

DESIGN AND CONSTRUCTION STANDARDS

TOWN OF PITTSBORO, INDIANA



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FOREWORD

The “Design and Construction Standards – Town of Pittsboro” have been prepared to identify the Town’s minimum criteria for construction within the corporation limits.

All construction projects which are to become part of the Town's system, to be operated and maintained by the Town, shall conform to these standards. Construction drawings and specifications must be approved by the Town and a written permit obtained in accordance with existing ordinances before construction begins. In addition, sanitary sewer projects must be submitted to the Indiana Department of Environmental Management (IDEM) for approval. The Town will not approve a sanitary sewer project for construction until an approval from IDEM is received.

The Town will not approve a water main project for construction until an approval from

A pre-construction meeting shall be required prior to the start of work. The Developer shall contact the Town a minimum of 48 hours prior to the meeting and provide four (4) sets of approved construction plans at the meeting.

Construction observation shall be provided by the Town at the expense of the developer.

These standards were prepared with the intent of obtaining the highest quality of construction possible, consistent with accepted industry practices and specifications. As new materials become available and acceptable, the standards may be revised and updated.

Copies of the standards may be obtained from the Town Clerk's Office - Town Hall, Pittsboro, Indiana, (317) 892-3326.

I. DESIGN

BUILDER GUIDELINES FOR SITE DEVELOPMENT AND BUILDING CONSTRUCTION

The following guidelines have been prepared to assist in placing responsibility and providing criteria for orderly development of home sites in Pittsboro, Indiana. Home sites/subdivisions only or also include projects with infrastructure that will be operated and maintained by the Town.

Due to the unique characteristics of the Jeff Gordon Overlay District and the Downtown Overlay District, it is necessary to review the application of these Standards within the above noted two areas of the Town of Pittsboro on a site-specific basis. Modifications to or deviations from these Standards may be necessary within these two areas due to site restrictions, the existing pattern of development, and access to infrastructure. Such modification to or deviation from these Standards shall be at the sole discretion of the Town of Pittsboro as conditions dictate.

Streets and Curbs

- Once streets and curbs have been inspected and accepted for use, any damage from construction work, including but not limited to tracked equipment, backhoe outriggers, water tap construction, sump pump line construction, fuel and oil spills, or carelessness by employees of the building contractor, or any subcontractors and material suppliers, must be repaired (to the satisfaction of the Town) at the building contractor's expense.
- Streets must be kept clear of debris, construction materials (stone, sand, etc.) and erosion sediment on a daily basis. This includes mud deposited on the street as a result of vehicles leaving the construction site.

If necessary, the developer and/or Town representative will notify the builder to thoroughly clean the street, including any adjacent street areas that have been "dirtied" as a result of construction activities at a particular building site. If the street is not cleaned by a given date, the developer may clean the street and back charge the building contractor.

- Curbs must be protected from damage by tracked and heavy construction equipment that access the building site. Curbing that is cracked, crushed, gouged, scarred or otherwise damaged by carelessness of employees of the building contractor, or any subcontractors and material suppliers must be repaired (to the satisfaction of the Town) at the building contractor's expense.

Drainage

- All storm manholes, inlets, drains, and drainage structures (including culverts) must not be disturbed in any manner without permission from the developer and appropriate Town representative. If a structure needs to be raised, lowered, moved, or otherwise modified from the plan grade and elevations, it is the building contractor's responsibility to make sure that all work is completed in accordance with granted approvals, by an approved contractor, and at the building contractor's expense. This includes changes necessary to accommodate site grading and landscaping for the building site. Any changes that are made must not reduce the capacity or in any way change the function of the affected drainage system.

All manhole rims must be at or slightly above the finished grade elevation when the final grading and landscaping is completed. Manholes must not be left in a covered (buried) condition. Costs to raise or lower manhole elevations, or to uncover buried manholes, are the responsibility of the building contractor.

- Any existing drainage swales serving the building site are the responsibility of the building contractor to maintain during construction. Swales have been graded to specific elevations and slopes to provide continuous and uninterrupted drainage for the building site, as well as providing drainage for adjacent

properties. The swales have been constructed and seeded in accordance with the subdivision erosion control plan. If the swales are damaged, it is the responsibility of the building contractor, at his expense, to regrade, repair, and reseed the swales to conform to the size, shape, and slope contained in the development and erosion control plan. This includes repair and reconstruction of swales on adjacent properties that have been damaged by carelessness or negligence on the part of the building contractor's employees, subcontractors, or suppliers.

