal to and compatible with the material being welded and the completed stress welds shall be capable of developing the full tensile strength of the weaker or subordinate member. Welds shall be of the type required by the drawings.

D. The Contractor shall be responsible for all errors of fabrication and for correct fitting of the structural members shown on the shop drawings. The Contractor shall furnish instructions for the setting of anchors and shall ascertain that the items are properly set during the progress of the work.

E. Items noted to be galvanized shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM Specification A 123 or A153 as applicable.

F. Anchorage shall be provided where necessary for fastening miscellaneous metal securely in place.

G. Dissimilar Materials: Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a heavy coat of Tnemec 46-465 Heavy Duty Black, medium consistency coal tar to prevent galvanic or chemical corrosion.

H. Materials shall conform to the requirements specified for the particular item; and where these requirements are not specified in detail, the materials shall be suitable for the intended usage of the item.

I. Aluminum: Unless otherwise specified, aluminum items shall be in standard mill finish.

1.3 QUALITY ASSURANCE

Structural and Miscellaneous Steel

1. Except as otherwise specified or indicated on the drawings, all materials and work shall conform to the applicable provisions of the Ninth Edition of the AISC "Steel Construction Manual - Allowable Stress Design", Parts 1, 2, 3, and 4, and the "Specification for Structural Steel Buildings".
2. AWS Structural Welding Code D1.1.

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM):

1.	A 36	Structural Steel.
2.	A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
3.	A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
4.	A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5.	A 167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6.	A 194	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and high Temperature Service.
7.	A 307	Carbon Steel Externally and Internally Threaded Standard Fasteners.
8.	A 320	Alloy-Steel Bolting Materials for Low-Temperature Service.
9.	A 325	High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
10.	A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11.	A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12.	A 525	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements.
13.	A 710	Low-Carbon Age-Hardening Nickel- Copper- Chromium-Molybdenum- Columbium and Nickel-Copper-Columbium Alloy Steel.
14.	B 209	Aluminum and Aluminum – Alloy Sheet and Plate.
15.	B 308	Aluminum – Alloy 6061-T6 Standard Structural Shapes.
16.	B 211	Aluminum and Aluminum Allow Bar, Rod and Wire.
17.	B 429	Aluminum – Alloy Extruded Structural Pipe and Tube.
18.	B 221	Aluminum and Aluminum – Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
19.	F 593	Stainless Steel Bolts, Hex Cap Screws, and Studs.
20.	F 594	Stainless Steel Nuts.

B. Federal Specifications (FS):

1.	FF-S-325(3)	Shield, Expansion, Nail Expansion, and Nail, Drive Screw (Devices Anchoring, Masonry).
2.	QQ-F-461C(1)	Floor Plate, Steel, Rolled.
3.	QQ-Z-325C	Zinc Coating, Electrodeposited, Requirements for

4. RR-G-661D Grating, Metal, Bar Type (Floor, Except for Naval Vessels).
5. SS-C-153C Cement, Bituminous, Plastic.
6. TT-C-494 Varnish, Asphalt.

C. Military Specifications:
1. MIL-C-18480A Coating Compound, Bituminous, Solvent; coal tar base. (DOCKS & AM-3
2. MIL-P-21035A Paint, High Zinc Dust Content, Galvanizing Repair (Metric).

D. Occupational Safety and Health Administration (OSHA) Regulations.

E. Aluminum Association "Specifications for Aluminum Structures" and "Engineering Data for Aluminum Structures."

1.5 SUBMITTALS

Shop Drawings:
1. Submit shop drawings covering all items, specified or required, indicating all shop and erection details.
2. Indicate all required field measurements.
3. Indicate surface preparation and shop paint. Note shop paint shall be as specified in Section 09900.
4. Safe working load capacity in tension and shear for each size and type of concrete anchor used shall be submitted.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Structural and miscellaneous metal work shall be fabricated in conformity with dimensions, arrangement, sizes, and weights or thickness specified or indicated on the drawings.

B. All members and parts, as delivered and erected, shall be free of winds, warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. Erection drawings shall be prepared, and each separate piece shall be marked as indicated thereon. All field connection materials shall be furnished.

C. Structural and miscellaneous metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

D. Before assembly, surfaces to be in contact with each other shall be thoroughly cleaned. All parts shall be assembled accurately as indicated on the drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills. Enlarging holes by burning will not be permitted.

2.2 CONNECTIONS

A. Unless otherwise noted, connections shall conform to the details indicated on the drawings. Connections not specifically detailed on the drawings, shall develop the full strength of the least strength member of the connection.

B. Unless welded connections are noted on the drawings, the shop-fabricated portions of structural connections may be welded or bolted. The shop portion of beam-to-column connections shall be attached to the beam unless otherwise indicated on the drawings.

C. Unless otherwise noted on the drawings, bolted connections for structural steel, as defined in the AISC manual, shall be made with ¾ inch ASTM A325 high strength bolts. Provide galvanized fasteners where base metal is galvanized.

D. Field-welded connections will not be acceptable for structural steel unless indicated on the drawings.

E. Connections for miscellaneous steel work not included in the AISC definition of structural steel may be made with unfinished bolts. All unfinished bolts shall be equipped with self-locking nuts or unfinished nuts and lock washer.

F. Bolt holes shall have a diameter nominally 1/16 inch larger than the nominal bolt diameter. Bolt holes for one ply only of vertical diagonal bracing connections may be oversize to a diameter nominally 3/16 inch larger than the nominal bolt diameter. If oversize holes are provided in an outer ply, a hardened flat washer shall be installed over each hole during bolting. Slotted holes shall not be used except for girt connections and other locations specifically indicated on the drawings.

G. Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Bolt length shall be increased as required to accommodate the beveled washer.

H. Unless otherwise noted, aluminum connections shall be all-bolted bearing type, using ¾ inch bolts and nuts equipped with a helical spring lock washer under the stationary element (bolt head or nut) and a flat washer under the turned element. Bolts and nuts for structural aluminum connections shall be stainless steel. Bolts and nuts for nonstructural miscellaneous aluminum assemblies shall be aluminum. A sufficient number of bolts shall be provided in each connection to develop the shear strength of the members. Unless otherwise noted, welded connections will not be acceptable.

2.3 BOLTED STRUCTURAL CONNECTIONS

A. Except as modified or supplemented herein, high strength bolts, method of installation, and bolting tools and equipment shall conform to the requirements of the “Specification for Structural Joints Using ASTM A325 or A490 Bolts” as approved by the Research Council on Structural Connections.

B. To facilitate proper tightening of fastener assemblies, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the indicator washer protrusions, in all cases.

2.4 WELDING

A. Welding and related operations shall conform to applicable provisions of the Structural Welding Code, AWS D1.1, of the American Welding Society. All welding shall be performed in accordance with written procedures, using only those joint details, which have prequalified status when performed in accordance with AWS D1.1. Use of electro slag or electro gas welding processes or the short-circuiting transfer mode of the gas metal arc process will not be acceptable.

B. Welds not dimensioned on the drawings shall be sized to develop the full strength of the least strength component of the connection. Fillet welds not dimensioned shall be ¼”.

C. Where structural or miscellaneous steel connections are welded, all butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at lest 2 inches and shall be spaced not more than 6 inches apart.

D. Welded connections for structural steel and for stairs shall be made with filler metal having a minimum tensile strength of 70 ksi.

2.5 FIELD ERECTION

A. Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevation of the top of the floor and roof members shall be within 1/16 inch of the elevations indicated on the drawings.

B. Unless otherwise acceptable to the Engineer, a platform or other means of access shall be provided at each field connection to facilitate inspection.

C. Base plates shall be set level in exact position and grouted in place.

D. The faces of girts and other supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch.

2.6 MATERIALS

A. All structural steel shapes, plates, bars, and their products shall conform to the requirements of ASTM A 36 or A 992.

B. All miscellaneous and structural steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

C. Unless otherwise shown, aluminum metalwork shall be of Alloy 6061-T6. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated with a heavy coat of Tnemec 46-449 Heavy Duty Black. Aluminum design shall be in accordance with the Aluminum Association standards. Aluminum shall be fastened with stainless steel bolts.

D. Unless otherwise shown, iron castings shall conform to the requirements of ASTM A 48 "Specifications for Gray Iron Castings," Class 35B or better.

E. Fasteners shall meet all design requirements for intended application.

2.7 STUDS

A. Studs shall be Nelson Granular Flux-Filled or approved equal.

PART 3 EXECUTION

3.1 STRUCTURAL STEEL WORK

A. Structural steel work shall be fabricated and erected in accordance with the applicable provisions of the AISC Specification. Fabrication and assembly shall be done in the shop to the greatest extent possible. All Structural steel work shall be hot-dip galvanized, unless noted otherwise.

B. After erection, the field bolt heads and nuts, field welds and any abrasions in the galvanizing shall be cleaned and touched-up with cold galvanizing as specified in Section - 09900.

3.2 LINTELS AND MISCELLANEOUS PLATES AND SHAPES

A. Fabricate and install as indicated to complete the work.

3.3 STUDS

A. Shall be automatically end welded in the shop on centers shown on the drawings. All stud welds shall be made in accordance with recommendations of the Nelson Stud Welding Division, Lorain, Ohio.

3.4 REPAIR OF DAMAGED HOT-DIP GALVANIZING

A. Remove foreign matter from both damaged and contiguous undamaged area by wire brushing and/or cleaning with a metal conditioner furnished and recommended by the manufacturer of the cold galvanizing compound.

B. Apply cold galvanizing compound to damaged area, ensuring an overlap of the surrounding undamaged galvanizing for continuity of galvanic protection.

3.5 WELDING

A. All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other applicable standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material, which is to be painted or coated, shall be ground to a radius as required to ensure satisfactory paint adherence.

3.6 FINISH

A. All steel shall be hot-dip galvanized after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc according to ASTM A123. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz/ft^2 of surface.

B. Zinc coating that has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damaged area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to touching-up. Reference Section - 09900.

END OF SECTION

SECTION 05530

GRATINGS AND COVER PLATES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes formed floor and stair tread gratings; floor cover plating; and perimeter closure.

B. Related Sections:
1. Section 05500 - Metal Fabrications.

1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36 M - Standard Specification for Carbon Structural Steel.
2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A1011/A1011M - Standard Specifications for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

B. American Welding Society:
1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.

C. National Association of Architectural Metal Manufacturers:
1. NAAMM MBG 531 - Metal Bar Grating Manual.
2. NAAMM MBG 532 - Heavy Duty Metal Bar Grating Manual.

D. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.
3. SSPC SP 10 - Near-White Blast Cleaning.

1.3 PERFORMANCE REQUIREMENTS

A. Design Live Load: Uniform load of 100 lb/sq. ft. minimum; concentrated load of force 300 lb.

B. Maximum Allowable Deflection Under Live Load: 1/240 of span; size components for single span.

C. Maximum Spacing Between Bars: 1-3/16”.

1.4 SUBMITTALS

A. Section 01330 - Submittal Procedures: Submittal requirements.

B. Shop Drawings: Indicate details of gratings, plates, component supports, anchorage, openings, perimeter construction details, and tolerances. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Product Data: Submit span and deflection tables.

1.5 QUALIFICATIONS

Design gratings and plates under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Iowa.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 COORDINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Coordinate Work with placement of frames.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Formed Steel for Weldiing: ASTM A36/A36M, of rectangular shape.

B. Formed FRP: Reference Section 06610.

C. Cover plates shall be tread plate having a raised figure pattern. Cover plates shall be aluminum alloy 6061-T6.

D. Welding Materials: AWS D1.1, or AWS D1.2, type required for materials being welded.

E. Touch-Up Primer for Galvanized Surfaces: Reference Section - 09900.

2.2 ACCESSORIES

A. Fasteners and Saddle Clips: Stainless steel.

B. Perimeter Closure: Same material as grating.

C. Edge Banding: Openings 2-inch or greater in dimension and grating edges shall be banded with a bar of the same depth and thickness of the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.

2.3 FABRICATION

A. Grating fabrication shall be in accordance with the NAAMM Metal Bar Grating Manual and applicable industry standards.

B. Fabricate grates and plates to sizes indicated.

C. Weld joints of intersecting metal sections.

D. Bearing Bar: 1½ x 3/16 inch size, spaced 1 3/16 inches on center.

E. Cross Bar: spaced 4 inches on center.

F. Aluminum cover plates shall be ¼” thick unless otherwise noted. Frames and stiffened panels shall be as detailed on the drawings.

2.4 SHOP FINISHING

A. Galvanizing: ASTM A653/A653M to G90.

B. Aluminum: Mill finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 - Administrative Requirements: Coordination and project conditions.

B. Verify opening sizes and dimensional tolerances are acceptable.

C. Verify supports are correctly positioned.

3.2 INSTALLATION

A. Place frames in correct position, plumb and level.

B. Anchor by welding, bolting through saddle clips.

C. Set perimeter closure flush with top of grating and surrounding construction.

D. Secure to prevent movement.

3.3 ERECTION TOLERANCES

A. Maximum Space Between Adjacent Sections: ¼ inch.

B. Maximum Variation From Top Surface Plane of Adjacent Sections or Structure: 1/8 inch.

3.4 CLEANING

A. Section 01700 - Execution Requirements: Final Cleaning.

B. Clean welds and damaged coatings and apply touch-up for galvanized finish - Reference Section - 09900.

END OF SECTION

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION IX

FINISHES

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 09900

PAINTING AND COATING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials and equipment to perform all operations required to paint the facilities including, but not limited to, metal, equipment surfaces, piping, valves, concrete, masonry, drywall, and wood.

1.2 SUBMITTALS

A. Submit manufacturer's product data sheets showing the following information, including surface preparation products such as block fillers and galvanized metal primers:
1. Percent solids by volume.
2. Minimum recommended dry-film thickness per coat for prime, intermediate, and finish coats.
3. Recommended surface preparation.
4. Recommended thinners.
5. Statement verifying that the prime coat used is recommended by the manufacturer for use with the intermediate and finish coats.
6. Application instructions including recommended equipment and temperature limitations.
7. Curing requirements and instructions.
8. Color selection charts.

B. Submit certification from field coat manufacturer that shop prime coat material to be applied by others is compatible with field coats.

1.3 REFERENCES.

Steel Structures Painting Manual, Volume 2, Systems and Specifications - Definitions of Steel Structures Painting Council (SSPC) Surface Preparation Specifications referred to in this section:
1. SSPC-SP1 - Solvent Cleaning
2. SSPC-SP2 - Hand Tool Cleaning
3. SSPC-SP3 - Power Tool Cleaning
4. SSPC-SP6 - Commercial Blast Cleaning
5. SSPC-SP7 - Brush-Off Blast Cleaning
6. SSPC-SP10 - Near White Metal Blast Cleaning

1.4 QUALITY ASSURANCE

A. Product Manufacturer

Company specializing in the manufacture of quality commercial and industrial paint and coating products for at least ten years.

B. Applicator

Company specializing in commercial painting and finishing for at least five years.

C. Single-Source Responsibility

Provide field primers and undercoat paint produced by the same manufacturer as the finish coats. All field paint shall be by the same manufacturer. Submit certification of compatibility with shop primers. (Reference Part 1.2.C.)

D. Field Samples

On wall surfaces and other exterior and interior components, duplicate finishes of prepared samples. Provide full-coat finish samples on at least 100 sq. ft. of surface until required sheen, color, and texture are obtained; simulate finished lighting conditions for review of in-place work. Final acceptance of colors will be from job-applied samples.

1.5 SURFACES NOT TO BE PAINTED

A. Existing surfaces unless specifically noted to be painted on Paint Schedule.

B. Prefinished items not to be painted include but are not limited to the following factory-finished components unless noted otherwise:
1. Toilet enclosures
2. Acoustic materials
3. Architectural woodwork and casework
4. Shop finished water treatment process, mechanical, and electrical equipment
5. Light fixtures
6. Switchgear
7. Distribution cabinets
8. Metal Building Wall and Roof Panels
9. FRP Pipe Supports, Hangers, and grating
10. Laboratory Cabinets

C. Finished metal surfaces not to be painted include unless noted otherwise:
1. Aluminum
2. Stainless steel and stainless steel piping, except for color coding
3. Chromium plated
4. Copper pipe, except for color coding

D. Interior and exterior galvanized metal surfaces shall not to be painted, unless noted otherwise in the paint schedule or on the plans.

E. Operating parts not to be painted include moving parts of operating equipment, such as the following:
1. Valve and damper operators
2. Linkage
3. Sensing devices
4. Motor and fan shafts

F. Labels

Do not paint over Underwriters Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

G. Concrete and masonry surfaces unless noted to be painted on Paint Schedule.

H. Shop primed steel joists if not exposed to view upon completion of construction.

I. Miscellaneous Items
1. Fencing
2. Concrete reinforcement steel
3. Buried piping unless specifically noted otherwise
4. Exposed electrical conduit.

1.6 PAINT SCHEDULE

A. The Paint Schedule located at the end of this section and the Room Schedule on the drawings indicate which surfaces are to be painted.

B. If there is doubt as to whether a surface is to be painted, assume it is until instructed otherwise by Engineer.

1.7 SPECIAL INSTRUCTIONS

A. Furnish, at no additional charge for use during this project, necessary dry and wet film thickness gauges and electrical flaw detection equipment necessary for field checking coatings.

B. Two weeks prior to the beginning of any painting, establish with the Owner's Representative a mutually agreeable schedule for the painting work. Design the schedule to allow for all inspections required.

PART 2 MATERIALS

2.1 PAINT SYSTEMS SCHEDULE

A Paint Systems Schedule is located at the end of this section. Painting products are listed on the schedule.

2.2 MANUFACTURERS

A. Tnemec Company, Inc., Kansas City, MO

B. Devoe, Cleveland, OH

C. Sherwin-Williams

D. Pittsburg Paints

E. Or equivalent

F. Paint and related surface preparation products listed on the Paint Systems Schedule refer to Tnemec Company, Inc., Kansas City, MO. Other manufacturer's products can be utilized subject to submittal and acceptance of sufficient information to allow the Engineer to determine that the proposed products are equal to the Tnemec products listed.

2.3 TOUCH-UP PAINT

Furnish a minimum of one gallon of each paint in each color used for touch-up and minor repair work. Furnish the paints in unbroken containers clearly labeled with the manufacturer's name, product number or name, color, date of manufacture and coating system used.

2.4 COLORS

Paint colors will be selected from the manufacturer's standard color chats by the Engineer and Owner.

2.5 GALVANIZED METAL TOUCH-UP

Coat with Rust-Oleum Zinc Rich "Cold Galvanizing Compund", 3 mils DFT minimum. Provide SSPC-SP1 surface preparation.

2.6 TRANSPARENT WOOD FINISHES

Transparent finish these wood items:
1. Interior doors
2. Other millwork, unless scheduled or specified for paint or prefinished.

Finish With:
1. 1 coat oil stain and wipe
2. 1 coat sanding sealer, lightly sand
3. 1 coat of gloss varnish plus one coat satin varnish for interior work; 2 coats waterproof clear satin spar varnish on exterior face of exterior doors.

Sprayed lacquer coatings on interior doors, **only**, may be substituted if fully finished samples are submitted and approved by Engineer as equal to the above finish.

Engineer will select stain. Submit samples of woods to be used, completely stained and finished, for Engineer's approval.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
   1. Product name or title of material
   2. Product description (generic classification or binder type)
   3. Manufacturer's stock number and date of manufacture
   4. Contents by volume, for pigment and vehicle constituents
   5. Thinning instructions
   6. Application instructions
   7. Color name and number

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

C. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

3.2 JOB CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C).

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces.

D. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified.

3.3 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.

B. Do not begin to apply paint until unsatisfactory conditions have been corrected.

C. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

D. Review other Sections in which primers are shop applied to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

E. Notify the Engineer about anticipated problems using the materials specified over substrates primed by others.

3.4 PREPARATION

A. General
1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
2. Place drop cloths as required to protect floors, equipment, and surfaces not to be painted from spray, splatter, and drips.

B. Cleaning

Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease prior to cleaning. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation
1. Clean and prepare surfaces to be painted according to the manufacturer's instructions for each particular substrate condition, the specification sections for the substrate, and as specified in the system schedule.
2. Provide barrier coats over incompatible primers or remove and reprime. Notify Engineer in writing about anticipated problems using the specified finish-coat material with substrates primed by others.

D. Wood
1. Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
2. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
3. Prime, stain, or seal wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood.

E. Ferrous Metals

1. Provide surface preparation as shown on the Paint System Schedule in accordance with the Steel Structures Painting Council methods.
2. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

3.5 APPLICATION

A. General
1. Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
5. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
6. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.
7. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
8. Sand lightly between each succeeding enamel or varnish coat.
9. Omit primer on surfaces that have been shop-primed. However, prepare surface and apply touch-up primer to damaged areas.

B. Scheduling Painting
1. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures
1. Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.
2. Use brushes best suited for the material applied.
3. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
4. Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Materials Preparation
1. Carefully mix and prepare paint materials according to manufacturer's directions.
2. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
3. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
4. Use only thinners approved by the paint manufacturer and only within recommended limits.

5. The manufacturer's recommended pot life limits for all multi-component materials shall be strictly observed. When pot life has been exceeded, the material shall be discarded, even if it still looks like it is satisfactory to use.

E. Tinting

Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

F. Completed Work

Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with specified requirements.

3.6 CLEANING

A. At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.7 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.8 FIELD QUALITY CONTROL

A. After application of protective coatings, check all surfaces with a dry film thickness gauge to ensure specified dry film thickness have been attained.

B. Where shown on the Paint Schedule, check all submerged or intermittently wetted metal surfaces for film continuity electrically using an approved high or low voltage flaw detector as manufactured by Tinker-Rasor, or equal. Repaint pinholes and holidays to the required coat coverage. Make all metal surfaces meet the minimum continuity requirements for their coating.

C. The Engineer may perform independent testing of the paint systems including wet film, dry film, holiday, or testing of the paint products as deemed necessary.

END OF SECTION 09900

PAINT SYSTEMS SCHEDULE

(Utilizing Tnemec Paints)

System No.	Description	Surface Preparation	Prime Coat Series	Prime Coat Min. DFT	Intermediate Coat Series	Intermediate Coat Min. DFT	Final Coat Series	Final Coat Min. DFT
1	Exterior Metal - Architectural	SSPC SP3	10	4.0 to 6.0	6	2.0 to 3.0	6	2.0 to 3.0
2	Exterior Metal - Corrosive	SSPC SP6	66-1211	2.0 to 3.0	66	2.0 to 3.0	73	2.0 to 3.0
3	Exterior Galv. Metal	SSPC SP1 & brush blast	66-1211	4.0 to 6.0	66	2.0 to 3.0	73	2.0 to 3.0
4	Exterior Concrete	14 day cure & clean and dry	156	4.0 to 8.0	---	---	156	4.0 to 8.0
5	Exterior Burried Concrete	14 day cure & clean and dry	46-465	8.0 to 12.0	---	---	46-465	8.0 to 12.0
6	Exterior Masonry	28 day cure & clean and dry	130	60 to 80 ft2/ gal	156	4.0 to 8.0	156	4.0 to 8.0
7	Exterior Wood	sand & no residues	36	2.0 to 3.0	6	2.0 to 3.0	6	2.0 to 3.0
8	Exterior Pipe and Equipment	SSPC SP6, See Note 2 for DIP	66-1211	3.0 to 5.0	66	4.0 to 6.0	73	4.0 to 6.0
9	Exterior PVC and FRP	Lightly Abrade	66	2.0 to 3.0	---	---	73	1.0 to 2.0
10	Buried Metal	SSPC SP10	46H-413	14.0 to 20.0	---	---	---	---
11	Aluminum in Contact with Concrete	SSPC SP6	46-413	16.0 to 20.0	---	---	---	---
12	Submerged Metal - Potable	SSPC SP10	20-1255	3.0 to 5.0	---	---	20-WH02	4.0 to 6.0
13	Submerged Metal - Nonpotable	SSPC SP10	66-1211	3.0 to 5.0	---	---	66	4.0 to 6.0
14	Submerged Concrete - Potable	28 day cure & brush blast	20-1211	4.0 to 6.0	20-1255	4.0 to 6.0	20-WH02	4.0 to 6.0
15	Submerged Concrete - Nonpotable	28 day cure & brush blast	66	4.0 to 6.0	66	4.0 to 6.0	66	4.0 to 6.0
16	Metal High Temp	SSPC SP10	39	.7 to 1.5	39	0.7 to 1.5	39	0.7 to 1.5
17	Interior Metal - Architectural	SSPC SP3	10	2.0 to 3.5	6	2.0 to 3.0	6	2.0 to 3.0
18	Interior Metal - Corrosive	SSPC SP6	66	2.0 to 3.0	66	3.0 to 5.0	66	3.0 to 5.0
19	Interior Galv. Metal	SSPC SP1 & brush blast	27	4.0 to 6.0	---	---	73	2.0 to 3.0
20	Interior Concrete - Architectural	28 day cure & clean and dry	6	1.5 to 2.0	---	---	6	1.5 to 2.0
21	Interior Concrete -Corrosive	28 day cure & brush blast	66-1211	4.0 to 6.0	---	---	66	4.0 to 6.0
22	Concrete Floor Painted	28 day cure & brush blast	201	6.0 to 8.0	280	8.0 to 10.0	280	8.0 to 10.0
23	Concrete Floor Clear Sealer	28 day cure & brush blast	201	10.0 to 12.0	---	---	---	---
24	Interior Masonry - Architectural	28 day cure	130	60 to 80 ft2/ gal	6	2.0 to 3.0	6	2.0 to 3.0
25	Interior Masonry - Corrosive	28 day cure	130	60 to 80 ft2/ gal	66	4.0 to 6.0	66	8.0 to 12.0
26	Interior Wood	sand & no residues	36	2.0 to 3.0	6	2.0 to 3.0	6	2.0 to 3.0
27	Interior Gypsum Drywall	See Spec. 09255	51-792	1.0 to 2.0	6	1.5 to 2.0	6	1.5 to 2.0
28	Bound Absorption Panels	No residues	23	1.5 to 3.0	23	1.5 to 3.0	---	---
29	Interior Pipe and Equipment (1)	SSPC SP6, See Note 2 for DIP	66-1211	3.0 to 5.0	66	4.0 to 6.0	66	4.0 to 6.0
30	Interior PVC and FRP	Lightly Abrade	66-1211	2.0 to 3.0	---	---	66	2.0 to 3.0
31	Electrical Conduit Runs, Metalic Tubing	SSPC SP6	37	2.0 to 3.5	Match	Wall	Match	Wall
32	Cotton/ Canvas on Pipe Insulation	---	6	1.5 to 2.0	---	---	6	1.5 to 2.0
33	Submerged Metal - Zinc Primer	SSPC SP10	91-H2O	2.5 to 3.5	20-1255	4.0 to 6.0	20-WH02	4.0 to 6.0
34	Metal Corrosive - Zinc Primer	SSPC SP6	91-H2O	2.5 to 3.5	66	3.0 to 5.0	66	3.0 to 5.0
35	Interior Gypsum Drywall - Epoxy	See Spec. 09255	151-1051	1.0 to 2.0	84	3.0 to 4.0	84	3.0 to 8.0
36	Exterior Metal - Architectural, Epoxy	SSPC SP 3	27	4.0 to 6.0	---	---	73	2.0 to 3.0
37	Interior Metal - Architectural, Epoxy	SSPC SP 3	27	4.0 to 6.0	---	---	73	2.0 to 3.0

Notes:

All paint systemd may not be used on this project.

1 Unless otherwise specified.

2 Surface prep shall be incompliance with Tnemec Techniacal Bulletin No. 07-52. If surface profile is less than 1.5 mils then brush-off blast clean, if surface profile is more than 1.5 mils then hand or power tool clean.

PAINT FINISH SCHEDULE

Area or Item	Paint System	Comment
NEW CONSTRUCTION		
Misc. Interior Non-Galv. Metal	18	Unless noted otherwise on plans, or spec.
Misc. Exterior Exposed Non-Galv. Metal	2	Unless noted otherwise on plans, or spec.
Gypsum Drywall	27	See Room Schedule
Exterior Side of Hollow Metal Doors and Frames	3	Factory galvanized. Provide prime, intermediate & finish coats in the field
Interior Side of Hollow Metal Doors and Frames	3	Factory galvanized. Provide prime, intermediate & finish coats in the field
Steel in the Chemical Feed Rooms	18	
Concrete floors not covered with floor coverings.		Clear Concrete Floor Sealer per Section 03345. (1)
Interior Pipe, Supports, Hangers, and Equipment		Do not paint Galv., SST, or FRP Pipe, supports and hangers
Submerged Pipe, Supports, and Steel Items	12	
PVC Chemical Feed Pipes	30	For color code banding only - do not paint entire pipe.
Plumbing Piping	29, 30 or 31	On PVC and copper for color code banding only - do not paint entire pipe.
Exterior Side of Overhead Doors and Frames	3	Door slats or panels shall be factory finished and will not be field painted. Frames and other metal surfaces shall receive prime, intermediate, and finish coats in the field.
Interior Side of Overhead Doors and Frames	3	Door slats or panels shall be factory finished and will not be field painted. Frames and other metal surfaces shall receive prime, intermediate, and finish coats in the field.
Exterior Overflow and Vent Pipes at Clearwell	2	
Surge Tank Exterior	29	Factory-primed by tank manufacturer. Provide touch-up of prime coat and provide intermediate and final coats.
Surge Tank Interior	N/A	All interior surfaces will be factory-coated by tank manufacturer.
Air Compressors and Receiver Tanks	N/A	Compressor and tank interiors and exteriors to be factory-coated.
Wells - Exposed Pitless Units	18	
Conduit	N/A	Conduit shall not be painted.
Aerator Structural Stand	2	
High Service Pumps - Discharge Head and Motor	N/A	Factory Coated

Notes:
(1) Sealer not required on basin floors.
(2) Galvanized members shall not be painted, unless specifically indicated on the schedule or the plans.

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION XI

EQUIPMENT

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 11205
PARSHALL FLUME

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Parshall flumes.

1.2 REFERENCES

A. ASTM D 638 - Standard Test .Method for Tensile Properties of Plastics.

B. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

C. ASTM D 2583 - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

D. United States Department of Interior, Bureau of Reclamation, Water Measurement Manual.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Test results of representative fiberglass reinforced plastic laminate.

C. Shop Drawings: Show:
   1. Critical dimensions, jointing and connections, fasteners and anchors.
   2. Materials of construction.
   3. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.

D. Samples: 8-inch square sample of representative fiberglass reinforced plastic laminate.

E. Manufacturer's installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. The product shall be as manufactured by TRACOM, Inc.; or approved equal.

B. Warranty: Flumes shall be warranted to be free of defects in workmanship and materials for a period of two years from shipment.

2.2 PARSHALL FLUMES

A. Flume Type: Provide flume(s) of the following type(s):

1. Size: 3-inch throat

B. Materials:
1. One-piece, fiberglass reinforced plastic.
2. Gloss inside surfaces, free of irregularities.
3. Minimum 3/16 inch wall thickness.
4. Minimum 30% E-glass by weight.
5. Isophthalic polyester resin.
6. Pultruded fiberglass reinforced plastic bracing at top of flume (inlet and outlet), T-304 stainless steel hardware.
7. 2 inch (minimum) top and end flanges.
8. Molded-in stiffening ribs, maximum 12 inch center to center spacing.
9. 15 rail Isophthalic U.V. resistant gel coat on all surfaces.
10. Integral anchor clips drilled for 3/4 inch.
11. Tensile strength (ASTM D 638): 14,000 psi.
12. Flexural strength (ASTM D 790): 27,000 psi.
13. Flexural modulus (ASTM D 790): 1,000,000 psi.
14. Barcol hardness (ASTM D 2583): 50.

C. Accessories:
1. Aluminum or stainless steel ultrasonic transducer mounting Bracket shall be supplied with the flume which shall have elevation adjustment capabilities. All fasteners shall be stainless steel.
2. 5-rail mylar, laminated, high visibility staff gauge:
   a. Graduated in tenth and hundredths of a foot.
3. Anchors clips shall be provided for permanently anchoring flume to concrete structure.
4. There shall be a permanently attached stilling well of 8” diameter.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the flume dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until condition deficiencies have been corrected.

3.2 INSTALLATION

A. Install products in accordance with engineer's instructions, plans, blueprints, etc.

B. Ensure that the product is installed plumb and that the floor is level.

C. Set the flume at the elevation indicated on the engineer's drawings.

D. Embed flume in concrete; pour concrete in maximum 12 inch lifts; internally brace the flume as necessary to ensure bowing does not occur.

3.3 ADJUST AND CLEAN

A. Clean surfaces in accordance with the manufacturer's instructions.

B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION 11205

SECTION 11290

LIQUID CHEMICAL FEED PUMPS

PART 1 GENERAL

1.1 DESCRIPTION

A. This section covers materials and installation of peristaltic metering pumps and chemical transfer pumps including motor, pump, baseplate, calibration columns, pressure relief valves, and foot valves. **All the equipment outlined in this section shall be furnished by one supplier.**

1.2 RELATED SECTIONS

A. Section 09900 - Painting and Coating.

B. Section 13400 - Instrumentation and Control

C. Section 15042 - Cleaning and Pressure Testing of Pipelines.

D. Section 15060 - Pipe and Pipe Fittings.

E. Section 15100 - Valves and Operators.

F. Section 15190 - Mechanical and Piping Identification.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Submit dimensional layouts and mounting and installation details. Submit manufacturer's catalog data and descriptive literature, describing materials of construction, and rotational speed at the specified flow. Show coatings.

C. Provide additional O&M data per Section 01700.

PART 2 MATERIALS

2.1 MANUFACTURERS

A. The chemical metering pump shall be as manufactured by Watson Marlon, Flomotion Systems, or approved equal.

B. Alternates or approved equals to specifications must be approved by the Engineer a minimum of seven (7) days prior to bid opening to be considered. Submit equipment information indicating compliance with the specification.

2.2 PERISTALTIC METERING PUMPS

A. The metering pumps shall be positive displacement peristaltic pumps. Pump materials of construction shall be suitable for use with the liquids to be pumped. Pump manufacturer shall submit documentation indicating that all the materials selected are compatible with the liquid to be pumped. Materials of construction shall be provided for the pump head, valve body, valves, valve seat, pump tubing, drive housing, and base.

B. Pumphead shall consist of a fixed track, a hinged guard door, and spring loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning.

C. Roller arms shall be fitted with stainless steel springs and compression rollers.

D. Pump tubing shall have molded fittings and shall be in contact with the inside diameter of the track. Tubing shall be replaceable without the use of tools or disassembly of the pumphead. Tubing shall be constructed from materials compatible with the chemical pumped.

E. Metering pump rotational speed shall be adjustable from 0.1 to 220 rpm, 0.1 rpm throughout the range.

F. Power supply will be 120 volt, 60 Hz, single phase. Metering pumps shall have a plug-in type electrical connection.

G. The metering pumps shall be flow proportional. The pump shall be capable of accepting on-off signal from the plant control system, a 4-20 mA input signal for flow proportional control, and a 4-20 mA output signal to verify pump is operational.

H. Pumps shall have a leak detection switch which switches pump off after detection of chemical leak.

I. Metering pumps shall have a minimum suction lift as indicated in the chemical feed schedule on the plan drawings.

J. Provide pump base as required for shelf top mounting.

K. All peristaltic metering pumps shall be the same model. Pump shall be capable of use at any chemical feed location by installing properly sized pump tubing.

2.4 PRESSURE RELIEF VALVE

A. A pressure relief valve shall be furnished and installed for each feed system as indicated in the chemical feed schedule and schematic drawings as shown on the plans. The pressure relief valve shall be field adjustable, but shall be shipped from the supplier set at a pressure of 45 psi. The valves shall be constructed of PVC with a Hypolon diaphragm. The valves shall have a maximum operating pressure of at least 100 psi. The valves shall be globe style. End connections shall be a minimum of 1/4-inch threaded NPT.

2.5 SOLUTION TUBE

A. Chemical solution tubes shall be made of PVC or polyethylene. Tubes shall extend to 1/3 the parent pipe inside diameter. Solution tubes shall slide through a corporation stop or ball valve, and shall include a check valve, and restricting chain to allow the solution tube to be withdrawn while the parent pipe is under pressure. Corporation stop, ball valves and check valves shall be constructed of materials compatible with feed chemical. Contractor shall coordinate thread type with solution tube supplier.

2.6 SPARE PARTS

A. Provide the following spare parts for each pump:

Quantity	Item
4	Spare tubing

B. Provide the following spare parts, which shall be compatible with all equally sized pumps.

Quantity	Item
1	Spare Pump
1	Pressure Relief Valve

C. Pack spare parts in a box; label with the job location, pump type and model, manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained within.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Pump assemblies and related equipment shall be installed as indicated on the drawings and in accordance with the manufacturer's recommendations. Provide the manufacturer's recommended lubricants for each piece of equipment.

3.2 PAINTING AND COATING

A. Coat all metal components at the factory with manufacturer’s standard coating. Touch up after installation.

3.3 FIELD TESTING

A. District personnel will operate each diaphragm metering pump, using the fluid they are to normally pump, following installation and start-up for fifteen (15) consecutive days during which time no repairs or corrections shall be required for proper operation. The manufacturer is responsible for repairs and corrections during the fifteen (15) days. If a repair or correction is required, the fifteen days shall start over.

B. Assure that manual and automatic rotational speed adjustments perform over the specified adjustment range.

C. Assure that tubing do not leak or tear. Repair or replace any leaking tubing.

D. Assure that pressure-relief valves have been provided and set as specified. Repair or replace any valves not set or operating as specified.

E. Demonstrate that automatic controls are functioning.

END OF SECTION 11290

SECTION 11320
INDIVIDUAL GRINDER PUMP STATIONS

PART 1 GENERAL

1.1 GENERAL DESCRIPTION

A. The contractor shall furnish and install complete, factory-built and tested Grinder Pump Stations suitably mounted in basins constructed of fiberglass or high density polyethylene, electrical quick disconnect (NEMA 6P), pump removal system, shut-off valve, anti-siphon valve, and check valve assembled within the basin, electrical alarm panel, and all necessary internal wiring and controls. All pump motor-grinder units shall be of like type and horsepower.

1.2 SHOP DRAWINGS

A. Furnish a minimum of six (6) sets of shop drawings detailing the equipment including dimensional data and materials of construction.

B. Manufacturer shall provide detailed design and construction drawings for tank basin including anti-flotation rings. Provide designs and drawings based on a minimum overall tank depth of eight (8) feet and one-foot increment thereafter to a maximum overall depth of thirteen (13) feet. Design shall indicate minimum diameter of basin hole, minimum thickness of anti-flotation ring and placement of lifting lugs. Maximum bury depth of 20 feet shall be used for basin design. Design of anti-flotation ring shall be based on a minimum depth to groundwater of 2 feet.

1.3 MANUFACTURER

A. Grinder pump stations, complete with all appurtenances, form an integral system, and as such, shall be supplied by one grinder pump station manufacturer. The Contractor shall be responsible for the satisfactory operation of the entire system. The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product, submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The Manufacturer shall provide a reference and contact list from ten of its largest contiguous grinder pump installations of the type of grinder pumps described within this specification.

B. The Manufacturer of the grinder pump stations shall be Environment One Corporation, Barnes Pumps, Inc., Delta Environmental Products, Hydromatic, Myers, or approved equal.

1.4 MANUFACTURER'S EXPERIENCE

A. Equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. Submit detailed installation and user instructions for its product; submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts.

B. Provide a reference and contact list from the three largest completed contiguous grinder pump installations. The references listed shall have been in operation a minimum of five (5) years after final acceptance by the system owner and shall consist of a minimum of 25 units discharging into common force mains forming a low pressure sewer system.

C. The equipment furnished hereunder shall be the product of a company experienced in the design and manufacture of grinder pumps specially designed for use in low pressure sewer systems. Manufacturer shall have at least five (5) years of experience in the design and manufacture of units of identical size and performance to the requirements specified herein.

1.5 OPERATING CONDITIONS

A. The pumps shall be capable of delivering 15 GPM against a rated total dynamic head of 0 feet (0 PSIG) and 9 GPM against a rated total dynamic head of 138 feet (60 PSIG). Pumps must also be capable of 5 GPM @ 230 feet TDH intermittent duty without exceeding nameplate amperage. The pump(s) must also be capable of operating at negative total dynamic head without overloading the motors or damaging the pumps. Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

1.6 WARRANTY

A. Provide a parts and labor warranty on the complete station and accessories, including, but not limited to, control panel, and check valve, for a period of twelve (12) months after notice of OWNER'S acceptance. Any defects found during the warranty period will be reported to the Manufacturer by the OWNER.

B. Pump manufacturer shall provide a warranty Performance Certification statement executed by the most senior executive officer of the grinder pump manufacturer, which certifies a minimum of a twenty four month warranty. Manufacturer must further detail any exclusions from the warranty or additional cost items required to maintain the equipment in warrantable condition, and all associated labor and shipping fees, and certify that the manufacturer will bear all costs to correct any original equipment deficiency for the effective period of the warranty. All preventative maintenance type requirements shall be included as exclusions. Requirements include, but are not limited to: un-jamming grinder mechanism, unplugging of lines, periodic motor maintenance, and periodic cleaning of liquid level controls. Quotes with incomplete or missing performance Certification form shall be rejected.

PART 2 PRODUCT

2.1 PUMP

A. Custom designed, integral, vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. All material shall be suited for submergence in domestic wastewater service.

B. Pump(s) shall be suitable for long term submergence in sewage. Grinder pump(s) shall be U.L. Listed to Standard 778 and CSA Listed to Standard 108. The pump housing, grinder housing and motor housing shall be constructed of high quality ASTM class 30 minimum cast iron. The pump(s) shall be painted with air dry enamel. All exposed hardware shall be 300 series stainless steel. Discharge connection shall be a standard 1.25 inch NPT in the vertical position.

C. Rotor shall be through-hardened stainless steel. Cast rotors and/or rotors with imperfections on the rotor surface will not be allowed.

D. Stator shall be a compounded elastomer designed and warranted for use in wastewater. Physical properties shall include high tear and abrasion resistance, grease resistance, water and detergent resistance, temperature stability, good aging properties, and outstanding wear resistance.

2.2 GRINDER

A. Grinder shall be placed immediately below the pumping elements, direct-driven by a single, one-piece stainless steel motor shaft. Grinder impeller assembly shall be securely fastened to the pump motor shaft. Grinder shall be of the rotating type with a stationary hardened and ground stainless steel shredding ring spaced in accurate close annular alignment with the driven impeller assembly, which shall carry two hardened type 400 series stainless steel cutter bars.

B. Assembly shall be dynamically balanced and operate without objectionable noise or vibration over the entire range of recommended operating pressures. Grinder shall be constructed to eliminate clogging and jamming under all normal operating conditions including starting. Sufficient vortex action shall be created to scour deposits or sludge banks that would impair the operation of the pump.

C. Positioned in such a way that solids are fed in an upward flow direction.

D. Inlet shroud shall pass a three (3) inch sphere.

E. At maximum flow the average inlet velocity must not exceed 0.2 feet per second.

F. Impeller mechanism must rotate at a nominal speed of no greater than 1800 rpm.

G. Grinder shall be capable of reducing all components in normal domestic sewage, including paper, wood, plastic, glass, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and discharge piping. The grinder shall be capable of passing a series of stringy type solids (diapers, rags, feminine products, etc.) through the pump without roping or winding the material in or immediately below the pump suction. The grinder mechanism shall be capable of handling reasonable amount of grit as is often found in domestic sewage.

2.3 ELECTRIC MOTOR

A. As a maximum, the motor shall be a 2 HP, 1725 RPM, 120 or 240 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, squirrel cage induction type with a low starting current not to exceed 30 amperes and high starting torque of 8.4 foot pounds. Provide inherent protection against running overloads or locked rotor conditions by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. An automatically resetting, heat sensing thermal device that interrupts current flow if excessive temperature is detected shall be provided. Motor protector combination shall be listed by Underwriters Laboratories, Inc., for the application.

B. The motor shall be constructed with the open windings operating in a sealed housing.

2.4 MECHANICAL SEAL

A. Core shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. Seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring. The grinder pump rotor and stator must be replaceable without disturbing the mechanical seal.

2.5 TANK AND INTEGRAL ACCESSWAY

A. Basin shall be Fiberglas or high density polyethylene construction. Basin shall be provided with a three inch (minimum) width base mounted ballast support flange. All units shall be provided with a basin suitable for a ten foot overall depth from ground surface to bottom of basin.

B. Corrugated high density polyethylene sections are to be made of a double wall construction with the internal wall being generally smooth to promote scouring. Corrugations of outside wall are to be of minimum amplitude of 1-1/2" to provide necessary transverse stiffness. Any incidental sections of a single wall construction are

to be a minimum 0.250-inch thick. All seams created during tank construction are to be thermally welded and factory tested for leak tightness. Tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to maximum external soil and hydrostatic pressure.

C. The tank shall be furnished with one EPDM grommet fitting to accept a 4 .0” (nominal) ID PVC pipe.

D. The accessway shall be an integral extension of the wet well assembly and include a lockable cover assembly providing low profile mounting and watertight capability.

E. The station shall be provided with all necessary accessories to make penetrations for service line in the field.

F. All discharge piping shall be supplied by pump manufacturer.

G. The accessway or accessway cover shall include a single NEMA 6 electrical quick disconnect for all power and control functions, factory installed with accessway penetrations warranted by the manufacturer to be watertight. The accessway shall also include a 2 inch PVC vent to prevent sewage gasses from accumulating in the tank.

H. The diameter of the basin shall be a minimum of 24 inches and shall be eight feet in overall height.

I. Service line connection shall be a minimum of 30” above bottom of basin.

J. Provide a minimum of five (2) two (2) foot basin extensions. Manufacturer shall guarantee that additional extensions shall be delivered to the project site within five (5) working days after placement of order for additional basin extensions.

2.6 CHECK VALVE

A. Equip pump discharge with a factory installed, gravity operated, check valve built into the discharge piping. Valve shall have a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Valve operation shall provide maximum seating capability even at very low back pressure.

2.7 CORE UNIT

A. Grinder pump station shall have cartridge type easily removable core assemblies containing pump, motor, grinder, check valve, anti-siphon valve, and electrical quick disconnect and wiring. The watertight integrity of each core unit shall be established by 100% factory test at a minimum of 5 PSIG.

2.8 CONTROLS

A. Wastewater level detection for controlling pump operation shall be accomplished by monitoring the pressure changes or by float switches.

B. The grinder pump will be furnished with a length of 6 conductor 14 gauge, type SJOW or SOW cable, pre-wired and watertight to meet UL requirements. Cable length shall be a minimum of 100 feet.

2.9 ALARM PANEL

A. Each grinder pump station shall include a NEMA 4, UL listed alarm/disconnect panel suitable for wall or pole mounting. The NEMA 4 enclosure shall be manufactured of thermoplastic to assure corrosion resistance. The enclosure shall include a hinged, pad lockable cover, secured dead front and component knock-outs.

B. For each core, the panel shall contain one-15 amp, double pole circuit breaker for the power circuit and one - 15 amp single pole circuit breaker for the alarm circuit. The

panel shall contain terminal blocks, integral power bus, push to run feature and a complete alarm circuit.

C. The alarm panel shall include the following features: audio & visual alarm, push to run switch, and high level alarm.

D. When liquid level in the sewage wet-well rises above the alarm level, visual and audio alarms will be activated. The contacts on the alarm pressure switch will close.

E. The audio alarm may be silenced by means of the externally mounted, push-to-silence button.

F. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "Off" setting of the alarm pressure switch.

G. The visual alarm lamp shall be inside a red fluted lens at least 2-5/8" in diameter and 1 - 11 /16" in height. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4 rating.

H. The audio alarm shall be a printed circuit board in conjunction with an 86 dB buzzer with quick mounting terminal strip mounted in the interior of the enclosure. The audio alarm shall be capable of being deactivated by depressing a push-type switch which is encapsulated in a weatherproof silicone boot and mounted on the bottom of the enclosure.

I. The entire alarm panel as manufactured shall be listed by Underwriters Laboratories, Inc.

J. A pump hour meter shall be provided in the control panel.

2.10 SERVICEABILITY

A. The grinder pump core unit shall have two lifting hooks complete with lift-out harness connected to its top housing to facilitate easy core removal. All mechanical and electrical connections must provide easy disconnect accessibility for core unit removal and installation. A push to run feature will be provided for field trouble shooting. All motor control components shall be mounted on a readily replaceable bracket for ease of field service.

2.11 SAFETY

A. The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump station shall be listed by Underwriter Laboratories, Inc., to be safe and appropriate for the intended use.

B. The grinder pump shall meet accepted standards for plumbing equipment for use in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low pressure sewer system application. As evidenced of compliance with this requirement, the grinder pump shall bear the seal of NSF International.

2.12 MANUALS

A. Provide five copies of Operation and Maintenance Manuals for the Owner.

PART 3 EXECUTION

3.1 FACTORY TEST

A. Each grinder pump shall be submerged and operated for 5 minutes (minimum). Include the testing of all ancillary components such as, the anti-siphon valve, check valve, discharge line, level sensors and each unit's dedicated controls. Actual appurtenances

and controls which will be installed in the field, shall be particular to the tested pump only. A common set of appurtenances and controls for all pumps will not be acceptable. Certified test results shall be available upon request showing the operation of each grinder pump at two different points on its curve, with the maximum pressure no less than 60 psi. The OWNER reserves the right to inspect such testing procedures, at the grinder pump manufacturer's facility.

3.2 DELIVERY

A. All grinder pump units will be delivered to the job site, 100% completely assembled, including testing, ready for installation.

3.3 INSTALLATION

A. Comply with Section 02225 for excavation and backfill requirements not specified herein. Excavate basin hole to minimum dimensions listed in shop drawings.

B. Provide a firm, dry subgrade for the structure, and guard against flotation or other damage resulting from general water or flooding. Stations shall not be set into the excavation until the installation procedures and excavation have been approved by the Engineer.