- Storm sewer inlets and drains on and adjacent to the building site must be protected from sand, stone, mud, silt, and other foreign materials that can accumulate in the inlet, drain, or storm sewer. The building contractor is responsible, at his own expense, for removing such materials in inlets and drains which was caused by carelessness and negligence on the part of his employees, subcontractors, or suppliers, and for cleaning storm sewers of accumulated materials so as to return them to an open and free flowing condition. Upon notice by the developer or Town representative to clean storm inlets, drains, or storm sewers, and given a reasonable time to comply, the developer may have the structures cleaned and back charge the building contractor.
- New developments that have dedicated sump pump and foundation drain collection systems shall connect to a dedicated storm sewer within an easement at the rear of the lot. Sump pump drains shall not be connected to a curb underdrain. Sump pumps must not surface discharge into streets or curbs. Check the development plan or contact the developer regarding the location of said connection points. In some developments, alternate drainage connections may be available for such connections.
- Downspouts should not be connected to the building foundation drains or to perforated pipe provided for sub-base drainage at the curb. Downspouts should surface discharge to the lawn area adjacent to the home or to dedicated sump pump and foundation drain systems.
- **DO NOT** discharge sump pumps, foundation drains, or downspouts to the sanitary sewer system. Likewise, **DO NOT** drain, directly or indirectly, basement or foundation excavations to the sanitary sewer to remove groundwater or rainfall accumulations. Should such an incident occur, the building contractor will be held responsible for the cost of cleaning and possibly televising sewer segment(s) found to be affected by the introduction of muddy water. These activities are illegal and will be pursued vigorously to the maximum extent possible. The contractor may be liable for costs to treat the extraneous water at the wastewater treatment plant.

Sanitary Sewers

- Sanitary sewers and manholes must not be disturbed in any manner without permission of the developer and appropriate Town representative. If the manhole needs to be raised, lowered, moved, or otherwise modified from the plan grade and elevations, it is the building contractor's responsibility to make sure that all work is completed in accordance with granted approvals, by an approved contractor, and at the building contractor's expense. This includes changes necessary to accommodate site grading and landscaping for the building site. All manhole rims must be a minimum of 2" above the finished grade elevation when the final grading and landscaping is completed. Manholes must not be left in a sump condition where accumulated rain or groundwater can accumulate on the cover. Manholes must not be left in a covered (buried) condition. Costs to raise or lower manhole elevations, or to uncover buried manholes, are the responsibility of the building contractor.

Excavations

- All excavations within 5 feet of the back of curb must be backfilled with compacted granular material (#8 stone) or flowable fill. (Example: When tapping water mains, the tap or receiving pit (or any other excavation) must be backfilled as noted.)

If the curb or street is undermined when making the excavation, the developer and Town representative must be contacted to inspect the excavation and approve the method of backfill. An inspection may also be made of the underdrain to determine if any damage has occurred. All costs to place compacted granular backfill, as well as costs for any curb, street, or underdrain repair associated with the undermining, will be the building contractor's responsibility.

Sidewalks at Driveway Crossing

- Sidewalks must be 6 inches thick (minimum) for the length of sidewalk through driveway crossings. Expansion joint material must be used between the sidewalk and driveway pavement (each side of walk) when concrete drives are constructed. The walkway and subgrade must be constructed in accordance with the detail information contained in the Pittsboro Construction Standards.

Erosion Protection

- Developments of 1 acre or more are required (by state law) to have an approved stormwater pollution prevention pan (SWPPP) for the development. The erosion control measures must be in accordance with requirements contained in the state regulation known as "Rule 5". It is the developer's responsibility to obtain the Rule 5 approval.

Erosion protection measures, which have been implemented by the developer (for any development), must be restored on those properties that have been damaged as a result of carelessness or negligence of the building contractor's employees, subcontractors, or suppliers. The cost of restoration is the responsibility of the building contractor, and may be back charged by the developer after sufficient time and notice has been given to make the repairs.

- Erosion from the building contractor's site must be controlled so that erosion of soils and the deposit of silt does not occur on streets or adjacent property. Erosion protection should be accomplished using industry-accepted measures, such as silt fence, rock check dams, etc. Inlets and drains which receive stormwater runoff from the building site must be protected from deposition of silt.