C. Installation shall be accomplished so that 1" to 4" of accessway, below the bottom of the lid, extends above the finished grade line. The field adjustment of basin height shall comply with manufacturers written instructions. Finished grade shall slope away from the unit. The diameter of the hole must be large enough to allow for the concrete anchor.

D. Place 6 inch (minimum) layer of bedding material under each basin.

E. Concrete anti-floatation collar, as sized according to the manufacturer's instructions detailed in the shop drawings, shall be poured in place after installation or precast prior to installation.

F. The unit shall be leveled, and filled with water, to the bottom of the inlet, to help prevent the unit from shifting while the concrete is being poured if anti-flotation collar is poured on-site. The concrete must be manually vibrated to ensure there are no voids. If it is necessary to pour the concrete to a level higher than the inlet piping, an 8" sleeve is required over the inlet prior to the concrete being poured.

G. Provide and install a four foot piece of four inch SDR 23.5 PVC pipe with water tight cap, to stub-out the inlet to the basin.

H. After concrete has cured, for a minimum of two days, backfill with granular backfill to within three foot of finished grade. The remainder of the excavation shall be backfilled with material excavated.

I. Install manufacturer supplied check valve, gate valve and 1 ¼” female NPT fitting in station discharge piping at locations as indicated on the drawings.

J. Contractor shall install the service line from the house to the pump basin.

K. Contractor shall furnish and install all electrical wiring to operate pump station control panel and pump station.

3.4 START-UP AND FIELD TESTING

A. Provide the services of qualified factory trained technician(s) to inspect placement and wiring of each station, perform field tests as specified and instruct Owner's personnel in the operation and maintenance of the equipment before acceptance by the Owner.

B. Provide all equipment and materials necessary to perform testing.

C. The services of a trained factory-authorized technician shall be provided for a minimum of two days.

D. Upon completion of the installation, the authorized factory technicians will perform the following test on each station:
   1. Make certain the discharge shut-off valve is fully open. This valve must not be closed when the pump is operating. In some installations, there may be a valve(s) at the street main that must also be open.
   2. Turn ON the alarm power circuit.
   3. Fill the wet well with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
   4. Turn ON pump power circuit. Initiate pump operation to verify automatic "on/off" controls are operative. Pump should immediately turn ON. Within one minute alarm light will turn OFF. Within three minutes the pump will turn OFF.

E. Upon completion of the start-up and testing, the Manufacturer shall submit to the Owner the start-up authorization form describing the results of the tests performed for each grinder pump station. Final acceptance of the system will not occur until authorization forms have been received for each pump station installed.

END OF SECTION 11320

SECTION 11376

SURFACE AERATORS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work under this section shall cover materials, and installation of a motor driven propeller type, horizontal, aspirating aerator as shown on the Contract Drawings and specified herein.

1.2 SHOP DRAWINGS

A. Furnish a minimum of six (6) sets of shop drawings detailing the equipment including dimensional data and materials of construction.

B. Manufacturer shall provide detailed design and construction drawings for surface aerators including anchoring details.

1.3 MANUFACTURER

A. The aerators shall consist of an electric motor drive above the water surface. The motor shall be connected to a hollow shaft within a protective housing positioned at a 25 to 45 degree angle downward into the water. Aerators with submersible motors are not acceptable. The shaft shall be connected to and drive a propeller beneath the water surface. The propeller shall thrust water past a diffuser to induce a pressure differential, drawing air through intake holes above the water surface down through the rotating hollow shaft and diffuser into the water.

B. The surface aerators shall be Model Aire-O_2 Series 275 Aspirator Aerator system as manufactured by Aeration Industries International, or approved equal.

1.4 MANUFACTURER'S EXPERIENCE

A. Equipment specified shall be a product of a company experienced in the design and manufacture of surface aerators for specific use in wastewater treatment lagoons. Submit detailed installation and user instructions for its product; submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of surface aerator replacement parts.

B. The equipment furnished hereunder shall be the product of a company experienced in the design and manufacture of surface aerators specially designed for use in low pressure sewer systems. Manufacturer shall have at least five (5) years of experience in the design and manufacture of units of identical size and performance to the requirements specified herein.

1.5 OPERATING CRITERIA

A. Each surface aerator assembly to be furnished and installed shall have the capability of delivering a total of 1.8 lbs O_2/hr.

1.6 WARRANTY

A. Provide a parts and labor warranty on the complete surface aerator and accessories, for a period of twelve (12) months after notice of OWNER'S acceptance. Any defects found during the warranty period will be reported to the Manufacturer by the OWNER.

PART 2 PRODUCTS AND MATERIALS

2.1 MOTORS

A. Each motor shall be 3,600 rpm, squirrel cage, induction, cast iron construction with a service factor of 1.15. Each motor shall be designed for full voltage starting at 230 VAC, 1 phase, 60 Hz current, TEFC. Each motor shall be minimum 1 HP, specifically designed to operate at an angle.

B. Starting duty shall be suitable for two starts per hour. Motors shall be totally enclosed, fan cooled type, and shall be suitable for continuous full load operation. Motor insulation shall be NEMA Class “F”, designed specifically for severe duty. A porous drain plug shall be provided to automatically drain any condensate which may form inside the motor.

2.2 MOUNTING FLANGE

A. Mounting flange shall be stainless steel.

2.3 SHAFTING

A. The shaft shall be hollow, constructed of stainless steel, full-welded to a forged carbon steel universal joint coupling. Units with solid shafts are not acceptable. Shaft shall be dynamically balanced. Units that utilize vibration dampeners to control fatigue stress failures due to vibration are not acceptable.

B. The universal joint coupling shall include a standard grease fitting for lubrication. Units that utilize flexible couplings to attach the shaft to the motor are not acceptable.

2.4 HOUSING

A. The housing shall be stainless steel, non-corrosive, and flanged for mounting to the aerator. The housing shall form a guard around the hollow shaft and support a field replaceable, water-lubricated bearing, press-fitted into the housing lower end. Water lubrication holes shall penetrate the housing in the area surrounding the bearing.

2.5 BEARINGS

A. The aerator shall be supplied with a field replaceable water lubricated lower support bearing. The bearing shall be constructed of an appropriate material for the application inside a fiber backing. The bearing shall be press-fitted into the housing to allow ease of replacement. Bearings requiring factory replacement are not acceptable.

2.6 PROPELLER

A. The propeller shall be stainless steel specifically designed to maximize oxygen transfer and mixing characteristics. Propellers shall be self-tightening such that the propeller threads tighten on the shaft threads during normal operation. The entire flow of aspirated air shall pass through the propeller via the hollow drive shaft along the axis of the propeller hub.

2.7 DIFFUSER

A. Aerator shall be equipped with a stainless steel, self-tightening, diffuser threaded to the drive shaft. The aspirated air shall flow through the diffuser in one direction parallel with the axis of the diffuser. The entire flow of aspirated air shall exit at the diffuser opening.

2.8 VORTEX SHIELD

A. A vortex shield shall be furnished with each unit to eliminate the formation of vortices, maximize shaft airflow, and prevent cavitation damage to the propeller during operation. Units without vortex shields are not acceptable.

2.9 FLOTATION

A. The aerator flotation assembly shall be constructed of molded low-density polyethylene with ultraviolet inhibitor or stainless steel, filled with urethane foam. To allow for servicing by not removing the aerator from the flotation, the flotation assembly shall be designed so the aerator may be pivoted completely out of the water

2.10 ELECTRICAL CABLE

A. Cable shall be CSA/UL approved for severe environments, suitable for underwater service and one continuous length.

2.11 ARE PARTS SHALL INCLUDE

A. One complete replacement set of bearings

PART 3 CONSTRUCTION METHODS

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and approved Shop Drawings.

3.2 SERVICES OF MANUFACTURER

A. The manufacturer of the aeration equipment shall provide the services of a trained, qualified representative for at least one days for the purpose of inspecting the installation. Each aerator shall be checked for lubrication, alignment, rotation, vibration, and the representative shall notify the Contractor and the engineer of anything in the installation which might render the manufacturer's warranty null and void. The manufacturer's representative shall also instruct the operating personnel as to the proper method and the recommended lubrication and maintenance procedures.

END OF SECTION 11376

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION XV

MECHANICAL

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 15041

DISINFECTION OF PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes materials and procedures for disinfection of water mains by the continuous feed method and by the slug method and disinfection of structures. Do not use the tablet method to disinfect pipelines. Disinfect piping in accordance with AWWA C651 and disinfect structures in accordance with AWWA C652 as modified below.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. 15042 - Cleaning and Pressure Testing of Process Piping.

B. 15060 - Pipe and Pipe Fittings.

1.3 JOB CONDITIONS

A. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Engineer and cognizant regulatory authorities.

B. Use potable water for chlorination.

C. Potable water for disinfection will be available from the Owner at no cost.

PART 2 MATERIALS

2.1 GAS CHLORINE

A. Inject with a gas feed chlorinator and a water booster pump. Use an experienced operator and follow the instructions of the chlorinator manufacturer.

2.2 CALCIUM HYPOCHLORITE (DRY)

A. Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate.

2.3 SODIUM HYPOCHLORITE (SOLUTION)

A. Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

2.4 CHLORINE RESIDUAL TEST KIT

A. For measuring chlorine concentration, supply and use a medium range, drop count, titration kit or an orthotolidine indicator comparator with wide range color discs. Range 1.0 to 50 mg/l. Products: Hach Chemical or equal. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 EXECUTION

3.1 CONTINUOUS FEED METHOD FOR PIPELINES

A. Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 50 mg/l. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

3.2 DISINFECTION OF VALVES AND APPURTENANCES

A. During the period that the chlorine solution is in the section of pipeline, open and close valves to obtain a chlorine residual at all pipeline appurtenances.

3.3 CONFIRMATION OF RESIDUAL

A. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 25 mg/l minimum exists along the pipeline by sampling at air valves and other points of access.

3.4 PIPELINE FLUSHING

A. After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the chlorine concentration in the water leaving the pipe is within 0.5 mg/l of the replacement water. Dechlorinate water if it discharged at a location such that the water could enter adjacent water sources.

3.5 BACTERIOLOGIC TESTS

A. Collect two samples, deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline and in each structure after chlorination and refilling. Contractor is responsible for laboratory costs.

3.6 REPETITION OF PROCEDURE

A. If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

3.7 TEST FACILITY REMOVAL

A. After satisfactory disinfection, replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

END OF SECTION 15041

SECTION 15042

CLEANING AND PRESSURE TESTING OF PIPING

PART 1 GENERAL

1.1 DESCRIPTION

A. This section specifies the cleaning and hydrostatic testing of piping.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. 15041 - Disinfection of Piping
15060 - Pipe and Pipe Fittings

1.3 TEST PRESSURES

A. Test pressures for the various services and types of piping are shown on the piping schedule in Section 15060.

1.4 SUBMITTALS

A. Test bulkhead locations and design calculations.

B. Pipe attachment details.

1.5 TESTING RECORDS

A. The Engineer will review the testing observations and reports. These reports shall include:
1. Date of test.
2. Identification of pipeline tested or retested.
3. Identification of pipeline material.
4. Identification of pipe specification.
5. Test fluid.
6. Test pressure.
7. Remarks: Leaks identified (type of location), type of repairs, or corrections made.
8. Prepare written report at the conclusion of each testing period and submit to the Engineer for review.

1.6 JOB CONDITIONS

A. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Engineer and cognizant regulatory authorities.

PART 2 MATERIALS

2.1 TESTING FLUID

A. Testing fluid shall be potable. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping. Plug taps or connections to the existing piping from which the test fluid was obtained.

B. Air can be used for pressure testing chemical feed piping at the Contractor's option.

C. Potable water can be obtained from the Owner at no cost. The Contractor is responsible for transporting water from the Owner's source to the job-site. The quantity and delivery rate must be coordinated with the Owner prior to use.

2.2 TESTING EQUIPMENT

A. Provide pressure gages, pipes, bulkheads, pumps, and meters to perform the hydrostatic testing.

2.3 VENTS AND DRAINS

A. Install temporary vents on the high points of piping and temporary drains on low points of aboveground piping to allow for pressure testing of pipelines. Provide a valve at each vent or drain point. Valves shall be 3/4-inch for piping 3 inches and larger and 1/2-inch for piping smaller than 3 inches. Temporary vents and drains shall be removed following pressure testing, and taps in permanent piping shall be plugged.

PART 3 EXECUTION

3.1 TESTING PREPARATION

A. Pipes shall be in place and anchored before commencing pressure testing.

B. Conduct hydrostatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

3.2 INITIAL PIPELINE FILLING

A. Maximum rate of filling shall not cause water velocity in pipeline to exceed 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

3.3 CLEANING

A. Before conducting hydrostatic tests, flush all piping with water to remove dirt and debris. Maintain a flushing velocity of at least 3 fps. Flush pipes for time period as given by the formula:

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)
L = pipe length (feet).

3.4 TESTING AND DISINFECTION SEQUENCE OF POTABLE WATER PIPING

A. Perform chlorination per Section 15041 subsequent to cleaning and hydrostatic testing.

B. Locate and install test bulkheads, valves, connections to existing pipelines, and other appurtenances in a manner to provide an air gap separation between existing potable water pipelines and the pipeline being tested. Disinfect water and pipeline being tested before hydrostatic testing when connected to an existing, previously disinfected potable waterline.

3.5 HYDROSTATIC TESTING OF ABOVEGROUND OR EXPOSED PIPING

A. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak at least 48 hours to absorb water before conducting the pressure test.

B. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Subject the piping system to the test pressure indicated on the pipe schedule in Section 15060. Maintain the test pressure for a minimum of 8 hours plus additional time required to inspect the system for leakage. The maximum permissible pressure drop during the test shall be 5 pounds per square inch (psi). Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

3.6 HYDROSTATIC TESTING OF BURIED PIPING

A. Conduct hydrostatic tests on buried piping after the trench has been completely backfilled. The pipe may be partially back filled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

B. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured.

C. Pressure test pipe located beneath floor slabs before slab is poured.

D. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak for at last 48 hours to absorb water before conducting the pressure test.

E. Maintain the test pressure for a minimum duration of 8 hours. The maximum permissible pressure drop during the test shall be 5 pounds per square inch (psi). After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system.

F. The allowable leakage rate for PVC pipe is defined by the formula:

$$L = \frac{N \times D \times (P)^{1/2} \times T}{7{,}400}$$

in which:
L = allowable leakage (gallons) during the test period
N = number of joints in the pipe tested
D = diameter of the pipe (inches)
P = specified test pressure (psig)
T = duration of test (hours)

G. The allowable leakage rate for ductile iron pipe is defined by the formula:

$$L = \frac{S \times D \times (P)^{1/2} \times T}{133{,}200}$$

in which:

L = allowable leakage (gallons) during the test period
S = length of pipe tested (feet)
D = nominal diameter of the pipe (inches)
P = specified test pressure (psig)
T = duration of test (hours)

H. Repair and retest any pipes showing leakage rates greater the that allowed in the above formulas.

I. Regardless of the rate of leakage, stop all detectable leaks.

3.7 IN-LINE VALVES

A. All in-line valves shall be tested for drip-tight closure for a period of two hours.

3.8 REPETITION OF TEST

A. If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. All visible leakage shall be eliminated.

3.9 BULKHEAD AND TEST FACILITY REMOVAL

A. After a satisfactory test, drain the water, remove test bulkheads and other test facilities.

END OF SECTION 15042

SECTION 15060

PIPE AND PIPE FITTINGS – WATER TREATMENT

PART 1 GENERAL

1.1 DESCRIPTION

This section describes the general requirements of materials, testing, and installation of the following piping materials:

A. Ductile Iron (DI) Pipe and Fittings.

B. Polyvinylchloride (PVC) Pipe and Fittings.
   1. Schedule 80 PVC Pipe and Fittings.
   2. SDR Pressure Rated PVC Pipe and Fittings.
   3. AWWA PVC Pipe and Fittings.

C. Small Steel Piping and Fittings
   1. Steel Pipe and Fittings (3-Inches and Smaller).
   2. Stainless Steel (SS) Pipe and Fittings (3-Inches and Smaller).

D. Miscellaneous Piping Items
   1. Flexible Pipe Couplings.
   2. Grooved-End Couplings.
   3. Restrained Flange Adapter.
   4. Gaskets.
   5. Modular Annular Sealing Devices.
   6. Bolts and Nuts for Flanges and Mechanical Joints.
   7. Flange Insulation Kits.
   8. Buried Pipe Warning Tape.

1.2 APPLICABLE PROVISIONS

A. Drawings, General and Supplementary Conditions of the Contract, and Division 1 shall govern the work of this section.

1.3 RELATED SECTIONS

The following Sections Contain requirements that relate to this Section:

A. 02225 - Trenching, Backfilling and Compacting.

B. 15041 - Disinfection of Piping and Structures.

C. 15042 - Cleaning and Pressure Testing of Pipelines.

D. 15100 - Valves and Operators.

1.4 DEFINITIONS

A. “Buried piping” is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Piping enchased in concrete is considered to be buried. Do not coat encased pipe.

B. “Exposed piping” is piping that is located above ground; inside buildings, vaults, or other structures; or in underground concrete trenches or galleries.

1.5 SUBMITTALS

A. Submit the following in accordance with General Conditions, Special Conditions, and Section 01300:

1. Product Data.
   a) Submit manufacturer's data sheet for each type of piping.
   b) Submit manufacturer's data sheet for gaskets supplied, showing dimensions and bolting recommendations.
   c) Submit manufacturer's data sheet for insulating unions, showing recommended installation procedures.
2. Certificates.
   a) Submit affidavits of compliance that proposed pipe, fittings, and appurtenances meet the referenced standards.
   b) Submit certification that cement lining complies with referenced standards.
   c) Submit certification that gaskets comply with referenced standards.
   d) Submit certification that O-Rings in chemical service are chemically compatible.
   e) Submit certification that the polyethylene encasement complies with referenced standards.
   f) Submit certification that all piping materials that come into contact with drinking water (including raw and process waters), drinking water chemicals, or both comply with NSF 61.
   g) Submit certification that bolts and nuts comply with referenced standard, including coatings if specified.

1.6 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS INTERNATIONAL (ASTM)

ASTM D 1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2680	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D 2855	Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

ASTM F 437	Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 439	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	(2002) Standard Specification for Chlorinated Poly(Vinyl
ASTM F 441M	Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 442	(1999) Standard Specification for Chlorinated Poly(Vinyl
ASTM F 442M	Chloride) (CPVC) Plastic Pipe (SDR-PR)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

NATIONAL SANITATION FOUNDATION INTERNATIONAL NSF

NSF 61	(2007) Drinking Water System Components -- Health Effects

PART 2 - MATERIALS

2.1 DUCTILE IRON (DI) PIPE AND FITTINGS

A. Pipe

Pipe shall be ductile iron, conforming to AWWA C151.

B. Lining

Cement-mortar-lined pipe and fittings shall conform to AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Lining material shall conform to ASTM C150, Type II. Cement-mortar-lining shall be given a seal-coat of asphaltic material per AWWA C104; the solvents used for such seal-coat shall be NSF approved for use for potable water and shall not contain perchloroethylene (PCE) or trichloroethylene (TCE).

C. Pipe Wall Thickness

1. Pipe with threaded flanges shall be Class 53.
2. Buried pipe with push-on, mechanical joints, or plain end:

Pipe Size (in.)	Wall Thickness
4 to 12	Class 350

3. Pipe having grooved-end joints:

Pipe Size (in.)	Wall Thickness
4 to 16	Class 53

D. Flanges
1. Flanges shall be Class 125 per AWWA C115. Flanges on pipe shall be either cast or threaded.
2. It shall be the responsibility of the contractor to verify the compatibility of all flanges and appurtenances.

E. Joints
1. Joints in piping located in vaults and structures shall be flanged, flexible or rigid grooved end, or restrained flexible coupling as shown on the drawings. Joints in buried piping shall be of the push-on or mechanical-joint type per AWWA C111/ANSI A21.11.
2. Buried restrained push-on joints with test pressure of 150 psi or less shall be as per AWWA C111/ANSI A21.11 and shall be capable of transmitting the full longitudinal thrust developed at design pressure with a 1.5 factor of safety. Restrained joints shall be American Lok-Ring or Flex-Ring Joint pipe or equal. Pipe 12" and smaller may alternately utilize mechanical joints with retaining wedges such as EBAA Iron Series 1100, Ford Series 1400 or equal, for applications where the test pressure is 150 psi, or less.
3. All welding of retainer rings shall be done in the pipe manufacturers shop except for necessary restrained closure pieces. A maximum of one field cut closure pipe piece between each pair of fixed pipe sections (i.e. end points, fittings, etc.) may have the retainer ring field welded. Field welding shall be done by methods and qualified welders approved by the pipe manufacturer.

F. Fittings
1. Class 125 fittings shall conform to AWWA C110 or C153 with a minimum pressure rating of 250 psi. Flanges shall be flat faced for Class 125.
2. Fittings shall be cement-mortar-lined with single thickness as specified in AWWA C104, Section 4.8.
3. Grooved-end fittings shall conform to AWWA C110 and ANSI B16.1 with grooved ends conforming to AWWA C606. Joints shall be cut or shouldered as applicable. It shall be the responsibility of the contractor to verify compatibility of all grooved end connections and appurtenances.

2.3 PVC PIPE AND FITTINGS (SCHEDULE 80 PVC)

A. Materials shall conform to ASTM D 1784, Type I Grade 1 (Cell Classification 12454-B) and meet the requirements of NSF 61.

B. Pipe shall be PVC plastic pipe conforming to ASTM D 1785, Schedule 80. Use Material Designation Code PVC 1120 or PVC 1220.

C. Fittings and Couplings:
1. Threaded-type fittings and couplings shall be PVC plastic pipe fittings conforming to ASTM D 2464, Schedule 80.
2. Schedule 80 socket-type fittings and couplings shall be PVC plastic pipe fittings conforming to ASTM D 2467.
3. PVC flanges shall be made of the same material as the pipe. Flanges, including two-piece Van Stone style flanges, shall match the dimensions of ANSI B16.5, Class 150, steel flanges.
4. Unions shall have socket-type ends, fluorocarbon elastomer (Viton® or equal) O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D 1784. O-Rings in chemical service shall be verified for chemical compatibility by manufacture.
5. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

D. Solvent Cement shall conform to ASTM D 2564.

2.4 PRESSURE CLASS PVC PIPE

A. Materials shall conform to ASTM D 1784 (Cell Classification 12454-B) PVC 1120.

B. Pipe shall be PVC plastic conforming to ASTM D 2241, Class 160 (SDR 26), or Class 200 (SDR 21) as shown on the project Drawings. Pipe shall be iron pipe size.

C. Restrained pipe shall be by Class 250, shall use a gasketed, spline inter-lock system, and shall be as manufacture by CertainTeed "Yellowmine", Victaulic "Aquamine" or equal.

D. Pipe joints should be single gasketed with integral bell joints in conformance with ASTM D 3139. Gasket material shall be per ASTM F477.

E. Fittings. Push joint or mechanical joint ductile iron fittings meeting AWWA C110 or C153 can be used.

F. Lining and Coating for Fittings. Provide cement-mortar lined fittings per AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Cement for lining shall conform to ASTM C150, Type II.

G. Restrained PVC pipe joints and fittings. For mechanical joint applications the restraint device shall use wedge feature, not set screws. EBAA Iron Series 2000, Ford Series 1500, or equal. For push joint applications the restraint device shall use a serrated ring. EBAA Iron Series 6500 , Ford Series 1390, or equal.

2.5 AWWA PVC Pipe

A. Pipe shall be in conformance with AWWA C900, rubber-ring gasket bell end or plain end with elastomeric gasket coupling. Class 150 cast iron pipe O.D.

B. Materials shall be ASTM D1784 cell classification 12454-B.

C. Fittings shall be ductile iron conforming to AWWA C110 or C153 with a minimum pressure rating of 250 psi. Size bells specifically for OD of cast iron equivalent PVC pipe including rubber-ring retaining groove.

D. Flanges on outlets of fittings shall be Class 125 per ANSI B16.1.

E. Lining and Coating for Fittings. Provide cement-mortar lined fittings per AWWA C104. Lining thickness shall be the single thickness listed in AWWA C104, Section 4.8. Cement for lining shall conform to ASTM C150, Type II.

F. Restrained pipe, 4" through 12" shall use a gasketed, spline inter-lock system, and shall be as manufacture by CertainTeed "Certa-Lock", or equal. Class shall match adjacent PVC pipe class.

G. Restrained PVC pipe joints and fittings. For mechanical joint applications the restraint device shall use wedge feature, not set screws. EBAA Iron Series 2000, Ford Series 1500, or equal. For push joint applications the restraint device shall use a serrated ring. EBAA Iron Series 1600 , Ford Series 1390, or equal.

2.6 STEEL PIPE AND FITTINGS (3-INCHES AND SMALLER)

A. Pipe shall be black or hot-dipped, zinc-coated welded or seamless steel pipe conforming to ASTM A53, Types E, F, and S, or ASTM A135 as shown on drawings. Use threaded Schedule 40 or 80 as shown on the drawings per ANSI B36.10.