Maintenance of Site

- Damage to any lot in the development which is attributable to or the result of construction activities on the building contractor's site is the responsibility of the building contractor to repair and return the site to the conditions that existed prior to start of construction. The cost for taking corrective action shall be paid by the building contractor. This includes damage by employees, subcontractors, and material suppliers. Damage includes, but is not limited to, parking or driving any type of vehicle on property other than the property for which the builder is responsible; cleaning of concrete trucks and depositing of leftover materials; placing or storing of building materials; and depositing of dirt, stone, gravel, or any other leftover materials.

Costs for removing unwanted deposited materials, and repairing damage to other property, may be backcharged to the building contractor after sufficient time and notice has been given by the developer.

- All loose trash and leftover material must be controlled and disposed of in an acceptable manner. This includes cleaning up trash and materials that have been allowed to scatter to adjacent or nearby properties. Cleanup of materials and trash should be made on a daily basis to maintain a safe and presentable work site. Costs for cleanup of materials are the responsibility of the building contractor.

Once sufficient time and notice has been given, the developer may backcharge the building contractor for any cleanup of extraneous materials or trash that results from the building contractor's work site.

Fire Department Connections

- Where required – Any building or structure required to be equipped with a sprinkler or standpipe system, the fire department connection (FDC) shall be a 5-inch storz type and shall be located within one hundred (100) feet of a fire hydrant and within fifty (50) feet of a twenty (20) foot wide minimum paved driveway or street.
- Location of fire department connection shall be approved by the fire chief or his authorized representative prior to construction.

General Note:

Standard details have been developed for use with construction work in Pittsboro. These standard details contain information regarding Pittsboro's requirements for construction of sidewalks, house laterals, and other information that will be useful to the builder or his subcontractors.

**DESIGN STANDARDS
FOR
STORMWATER AND SUBSURFACE DRAINAGE**

I. General

- A. The developer of a project shall provide the development with an adequate stormwatersystem, in accordance with Town standards. The major water-transporting components of the stormwater management system, such as storm sewers, underdrains, grassed waterways, sediment basins, and stormwater ponds, shall be constructed at the same general time as, or before, the initial street construction.
- B. Discharge of stormwater from a new development shall not adversely affect any adjoining properties. The Town shall approve the location, flow rate, and outlet velocity of discharges from a new development. It may be necessary for the developer to obtain a drainage easement from downstream property owner(s).
- C. Stormwater that will outlet to a County Legal Drain will need to receive approval from the Hendricks County Drainage Board
- D. Stormwater drainage facilities shall be designed such that no habitable structures will be impacted by a 100-year frequency flood.
- E. It is illegal for sump pumps, downspouts, or foundation drains to be connected to the sanitary sewer.
- F. The stormwater drainage system shall be separate and independent of any sanitary sewer system, and points of outlet discharge shall be approved by the Town.
- G. Stormwater drainage facilities shall be located within street rights-of-way where possible, or in perpetual, unobstructed easements of appropriate width, and shall be constructed in accordance with the details on the on the developer's approved construction plans.
- H. It is the responsibility of the developer to keep all major watercourses and drainage systems, not under the jurisdiction of any public agency, open and free flowing.
- I. All stormwater conveyances (culverts, storm sewers, ditches, swales) shall be designed with adequate capacity to convey potential runoff from the entire upstream drainage area, whether inside or outside the proposed development.
- J. The developer of any project that makes any surface change is required to:
1. Collect on-site surface runoff and dispose of it to the point of discharge to an adequate outlet approved by the Town.
 2. Develop a drainage system to convey both existing and potential off-site runoff through the subject development, with the upstream, off-site portion of the drainage area under fully developed conditions.
 3. Pay his proportionate share of the total cost of off-site improvements to the common natural watercourse, based on a fully developed drainage area.
 4. Provide and install at his expense, in accordance with Town standards, all drainage and erosion control improvements.
- K. On-site drainage facilities shall be sufficient to accept:
1. Surface water runoff from the property after total development,
 2. The present surface water runoff received from developed areas upstream,

3. The present surface water runoff received from undeveloped areas upstream, and
 4. That part of the surface water runoff attributable to future development in undeveloped areas upstream that is not reasonably likely to be accommodated in such upstream areas.
- L. When a proposed drainage system shall carry water across property outside the development, appropriate drainage rights must be secured by the developer and indicated on the plat.
- M. Erosion and sediment control measures will be required as part of the development to minimize the loss of soil and adverse effects on the development site and downstream properties.
- N. The approval of the Indiana Department of Natural Resources Division of Water, the U.S. Army Corps of Engineers, and the Hendricks County Soil and Water Conservation District must be obtained, as appropriate, and their requirements must be followed for all areas within the jurisdiction of those agencies.
- O. These standards are to be used in conjunction with the Unified Development Ordinance and other Town regulations.

II. Stormwater Management System Design

- A. A drainage plan for the entire development shall be provided with the initial submittal to the Town for plat review. This stormwater management plan shall be prepared on the basis of the total, ultimate development of the property, even though it may be developed in phases over a period of years.
- B. The drainage plan shall contain a map of the total property and sub-basins within the overall collection system, and off-site drainage boundaries, as appropriate. The map shall indicate the drainage boundary for the development and the drainage collection system within each of the identified drainage sub-basins.
- C. A narrative description of the planned stormwater management system, and how it will address the Town's drainage requirements, is to be provided as part of the drainage plan.
- D. A narrative description of the existing land use and the proposed land use under ultimate development conditions is to be provided as part of the drainage plan.
- E. Design calculations for the proposed stormwater management system are to be provided as part of the drainage plan. This includes storm sewer systems, surface ditches or swales, and stormwater ponds. Required design information to be submitted for each of these facilities is provided in the following sections.

III. Open Channel System Design

- A. Open channel conveyance can range from shallow V-notch grassed swales to trapezoidal-shaped ditches.
- B. Grass-lined stormwater channels shall be provided with permanent seeding within seven days after finish grading is complete. It may be necessary to provide erosion control blanket to assure the establishment of vegetation. The maximum side slopes of grass-lined channels shall be 3 (horizontal) to 1 (vertical).
- C. Riprap-lined channels shall have maximum side slopes of 1-1/2 (horizontal) to 1 (vertical).
- A. All drainage swales shall be provided with an underdrain system (6-inch minimum diameter sleeved perforated or slotted pipe) and shall have a minimum slope of 0.5%.
- D. Open channels carrying a flow greater than 30 cubic feet per second (cfs) shall be capable of accommodating a 50-year frequency design storm within the drainage easement.
- E. Any alteration of an existing open channel traversing a development shall be sized to a minimum 25-year design storm or to the capacity of the existing channel, whichever is greater.

F. Culvert or bridge structures required as part of the open channel drainage system shall be capable of accommodating the following design storms over off-site areas in their present state, and on-site areas in their post-development state.

1. Local Street – 25-year frequency storm event
2. Collector Street – 50-year frequency storm event
3. Arterial Street – 100-year frequency storm event

G. Open channels shall be designed using the standard “rational method” calculation procedures, and the design calculations shall be submitted for all new open channels to be constructed. A map showing the service area of the proposed open channel shall be provided. The calculations shall show the times of concentration, the shape and size of the channel, the channel invert elevations and slope, the weighted roughness coefficient, the appropriate design flow, the channel capacity, and the flow velocity. (Flow velocities shall be maintained at or less than 5 feet per second.) Calculations of head loss through culverts shall be provided.

IV. Subsurface Drainage

A. Subsurface drainage piping is to be provided for two main purposes: street subsurface drainage and open channel underdrains. A separate piping system shall also be made available to provide an outlet for sump pump systems. Both collection systems shall discharge to a storm sewer system. No subsurface drainage system connections will be permitted to the sanitary sewer system.

B. The developer shall provide a subsurface drainage system to be placed along both sides of new streets, under the gutter line at the inside face of the curbing. The drains shall be 2 feet below the soil subgrade and parallel with the longitudinal pavement grade. The purpose of the subsurface piping system is to provide a positive drainage outlet for the street sub-base. No connections, including sump pumps will be allowed on this line.

C. The street subsurface drainage piping shall be 6-inch diameter (minimum size) sleeved perforated or slotted pipe. The piping shall have a minimum slope of 0.1 percent and be surrounded by #8 washed aggregate. The stone envelope around the pipe is to be wrapped in filter fabric to keep fines from clogging the underdrain system.