B. Fittings, couplings, and unions shall be black or hot-dipped zinc-coated malleable iron threaded fittings conforming to ANSI B16.3, (ASTM A 47, Grade 35018), Class 150 or 300. Use Class 150 except where required for an anticipated working pressure of 200 psi or above.

C. Threading shall conform to ANSI B1.20.1. Jointing lubricant shall be polytetrafluoroethylene (PTFE, Teflon®) or PTFE tape.

2.7 STAINLESS STEEL PIPE AND FITTINGS (3-INCHES AND SMALLER)

A. Stainless steel pipe shall be Type 304, unless shown to be Type 316 on drawings. Pipe shall conform to ASTM A312, Schedule 40.

B. Fittings, couplings, and unions shall be Type 304, unless shown to be Type 316 on drawings. Fittings shall conform to ASTM A403 and shall have a minimum working pressure rating of 150 psi.

C. Threading shall conform to ANSI B1.20.1. Jointing lubricant shall be polytetrafluoroethylene (PTFE, Teflon®) or PTFE tape.

2.8 FLEXIBLE PIPE COUPLINGS

A. Couplings shall have middle rings made of steel conforming to ASTM A 36, A 53 (Type E or F), or A 512 having a minimum yield strength of 30,000 psi. Follower rings shall be steel (ASTM A 108, Grade 1018, or ASTM A 510, Grades 1018 or 1021). Minimum middle ring length shall be 5-inches for pipe sizes 3/4 inch through 4-1/2 inches; 7-inches for pipe sizes 5-inches through 24-inches; and 10-inches for pipe sizes larger than 24-inches. Longer couplings shall be provided adjacent to buried valves to allow valve removal.

B. Coupling shall be Dresser Style 38 or equal.

C. Steel sleeve bolts shall have a minimum yield strength of 40,000 psi, an ultimate strength of 60,000 psi, and shall conform to AWWA C111.

D. Steel follower rings shall be cast, forged, or hot rolled in one piece. Do not use rings fabricated from two or more shapes.

E. Flanged coupling adapters shall be steel: Dresser Style 128, or equal. Flange ends shall conform to ANSI B16.1, Class 125.

F. Transition couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, or equal.

G. Insulating couplings shall be Steel: Dresser Style 39, or equal.

H. Combination transition and insulating couplings shall be steel: Dresser Style 39-162 or equal.

I. Joint Harness
   1. Joint harness for flexible couplings shall be as shown on the drawings. Bolt or stud material shall conform to ASTM A 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H. Joint harness for ductile iron pipe shall be as shown on drawings. Retainer gland shall be ductile iron in accordance with ASTM A 536. Retainer ring used for welding to pipe to restrain retainer gland shall be steel, ASTM A36.
   2. Provide washer for each nut. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8 inch.

J. Gaskets for flexible pipe couplings shall be made of Buna-N material or an approved equal.

2.7 GROOVED-END COUPLINGS

A. Couplings shall conform to AWWA C606.

B. Grooved-end pipe couplings shall be malleable iron, ASTM A 47 (Grade 32510), or ductile iron, ASTM A 536 (Grade 65-45-12). Gaskets shall be halogenated butyl rubber and shall conform to ASTM D 2000.

C. Bolts in exposed service shall conform to ASTM A 183, 110,000-psi tensile strength. Bolts in buried or submerged service shall be Type 304 Stainless Steel ASTM A 193, Grade B8, Class 2.

D. Couplings for pipe 36-inches and smaller shall be rigid type except where flexible radius couplings are noted on drawings. Couplings shall be Victaulic Style 31 or 44 (DIP), Style 07 or 77 (CMST) or equal.

E. Grooved-end adapter flanges for pipe having an operating pressure of 150 psi and less shall be Victaulic Style 341 (DIP), Style 741 (CMST), or equal. Flange dimensions shall conform to ANSI B16.1, Class 125.

2.8 RESTRAINED FLANGE ADAPTER

A. Restrained flange adapter shall be made of ductile iron conforming to ASTM A536.

B. Flange bolt circle of the adapter shall be compatible with Class 125 flanges per AWWA C115.

C. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges.

D. Restrained flange adapter shall be Series 2100 Megaflange as produced by EBAA Iron, Inc., or approved equal.

E. Restrained flange adapters shall only be used specifically where shown on drawings, or with written approval from the Engineer for additional locations.

2.9 GASKETS

A. Gaskets for 125 lb. flanges, except PVC pipe, shall be full face, 1/8-inch thick, cloth-inserted rubber with a Shore “A” hardness of 75 to 85. Gaskets shall be suitable for a pressure of 200 psi at a temperature of 180°F. Products: John Crane Co. Style 777 or equal.

B. Gaskets for PVC flanged joints shall be full faced, 1/8-inch thick, made of ethylene propylene diene monomer (EPDM) rubber. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange gasket and the adjacent flange.

C. Gaskets for push-on and mechanical joint fittings shall be in compliance with AWWA C111.

2.11 BOLTS AND NUTS FOR FLANGES AND MECHANICAL JOINTS

A. Bolts and nuts for flanges on exposed piping shall be carbon steel, ASTM A 307, Grade B.

B. Bolts and nuts for flanges on buried piping, submerged piping, and mechanical joints shall be Type 304 stainless steel conforming to ASTM F 593 or ASTM A 193 (Grade B8) for bolts and ASTM F 594 or ASTM A 194 (Grade 8) for nuts. Bolts than 1-1/8 inches shall be steel ASTM A 307 (Grade B), zinc plated. Mechanical joint bolts may alternately be “T-Bolts” of Corten® steel or equal.

C. Bolts and nuts used in flange insulation kits shall conform to the same requirements as described in Part 2.12 of this specification.

D. Form threads for stainless steel bolts by means of rolling, not cutting or grinding.

E. Provide washers for each nut. Washers shall be of the same material as the nuts.

F. Lubricant for stainless steel bolts and nuts shall be chloride free and shall be “TRX-Synlube” by Ramco, “Anti-Seize” by Ramco, “Husk-It” by Husky Lube O’Seal, or equal.

2.12 FLANGE INSULATION KITS

Provide flange insulation kits consisting of:

A. Insulating Gaskets: Full faced, same material and thickness as described in Part 0.

B. Insulating Stud Sleeves for Each Bolt: High-density polyethylene or spiral-wrapped mylar.

C. Insulating Washers for Each Bolt: 1/8-inch thick phenolic.

D. Steel Washers Over Each Insulating Washer: 1/8-inch thick cadmium plated.

E. One-piece molded acetal resin combination sleeve and washers are acceptable.

F. Flange insulation kit products: PSI Industries, Central Plastics Company, or equal.

2.13 BURIED PIPE WARNING / LOCATING TAPE

A. Buried pipe warning / locating tape shall be preprinted polyethylene and metallic tape, 6-inch minimum width. Tape shall be suitable for use with common metal detectors. Tape wording shall be "Caution – Pipeline Buried Below." Tape shall be Seton Name Plate Company or equal.

2.14 PAINTING AND COATING

A. Provide asphaltic coating on buried ductile iron pipe and fittings per AWWA C151. Wrap buried pipe, fittings, and joints with 8-mil polyethylene or 4 mil high density cross laminated tubing per AWWA C 105. Wrap tubing joints with 2-inch-wide adhesive tape, PolyKen 900, Scotch Wrap 50, or equal.

B. Coat buried flexible pipe couplings (including joint harness assemblies), transition couplings and flanged coupling adapters per Section 09900, System No. 10. Then wrap the couplings with polyethylene wrap per as described above.

C. Coat ductile iron, and black steel pipe and fittings exposed in structures per Section 09900, System No. 29. Apply prime coat in factory.

PART 3 – EXECUTION

3.1 HANDLING AND SHIPMENT

A. Pipe shall be handled carefully, and blocking and holddowns shall be used during shipment to prevent movement or shifting; coating damaged during shipment shall be repaired and inspected prior to installation.

3.2 DUCTILE IRON PIPE FABRICATION

A. Flanged pipe and fittings shall be shop fabricated, not field fabricated. Apply thread compound prior to installing threaded flanges to provide a leak free connection. There shall be Zero leakage through the threads at a hydrostatic test pressure of 250 psi without the use of a gasket.

3.3 INSTALLATION OF EXPOSED PIPING

A. Set piping plumb and at the horizontal and vertical location shown on the drawings. Use pipe hangers and supports to maintain alignment, as shown on the drawings.

B. Piping penetrations through walls, slabs, and floors shall be as detailed on the drawings or as allowed for alternate configurations as specified herein.

C. Inspect pipe before installation. Repair or patch any damaged areas on interior and exterior coatings with material matching the original lining and coating.

D. Install piping without springing, forcing, or overstressing the pipe.

E. Install pipe spools in walls and slabs before placing concrete.

F. Bolt holes of flanges shall straddle the horizontal and vertical centerlines of the pipe. Clean flanges by wire brushing before installing flanged fittings. Lubricate bolts with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure

testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

G. Provide a flange insulation kit at all flanges between dissimilar metals whether shown on drawings or not.

H. Complete coating of exposed pipe, if scheduled.

3.4 GROOVED-END PIPE AND FITTINGS

A. Install the grooved-end pipe and fittings in accordance with the coupling manufacturer's recommendations and the following.

B. Clean loose scale, rust, oil, grease, and dirt from the pipe or fitting groove before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior lips, pipe ends, and housing interiors.

C. Fasten coupling alternately and evenly until coupling halves are seated. Use torques as recommended by the coupling manufacturer.

3.5 INSTALLATION OF WALL SPOOLS IN NEW CONCRETE WALLS AND SLABS

A. Install wall spools and sleeves in walls before placing concrete. Do not allow any portion of the sleeve to touch any of the reinforcing steel. Install wall sleeve and collar assembly axial aligned with the piping to which it will be attached or will contain.

3.6 INSTALLING SCHEDULE 80 PVC OR CPVC PIPING

A. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent welded pipe ends as recommended by the pipe manufacturer.

B. Wipe away loose dirt and moisture from the ID and OD of the pipe end and the ID of the fitting before apply solvent cement. Do not apply solvent cement to wet surfaces.

C. Make up solvent welded joints per ASTM D 2855.

D. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

E. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages.

F. Cut threaded ends to the dimensions of ANSI B1.20.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe hold-down methods, saw cutting blade size, and saw cutting speed. Pipe or tubing cutters shall be specifically designed for use on PVC pipe.

G. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to protect from scratching the pipe.

H. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.

I. Apply PTFE thread compound or PTFE tape lubricant to threads before screwing on the fitting.

J. Provide unions on exposed piping 3-inches and smaller as follows:
   1. Provide a union 6 to 12-inches downstream of valves.
   2. Upstream and downstream of equipment which may need to be removed for maintenance.
   3. Where shown on the drawings.

END OF SECTION 15060

SECTION 15088

BLADDER PRESSURE CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes materials, testing, and installation of a vertical bladder-type pre-charged steel hydro-pneumatic tank with replaceable heavy-duty butyl rubber bladder. The purpose of the system is to stabilize distribution pressures due to facility start-up and shutdown.

B. Work includes acquisition, testing, and installation of pressure vessel, rubber bladder, lifting rings, floor mounting legs/skirt, water relief valve, and charging valve connection. Contractor shall supply all necessary materials, equipment, tools, labor, and superintendence necessary for completion of the work.

1.2 RELATED SECTIONS

A. Section 09900 - Painting.

B. Section 15041 - Disinfection of Piping & Structures.

C. Section 15042 - Cleaning and Pressure Testing of Pipeline.

D. Section 15060 - Pipe and Pipe Fittings.

E. Section 15100 - Valves and Operators.

1.3 SUBMITTALS

A. Submit shop drawings in accordance with the Section 01300.

B. Submit layout drawings showing dimensions of equipment and accessories. Show equipment weights and anchor bolt designs. Show weight of pressure vessel, both empty and filled with water. Provide dimensional drawings and layouts for water relief valve, charging valve, floor-mounted legs/skirt.

C. Submit manufacturer's catalog data on pressure vessel, gages, and valves.

E. Submit ASME Manufacturer’s Data Report for Pressure Vessels (Form U-1A) for each pressure vessel certifying that the pressure vessel meets the ASME Boiler and Pressure Vessel Code requirements.

F. Calculations for tanks and supports, stamped by a licensed civil or structural engineer, in the state of the project.

G. Painting Systems.

H. O&M data.

NOTE: Items E and F submitted at time of shipment.

1.4 MANUFACTURER'S SERVICES

Provide equipment manufacturer's services at the jobsite for the minimum person-days listed below, travel time excluded:

A. One-half man-day for installation assistance and inspection of the bladder tank.

B. One-half man-day for field-testing, adjustment of bladder tank, and to instruct the Owner's personnel in the operation and maintenance of bladder tank.

1.6 MANUFACTURERS

A. The surge control systems shall be manufactured by Amtrol, AAtanks, Young Engineering and Manufacturing, or equal.

PART 2 - MATERIALS

2.2 PRESSURE VESSEL

A. The bladder-type tank shall be based on water-in-the-bladder design, which will require the manufacture to provide a 90-degree elbow at the bottom for connection to the discharge pipe, as shown on drawings. The system connection size shall be as shown on drawings, but shall be verified by the manufacturer.

B. Materials for the tank, design, and shop fabrication and inspection shall comply with Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, with only the plate steels in Table UCS-23 of said code being used. Design pressure shall be at least 10% above the maximum operating or surge pressure which ever is greater, but shall be a minimum of 150 psi.

C. Provide support structure, and other appurtenances necessary to complete the installation of the unit. The tank shall be provided with lifting rings and a floor mounting legs/skirt for vertical installation. The floor mounting legs/skirt shall be of adequate height to allow access to the 90-degree elbow during and after installation.

D. Provide ASME code stamp and pressure rating on the pressure vessel.

E. The tank shall be provided with a standard “Schrader” tire valve (0.302-inch O.D., 32 threads per inch) charging valve connection to facilitate on-site charging of the tank to meet system requirements.

F. Provide 18-inch diameter or larger flanged access port, flanged outlet for pipe connection to system, and ¼-inch NPT pressure gauge tap for vessel air pressure. Flanges shall be Class 150 in compliance with AWWA C 207, Class F or ANSI B16.5. Couplings shall be 3,000-pound, WOG forged steel, per ASTM A 105, Grade 70. Threads shall comply with ANSI B2.1. Joint lubricant shall be Teflon joint compound or Teflon tape.

G. The bladder surge control system shall be sized as to fit the building limitations as shown on the drawings. The bladder surge tank and its appurtenances shall not exceed a height from the finished floor surface such that at least four feet of clearance from ceiling beams is maintained.

2.3 BLADDER

A. Manufacturer shall provide a replaceable heavy-duty, butyl rubber bladder, designed for use within the selected pressure vessel as part of a packaged bladder pressure control system.

PART 3 EXECUTION

3.1 WELDING

A. Welding shall comply with the ASME Boiler and Pressure Vessel Code, Section VIII.

3.2 PAINTING AND COATING

A. Coat the interior of the pressure vessel per Section 09900, System 12. Apply coating at shop.

B. Coat the exterior of pressure vessel and associated appurtenances per Section 09900, System 29. Apply the prime coat at shop, and finish coats (intermediate and final) in the field.

3.4 DISINFECTION

A. Disinfect interior of lined tank and associated piping and appurtenances per Section 15041.

END OF SECTION 15088

SECTION 15100

VALVES AND OPERATORS – WATER TREATMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes materials, testing and installation of butterfly, gate, ball, check, solenoid, pressure-reducing (2-inch or less), pressure relief valves (3/4-inch or less), and sample taps.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15041 - Disinfection of Piping and Structures.

B. Section 15042 - Cleaning and Pressure Testing of Pipelines.

C. Section 15060 - Pipe and Pipe Fittings.

1.3 SUBMITTALS

A. Submit manufacturer's catalog data and detail construction sheets showing all valve parts and describing material of construction by material and specification (such as ANSI, ASTM, SAE or CDA) and grade or type.

B. Show valve dimensions including laying lengths. Show dimensions and orientation of valve operators, as installed on the valves. Provide port diameter, or opening area.

C. Show valve linings and coatings. Submit manufacturer's catalog data and descriptive literature.

D. Submit certification from manufacturer that butterfly valves are NSF 61 listed.

PART 2 MATERIALS

2.1 GENERAL

A. Valves shall be installed complete with flange gaskets, nuts and bolts, operating handwheels, or levers, chain wheels, extension stems, floor stands, operators, operating nuts and wrenches required for operation.

B. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached plate.

2.2 VALVE OPERATORS

A. Provide lever, or handwheel actuators for exposed valves 4-inches and smaller. For larger valves, provide handwheels.

B. Provide 2-inch AWWA operating nuts and extension stems for all valves.

C. Provide gear operators on 6-inch and larger butterfly valves. Gear operators for valves through 10-inches shall be of the worm gear, scotch yoke traveling nut, or link lever traveling nut type. Gear operators for 12-inch and larger valves shall be link lever traveling nut type.

D. Design gear actuators assuming that the differential pressure across the plug or disc is equal to the test pressure of the connecting pipeline and assuming a line fluid temperature range of 33 degrees F to 80 degrees F unless otherwise required in the detailed valve specifications.

E. Gear operators shall be enclosed, suitable for running in oil or grease with seals provided on shafts to prevent entry of dirt and water into the actuator. Gear operators for valves located in exposed services shall contain a dial indicating the position of the disc or plug.

F. Traveling nut and worm and gear operators shall be of the totally enclosed design so proportioned as to permit operation of the valve under full operating head with a maximum pull of 80 pounds on the handwheel or crank. Provide stop limiting devices in the operators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design operator components between the input and the stop-limiting devices to withstand without damage a pull of 300 pounds for handwheel or chainwheel operators, and 450 pounds for buried valves when operating against the stops.

G. Valve operators, handwheels or levers shall open by turning counterclockwise.

2.3 VALVE BOXES FOR BURIED VALVES

A. Top section and lid shall be cast-iron, Clay & Bailey Figure 2194, or equal. Extension pipe shall be 6-inch, Class 160 PVC pipe. Coat cast-iron items per Section 09900, System 10.

2.4 EXTENSION STEMS FUR BURIED VALVE ACTUATORS

A. Provide operating extension stems to bring the operating nut to a point 6-inches below the surface of the ground and/or box cover. Extension stems shall be steel and shall be complete with 2-inch-square operating nuts and to the valves shall withstand without damage an input torque of 300 foot-pounds.

B. Extension stem diameters shall be 7/8” diameter minimum.

2.5 BOLTS AND NUTS FOR FLANGED VALVES

A. Bolts and nuts for flanged valves shall be as described in the detail piping specifications.

2.6 GASKETS

A. Gaskets for flanged end valves shall be as described in the detail piping specifications.

2.7 LINING AND COATING

A. Coat the exterior of metal valves located in vaults and structures per Section 09900, System 29. Apply the specified prime coat at the place of manufacture. Apply finish coat at the place of manufacture or at the jobsite. Finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves. Do not coat bronze, brass, or stainless steel valves.

B. Line the interior metal parts of metal valves 4-inches and larger, excluding seating areas and bronze and stainless-steel pieces, per Section 09900, System No. 12. Apply lining at the place of manufacture. Alternately apply a fusion-bonded lining suitable for potable water in compliance with AWWA C 550.

C. Coat the exterior of buried metal valves at the place of manufacture, per Section 09900 system 12.

2.8 PACKING, O-RINGS, AND GASKETS

A. Unless otherwise stated in the detailed valve specifications, packing, O-rings, and gaskets shall be one of the following materials.
   1. Teflon.
   2. Kevlar aramid fiber.
   3. Acrylic or aramid fiber bound by nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.
   4. Buna-N (nitrile).

2.9 RUBBER SEATS

A. Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l in the fluid conveyed.

2.10 VALVE END CONNECTIONS

A. Valve end connections for exposed valves shall be flanged. The Contractor shall verify the compatibility of valve ends, including class and drilling of flanges with the connecting pipe. Buried valve end connections shall be mechanical joint or a push-on unless shown otherwise on the drawings, or in Schedules.

2.11 BUTTERFLY VALVES

A. Thrust Bearings for Butterfly Valves:

Provide thrust bearings to hold the valve disc in the center of the valve seat. No bearings shall be mounted inside the valve body within the waterway. Do not use thrust bearings in which a metal bearing surface on the disc rubs in contact with an opposing metal surface on the inside of the body.

B. Actuator Sizing for Butterfly Valves:

Actuators shall be sized to produce output torque values as calculated by the manufacturer using Section 3.8 of AWWA C504 with a safety factor of 1.25 for manual valves. Safety factors specified in Table 6 of AWWA C504 shall be used for cylinder operated valves. Minimum cylinder bore diameters as specified in this specification section 2.3A are applicable to all cylinder operated butterfly valves.

C. Port Sizes for Class 150 Butterfly Valves:

For valves 24-inches and smaller, the actual port diameter shall be at least 93.5% of the nominal valve size. For valves larger than 24-inches, the port diameter shall not be more than 1.25-inches smaller than the nominal valve size. The dimensions of the port diameter shall be the clear waterway diameter plus the thickness of the rubber seat.

D. Corrosion-Resistant Materials in Butterfly Valves:

Where AWWA C504 (Subsections 3.5, 3.6, and 3.7) requires "corrosion resistant" material, such materials shall be one of the following:
   a. Bronze having a minimum zinc content of 7% and a maximum aluminum content of 2%.
   b. Type 304 or 316 stainless steel.
   c. Monel (UNS N04400).

d. Synthetic nonmetallic material

E. Seating Surfaces in Butterfly Valves:

Seating surfaces shall be Type 304 or 316 stainless steel or nickel-copper per AWWA C504, Sections 2.2 and 3.5, or nickel-chromium alloy containing a minimum of 72% nickel and a minimum of 14% chromium.

F. Butterfly Valves 4 Inches and Larger, Class 150B:

Butterfly valves shall be short body flanged or wafer style with AWWA laying length and shaft diameter, conforming to AWWA C504, Class 150B. Minimum working differential pressure across the valve disc shall be 150 psi. Flanged ends shall be Class 125, ANSI B16.1, and wafer valves shall fit between Class 125 flanges. Push-on and mechanical joint ends shall comply with ANSI A21.11. Valve shafts shall be type 304 or 316 stainless steel. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc.

G. Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast iron or ductile iron	ASTM A 48, Class 40; ASTM A 126, Class B; or ASTM A 536, Grade 65-45-12
Exposed body capscrews and bolts and nuts	Stainless steel	ASTM A 276, Type 304 or 316
Discs	Cast iron, ductile iron, or Ni-Resist	ASTM A 48, Class 40; ASTM A 536, Grade 65-45-12; ASTM A 436, Type 1; or ASTM A 126, Class B
Shafts	Stainless Steel	ASTM A276, Type 304, 316, 317, 17-4 ph, ASTM A-546, Type 630 Condition H-1100
Disc fasteners, seat retention segments, and seat fastening devices	Stainless steel	ASTM A 276, Type 304 or 316
Seat material	Buna-N	----

The valve seat shall be secured to or retained in the valve body. Valves shall be Pratt, Dezurik, or equal. **Alternates or approved equals to specifications must be approved by the Engineer a minimum of seven (7) days prior to bid opening to be considered. Submit equipment information indicating compliance with the specification.**

2.12 RESILIENT WEDGE GATE VALVES

A. Valves shall comply with AWWA C509 and the following:

The minimum rated working pressure shall be 200 psi. Valves shall have nonrising stems. Valve stems shall be cast integral with stem collar and furnished of cast, forged, or rolled bronze. Stem nuts shall be independent of the wedge and shall be made of solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and aluminum of 10% elongation in 2-inches (ASTM B584 or B783, Alloy C87600 or C99500). All body bolts shall be 316 stainless steel. Cast-iron wedge shall have sealing surfaces of the wedge permanently bonded with resilient materials to meet ASTM tests for rubber to metal bond, ASTM D429.

B. Provide reduction thrust bearings both above and below the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

C. Flanges shall be Class 125 per ANSI B16.1, mechanical joint ends shall comply with ANSI A21.11.

D. Valve shall be Clow R/W, American Darling CRS-80, Waterous Series 500, Kennedy Ken-Seal, Mueller, or equal.

2.13. BALL VALVES

A. Bronze Ball Valves 2-Inches and Smaller:

Ball valves, 2-inches and smaller, for air or water service shall be bronze body per ASTM B 62. Provide Type 316 stainless-steel ball. Valves shall have screwed ends (ANSI B1.20.1), nonblowout stems, reinforced Teflon seats, and have plastic coated lever operators. Valves shall have a pressure rating of at least 300 psi WOG at a temperature of 150° F.

B. Double Union PVC Ball Valves 3-Inches and Smaller:

Thermoplastic ball valves, 3-inches and smaller, for water and chemical service shall be rated at a pressure of 150 psi at a temperature of 100° F. Body, ball, and stem shall be PVC conforming to ASTM D 1784, Type 1, Grade 1. Seats shall be Teflon. O-ring seals shall be Viton except that O-rings for valves used in chemical service shall be verified for chemical compatibility by manufacture. Valve ends shall be of the double-union design. Ends shall be threaded. Valves shall have handle for manual operation. Valves shall be as manufactured by Chemtrol, Hayward, R & G Sloan, or equal.