D. Underdrain systems shall be provided for drainage ditches and swales as described in Section III, Open Channel System Design, above. The swale subsurface drainage system shall have a minimum of 12 inches of cover and be constructed in accordance with Item C, above.

E. The developer shall also provide a separate piping system and outlet flow from foundation drains and sump pump drains from building structures. This system shall be located along the street frontage within right-of-way. These drainage lines shall be located back of the curb and shall be 6-inch diameter, or greater, smooth-wall PVC pipe with a minimum grade of 0.5% to their point of discharge into the stormwater piping system.

D. When approved by the Town, sump pump lines may be connected to the underdrain piping system provided for a grassed waterway or other open channel conveyance located along rear lot lines. This system shall be sized for the planned number of homes discharging to the line.

E. Subsurface drainage systems are provided to receive flow from building drains, either sump pump or foundation, and shall provide directional tees for each property to be served by the drain. One section, extending at least 18” beyond the easement shall be provided at each tee, and shall be capped and its location marked. The location of each connection termination shall be adequately marked so that it can be field located when the corresponding parcel/lot is developed.

F. Downspouts are to be discharged to the ground surface of the subject property.

C. The developer shall provide the location of existing agricultural or other subsurface drainage systems, and shall provide a plan for the continuation of all underground drainage tiles that are affected by the construction process. When a development encompasses an entire area served by an existing underground drainage system, said system may be abandoned upon approval by the Town.

V. Storm Sewer Design

- A. A storm sewer system shall have no interconnections with any sanitary sewer system.
- B. The developer shall provide a storm sewer system whenever curbs and gutters are installed and whenever evidence available to the Town indicates that natural surface drainage is inadequate.
- C. The primary plat submittal shall provide drawings that show the layout of the entire stormwater collection system. All components of the system shall be located within the street right-of-way, or within dedicated drainage/utility easements.
- D. Storm sewers shall be designed on the basis of a minimum 10-year peak design rainfall frequency.
- E. The minimum storm sewer shall be 12-inch diameter reinforced concrete pipe, or 12-inch pipe material having an equivalent or better roughness coefficient. The minimum pipe flow velocity shall be 2.5 feet per second when flowing full.
- F. Storm sewers shall be designed using the standard “rational method” calculation procedures, and the design calculations shall be submitted for all new storm sewers to be constructed. A map showing the service area of the proposed sewer shall be provided. The calculations shall show the times of concentration, the type and size of pipe, the pipe invert elevations and slope, the roughness coefficient, the 10-year design flow, the pipe capacity, and the flow velocity. Allowance shall be made for head loss through manholes and junction boxes. The hydraulic grade line shall be indicated for all storm sewers.
- G. The outfall velocity where a storm sewer discharges to an open channel or stormwater pond shall be maintained at 5 feet per second or less to minimize erosion. Riprap shall be placed around and downstream from storm sewer outfall structures.
- H. Storm sewer inlets shall be provided so that surface water is not carried across or around any intersection, or for a distance of more than 400 feet in the gutter on Local Streets or 300 feet on Collector Streets.

VI. Stormwater Storage Facilities Design

- A. It is the intent of the Town’s stormwater guidelines to control the normal increase in runoff volume from new developments by means of stormwater ponds. These may be designed as dry basins (detention ponds) or wet basins (retention ponds).
- B. Stormwater ponds, either detention or retention, are to be used as the means of controlling runoff from the development area. The peak discharge from the development’s stormwater pond, under 100-year rainfall conditions, shall be limited to the 10-year frequency peak discharge from the development site under pre-developed condition. In addition, the post developed 10-year frequency peak discharge shall not exceed the pre-developed 2-year frequency peak discharge.
- C. The rainfall duration used in determining the 10-year pre-developed peak discharge shall be equal to the time of concentration for the tributary drainage area, or the 24- hour duration storm, whichever results in a lesser peak discharge. Rainfall depths are to be obtained from the National Oceanic and Atmospheric Administration (NOAA). The rainfall distribution used in hydrograph development shall be the Type II rainfall distribution, as described in publications of the U.S. Soil Conservation Service (SCS), now the U.S. Natural Resources Conservation Service.
- D. The 10-year peak discharge shall be based on land use conditions prior to the proposed development, using corresponding runoff coefficients, travel times, and other basin parameters.