C. Stainless Steel Ball Valves 2-Inches and Smaller:

Ball valves 2-inches and smaller, for air or water service shall be Type 316 SST body. Provide Type 316 Stainless Steel ball. Valves shall have screwed ends (ANSI B1.20.1), nonblowout stems, reinforced Teflon seats, and have plastic coated level operators. Valves shall have a pressure rating of at least 300 psi WOG at a temperature of 150 degrees F.

2.14. CHECK VALVES

A. Bronze Ball Check Valves 2-Inches and Smaller:

Bronze ball check valves 2-inches and smaller shall be Class 200, bronze body, ASTM B 61 or B 62. Ends shall be female threaded, ANSI B1.20.1. Ball shall be stainless steel, Type 440. Minimum working pressure shall be 300 psi WOG at a temperature of 150° F. Valves shall be Lunkenheimer, Crane or equal.

B. PVC Ball Check Valves:

PVC check valves, 3-inches and smaller, shall be constructed of PVC per ASTM D 1784, Type I, Grade 1. Ends shall be double union, threaded. Seats shall be Viton. O-Rings shall be Viton, except that valves used in chemical service shall be verified for chemical compatibility by manufacture. Valve shall have a pressure rating of 150 psi at a temperature of 75° F.

C. Bronze Swing Check Valves 2-Inches and Smaller:

Bronze swing check valves 2-inches and smaller shall be 300 psi WOG minimum. Valves shall be Y-pattern bronze body ASTM B61 or B62. Ends shall be female thread, ANSI B1.20.1. Disc shall be bronze, swing type. Valves shall be Crane, Stockham, or equal.

D. Stainless Steel Swing Check Valves 2-Inches and Smaller

Valves shall be by Y-Pattern, 200 psi WOG minimum. Valve body, disc, hinge pin, bonnet, and plug shall be Type 316 Stainless Steel. Valve shall be Watts Series 806, or equal.

E. Silent Check Valves

Operation by means of a globe style, silent check valve flanged, with a flow area greater than the nominal pipe diameter. Minimum operating pressure shall be 150, or 300 psi as shown in Valve Schedule. Class 125 and Class 250 flanges shall conform to ANSI B16.1. A disc mounted on a longitudinal shaft equipped with a spring mechanism to provide for nonslam closure of the valve without backflow, in any position, and not dependent on gravity or backflow for closure. Materials of construction shall be as follows:

Component	Material	Specification
Body	Ductile Iron or Cast Iron	ASTM A 536; ASTM A 48,Class 30 ASTM A126, Class B
Plug & seat	Bronze	ASTM B 584 (Alloys C92200, C83600,C94700)
Spring	Stainless Steel	Type 303, 304, or 410

Valves shall be APCO Series 600, Val-Matic, or equivalent.

2.15 SOLENOID VALVES

A. Solenoid Valves 2-Inches and Smaller:
Solenoid valves of sizes 1/4 inch through 2-inches for water and air service shall have forged brass (Alloy C23000) or bronze (ASTM B 62) bodies with Teflon main seats. Internal plunger, core tube, plunger spring, and cage assembly shall be stainless steel (Types 302, 304, and 305). Solenoid enclosures shall be NEMA 3 or 4. Valve actuators shall be 120-volt

a-c, unless shown otherwise on the drawings. Seat and seal material shall be Teflon or Buna N. Valves shall have a maximum operating pressure and a maximum differential pressure of 125 or 150 psi. Solenoid valves shall be normally open, normally closed, two way, three way, or slow closing as shown on the Schedule. Valves in low pressure applications such as supplies to analyzer panels shall not require line pressure to open. Valve shall have threaded end connection. Valves shall be ASCO "Redhat"; Skinner-Lancer or equal.

2.16 AIR AND VACUUM VALVES

A. Valve design and operation.

1. Air and vacuum valves for water service shall have a float assembly and large venting orifice to exhaust large quantities of air from pipelines when being filled and to admit large quantities of air when pipelines are being drained. Valve shall have a body with a flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat. Float shall be unconditionally guaranteed. Do not use designs having levers and weights attached to the floats. Float shall have a one-piece guide rod extending out of the bottom end to engage the guide bushings in the valve body at all times. Air and vacuum valves shall include a throttling device to control air output but allow full air input to the pipeline.

2. Air and vacuum valves 4-inches and larger shall have 1/2-inch threaded outlets with bronze plugs near the top and bottom of the valve body. Air and vacuum valves shall include a throttling device to control air output but allow full air input to the pipeline. The valve assembly shall incorporate a perforated baffle on the inlet to prevent the water column entering the valve from slamming the float shut, and an isolation butterfly valve.

B. Materials of Construction:

Item	Material	Specification
Body and Cover and Baffle	Cast iron	ASTM A 48, Class 35 or ASTM A126, Grade B
	Ductile iron	ASTM A 536, 65-45-12
Float, guide rod guide bushings	Stainless Steel	AISI Type 304, 303
Seat	Buna-N	---
Water Diffuser (Surge Check Plug)	Bronze	ASTM B584 C83600
Throttling Device	Malleable Iron	---

C. Valves with cast iron body and cover shall have an operating pressure of 150 psi. Valves constructed with ductile iron body and cover shall have an operating pressure of 300 psi.

2.17 SAMPLE TAPS

A. Sample Taps 1/2 Inch and Smaller: Taps shall be all bronze (ASTM B 62) or brass (ASTM B 16), rated at 300 psi WOG. Provide lever or tee handle operator. Sample taps shall have no threads on outlet. Sample taps shall be Crane, Lunkenheimer, or equal.

2.18 PRESSURE-REDUCING VALVE, 2-INCHES AND SMALLER

A. Valve shall be for water service. Pressure reducing valve shall be bronze body ASTM B62, with 416 stainless-steel trim and strainer, and Buna-N disc. Valve shall have threaded end connections. The valve shall have a minimum operating pressure of 300 psi. The outlet pressure shall be adjustable over the range of 10 to 80 psi and shall be set to the pressure shown on the drawings. Valve shall be Clayton Valve Model 990, or equal.

2.19 PRESSURE RELIEF VALVE, 2-INCH AND SMALLER

A. Pressure Relief Valve, 2-Inch and Smaller:

Valve shall be for water service. Pressure relief valve shall be bronze body ASTM B62 with 303 stainless steel trim, and Buna-N disc. The valve shall have threaded end connections. The valve shall have a minimum operating pressure at 300 psi. The outlet pressure shall be adjustable over the range of 20 to 200 psi and shall be set to the pressure shown on the drawings. Valve shall be Clayton Valve Model 55F, or equal.

PART 3 EXECUTION

3.1 JOINTS

A. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

3.2 EXPOSED VALVE INSTALLATION

A. Install valves in horizontal runs of pipe having centerline elevations 4'-6" or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4'-6" and 6'-9" above the floor with their operating stems horizontal.

B. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

C. Valve operator locations have been shown arbitrarily on the drawings. Contractor shall verify the location of the operator to comply with above requirements, and to allow access for installation operation, and maintenance.

3.3 MOUNTING GEAR OPERATORS

A. The valve manufacturer shall select and mount the gear operator and accessories on each valve and stroke the valve from fully open to fully closed prior to shipment.

3.4 FIELD INSTALLATION OF GEAR ACTUATOR

A. Provide the actuator manufacturer's recommended lubricating oil in each actuator before commencing the field testing.

3.5 VALVE LEAKAGE TESTING

A. Test valves for leakage at the same time that the connecting pipelines are tested. See Section 15042 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace leaking valves and retest.

3.6 VALVE FIELD TESTING

A. Operate manual valves through 10 full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. If valves stick or bind, repair or replace the valve and repeat the tests.

END OF SECTION 15100

SECTION 15111

PRESSURE GAGES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Materials and installation of pressure gages and accessories.

1.2 RELATED SECTIONS

A. Section 15042: Cleaning and Pressure Testing of Pipelines.

B. Section 15060: Pipe and Pipe Fittings.

C. Section 15100: Valves and Operators.

1.3 SUBMITTALS

A. Section 01300, procedures for submittals.

B. Manufacturer's catalog data and descriptive literature. Call out materials of construction by ASTM reference and grade.

C. Manufacturer's certificate of compliance with the referenced ANSI standards.

D. O&M data per Section 01700.

PART 2 MATERIALS

2.1 MANUFACTURERS

A. Gages, diaphragm seals, dampeners, and tools shall be as manufactured by Ashcroft, Crosby, Marshalltown, Marsh, or equivalent.

2.2 GAGE DESIGN

A. Gages 4-1/2 inches in size shall comply with ANSI B40.1, Grade 1A (+/- 1.0% accuracy). Gages 2-1/2 inches in size shall comply with ANSI B40.1, Grade A (+/- 2-1/2% accuracy). Gages shall incorporate the following features:
   1. Solid or open front with side or rear blowout relief.
   2. Pressure tight.
   3. 270-degree arc with adjustable pointer.
   4. Stem mounted, 1/2 inch size.
   5. Hermetically sealed.
   6. Liquid filled.

B. Size of gage shall be 2-1/2 inches, except for gauges located on high service pump discharge lines which shall be 4-1/2 inches.

C. Pressure ranges shall be as indicated on the schedule.

2.3 MATERIALS OF CONSTRUCTION

Materials of construction shall be as shown in the following table:

Item	Material	Specification
1. Case	Stainless Steel	--------
2. Bourdon tube	Stainless Steel	AISI 316
3. Windows	Acrylic Plastic	--------
4. Ring	Stainless Steel	--------
5. Stem	Stainless Steel	AISI 316
6. Dial face	Aluminum with clear baked-on acrylic coating	6061-T6, ASTM B 209

2.4 PULSATION DAMPENERS

A. Provide pulsation dampeners with gauge assemblies. Material of construction shall be Type 316 stainless steel. Dampening shall be achieved by use of a pin in selected holes. Pin shall move up and down in normal operation. Connections shall be NPT female and shall match the connection size of the attached pressure gauge.

2.5 DIAPHRAGM SEAL

A. Diaphragm seal shall isolate pressure gauge from corrosive liquids. Bottom housing shall be PVC, diaphragm material shall be Teflon. Diaphragm seal shall be rated as continuous duty. Unit shall be capsule type which will allow the diaphragm to be replaced. Filling fluid shall be Halocarbon.

PART 3 EXECUTION

Not Used

END OF SECTION 15111

SECTION 15177
ULTRASONIC OPEN CHANNEL FLOW METER

PART 1 GENERAL

1.1 APPLICABLE PROVISIONS

A. Applicable provisions of Division 1 shall govern work of this section.

1.2 DESCRIPTION OF WORK

A. Furnish and install one ultrasonic microprocessor-based flow meter device in the location as shown on the drawings and in accordance with the Manufacturer's recommendations. Provide all required electrical controls and wiring as specified in Division 16 – Electrical.

1.3 RELATED WORK ELSEWHERE

A. Division 16 - Electrical

1.4 SHOP DRAWINGS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals – Division 1 of these specifications.

1.5 OPERATION AND MAINTENANCE MANUALS

A. The manuals shall include operating and maintenance literature for all components provided. The submitted literature shall be in sufficient detail to allow for the installation, operation, adjustment, calibration, maintenance and removal of each component provided.

B. Preparation of this document shall be in conformance with the requirements stated in Submittals – Division 1 of these specifications. The Contractor shall submit to the Engineer for review an outline of any variations of information for the operation and maintenance manuals and other documentation he proposes to prepare.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. The flow meter shall be programmed for a 3" throat width Parshall flume and scale at maximum to the flumes' maximum flow measurement capability.

2.2 MANUFACTURER

A. Model Vantage 2200 as manufactured by Eastech Badger, Tulsa, OK; or approved equal.

2.3 ENCLOSURE

A. IP66/NEMA 4X

B. Rated for cold weather outdoor installation outside of the flume structure.

C. Provide heater and thermostat and lockable access door.

2.4 POWER

A. 80/240 VAC, 50/60 Hz or 12-28 VDC at 150 mA with surge suppression and fuse.

2.5 OUTPUTS

A. 4-20 mA isolated into 1000 ohms, monitored to detect open circuits, with RFI and gas discharge surge protection and two fuses.

2.6 RELAYS

A. A minimum of 5 relays rated at 0.25A at 120 VAC or 0.5 A at 24 VDC. The relays must be assigned by the front panel key-pad for up to three setpoints, loss of signal, 4-20 loop, overange 1, overange 2, contact integrator or pump alternation.

2.7 DATA LOGGER

A. There shall be a data logger integral to the electronics. The data logger shall have non-volatile flash memory with a minimum storage capacity of 32768 records. Software shall be supplied for downloading the data. The logged data shall have the capability to be displayed on the backlit display in graphing form for daily minimum, maximum, average and total flow units for the past eight days.

2.8 DATA RETRIEVAL

A. Capabilities to retrieve data from the data logger by connection to a laptop computer or PDA shall be provided.

2.9 SENSOR

A. The sensor shall be designed for flow measurement and designed for use in Class I, Division 1, Groups A, B, C & D hazardous areas. The sensor shall be made of Tefzel or PVC and be supplied with 30 feet of cable. 1000 maximum cable runs shall be allowed. Splices shall be made waterproof. The maximum level range of the sensor shall be 16 feet.

B. The sensor shall be accurate to 0.02 inches or 0.05% of target distance.

C. The sensor cables shall be run in dedicated conduit.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in the location indicated on the Drawings and in accordance with manufacturer's instructions and approved shop drawings.

3.2 EQUIPMENT START-UP

The equipment shall be started by a factory-trained representative who shall certify to the Engineer that all equipment is properly installed and the plant operator has been instructed concerning proper operation and maintenance.

END OF SECTION 15177

SECTION 15870

POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall exhausters.

1.02 RELATED SECTIONS

A. Section 16180 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.03 REFERENCES

AMCA 99 - Standards Handbook.

AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal.

AMCA 300 - Test Code for Sound Rating Air Moving Devices.

AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

UL 705 - Power Ventilators.

SMACNA - Low pressure duct construction standard.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01700.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 PRODUCTS

2.01 WALL EXHAUSTERS

A. Manufacturers:
   1. Greenheck

2. Cook

B. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch (13 mm) mesh, 16 gage (2.0 mm) aluminum bird screen.

C. Electrical Characteristics and Components
1. Electrical Characteristics: See schedule.
2. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor. Also provide solid state speed controller in housing for balancing on direct drive fans.

D. Backdraft Damper: Gravity activated, aluminum multiple blade construction, felt edged with nylon bearings.

E. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self aligning pre-lubricated ball bearings.

2.04 THERMOSTAT

Thermostat: Line voltage, heavy-duty snap action or low voltage programmable, 55-degree to 95-degree temperature range cooling type thermostat. Based on White Rodger 179-1 for line voltage cooling stat and IE30-343 for low voltage. Provide thermostat where indicated on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure wall exhausters with stainless steel lag screws to structure. Provide framing per detail on drawings.

C. Extend ducts to inline duct fans as shown on drawings.

D. Install flexible connections between fan inlet and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.

E. Provide sheaves or speed control required for final air balance. (Speed control on all direct drive fans) mount speed control at fan.

F. Install backdraft dampers on wall exhausters.

G. Do not operate fans for any purpose until ductwork is clean, bearings lubricated, and fan has been test run under observation.

3.02 POWER VENTILATOR SCHEDULE

See Drawing for Schedule.

END OF SECTION 15870

SECTION 15940

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers.

1.02 REFERENCES

ADC 1062 - Certification, Rating and Test Manual.

AMCA 500 - Test Method for Louvers, Dampers and Shutters.

ARI 650 - Air Outlets and Inlets.

ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

NFPA 70 - National Electrical Code.

NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.04 PROJECT RECORD DOCUMENTS

Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

1.06 QUALIFICATIONS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Greenheck

B. LD, Louvers and Dampers

C. C. Carnes

D. Cesco

E. Substitutions: Approved equal.

2.02 LOUVERS

A. Stationary 4-inch deep louver .060 extrusion of 6063-T5 aluminum with caulking returns. The blades are to be “I” shape .064 extrusions of 6063-T5 aluminum. Stainless steel screws and hardware. The louver is to have insect screen on inside face of unit.

B. Control damper: Fabricate frame of 18 gage galvanized steel, blades to be minimum of 24 gage galvanized steel.

C. Provide extended sill to finish opening. Also provide stainless steel cover frame to finish entire opening around louver.

D. The control damper/louver is to a Cesco Model CDAF-PB with a high static fast acting motor unless noted.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

C. The contractor is to seal around the louver units to make weather tight. Provide additional blade seals as required on both the horizontal blades and edge seals.

D. Provide flashing under both louvers to prevent water leakage into the building.

E. Mechanical contractor is to coordinate with electrical contractor on voltage of louver operators.

END OF SECTION 15940

IOWA DEPARTMENT OF NATURAL RESOURCES

DIVISION XVI

ELECTRICAL

IOWA DEPARTMENT OF NATURAL RESOURCES
ENGINEERING BUREAU
WALLACE STATE OFFICE BUILDING
DES MOINES, IA 50319-0034

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Raceways.
2. Supporting devices for electrical components.
3. Electrical identification.
4. Utility company electricity-metering components.
5. Electrical demolition.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.3 COORDINATION

A. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.

B. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for service entrances and electricity-metering components.

C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. RMC: Rigid metal conduit; galvanized rigid steel; ANSI C80.1.

B. RNC: Rigid nonmetallic conduit; NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.

C. Raceway Fittings: Specifically designed for raceway type with which used.

2.2 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading.

D. Nonmetallic Slotted Channel and Angle: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface. Strength rating to suit structural loading.

E. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.

1. Materials: Same as channels and angles, except metal items may be stainless steel.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

2.3 ELECTRICAL IDENTIFICATION

A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).

C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:

1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
2. Embedded continuous metallic strip or core.
3. Printed legend that indicates type of underground line.

F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.

G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.

1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.

H. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.4 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

A. Comply with requirements of electrical power utility company for current transformer cabinets and meter sockets.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

A. Outdoor Installations:

1. Exposed: RMC.
2. Underground, Single Run: RNC.
3. Boxes and Enclosures: NEMA 250, Type 3R or Type 4, unless otherwise indicated.

3.3 RACEWAY INSTALLATION

A. Use RMC for all sweeps, elbows and where RNC turns up above grade, and RMC up to panelboards, etc.

3.4 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, slotted channel system components.

B. Dry Locations: Steel materials.

C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb (90-kg) minimum design load for each support element.

3.5 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment. On wiring, provide marking at load, in panel and at all openings where wiring may be visible.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project. Coordinate and get approval from Engineer before labeling.

C. Self-Adhesive Identification Products: Clean surfaces before applying.

D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

E. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches (150 to 200 mm) below finished grade or as shown on drawings. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm), overall, use a single line marker.

F. Install warning, caution, and instruction signs where required to comply with 29 CFR 1910.145, Chapter XVII, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install metal-backed butyrate signs for outdoor items.

3.6 ELECTRICITY-METERING EQUIPMENT

A. Install utility company metering equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.7 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

END OF SECTION 16050

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Requirements specified in this Section may be supplemented by requirements of other Sections.

1.2 SUBMITTALS

A. Product Data: For ground rods.

B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled under UL 467 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Apache Grounding/Erico Inc.
2. Boggs, Inc.
3. Chance/Hubbell.
4. Copperweld Corp.
5. Dossert Corp.
6. Erico Inc.; Electrical Products Group.
7. Framatome Connectors/Burndy Electrical.
8. Galvan Industries, Inc.
9. Harger Lightning Protection, Inc.
10. Hastings Fiber Glass Products, Inc.
11. Heary Brothers Lightning Protection Co.
12. Ideal Industries, Inc.
13. ILSCO.

14. Kearney/Cooper Power Systems.
15. Korns, C. C. Co.; Division of Robroy Industries.
16. Lightning Master Corp.
17. Lyncole XIT Grounding.
18. O-Z/Gedney Co.; a business of the EGS Electrical Group.
19. Raco, Inc.; Division of Hubbell.
20. Robbins Lightning, Inc.
21. Salisbury, W. H. & Co.
22. Superior Grounding Systems, Inc.
23. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Grounding Electrode Conductors: Stranded cable.

D. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

E. Bare, Solid-Copper Conductors: ASTM B 3.

F. Assembly of Bare, Stranded-Copper Conductors: ASTM B 8.

G. Bare, Tinned-Copper Conductors: ASTM B 33.

H. Copper Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

I. Copper Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

J. Tinned-Copper Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

K. Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4 by 120 inches in diameter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Underground Grounding Conductors: Use copper conductor. Bury at least 24 inches (600 mm) below grade.

E. Equipment Grounding Conductors: Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

1. Install insulated equipment grounding conductors in feeders and branch circuits.
2. Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal.
3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.

G. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

H. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers or supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

I. Connections: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

6. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
7. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
8. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
9. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
11. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is indicated and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod, ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Nominal maximum values are as follows:

    a. Equipment Rated 500 kVA and Less: 10 ohms.

END OF SECTION 16060

SECTION 16111

CONDUIT

PART 1 GENERAL

1.1 WORK INCLUDED

A. Metal conduit.

B. Flexible metal conduit.

C. Liquidtight flexible metal conduit.

D. Nonmetal conduit.

E. Fittings and conduit bodies.

1.2 RELATED WORK

A. Section 16130 - Boxes.

B. Section 16170 - Grounding and Bonding.

C. Section 16190 - Supporting Devices.

D. Section 16195 - Electrical Identification.

1.3 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated.

C. ANSI/NEMA FB 1 - Fittings, cast metal boxes, and conduit bodies for conduit and cable assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. NECA "Standard of Installation."

1.4 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70 (NEC 2005).

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Accurately record actual routing of conduits larger than 2 inches.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (National Electrical Code).

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site.

B. Accept conduit on site. Inspect for damage.

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

D. Protect PVC conduit from sunlight.

1.8 PROTECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.7 SUBMITTALS

Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, fittings, and conduit bodies.

PART 2 PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Minimum Size: above grade, 1/2 inch unless otherwise specified.

B. Underground Installations:
   1. Use rigid steel conduit or nonmetallic Schedule 40 conduit.
   2. Minimum size: 3/4 inch.

C. Outdoor locations, above grade: Use rigid steel conduit to 12'-0 above grade.

D. In Slab on or Above Grade Concrete:
   1. Use rigid steel conduit, intermediate metal conduit or non-metallic scheduled conduit.
   2. Maximum size conduit in slab: 3/4 inch; 1/2 inch for conduit crossing each other.

E. Wet and Damp Locations above grade: Use rigid steel or intermediate metal conduit.

F. Dry Locations:
   1. Exposed: Use Rigid Metal Conduit (RMC).

G. Indoor locations: Use rigid steel conduit.

2.2 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

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

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.3 FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction.

B. Fittings: ANSI/NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction with PVC jacket.

B. Fittings: ANSI NEMA FB 1.

2.5 NONMETALLIC CONDUIT

A. Description: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.6 CONDUIT FITTINGS

Description: All fittings in wet or damp locations are to be weathertight.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install conduit in accordance with NECA "Standard of Installation".

B. Install nonmetallic conduit in accordance with manufacturer's instructions (underground only).

C. Arrange supports to prevent misalignment during wiring installation.

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

E. Fasten conduit supports to building structure and surfaces under provisions of Section 16190.

F. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

G. Arrange conduit to maintain headroom and present neat appearance.

H. Route conduit parallel and perpendicular to structure. Run concealed in wall, above ceiling or under floor unless not possible.

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

J. Maintain adequate clearance between conduit and piping.

K. Cut conduit square using saw or pipecutter; de-burr cut ends.

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

M. 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 20 minutes, minimum.

N. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.

O. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size.

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

Q. Provide suitable pull string in each empty conduit except sleeves and nipples.

R. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

S. Ground and bond conduit under provisions of Section 16170.

T. Identify conduit under provisions of Section 16195.

U. Use compression fittings on conduit. Steel set screw fittings will be allowed in locations not wet or damp.

V. Use non-metallic conduit underground only. Provide rigid conduit on 90 degree sweeps and to above grade and metal conduit from that point on. Also use rigid conduit for elbows & sweeps.

W. Seal all penetrations through walls and floors with fire caulking.

X. All conduit installed underground to be made with watertight connections. Conduit openings through walls are to be sealed weathertight.

END OF SECTION 16111

SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Available Manufacturers:
1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.
5. Essex Wire

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THW, THHN-THWN, XHHW, UF, USE and SO complying with NEMA WC 5 or 7.

E. Multiconductor Cable: Type USE with ground wire.

2.3 CONNECTORS AND SPLICES

A. Available Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway.

D. Direct Buried Feeders and Branch Circuits: Type UF/USE when listed for direct burial, with ground wire.

3.2 INSTALLATION

A. Conceal cables unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Identify and color-code conductors and cables according to other Division 16 Sections.

E. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

END OF SECTION 16120

SECTION 16141

WIRING DEVICES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Wall switches.

B. Receptacles.

C. Device plates and box covers.

D. Limit Switches.

1.2 RELATED SECTIONS

A. Section 16130 - Boxes.

B. Section 16195 - Electrical Identification.

1.3 REFERENCES

A. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet.

B. FS W-S-896 - Switch, Toggle.

C. NEMA WD 1 - General-Purpose Wiring Devices.

D. NEMA WD 5 - Specific-Purpose Wiring Devices.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 01340.

B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - WALL SWITCHES

A. Hubbell, Model CS1221 GRY.

B. Eagle.

C. Leviton.

2.2 WALL SWITCHES

A. Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP: NEMA WD; 1 AC general use specification grade snap switch with toggle handle, AC quiet type rated 20 amperes and 120-277 volts AC. Handle: Gray plastic. Equip with mounting yoke insulated from switching mechanism, color coded by Amperage.

B. Two Pole switches are to match single pole.

C. Three way switches to match single pole.

D. Four way switches to match single pole switch.

2.3 ACCEPTABLE MANUFACTURERS - RECEPTACLES

A. Hubbell. Model CR 20 GY.

B. Eagle. Model 5362 GY

C. Leviton. Model 5362

2.4 RECEPTACLES

A. Convenience and straight-blade receptacles: NEMA WD 1.

B. Locking-Blade Receptacles: NEMA WD 5.

C. Convenience Receptacle Configuration: NEMA WD 1; Type 5-20 R, gray face. Specification grade with high impact nylon face, back and side wired. Heavy duty triple wipe contacts. 20 amp, 120 volt.

D. Specific-use Receptacle Configuration; NEMA WD 1 or WD 5; type as indicated on Drawings, gray face.

E. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. Class “A” personnel protection (All exterior receptacles to be GFCI) (gray in color). GFCI receptacles are to be based on Hubbell GFST 20 GY, 20 amp, 120 volt receptacle.

2.5 ACCEPTABLE MANUFACTURERS - WALL PLATES

A. Hubbell.

B. Taymac.

C. Leviton.

D. Mulberry.

2.6 WALL PLATES

A. Cover Plate: 316 Stainless Steel (use gasketed cover plates for all boxes outside of Office and Write-up areas. Provide gray nylon cover plates in the office areas.

B. Weatherproof Cover Plate: Gasketed cast metal or plastic hinged device covers. Must meet current NEC (weatherproof with device engaged). (Hubbell, Taymac). Based on Taymac 99510C.

2.7 DOOR LIMIT SWITCHES

Square D or equal door frame mounted limit switch, Class 9007, Model AO2.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wall switches 44 inches above floor, OFF position down.

B. Install convenience receptacles 32 inches above floor, 4 inches above counter backsplash, grounding pole on top.

C. Install specific-use receptacles at heights shown on Contract Drawings.

D. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions.

E. Install gray nylon cover plates on switch, receptacle, and blank outlets in all finished interior areas, using jumbo size plates for outlets installed in masonry walls.

F. Install stainless steel plates on junction boxes on exterior areas, above ceilings, and on surface-mounted outlets.

G. Install devices and wall plates flush and level.

H. Provide stainless steel cover plates on switch, receptacle, and blank outlets in all unfinished areas and on exterior surfaces.

END OF SECTION 16141

SECTION 16160

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hinged cover enclosures.

B. Cabinets.

C. Terminal blocks.

D. Time Delays.

E. Relays.

F. Push-button.

G. Selector switches.

1.2 RELATED SECTIONS

A. Section 16190 - Supporting Devices.

B. Section 16195 - Electrical Identification.

1.3 REFERENCES

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and System.

C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of Section 01340.

B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.

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

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.6 EXTRA MATERIALS

Provide two of each cabinet key.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hoffman.

B. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

C. Hubbell Inc.

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, Type 1, Type 12 or Type 3R steel enclosure, as required by service conditions.

B. Covers: Continuous hinge, held closed by flush latch operable by key.

C. Provide interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.

D. Enclosure Finish: Manufacturer's standard enamel.

2.3 CABINETS

A. Boxes: Galvanized steel.

B. Box Size: Minimum size as required by service conditions.

C. Fronts: Steel, type with concealed trim clamps, concealed hinge, and flush lock. Finish with gray baked enamel.

D. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

E. Provide accessory feet for free-standing equipment.

2.4 TERMINAL BLOCKS

A. Manufacturers:
1. Phoenix.
2. Square D.
3. Approved equal.

B. Terminal Blocks: ANSI/NEMA ICS 4.

C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 TIME DELAYS

A. Manufacturers:
   1. Square D
   2. Approved equal.

B. Rated voltage 120 volt/240 volt - 24vDC

C. May switch current - 5 amps.

D. Time as indicated on drawings.

2.6 RELAYS

A. Manufacturers
   1. Potter & Brumfield
   2. Square D
   3. Approved equal

B. Based on Square D Class 8501 Type K relays designed for multi-pole switching applications at 240 volt or below. Industry standard wiring and pin arrangement.

C. Relays to have:
   1. 10 amp contacts minimum.
   2. Horsepower rated.
   3. AC or DC

D. Provide sockets to match relay requirements. Based on Square D Class 8501 Type NR sockets.
   1. Sockets shall be Din Rail mounted or direct panel mounted.

2.7 PUSHBUTTONS

Manufacturers
1. Square D.
2. Cutler Hammer.
3. Approved equal.

2.8 SELECTOR SWITCHES

A. Manufacturers
   1. Square D.
   2. Cutler Hammer.
   3. Approved equal.

B. Based on Square D Class 9001 Type SK - 30.5 mm Corrosion Resistant Selector Switches. 2 position or 3 position as required.

C. Provide Nema Types 4x, 12, as required.

D. Provide glove hand knob.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that surfaces are ready to receive work.

3.2 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

C. Install cabinet fronts plumb.

D. Boxes to be painted with manufacturer’s standard color; baked enamel for rust resistance.

E. Exterior boxes shall be Nema 3R.

G. Boxes located other than in the Office and Write-up areas are to be Nema 12.

END OF SECTION 16160

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.2 REFERENCES

A. NECA - National Contractors Association.

B. ANSI/NFPA 70 - National Electrical Code.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's catalog data for fastening systems.

B. Provide dimensional drawings of fastening devices.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Supports can be galvanized steel, or epoxy painted steel or cast iron using System 16 in Section 09900. Galvanized, stainless steel, and FRP supports need no additional painting.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

C. Anchors and Fasteners:
   1. Concrete Structural Elements: Use precast insert system, expansion anchors and preset inserts.
   2. Steel Structural Elements: Use beam clamps and welded fasteners.
   3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
   4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
   5. Sheet Metal: Use sheet metal screws.
   6. Wood Elements: Use wood screws.

D. Strut:
   1. Manufactures Hubbell or B-Line.

2. Channels shall be U-shaped 1-5/8 inches wide by 1-5/8 or 3-1/4 inches deep. One side of the channel shall have a continuous open slot with in- turned clamping ridges. Deflection shall not exceed 1/240 of span. Use multiple back-to-back channels to achieve these criteria if a single channel is not sufficient.
3. Strut shall be fabricated of galvanized steel, 316 stainless steel, or fiberglass reinforced PVC (FRP). Accessories such as nuts, clamps, post braces, brackets, etc. shall be of same material as strut. If non-metallic accessory items are not available, use 316 stainless steel. See schedule in Part 3.1.J of this specification for locations of use for different types of strut.
4. Coat ends of cut FRP strut with manufacturers recommended sealing resin. Coat ends of cut galvanized strut with galvanized touch-up product per Section 09900.
5 Hanger Rods: Steel galvanized, 316 stainless steel or fiberglass reinforced PVC (FR) threaded both ends, threaded one end, or continuous threaded. Match strut type.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use powder-actuated anchors.

E. Obtain permission from Engineer before drilling or cutting structural members.

F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. Use strut supports to stand cabinets and panel boards a minimum of one inch off wall. Type of strut shall be as set forth in Part 3.1.J.

I. Coordinate location of anchors in all pre-stressed hollow core panels with general contractor. Contractors are to drill into the hollow cores to set anchors. Use epoxy set anchors with screens to provide anchoring.

J. Strut support schedule:

Location	Strut Pipe Support Material
All locations	FRP, Galv., or 316 SST

END OF SECTION 16190

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

1.2 RELATED SECTIONS

Section 09900 - Painting.

1.3 REFERENCES

ANSI/NFPA 70 - National Electrical Code.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved two-layer laminated plastic, black letters on white background.

B. Locations:
1. Each electrical distribution and control equipment enclosure.
2. Communication/instrumentation cabinets.
3. Motor controllers.
4. Exhaust fan control or override switches.
5. Process areas light switches and controls.

C. Letter Size:
1. Use 3/8 inch letters for identifying individual equipment and loads.
2. Use 1/2 inch letters for identifying grouped equipment and loads.

2.2 WIRE MARKERS

A. Description: Tape, split sleeve, or tubing type wire markers.

B. Locations: Each conductor is to be marked at panelboard gutters, pull boxes, outlet, pull and junction boxes, and at each load connection.

C. Legend:
1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
2. Control Circuits: Control wire number indicated on shop drawings. Also coordinate with instrumentation controls contractor.

2.3 UNDERGROUND WARNING TAPE

Description: 4 inch wide plastic tape, colored yellow with suitable warning legend describing buried electrical lines.

2.4 CONDUIT MARKING

Provide plastic marking tape with designation of equipment fed by conduit and source of power (panel designation). Maximum spacing to be 10'-0".

Marking for all exposed conduit. Any conduit longer than 6'-0". Provide lettering ½" high on conduits of ½" size. Provide lettering ¾" on conduit of ¾" size. Provide lettering 1" high on all other conduit. Tape should use black lettering on white background. Conduit marking shall include voltage and panel of origin.

PART 3 EXECUTION

3.1 PREPARATION

Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches below finished grade.

E. Provide nameplates on each Electrical panel, starter, disconnect, control box, transformer, etc.

END OF SECTION 16195

SECTION 16440

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Disconnect switches.

B. Fuses.

C. Enclosures

1.2 REFERENCES

A. ANSI/UL 198C - High-Intensity capacity fuses; current limiting types.

B. ANSI/UL 198E - Class R fuses.

C. FS W-F-870 - Fuseholders (for plug and enclosed cartridge fuses).

D. FS W-S 865 - Switch, box, surface-mounted.

E. NEMA KS 1 - Enclosed switches.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 01340.

B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

C. Submittals for fuses need to include type and short circuit information.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - DISCONNECT SWITCHES

A. Square D.

B. Hubbell.

C. Cutler Hammer. (Eaton/Westinghouse)

D. NO EXCEPTIONS.

2.2 DISCONNECT SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick- break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch

in ON position. Handle lockable in OFF position. Fuse clips: designed to accommodate Class R fuses.

B. Non-fusible Switch Assemblies: NEMA KS 1; Type GD; quick- make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: NEMA KS 1; Type 12, 3R or 4X as required by service conditions, or as called out on plans.
   1. Interior Dry Locations: Nema Type 12.
   2. Exterior Locations: Nema Type 3R (unless indicated otherwise).

D. Hubbell enclosed safety Switches: Nema 4x 30 amp through 100 amp, 120 volt through 480 volt 3-phase will be acceptable. Provide fused or non-fused as shown or required.

2.3 ACCEPTABLE MANUFACTURERS - FUSES

A. Little fuse.

B. Bussman. LPN-R, LPS-R as voltage requires.

2.4 FUSES

Fuses 600 Amperes and Less: ANSI/UL 198E, Class RK1; dual element, current limiting, time delay, 600 volt.
1. Interrupting Rating: 200,000 rms amperes.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install disconnect switches where indicated on drawings.

B. Install fuses in fusible disconnect switches.

C. Install disconnects as required for each piece of equipment. Verify with equipment suppliers.

D. Provide label on inside door of each switch indicating equipment to be fed, fuse size & class and motor size if applicable.

END OF SECTION 16440

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes distribution and branch-circuit panelboards and power outlet pedestals for recreational vehicle use..

1.2 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard, including the following:

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following data:

   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, and current, and voltage ratings.
   c. Short-circuit current rating of panelboards and overcurrent protective devices.
   d. Listing for series rating of installed devices.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Field quality-control test reports.

E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Div.
3. Siemens Energy & Automation, Inc.
4. Square D Co.
5. Midwest Electric

2.2 PANELBOARD FABRICATION AND FEATURES

A. Enclosures: Surface mounted cabinets. NEMA PB 1, Type 3R, suitable for environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions.

C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

D. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

E. Bus: Hard-drawn copper, 98 percent conductivity.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

G. Panelboard Short-Circuit Rating:

1. Listed with series-connected rating for protection by integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
2. Fully rated to interrupt symmetrical short-circuit current available at terminals.

H. Panelboards with Main Service Disconnect: Listed for use as service equipment.

I. Spaces for Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted, and secured with vault-type latch with tumbler lock; keyed alike.

B. Branch overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents, handle lockable.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Application Listing: Appropriate for application.

2.5 POWER OUTLET PEDESTAL

A. Overcurrent Protective Devices: Plug-in, full-module circuit breaker, 10,000 amp short-circuit rating. GFCI, UL Class A circuit breaker for 20 amp rating.

B. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

C. Pedestal: Integral pedestal mount for underground loop feed.

D. Enclosure: Rainproof. Construct of steel, with factory-applied finish coat.

E. Circuit Breaker and Outlet ratings:

Power Outlet Panel Rating	Mains	Receptacles	Circuit Breakers
50A	100A	(1) NEMA 5-20R	(1) 20 amp, 1-pole GFCI
Midwest U Φ 75 GP6		(1) 30 amp, 125v,2W	(1) 30 amp, 1-pole
		(1) NEMA 14-50R	(1) 50 amp, 2-pole

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mounting: Plumb and rigid without distortion of box.

C. Install filler plates in unused protective device spaces.

D. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

C. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

3.3 FIELD QUALITY CONTROL

A. Testing and Inspection: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers.
2. Test insulation resistance of panelboard bus with a megohmmeter, and ground continuity of cabinet and ground bus. Reject buses with insulation resistance less than 2 megohms.
3. Correct defective and malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 16442

SECTION 16483

VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

Variable frequency controller.

1.2 RELATED SECTIONS

A. Section 16195 - Electrical Identification: Engraved nameplates.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

A. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

B. Product Data: Provide 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.

E. The following information shall be submitted to the engineer prior to manufacture.
   1. Information summary including any exceptions.
   2. Dimensioned outline drawings.
   3. Mounting configuration.
   4. Conduit entry and exit locations.
   5. Ventilation requirements.
   6. Power and control schematics.
   7. AFD ratings and selected model numbers.
   8. Cable terminal sizes.
   9. Published AFD specification/ feature directory.
   10. Descriptive bulletin.

1.5 OPERATION AND MAINTENANCE DATA

A. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

B. Maintenance Data: Include routine preventive maintenance schedule.

C. Provide a complete set of installation instructions with O&M manual. Also provide a complete set of spare parts. The spare parts listing should include part numbers and cut away drawings of construction.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site. The electrical contractor is to take delivery and install equipment in accordance with the manufacturer's recommendations.

B. Accept controllers on site in original packing. Inspect for damage.

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

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.9 FIELD MEASUREMENTS

Verify that field measurements are as indicated on shop drawings.

1.10 MAINTENANCE SERVICE

Furnish service and maintenance of controller for two years from Date of Substantial Completion. Also provide complete warranty on all parts for a minimum of two years from substantial completion.

1.11 PRODUCT COORDINATION

All variable frequency drives for entire project must be by single manufacturer.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVE (VFD)

The Variable Frequency Drive (VFD) shall be of a Pulse Width Modulated (PWM) design as manufactured by; Eaton Corporation, Electric Drives Division (EDD), Model SV 9000 Series. Approved equals must be approved a minimum of 7 days prior to Bid. Provide the following basic features.

1. Input displacement power factor of >.98 at all operating speeds and loads.
2. Provide VFD to run 240 volt single phase input to the drive and 230 volt, 3 phase output to motor.

2.2 THE PWM VFD SHALL PROVIDE THE FOLLOWING DESIGN FEATURES AS STANDARD

A. Microprocessor logic. The VFD shall be microprocessor based and utilize digital input for parameter adjustment. Use of potentiometers for parameter adjustment is not acceptable.

B. Auto restart. The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.

C. Current limit. A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110%.

D. Digital output displays and input parameter programming. The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency or percent of base speed; motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.

E. Preset speed. Upon receipt of N.O. "dry" contact closure, the VFD shall run at a preset (field adjustable) speed. This contact is normally used for smoke purge or load shedding.

F. Critical Frequency Avoidance (Frequency jump points). The VFD shall provide a minimum of four (4) selectable frequency jump points, in 1.5 Hz increments, to be used to avoid critical resonance frequencies of the mechanical system.

G. Input signal follower. The input signal follower circuit shall have selectable differential inputs and accepts an electrical speed command from an external source rated at 0-5, 4-20 or 10-50 mA or voltage signals of 0-5 or 0-10 Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands. A+/- 10V bipolar input shall be standard.

H. Motor overload protection. Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputing specific motor parameters. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirements for motor overload relays on single motor applications.

I. Open collector outputs. The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.

J. Output signals. The VFD shall include analog output signals for output load, output speed, and motor voltage. The signals shall typically be 0 to 9 Vdc @ 1mA.

K. Stop mode functions. The VFD stopping mode functions shall be selectable for coast to rest or stopping at programmed decelerate.

L. V/Hz profiles. The VFD shall automatically select the carrier frequency that provides the lowest sound output. No VFD shall switch above 8 kHz.

M. Loss of follower signal. In the event of loss of input follower reference signal (transducer failure), the VFD shall, by user selection, go to either a preset speed which shall be user adjustable, or hold the VFD speed based on the last reference received. The VFD shall provide an open collector output for customer use, to indicate the loss of reference condition.

2.3 THE PWM VFD DESIGN SHALL PROVIDE THE FOLLOWING:

A. Input selection. Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus.

B. DC Bus. The DC shall be filtered by a series choke between the input selection and one or more capacitors to provide ripple free DC power. An additional series choke shall be located between the bus capacitor and the inverter to providing enhanced output short circuit and ground fault protection. The use of DC bus chokes shall be required to reduce input transformer sizing requirements (by 25 to 50%) of the main power distribution transformer vs VFDs that use only DC bus capacitors. VFDs which use only bus capacitors require that input isolation transformers or input line filters be supplied. Use of isolation transformers reduces systems efficiency (4 to 5%) and will be weighted against designs where required.

C. Inverter. The inverter shall use power transistors to provide three phase output power to the motor.

2.4 THE VFD SUPPLIER shall provide the same design/technology and digital display to cover the HP range for all VFDs. VFD supplier to provide the following documentation:

A. Documentation showing that the VFD is the same basic design.

B. One Instruction Manual to cover the full HP range for all VFDs.

C. Explanation of commonality of spare parts for all VFDs.

2.5 OUTPUT RATINGS. The VFD shall operate within the following ratings:

A. Frequency range, 1-66 Hz.

B. Frequency resolution, .1% of base speed with analog input .025% with digital input.

C. Frequency accuracy within .05% of set point.

D. Overload rating, 110% for one minute.

2.6 MOTOR PERFORMANCE. The VFD shall provide the following rating.

Speed regulation, 3%.

2.7 INPUT POWER. The VFD shall operate within the following parameters:

A. 415 to 500 V +5%/-10% or 195 to 245 V (+5%/-10%) as required.

B. 3 phase, 60 Hz.

2.8 SET-UP ADJUSTMENTS. Standard setup adjustments shall include:

A. Minimum speed, 0 to 100%.

B. Maximum speed, 0 to 100%.

C. Linear accel, .5 to 600 seconds.

D. Linear decel, .5 to 600 seconds.

E. Maximum output voltage, adjustable.

F. V/Hz, adjustable with selectable profiles.

G. Current limit, 50 to 110%.

2.9 ENVIRONMENTAL RATINGS. The VFD shall operate within the following parameters without the requirements for derating.

A. Operating temperature, 0C to 40C.

B. Altitude to 1000m (3300 ft).

C. Humidity, 95% non-condensing.

2.10 ENCLOSURES

Standard enclosure shall be NEMA 12 design for indoor units and NEMA 4X with ventilation fan and filtered intakes for outdoor units. Verify location. Provide heater in VFD for extreme cold operation.

2.11 CODES AND STANDARDS. The VFD shall meet the following standards.

A. CSA

B. ETL (UL 508)

C. NEMA

D. NEC

2.12 PROTECTIVE FEATURES. The VFD shall be designed to meet the following specifications and operate within the following parameters.

A. AC Input Fuses. The VFDs power circuit shall be fused and isolated internally with respect to ground. Fuses to be rated minimally at 200,000 A interrupting capacity.

B. Logic Common. The power units logic common shall be at ground potential.

C. Phase Loss Protection. Phase loss protection shall be provided to prevent single phasing of the VFD input.

D. Power Less Ride-Through. The VFD shall be capable of continued operation during an intermittent loss of power for 15 msecs. Opening of the VFDs input and/or output line switches while operating shall not result in damage to the power circuit components.

E. Short Circuit and Ground Fault Protection. The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at 480V plus 10% (528V). Use of isolation transformers for ground fault protection reduces systems efficiency (4 to 5%) and will be weighted against designs where required. The VFD supplier must demonstrate ground fault and short circuit protection at time of start up or plant witness test. The VFD shall be capable of providing 100% motor current intermittently. The VFD shall include an instantaneous overcurrent trip. The VFD shall not restart after electronic overcurrent trip until reset through the run/stop circuit or unless the auto restart function has been enabled.

F. Transient and Surge Voltage Protection. Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOV's).

The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with ANSI/IEEE C62. 41-1980 with the test circuit adjusted for a 2100 amp peak 8X20 s short circuit discharge current pulse.

G. Rotating Motor Start. The VFD shall be able to start into a rotating motor (any speed or direction) and accelerate (decelerate) to set speed without component loss.

2.13 RELIABILITY. A complete description of supplier's Quality Assurance and Testing program shall be provided.

A. Component Testing. All power semiconductors and integrated circuits shall be 100% tested.

B. Computerized ATE Testing. Computerized Automated Testing Equipment (ATE) shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0 C and 65 C and receive electrical power-on and power-off cycle tests.

C. Burn In. All VFDs shall be tested/run in the equivalent of a NEMA 1 enclosure. The burn in shall be conducted for a minimum of four hours at rated ambient (40 C) with a fully loaded motor.

2.14 MAINTAINABILITY

A. All control circuit voltages (12 Vdc, 24 Vdc, 160 Vdc and 120 Vac) shall be physically and electrically isolated from power circuit voltages (380 to 600 Vac, 600 Vdc) to insure safety to maintenance personnel.

B. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following; bus undervoltage, overcurrent, ground fault, timed overload and drive fault.

C. All printed circuit boards shall utilize quick disconnect plugs and/or pull apart terminal blocks to facilitate maintenance by providing quick changeout without disconnecting terminal strip connections thereby reducing wiring errors.

D. VFD shall be capable of starting and operating without a motor connected.

E. All set-up and operating parameters shall be stored in nonvolatile memory. The static memory module shall be able to be removed and installed in replacement logic boards with all set-up and operating parameters intact requiring no adjustment of replacement boards.

2.15 ADDITIONAL REQUIRED FEATURES.

A. Operator Panel. A deluxe soft touch operator panel shall be provided for the following functions.
   1. Shall digitally display motor speed, load, amps, and output volts.
   2. Shall have eight (8) LEDs for indicating drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.
   3. Shall provide selection for Hand - Off - Auto Control. In Hand mode, the VFD shall be started and stopped from the operator's panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.
   4. Shall provide selection for Manual ref. / Auto ref. In the Man ref. mode, the VFD speed reference shall be set from the operator's panel. In the Auto ref. mode, the VFD speed reference shall be set by the external source instrument signal.
   5. Shall have large (1/2" min.), easily readable, display. All mnemonics shall be displayed in English.
   6. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.

B. Circuit Breakers. The operating mechanism shall be designed so that the door can be padlocked in the "Off" position.

C. Communications Port. A communications port for RS 232C or RS 422 communications with selectable baud rates for 300, 1200, 2400, 4800, or 9600 baud shall be provided.

D. NEMA 12 enclosures indoors and NEMA 4X outdoors.

E. PI Regulator. The VFD shall include proportional and integral gain constant inputs for process control requirements.

F. Line reactors to keep the unit from nuisance tripping.

G. Protection
   1. All printed circuit cards shall be coated with a chemical, dust and moisture guard to insure long life in adverse environments.
   2. Over-temperature
   3. Short Circuit
   4. Ground Fault
   5. Line surge to 6000 VAC
   6. Phase loss
   7. Over-voltage
   8. Under-voltage
   9. Over-frequency
   10. Motor/Drive overload
   11. Programming password
   12. Current / Torque Limit

H. Factory installed RFI filters for electrical noise reduction to prevent interference with sensitive electrical equipment or wireless devices..

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.2 PREPARATION

Provide concrete housekeeping pad under the provisions of Section 03300.

3.3 INSTALLATION

A. Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Provide engraved plastic nameplates under the provisions of Section 16195.

E. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400.

B. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.5 MANUFACTURER'S FIELD SERVICES

Prepare and start systems under provisions of Section 01400.

3.6 ADJUSTING

A. Adjust work under provisions of Section 01700.

B. Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

3.7 CLEANING

Touch up scratched or marred surfaces to match original finish.

3.8 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 01650.