E. The inflow hydrograph (stormwater runoff) to all stormwater storage facilities shall be developed using a 100-year frequency 24-hour duration storm event, or a duration which results in a higher pool level for the 100-year storm routing.

F. The 100-year 24-hour inflow hydrograph shall be based on land use conditions representing fully developed conditions, using corresponding runoff coefficients, travel times, and other basin parameters.

G. A routing procedure shall be used to demonstrate that the stormwater storage facility will reduce the 100-year peak discharge from the developed area to a discharge rate equal to or less than the 10-year peak discharge under pre-development conditions. This calculation procedure will identify the peak discharge rate, the maximum pool elevation, and the maximum storage volume required.

H. The results of the routing procedure shall demonstrate that adequate storage volume has been provided. The storage facility shall not be overtopped by the 100-year 24-hour storm event, and shall have a minimum freeboard of 1 foot between the maximum routed pool elevation and the top of the facility embankment.

I. An emergency spillway shall be provided to discharge flow resulting from pool elevations greater than the 100-year 24-hour routed pool elevation. The spillway shall have a minimum size adequate to pass 1.25x the routed 100-year 24-hour storm event, with the primary spillway being plugged and non-functional, without overtopping the storage facility embankment. The elevation of the emergency spillway shall be placed at or above the routed 100-year 24-hour pool elevation.

J. Erosion protection shall be provided for the primary spillway and the emergency spillway so that the storage facility embankment will be adequately protected. The location of the emergency spillway shall be in undisturbed material, or otherwise protected from the effects of erosion, as approved by the Town.

K. The minimum allowable size for the primary spillway conduit from the stormwater storage facility shall be 12-inch diameter pipe. If further restriction of the outlet is required, the restriction shall be made at the inlet end of the conduit.

L. In those instances where the discharge velocity from the primary spillway or emergency spillway is excessive in the opinion of the Town, energy dissipation may be required.

M. Detention facilities, which are designed to have dry bottoms, shall be designed with longitudinal and transverse slope to the outlet structure, so that the facility will drain, leaving no ponded water. In addition, they must be designed to include underdrains to drain the bottom of the basin. This will allow the storage facility to be maintained.

N. Retention facilities shall have a minimum 6-foot wide safety ledge placed below the normal pool elevation at a maximum depth of 30 inches. Also, at least 25% of the pond shall have a minimum depth of 8 feet.

O. Methodology for developing peak discharges, discharge hydrographs, and flood routing calculations shall be in accordance with acceptable engineering practice. Calculations based on the Natural Resources Conservation Service procedures, the Corps of Engineers procedures, or the Bureau of Reclamation procedures are considered acceptable. The Town must approve any other procedures.

P. Peak discharge calculations shall be submitted for the 10-year pre-development conditions and for the 100-year developed conditions. The drainage calculations shall provide a map of the drainage area and provide the runoff coefficients, the times of concentration, and other basin parameters used to develop the appropriate peak discharges.

Q. Calculations shall be submitted showing stage-discharge relationships (rating curves) for the primary and emergency spillways, the stage-storage relationship for the storage facility, the inflow hydrograph for the 100-year 24-hour storm event, and the routed 100-year 24-hour discharge hydrograph.

R. To aid in developing a complete submittal, and in the Town's review of the submittal, the attached form entitled *Checklist for Drainage Review* shall be submitted as part of the drainage calculations.

VII. Drainage Easements

A. Stormwater drainage facilities shall be located in street right-of-way, where appropriate. In all other cases, the following perpetual drainage easements shall be furnished by the developer:

Drainage Item	Easement Width
Storm sewer	30 feet
Grassed waterways (including sized lined channels)	30 feet or channel width equivalent-plus 15 feet, whichever is greater
Detention Basin	Around the 100 year elevation

VIII. Grading for Drainage

A. In order to improve surface drainage, to control erosion, and to provide more suitable sites for building and other uses, proper procedures must be followed in site development.