B. Demonstrate operation of controllers in automatic and manual modes.

3.9 OPERATION

The VFD's are to be ready to receive signals from the existing RTU panel. The RTU will send START commands, STOP commands, and SPEED commands (4-20ma signal). The RTU is to receive a run signal, a fail signal and a 0 to 7.5 VDC speed indication signal from the VFD's.

3.10 START-UP

Start-up is to be provided by a trained employee or representative of the AFD manufacturer who has been certified in start-up, servicing and trouble shooting the specified product with a minimum of (3) years experience and shall reside locally.

1. Additionally, a local parts stock shall be maintained for all parts used in the AFD's furnished. The contractor is to have all AFDs fully wired and ready to run before providing start-up notification to the manufacturer.

3.11 TRAINING

Training is to be provided by an employee of the AFD manufacturer using drive simulators and instructional tools to provide informative training tailored to the needs of the client's employees. The class is to be (4) hours in length for a maximum of (12) trainees per class.

END OF SECTION

SECTION 16510

LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires and accessories.

B. Ballasts.

C. Lamps.

D. Luminaire accessories.

1.02 REFERENCES

A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. ANSI C82.4 - Ballasts for High-Intensity Discharge and Low Pressure Sodium Lamps (Multiple Supply Type).

C. NFPA 70 – National Electrical Code.

D. NFPA 101 - Life Safety Code.

1.03 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

B. Product Data: Provide dimensions, ratings, and performance data.

1.04 SUBMITTALS FOR CLOSEOUT

A. Submit manufacturer's operation and maintenance instructions for each product.

1.05 QUALIFICATIONS

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

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 (NEC 2005).

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.07 EXTRA PRODUCTS

A. Furnish 10% replacement lamps for each lamp type, minimum of four each.

B. Furnish two of each ballast type.

PART 2 PRODUCTS

2.01 EXTERIOR LUMINAIRES AND ACCESSORIES

A. Description:
1. Pole top fixture: Spaulding or approved equal. Reference schedule on drawings for fixture type and pole.

B. Model: Based on Spaulding CDS-F3-H25-H5-Q-DB-P1 250 watt Metal Halide. High impact polycarbonate or acrylic Lens.

C. Lens to be injection molded U.V. stabilized polycarbonate and prismatic lens combination. Type V Distribution.

E. Installation Conditions: Outdoor Use, Enclosed and Gasketed.

F. Mounting: As shown, Post Top.

2.02 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp specified.

B. Voltage: 120 volts match luminaire voltage.

2.03 LAMPS

A. Lamp Manufacturers: Philips or Sylvania.

B. Lamp Types: As specified for luminaire.
1. Metal Halide lamps to be coated lamps, based on Philips MH250/C/U.

2.04 LIGHTING PHOTOCELL

A. Manufacturers:
1. Intermatic.
2. Tork.
3. Approved equal.

B. Based on Intermatic. The photo control is to be relay type switching action model and have a rating of 1500 watts tungsten at 120 volt a.c.. The photo cell shall be mounted in the fixture to control each individual fixture The photocell shall be hail-safe wherein lighting load remains “on” in event of control circuit failure.

2.05 POLE

A. Manufacturers:
1. Spaulding Lighting.

2. Approved equal.

B. Based on Spaulding SSS-20-40-1-P2-DB. 20 foot Dark Bronze Pole.
   1. Each Light pole to have a 120 volt, 20 amp, GFI duplex receptacle mounted low on pole.

PART 3 EXECUTION

3.01 INSTALLATION

A. All light poles are to have hand holes for maintenance and wiring accessibility.

B. Locate luminaires as indicated on drawings.

C. Install accessories furnished with each luminaire.

D. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

E. Bond products and metal accessories to branch circuit equipment grounding conductor.

F. Coordinate Pole bases and bolt patterns with other trades as required. Provide template for construction.

3.02 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.03 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean finishes and touch up damage.

3.04 PROTECTION OF FINISHED WORK

A. Relamp luminaires and replace ballasts that have failed at Substantial Completion. Replace ballast that are noisy at substantial completion.

END OF SECTION 16510

APPENDIX
SOILS REPORT

GSI

Report of Geotechnical Investigation for CONTROLLED DISCHARGE LAGOON Volga River State Park I Avenue Fayette County, Iowa

GSI Project No. 086080
June 3, 2008

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I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Zachary G. Thomas — June 3, 2008

My license renewal date is December 31, 2008.
Pages covered by this seal: 1 - 12, Appendices A, B, C, & D
Date issued: June 3, 2008

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

GSI

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GSI

Geotechnical Investigation
CONTROLLED DISCHARGE LAGOON
Volga River State Park
I Avenue
Fayette County, Iowa

June 3, 2008
GSI Project No. 086080

INTRODUCTION

Geotechnical Services, Inc. (GSI) has completed the geotechnical investigation at the site of the proposed controlled discharge lagoon and underground utility line improvements at Volga River State Park near Fayette, Iowa. This investigation was authorized by Mr. Perry Gjersvik, P.E. of Bartlett & West Engineers on April 24, 2008 and performed in accordance with our revised proposal dated April 4, 2008.

This investigation includes eight test borings, laboratory testing, data analysis, and a report of our conclusions and recommendations as they affect sitework considerations.

The scope of this investigation did not include an environmental assessment for the presence of hazardous or toxic materials in the soil or ground water on or near this site. If contamination is suspected or is a concern, we recommend that the scope of this study be expanded to include an environmental assessment. Any statements in this report regarding odors, discoloration, or suspicious conditions are strictly for the information of our client.

GSI prepared this report under the supervision of a professional engineer licensed in the State of Iowa. Our recommendations are based on the applicable standards of the profession at the time of this report and within this geographic area. This report has been prepared for the exclusive use of Bartlett and West Engineers in accordance with generally accepted geotechnical engineering practices.

PROPOSED CONSTRUCTION

Our understanding of the project is based on the RFP issued by the Iowa Department of Natural Resources (IDNR) and e-mail and telephone correspondence with Mr. Gjersvik. This project consists of Phase II of the modernization of the northern RV, camping, cabin, and daytime facilities at Volga River State Park. We understand this phase includes the design and construction of a wastewater treatment and disposal system that consists of a controlled discharge lagoon with an outlet to Frog Hollow Creek. Underground utility lines will be installed as part of the proposed system and these underground utilities will be routed in the shoulders along the existing paved park roads. No layout drawings, grading plans, or final elevations for lagoon and piping construction were available at the time of this report. The new lagoon will be subject to current Iowa Department of Natural Resources (IDNR) design standards

SITE CONDITIONS

This proposed lagoon site is south of the RV pull-in area and north camping area at Volga River State Park in Fayette County, Iowa. The site is located east of the Frog Hollow Lake dam at the end of I Avenue. The site is currently uncultivated land that was covered with grass, weeds, and trees at the time of our field exploration. Surface topography generally slopes downhill to the south across the site. The existing park road shoulders were either crushed stone or grass and weeds at the surface.

SUBSURFACE EXPLORATION

The field exploration was conducted on May 15 and 16, 2008. The exploratory program consisted of drilling eight test borings near the locations shown on the boring location plan in appendix A. The boring location plan was electronically provided by Mr. Brad Pleima of Bartlett and West and modified by GSI to indicate approximate test boring locations. The test boring locations were selected by Bartlett and West and laid out in the field by the GSI field crew as close as possible to the requested locations. Surface elevations at the boring locations were interpolated from contours shown on the drawings provided in the IDNR RFP. The accuracy of the locations and elevations of the borings should be considered accurate with respect to the methods used.

Four test borings were drilled across the proposed wastewater treatment lagoon site to depths between 4.7 and 16 feet below existing site grades and four borings were drilled along the proposed underground utility line alignments to depths between 2½ and 5 feet below existing grades. The borings were completed with a truck-mounted Mobile B-57 drill rig using 4-inch continuous flight augers or a combination of 3¼-inch hollow stem augers and NQ2 wireline coring equipment. The hollow stem augers were advanced to practical refusal in the bedrock and wireline coring was completed through the hollow stem augers at Test Boring 4. The test borings were terminated at planned depths or rock bit refusal depths of 2½ to 16 feet below existing grades at the time of our field exploration.

Soil samples were obtained at the sampling intervals shown on the boring logs in appendix B. Split-barrel samples, designated "S" samples, were obtained while performing Standard Penetration Tests (SPT) with a thick walled sampler, 1.50-inch inside diameter, driven in general accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." The N-value, reported in blows per foot, is the number of blows required to drive the sampler the final 12 inches of the 18-inch sample interval. Recovered disturbed samples were extruded in the field after performing the field penetration tests, sealed in plastic bags, labeled, and transported to the laboratory for testing. Recovered core samples were measured and logged in the field and placed in a waxed cardboard box for transport to the laboratory.

The Boring Logs were prepared in general accordance with ASTM D2488, "Description of Soils (Visual-Manual Procedure)." Stratification lines shown on the boring logs represent approximate boundaries between soil types. Bedrock identification as shown on the boring logs is based on visual classification and our experience; petrographic analysis may indicate other rock types or units to exist. Our drill crew made ground water observations in the borings at the times and under the conditions stated on the boring logs.

LABORATORY TESTING

The field boring logs were reviewed to outline the soil types and depths of the soil strata. A laboratory testing program was then established to evaluate the engineering properties of recovered samples. Water content was determined on SPT samples. One Standard Proctor test was conducted on a representative sample from the upper portion of the soil profile within the

footprint of the lagoon. One hydraulic conductivity test was performed for lagoon liner design purposes. All tests were conducted by a GSI laboratory technician in general accordance with current ASTM test procedures. The water content, recovery, and RQD results are presented on the boring logs in appendix B and the Standard Proctor and hydraulic conductivity reports are in appendix C.

SUBSURFACE CONDITIONS

REGIONAL SOIL PROFILE

The project site is located within the "Paleozoic Plateau" geomorphic region. The region is characterized by a rugged bedrock-dominated topography with rolling uplands and deeply incised stream valleys with Paleozoic Age rock outcrops belonging to the Cambrian, Ordovician, Silurian, and Devonian Systems. Bedrock consists primarily of limestone, dolomite, sandstone, and shale.

Soil stratigraphy above the bedrock generally consists of a thin mantle of wind-blown Wisconsinan age silty clay loess over a Pre-Illinoian glacial till deposit. The till consists of a mixture of well-graded clay, silt, and sand with gravel, cobbles, and occasional boulders. In some areas, the upper portion of the till has weathered to a rust-colored clay termed "paleosol". In smaller areas, the paleosol extends to the bedrock surface in the form of a waxy red clay.

Overburden at the project site is generally underlain the Alexandrian series of the Silurian bedrock system. This formation is predominately dolomite and limestone with interbedded chert.

SITE SOIL PROFILE

Soil at the project site generally consisted of colluvium and glacial till overlying Silurian bedrock. Dark brown clayey silt with organics (topsoil) was encountered at the surface of Test Borings 1 through 4 and was approximately 6 inches thick. The topsoil was underlain by two to three feet of colluvium which consisted of brown clayey to very clayey fine to medium sand with trace limestone fragments and gravel. Light yellowish brown to tan weathered limestone was encountered at depths between 2½ to 3½ below existing grades in Test Borings 1 through 4. Test Borings 1 through 3 were terminated at rock bit and SPT refusal in the hard weathered limestone bedrock between depths of 4.7 and 9.1 feet. Test Boring 4 terminated in the weathered limestone bedrock at the bottom of a 10-foot long core run near a depth of 16 feet below existing grade.

Probe locations were conducted along the proposed underground sewer and water line alignments. These four locations generally encountered colluvium overlying residual soil or bedrock. The colluvium at the surface consisted of limestone fragments, clayey silt, sandy to very sandy lean clay and fine to medium sand. Probe location 4 terminated near a depth of five feet in the colluvium. Light brown to brown fat clay to sandy fat clay with limestone fragments was encountered below the colluvium at probe locations 1 and 3. Locations 2 and 3 encountered light yellowish brown to tan weathered limestone at depths of 1½ and 4 feet, respectively, below existing grades. Both of these locations terminated in the weathered bedrock at depths of 2½ and 5 feet below existing grades.

Field and laboratory testing of the site soils indicate the following ranges of in situ engineering properties:

Water Content, (%)	5 - 9
Standard Penetration Resistance, N (bpf)	45 - 50 for 1 inch

GROUND WATER

Ground water observations were made during drilling, shortly after completion of drilling, and 7 to 8 days after drilling. Test Borings 1 through 4 were dry during drilling and no ground water had accumulated in Test Borings 1 through 3 shortly after completion of drilling. Ground water measurement was not completed in Test Boring 4 shortly after completion of drilling due to bedrock core drilling operations. Volga River State Park staff reported to Mr. Gjersvik that Test Borings 1 through 4 were dry approximately 7 to 8 days after completion of drilling. All four probe holes were dry both during and shortly after completion of drilling. These ground water observations are not necessarily a true indication of the static ground water conditions. Observations over a long period of time are usually required to accurately determine the static ground water level and the seasonal variations.

The free ground water surface or ground water table within unconfined aquifers is generally a subdued reflection of surface topography. Water generally flows downward from upland positions (recharge zones) to low lying areas or surface water bodies (discharge zones). Therefore, ground

water levels and the level of any perched water at the project site will vary with climatic conditions, surface drainage, landscaping irrigation practices, and site topography.

CONCLUSIONS AND RECOMMENDATIONS

SITE CONSIDERATIONS

Regulations of the Iowa Department of Natural Resources (IDNR) state that the lagoon leachate seepage rate should not exceed $^{1}/_{16}$ of an inch per day with a water depth of six feet. For a compacted soil liner, the seepage rate is dependent upon several factors including the initial compaction density and water content of the soil, soil texture, soil permeability, and liner thickness. IDNR requires a minimum compaction density of 90 percent of Standard Proctor (ASTM D698) maximum dry unit weight of the liner soil. Our experience with similar projects indicates that a higher degree of compaction may be more cost effective since denser soils generally exhibit lower permeability and reduce liner earthwork quantities.

Standard Proctor and accompanying falling head permeability tests were performed on a representative composite soil sample obtained from the test borings. The falling head permeability test was conducted on a sample of auger cuttings from Test Borings 1, 2, 3, and 4 that was compacted above optimum water content and near 96 percent of the material's maximum dry unit weight (Standard Proctor). Permeability test results are summarized in the following table. The proposed final lagoon bottom and top of berm elevations were not available at the time of this report.

TABLE 1. FALLING HEAD PERMEABILITY TEST RESULTS
PROPOSED CONTROLLED DISCHARGE LAGOON
VOLGA RIVER STATE PARK, FAYETTE COUNTY, IOWA

Sample Designation	Test Boring Location	Soil Description	Water Content (%)	Dry Density (pcf)	Permeability (ft/day)	Minimum Liner Thickness* (feet)
Bulk Auger	Test Borings 1 through 4, -1 ft to -2½ ft	Brown CLAYEY FINE TO MEDIUM SAND	14.1	117.6	425×10^{-3}	> 6

*Minimum calculated liner thickness (Factor of Safety = 1.0) based upon Darcy's Law per IDNR regulations to restrict leachate loss to less than 1/16 inch per day under a 6 feet water head.

Based on the permeability test results, the minimum liner thickness with available on-site soils required by IDNR regulations would not be feasible due to the large thickness resulting from the high sand content of the colluvium soils. In addition to high hydraulic conductivity, there is 2½ to 3½ of separation between the existing ground surface and the underlying bedrock. A minimum of four feet of separation between the bottom of the lagoon cell(s) and the bedrock surface is required by IDNR 18C.3.6.2. If the separation between the bottom of the lagoon cell(s) and bedrock surface is less than 10 feet, a synthetic liner will be required to seal the lagoon.

In our opinion, there are three alternatives that could be considered for construction of wastewater treatment facilities at this site. One alternative would be to grade the site with available on-site materials and off-site borrow soil to place the bottom of the lagoon a minimum of four feet above the highest bedrock surface and then place a synthetic liner seal. Another alternative would be to import a large quantity of soil to the site in order to provide 10 feet of lagoon bottom-bedrock separation and then construction a standard soil liner designed based on additional laboratory test results. The third alternative would be to construct a different treatment system or move the proposed lagoon to a more favorable location in regard to geology and available earthwork materials.

If a synthetic liner is installed at this site, we recommend that a subsurface interceptor drain line system be installed around the lagoon footprint and below the cells to artificially lower the ground water to provide the Iowa Department of Natural Resources (IDNR) required four feet of separation which would help to facilitate lagoon construction and decrease the possibility of bubbles and failures of the synthetic liner system. The drain lines will improve berm slope stability and berm foundation support.

The invert of the subsurface drain lines should be installed a minimum of 6 feet below the proposed cell bottom subgrade elevations. We recommend that the drain lines be spaced 50 feet center to center. An acceptable subsurface drainage system could consist of either perforated or factory slotted rigid schedule 40 PVC pipe (minimum diameter of four inches), encased in clean granular material (less than five percent passing the No. 200 sieve), which is encapsulated by geotextile fabric capable of preventing the infiltration of fines into the clean granular materials. The compacted cohesive backfill above the free draining granular material should be a minimum of 2

feet thick. The invert of the subsurface drain line should be sloped to drain with a minimum fall of $^{1}/_{16}$ inch per lineal foot of drain line. The daylighted discharge end should be protected with coarse graded granular material or rip rap to minimize the potential for erosion. A suggested typical cross section of a subsurface interceptor drain line is provided in appendix D and plan details could be similar to IDOT RF-19C.

LAGOON EARTHWORK CONSTRUCTION

Construction of the wastewater treatment lagoon will involve implementing proper cut-and-fill procedures for earthwork to provide a stable lagoon. Based on test boring data, we assume that the pond bottom grade will be a minimum of four feet above the hard limestone bedrock. We recommend that sand seams or pockets within any cut slopes and fill sections be over-excavated a minimum of two (2) feet below the proposed surface and be replaced with cohesive compacted soil. This over-excavation should be performed in a benchlike manner to properly integrate the over-excavated material with cohesive soils above and below this layer. In addition, if granular seams or pockets are encountered within lagoon berm construction, we recommend that a similar over-excavation and compacted backfill procedure be implemented to minimize the potential for slope instability.

Prior to construction of lagoon berms, areas to receive fill should be stripped of vegetation or organic matter a minimum depth of 8 inches. Depth of stripping may be greater in low-lying areas in order to encounter a suitable subgrade. Subsequent to stripping, the exposed subgrade should be scarified, compacted, and proofrolled. The proofrolling process delineates shallow zones of soft or otherwise unsuitable soils, which may require additional removal or compaction prior to placement of fill. It should be recognized that it is difficult to achieve the recommended degree of compaction when working against a soft and yielding subgrade.

Prior to placement of fill, existing slopes should be deeply scarified. Where fill sections intercept slopes steeper than 5:1 (horizontal to vertical), the existing slopes should be adequately benched to integrate the new fill section with the existing terrain.

In general, the cohesive soils encountered in the test borings can be readily excavated with conventional excavation equipment. However, bedrock will likely be encountered and equipment

suitable for breaking apart the bedrock to facilitate construction will be required. A hydraulic impact breaker should be available for use to remove shallow limestone during excavation operations. Compaction of granular soils to the recommended minimum percentage compaction can be attained with vibratory compaction equipment. Generally, proper compaction of cohesive soils can be achieved with sheepsfoot or pneumatic type compactors under optimum water content conditions.

We recommend that cohesive soils, free of rubble and organics, having a Unified Soil Classification of CL, CL-ML, or CH be used for compacted fill. The colluvium (void of granular seams or pockets) tested for maximum Standard Proctor dry density and optimum water content would be suitable for fill application. The lagoon berm soils should be compacted to a minimum of 95 percent of the material's maximum dry unit weight as determined by ASTM D 698 (Standard Proctor).

Adjustment of the soil water content may be required in order to lower or raise the water content of the on-site soils to within acceptable limits of optimum water content for compaction purposes. It is recommended that compacted engineered fill for the berms be placed in a range of 0 to 4 percent above the optimum water content in order to achieve lower hydraulic conductivity and minimize shrinkage cracking. Soils placed below the optimum water content will be subject to an increased potential for shrinkage cracking resulting in a higher effective hydraulic conductivity. The on-site soils are generally 2 to 3 percent above optimum water content as determined by the Standard Proctor test performed. These soil water contents will likely decrease to constructible levels once the subsurface drain lines have been operating for a period of time.

If unstable subgrade conditions are encountered during construction activities such that standard equipment cannot operate efficiently and/or the specified compaction level can not be achieved, an over-excavation and structural backfill procedure may be necessary. The over-excavation should extend to a depth of two (2) feet or until the soft soils are removed, whichever is shallower. Soils from the cut sections can be used as structural backfill in the over-excavation and should be compacted to the levels specified in the previous paragraphs.

The IDNR requires a maximum slope configuration for inner and outer berm slopes of 3:1 (horizontal to vertical) and inner slopes no flatter than 4:1. In our opinion, these slope

configurations should provide adequate stability if not subject to moisture seepage and/or degradation due to weathering and exposure. Lagoon construction should be consistent with providing erosion control and positive surface drainage to preclude surface water accumulation adjacent to the lagoon. The inner slopes should be protected with rip-rap above and below the permanent lagoon water elevation as specified by IDNR.

GENERAL EARTHWORK AND UNDERGROUND UTILITY INSTALLATION

Vegetation and organic topsoil, estimated to be 4 to 6 inches deep, should be stripped from the site prior to earthwork operations to develop final site grades. In areas to accept new fill and at final grade in cut sections, an additional 12 inches of the ground surface should be scarified and compacted to eliminate a plane of weakness along the contact surface. Cohesive soil subgrades should be compacted to at least 95 percent of the maximum laboratory dry density (ASTM D698, Standard Proctor) at a water content between 0 and +4 percentage points of optimum water content before placement of new fill.

On-site or imported material used as structural fill below footings, slabs, and pavements should be inorganic lean or fat clay with a Liquid Limit less than 45 percent and a Plasticity Index less than 20 and be free of rubble and material greater than three inches in the maximum dimension.

Fill material should be placed in maximum loose lifts of 6 inches thick and compacted in accordance with the recommended minimum requirements in Table 2. Water content at the time of compaction should be controlled between 0 and +4 percentage points of optimum water content. We estimate that the shrinkage value for earthwork quantities will be on the order of 20 to 25 percent.

Vertical cuts and excavations should not be considered stable in any case. All excavations should be sloped back, shored, or shielded for protection of workers. Trenching and excavation activities should conform to federal, state and local regulations as a minimum. The sandy textured colluvial soils encountered in the test borings at the time of our field exploration generally classify as Type C soils according to OSHA's Construction Standards for Excavations. In general, the maximum allowable slope for shallow excavations in Type C soils is 1½:1 (horizontal: vertical), although other

provisions and restrictions may apply. Design and maintenance of all excavation slopes is the responsibility of the contractor.

The Iowa SUDAS standards and specifications provide SUDAS requirements for underground utility and storm sewer installation and may require bedding the pipe based on the type of pipe material. The thickness of bedding material is a function of pipe diameter and when required should be a minimum of four inches thick below the pipe and we recommend that the bedding extend one pipe radius above the base of the pipe. Bedding should be compacted to 90% of maximum Standard Proctor density in lifts no greater than six inches. Soft or unsuitable soil conditions encountered in the base of trenches ~~may~~ need to be over-excavated and replaced with structural backfill as determined by the Jurisdictional Engineer.

TABLE 2. RECOMMENDED GUIDELINES FOR DEGREE-OF-COMPACTION

Construction Application	Standard Proctor (ASTM D698) Cohesive Soil	Standard Proctor (ASTM D698) Cohesionless Soil	*Relative Density (D4253 & D4254) Cohesionless Soil
Building Foundation, Roadway Subgrades, and Critical Backfill Areas	95%	98%**	70%
Backfill Adjacent to Structures – Minor Subsidence Possible	90%	93%	45%
***Backfill in Non-Critical Areas – Moderate Subsidence Possible	85%	88%	20%

*Use Relative Density technique (ASTM D4253 & D4254) where Standard Proctor technique (ASTM D698) does not result in a definable maximum dry density and optimum moisture content.
**SUDAS recommends 95% for granular soils; however, experience indicates 98% generally results in better pavement performance.
**SUDAS recommends nothing compacted to less than 90% of Standard Proctor in non-critical areas or areas outside of road R.O.W.

Trench backfill compaction requirements above the pipe are determined by land use at final grade. Cohesive backfill that will ultimately support structures or pavements and all other areas determined by the Jurisdictional Engineer should be compacted to 95% of Standard Proctor maximum dry density. All other areas are to be compacted to 90% of Standard Proctor or greater.

Loose lifts placed into open trenches should be limited to thicknesses of 12 inches at depths of three feet or greater below final grade. In the zone between final subgrade elevation and three feet below final subgrade elevation, the backfill soils should be placed in maximum loose lifts of 6 inches.

GENERAL

In the event that any changes in the nature, design, or location of the structure are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing. Analyses and recommendations presented in this report are based in part upon the data obtained from the soil test borings. The nature and extent of variations across the site may not become evident until construction. If variations then appear, it will be necessary to reevaluate the recommendations of this report.

We require that GSI be provided the opportunity for a general review of the final design plans and specifications. This is to ensure that earthwork and foundation recommendations have been properly interpreted in the design and specifications. GSI will not be responsible for misrepresentation of this report resulting from partial reproduction or paraphrasing of its contents.

We also require that GSI be retained to provide continuous engineering services during construction of the foundation, excavation, and earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to modify recommendations in the event that subsurface conditions differ from those anticipated. Please review the ASFE document *"Important Information About Your Geotechnical Engineering Report"* located ahead of the Table of Contents for additional information regarding this report.

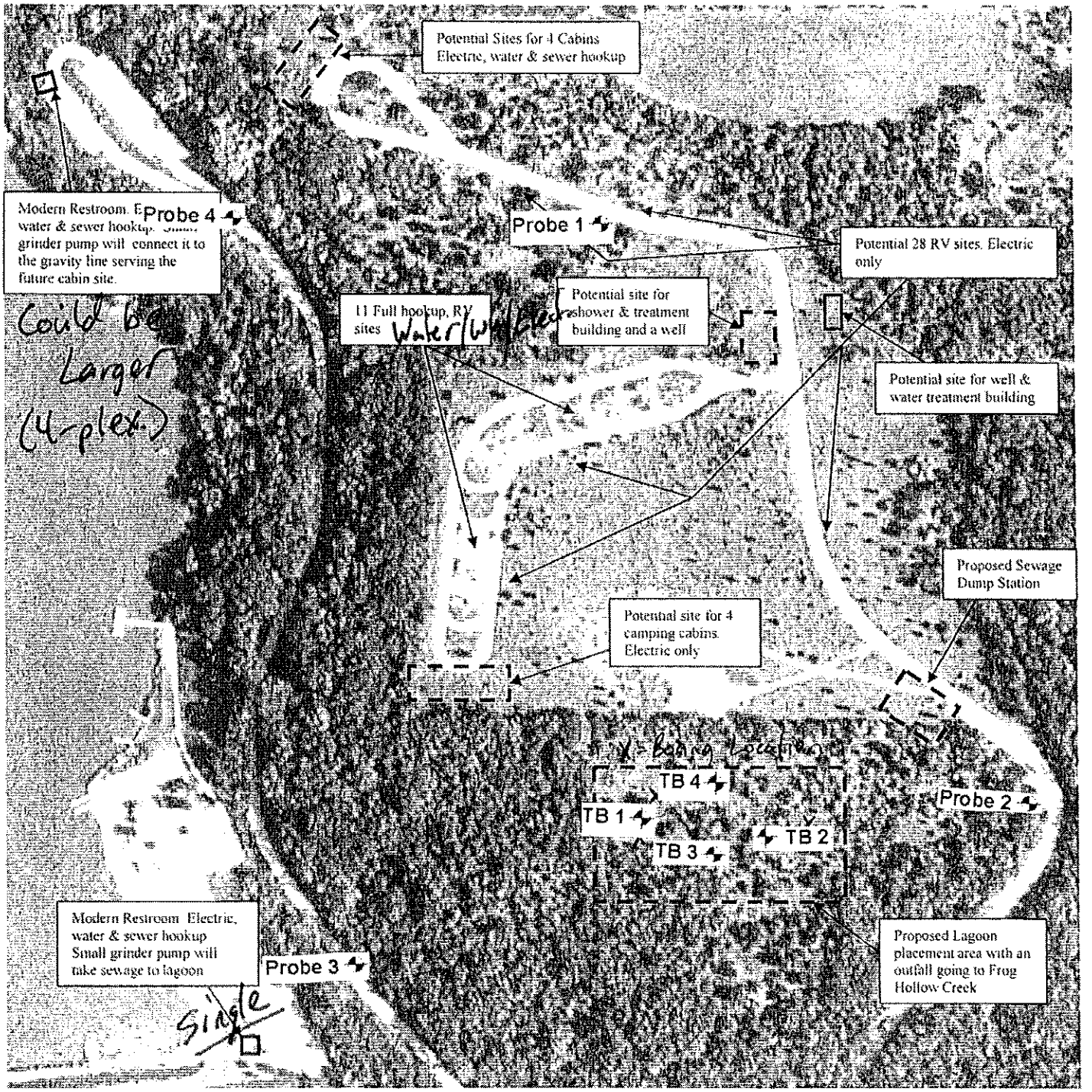
Respectfully,

Geotechnical Services, Inc.

Zachary G. Thomas, P.E.
Project Engineer

Michael T. Lustig, P.E.
Principal Engineer

ATTACHMENT II



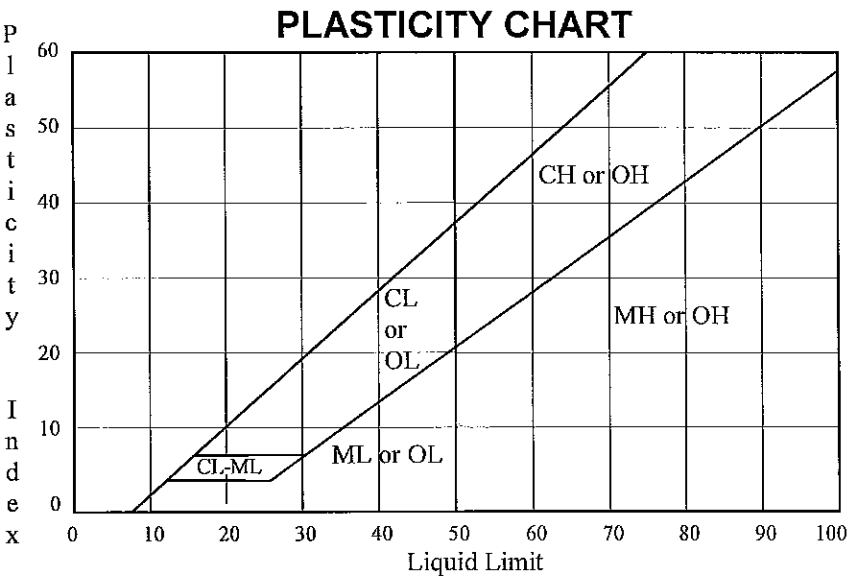
UNIFIED SOIL CLASSIFICATION SYSTEM

GROUP NAME	GROUP SYMBOL	SOIL DESCRIPTION	Comments
Peat	Pt	Highly organic soils	50% or more is smaller than No. 200 sieve
Fat Clay	CH	Clay - Liquid limit > 50% *	
Plastic Silt	MH	Silt - Liquid limit > 50% *	
Lean Clay	CL	Clay - Liquid limit < 50% *	
Silt	ML	Silt - Liquid limit < 50% *	
Silty Clay	CL-ML	Silty Clay *	
Clayey Sand	SC	Sands with 12 to 50 percent smaller than No. 200 sieve *	More than 50% is larger than No. 200 sieve and % sand > % gravel
Silty Sand	SM		
Poorly-graded Sand with Clay	SP-SC	Sands with 5 to 12 percent smaller than No. 200 sieve *	
Poorly-graded Sand with Silt	SP-SM		
Well-graded Sand with Clay **	SW-SC		
Well-graded Sand with Silt **	SW-SM		
Poorly-graded Sand	SP	Sands with less than 5 percent smaller than No. 200 sieve *	
Well-graded Sand **	SW		
Clayey Gravel	GC	Gravels with 12 to 50 percent smaller than No. 200 sieve *	More than 50% is larger than No. 200 sieve and % gravel > % sand
Silty Gravel	GM		
Poorly-graded Gravel with Clay	GP-GC	Gravels with 5 to 12 percent smaller than No. 200 sieve *	
Poorly-graded Gravel with Silt	GP-GM		
Well-graded Gravel with Clay **	GW-GC		
Well-graded Gravel with Silt **	GW-GM		
Poorly Graded Gravel	GP	Gravels with less than 5 percent smaller than No. 200 sieve *	
Well-graded Gravel **	GW		

* See Plasticity Chart for definition of silts and clays.

** See definition for well graded.

PLASTICITY CHART



LEGEND OF TERMS

SAMPLE IDENTIFICATION

U - Undisturbed (shelby tube)
S - Split barrel/SPT (disturbed)
C - California Sampler
L - Lasky continous sampler
A - Auger cuttings (sack sample)
B - Bulk sample (auger cuttings)
H - Head space sample

CONSISTENCY OF COHESIVE SOILS

Unconfined Comp.Strength, Qu, psf	
<500	Very Soft
500-1000	Soft
1000-2000	Medium stiff (Firm)
2000-4000	Stiff
4000-8000	Very stiff
>8000	Hard

RELATIVE DENSITY OF GRANULAR SOILS

N - blows per foot	
0-3	Very loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80	Very Dense

CLASSIFICATION CRITERIA FOR SANDS AND GRAVELS

Well graded sands (SW) $C_u = D_{60}/D_{10} \geq 6$ and $C_c = (D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1

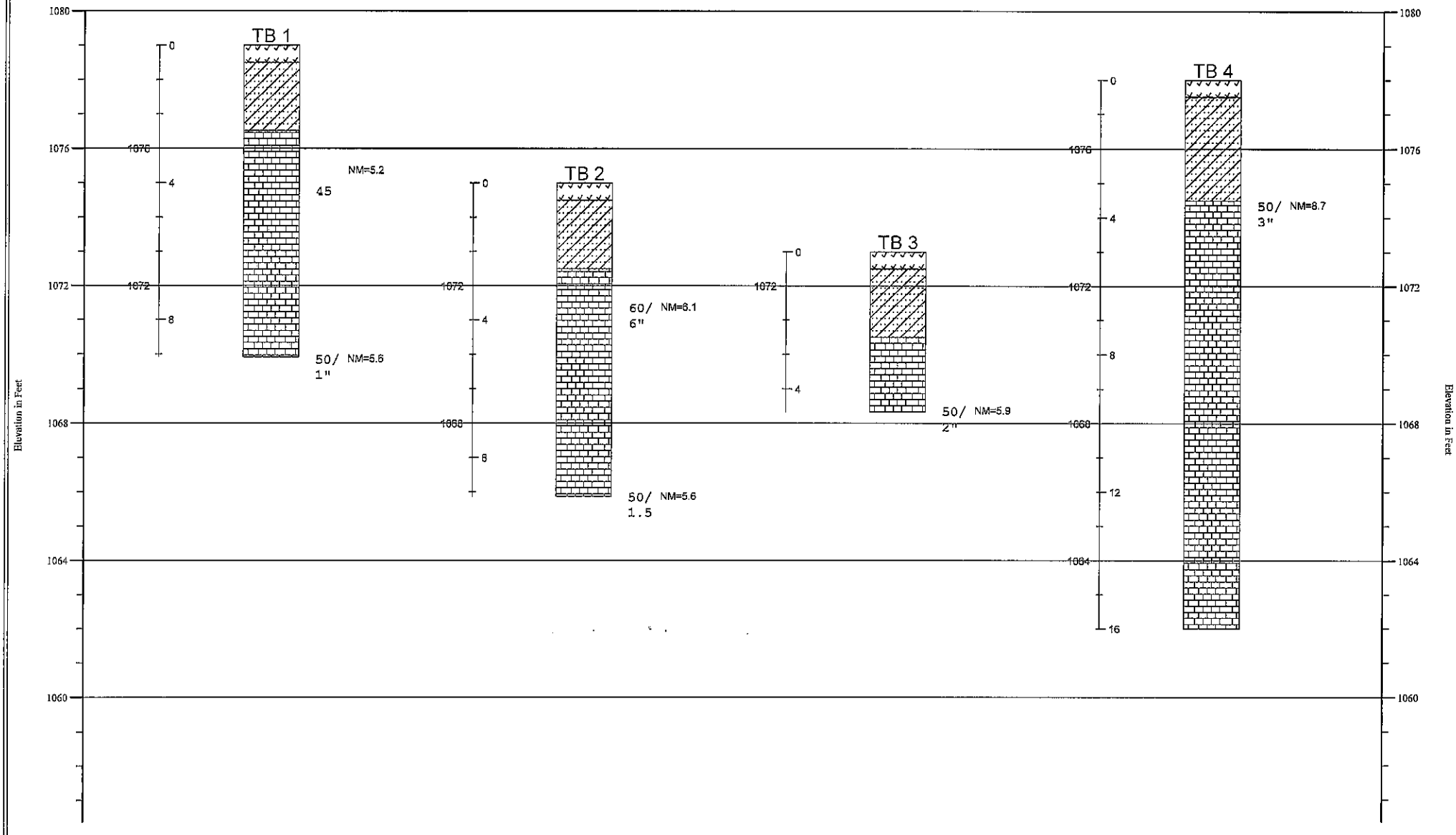
Well graded gravels (GW) $C_u = D_{60}/D_{10} \geq 4$ and $C_c = (D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1

Boulders	Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	FINES (silt or clay)
Sieve sizes 10"	3"	3/4"	#4	#10	#40	#200	

GSI

FORM 314 11/06

LOG OF BORINGS
Controlled Discharge Lagoon



Topsoil

Clayey sand

Limestone

BORING LOG No. TB 1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
TB 1	See Boring Location Plan	1079 ft	RFP Datum	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	8 DAYS	Grass and Weeds	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	Dry	n/a	Dry	4-inch CFA	9.08 ft

DEP. FT.	SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	% MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist CLAYEY SILT with organics TOPSOIL 0.5'	CL-ML				
				Brown, Moist to very moist CLAYEY FINE TO MEDIUM SAND trace limestone fragments, gravel COLLUVIUM 2.5'	SC				
3				Light yellowish brown to tan, Dry to damp, Hard WEATHERED LIMESTONE					3
	S1	45	90			5.2			
6									6
9				SILURIAN BEDROCK 9.1'					9
	S2	50/1"	50	Bottom of Boring @ 9.08' Rock Bit and SPT Refusal		5.6			
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 05/15/2008

BORING LOG No. TB 2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
TB 2	See Boring Location Plan	1075 ft	RFP Datum	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	7 DAYS	Grass and Weeds	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	Dry	n/a	Dry	4-inch CFA	9.13 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist CLAYEY SILT with organics TOPSOIL (0.5')	CL-ML				
				Brown, Very moist CLAYEY FINE TO MEDIUM SAND trace limestone fragments COLLUVIUM (2.5')	SC				
3				Light yellowish brown to tan, Dry to damp, hard WEATHERED LIMESTONE					3
	S1	60/6"	40			6.1			
6									6
9	S2	50/1.5	20	SILURIAN BEDROCK (9.1') Bottom of Boring @ 9.13' Rock Bit and SPT Refusal		5.6			9
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 05/15/2008

BORING LOG No. TB 3

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
TB 3	See Boring Location Plan	1073 ft	RFP Datum	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	7 DAYS	Grass and Weeds	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	Dry	n/a	Dry	4-inch CFA	4.67 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist CLAYEY SILT with organics — TOPSOIL (0.5')	CL-ML				
				Brown, Very moist VERY CLAYEY FINE TO MEDIUM SAND with limestone fragments, organics — COLLUVIUM (2.5')	SC				
3				Light yellowish brown to tan, Dry to damp, hard WEATHERED LIMESTONE					3
	S1	50/2"	30	SILURIAN BEDROCK (4.7')		5.9			
				Bottom of Boring @ 4.67' Rock Bit and SPT Refusal					
6									6
9									9
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 05/15/2008

BORING LOG No. TB 4

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
TB 4	See Boring Location Plan	1078 ft	RFP Datum	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	7 DAYS	Grass and Weeds	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	n/a	n/a	Dry	3.25-inch HSA & NQ2 Wireline	16 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist CLAYEY SILT trace organics TOPSOIL 0.5'	CL-ML				
				Brown, Moist CLAYEY FINE TO MEDIUM SAND with limestone fragments	SC				
3									3
				COLLUVIUM 3.5'					
	S1	50/3"	60	Light yellowish brown to tan, Dry to damp, hard WEATHERED LIMESTONE trace large crystalline seams and solution cavities throughout		8.7			
6									6
				Rock Bit Refusal, Begin NQ2 Wireline Coring					
9									9
	NQ2-1		90	RQD=0.54					
12									12
15									15
				SILURIAN BEDROCK 16.0' Bottom of Boring @ 16'					
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 05/16/2008

BORING LOG No. Probe 1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
Probe 1	See Boring Location Plan	n/a	n/a	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	Dry	n/a		4-inch CFA	5 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Tan, Dry LIMESTONE FRAGMENT COLLUVIUM — 0.3'					
				Dark brown, Damp to moist CLAYEY SILT	CL				
	A			COLLUVIUM — 2.5'					
3				Light brown, Moist FAT CLAY trace limestone fragments	CH				3
				RESIDUAL SOIL — 5.0'					
				Bottom of Boring @ 5'					
6									6
9									9
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 5-16-08

BORING LOG No. Probe 2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
Probe 2	See Boring Location Plan	n/a	n/a	MTL	CWM

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Grass	B-47
Dry	Dry	n/a	DRILLING METHOD: 4-inch CFA	TOTAL DEPTH: 2.5 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
	A			Dark brown, Moist SANDY LEAN CLAY trace limestone fragments COLLUVIUM	CL				
				1.5' Yellowish brown, Dry WEATHERED LIMESTONE SILURIAN BEDROCK					
3				2.5' Bottom of Boring @ 2.5' Rock Bit Refusal					3
6									6
9									9
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 5-16-08

BORING LOG No. Probe 3

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
Probe 3	See Boring Location Plan	n/a	n/a	MTL	CWM

WATER LEVEL OBSERVATIONS			TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	Grass	B-47
Dry	Dry	n/a	DRILLING METHOD: 4-inch CFA	TOTAL DEPTH: 5 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
				Dark brown, Moist to very moist VERY SANDY LEAN CLAY with rock fragments COLLUVIUM — 1.0'	CL				
				Brown, Moist SANDY FAT CLAY with rock fragments					
3	A				CH				3
				RESIDUAL SOIL — 4.0'					
				Light yellowish brown to tan, Dry, Hard WEATHERED LIMESTONE SILURIAN BEDROCK — 5.0'					
				Bottom of Boring @ 5'					
6									6
9									9
12									12
15									15
18									18
21									21

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PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 5-16-08

BORING LOG No. Probe 4

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
Probe 4	See Boring Location Plan	n/a	n/a	MTL	CWM

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING		Grass	B-47
				DRILLING METHOD	TOTAL DEPTH
Dry	Dry	n/a		4-inch CFA	5 ft

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, MOISTURE, CONSISTENCY / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: % MC	DRY DENS. pcf	Qu psf	DEP. FT.
	A			Dark brown, Very moist VERY CLAYEY FINE TO MEDIUM SAND COLLUVIUM	SC				
3				3.0'					3
				Light brown, Damp to moist FINE TO MEDIUM SAND trace fines COLLUVIUM	SP				
				5.0'					
				Bottom of Boring @ 5'					
6									6
9									9
12									12
15									15
18									18
21									21

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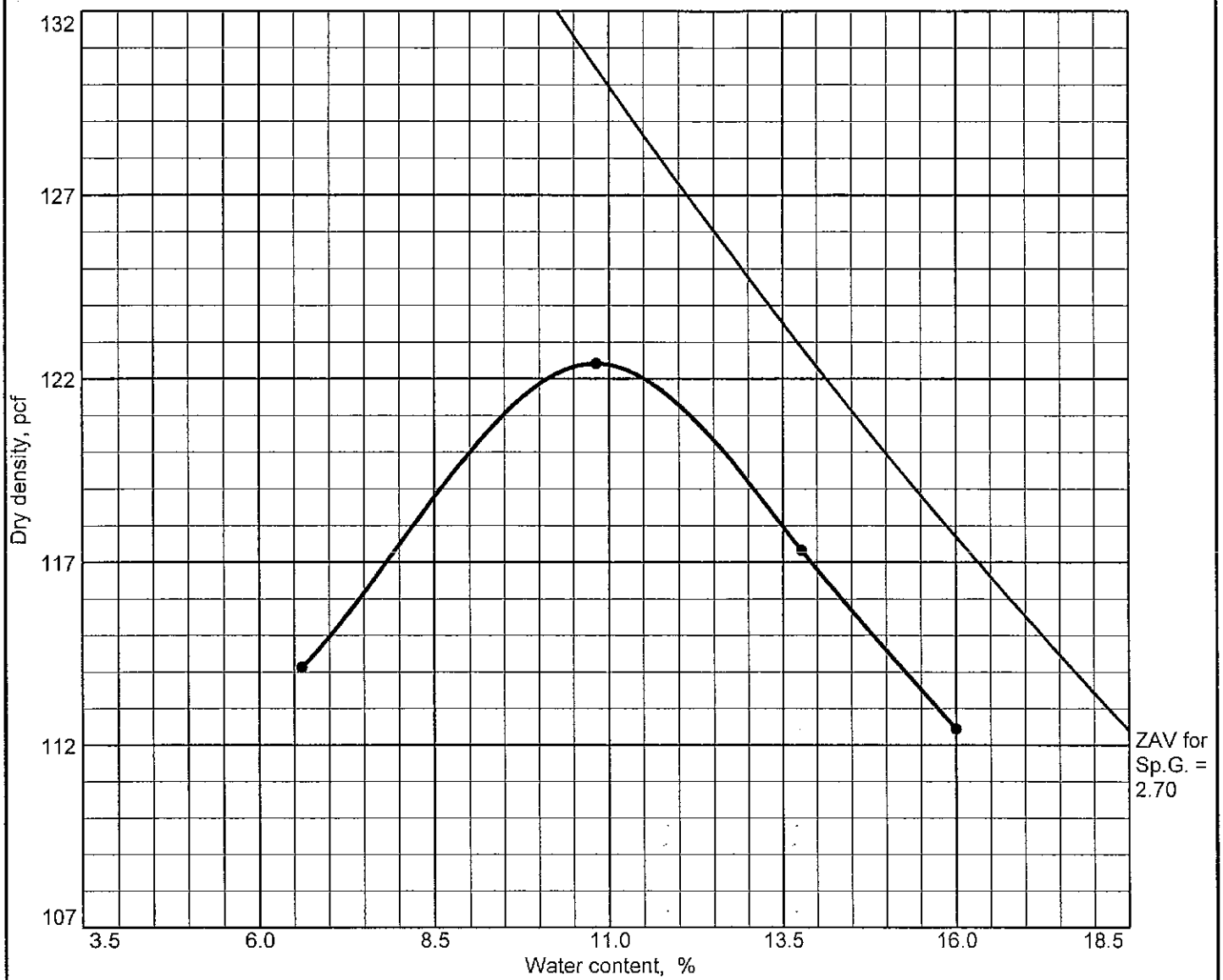
PROJECT: Controlled Discharge Lagoon
LOCATION: Volga River State Park, Fayette Co., IA
JOB NO.: 086080
DATE: 5-16-08

MOISTURE-DENSITY RELATIONSHIP



Test specification: ASTM D 698-91 Procedure A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
-1' to -2.5'			13.9	2.70				

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 122.4 pcf Optimum moisture = 10.8 %	Brown to dark brown VERY CLAYEY FINE TO MEDIUM SAND tr organics, fine gravel

Project No. 086080 **Client:** Bartlett & West

Project: Controlled Discharge Lagoon

● **Location:** TB 1-4 Bulk

Remarks:

Specific Gravity Assumed

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Figure

PERMEABILITY TEST REPORT

Sample Identification:
TB 1-4, -1' to -2.5', Bulk Auger

Sample Description:
Br to Rdh Br CLAYEY FINE TO MEDIUM SAND to VERY SANDY LEAN CLAY, tr limestone fragments

Preparation Remarks:
Remolded at 96% Standard Proctor at +3 of Optimum Moisture

SPECIMEN DATA

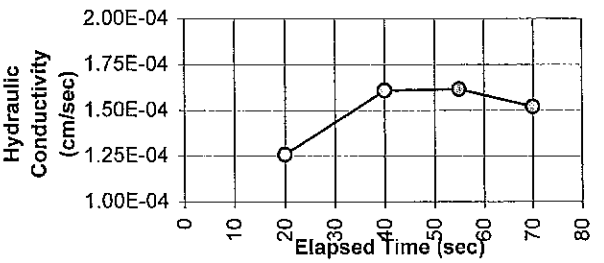
SAMPLE INFORMATION	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION	POROSITY
INITIAL DATA	134.2	117.6	14.1	0.432	88%	0.302
DURING TEST DATA			16.0		100%	
FINAL DATA	132.2	110.9	19.2	0.519	100%	0.342

INITIAL SPECIMEN DIMENSIONS:	Diameter=	6.350	cm
	Length=	7.595	cm
FINAL SPECIMEN DIMENSIONS:	Diameter=	6.730	cm
	Length=	7.170	cm

TEST INFORMATION

PERMEANT LIQUID USED:		De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE:		56.0 psi
EFFECTIVE CONSOLIDATION STRESS:	MAX=	5.6 psi
	MIN=	3.1 psi
HYDRAULIC GRADIENT RANGE:	HIGH=	27.49
	LOW=	24.65

AVERAGE HYDRAULIC CONDUCTIVITY
corrected to 20°C
1.50E-04 cm/sec



Test conducted according to ASTM D5084-90.

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Project	Volga River State Park Lagoon
Location	I Avenue, Fayette County, Iowa
Job Number 086080	Date 6/2/2008

FORM 316 3/97