B. The following requirements shall be met by new developments:

1. The locations, grading, and placement of subgrade (base) material of all streets, public driveways, and public parking areas shall be accomplished as the first work done on a development plan.
2. All lots, tracts, or parcels shall be graded to provide proper drainage away from the buildings without ponding, and all land within the development shall be graded to drain and dispose of surface water without ponding, except where approved by the Town. Around each permanent building foundation, there shall be a slope with a minimum vertical fall of 6 inches for the area measured from the foundation to a point 10 feet from the building foundation, or to the property line, whichever is closer.
3. All drainage provisions shall be of such design as to adequately convey the surface runoff to the nearest suitable outlet, such as a curbed street, storm drain, or natural watercourse. Where drainage swales are used to divert surface water away from buildings, they shall be sodded or planted, as required, and shall be of such slope, shape, and size as to conform to the requirements of the Town.
4. Concentration of surface water runoff shall be permitted only in swales or watercourses.
5. Land alteration shall be accomplished in such a way that the grades left at the time that the work is completed will be permanent and stable.
6. Excavation and fills shall conform to the following requirements:
 - a) Cut and fill slopes shall not be steeper than three-to-one (3:1), unless stabilized by a retaining wall or cribbing, as approved by the Town when handled under special conditions.
 - b) Provisions shall be made to prevent surface water from damaging the cut face of excavations or the sloping surfaces of fills, by installation of temporary or permanent drainage across or above this area.
 - c) Cuts and fills shall not endanger adjoining property.
 - d) Fills shall be placed and compacted to minimize sliding or erosion of the soil.

- e) Fills shall not encroach upon or impede flows of natural watercourses or constructed channels.
- f) Fills placed adjacent to natural watercourses or constructed channels shall have suitable protection against erosion during this period of construction.
- g) Grading shall not be done in such a way as to divert water onto the property of another land owner without the expressed consent of the adjacent land owner.
- h) During grading operations, necessary measures for dust control shall be exercised.
- i) Grading equipment shall not be allowed to cross live streams. Provisions shall be made for the installation of temporary or permanent culverts or bridges.

IX. Responsibility for Drainage and Erosion Control

- A. Whenever sedimentation is caused by stripping of vegetation, regrading, or other development activities, it shall be the responsibility of the developer, or other entity causing such sedimentation, to remove it from all adjoining surfaces, drainage systems, and watercourses, and to repair any damage at his expense as quickly as possible.
- B. Maintenance of all driveways, parking areas, drainage facilities, and watercourses within any development plan area is the responsibility of the developer, provided that said facilities have not been dedicated to the public and accepted by the appropriate authority for public maintenance.
- C. It is the responsibility of the developer, or other entity doing any action on or across a communal stream, watercourse, or swale, or upon the flood plain or floodway of any watercourse during the period of development, to return these areas to their original or equal conditions upon completion of said activities.
- D. No applicant or other entity shall block, impede the flow of, alter, construct any structure, deposit any material or thing, or commit any act which will affect normal or flood flow in any communal stream or watercourse without having obtained prior approval from the Hendricks County Drainage Board, the Indiana Department of Natural Resources Division of Water, or the U.S. Army Corps of Engineers, whichever are applicable.

X. Compliance with Regulations and Procedures

- A. All developments of the required size shall comply with applicable state requirements of Rule 5 (327 IAC 15-5) for erosion and sediment control. It shall be the responsibility of the developer to make the necessary submittals and obtain approval for his project. The developer shall provide the Town with evidence of his adherence to these requirements.
- B. The design, installation, and maintenance of the required drainage facilities and erosion and sediment control measures shall be in accordance with the standards and specifications of the U.S. Natural Resources Conservation Service (NRCS), the Indiana Department of Environmental Management (IDEM), and the Indiana Department of Natural Resources (IDNR).
- C. The approval of plans and specifications for the control of erosion and sedimentation shall be concurrent with the approval of the development and shall become a part thereof.
- D. Permission for clearing and grading prior to the approval of the development plan may be obtained under temporary easements or other conditions satisfactory to the Pittsboro Building Commissioner.
- E. In the event the developer proceeds to clear and grade prior to the approval of the subdivision or development plan, without satisfying conditions specified herein, the Plan Commission may revoke the approval of all plans and a suit for an injunction may be instituted to halt further construction until development plans are approved.

A. Topsoil shall not be removed from residential lots or used as spoil, but shall be redistributed so as to provide at least 6 inches of adequate cover on the lots. No cut trees, timber, debris, earth, rocks, stones, soil, junk, rubbish, or other waste materials of any kind shall be buried in any land, or left deposited on any lot or street in the development.

XI. Performance Principles

A. The following measures are effective in minimizing erosion and sedimentation and shall be included, where applicable, in the overall development plan. The measures used shall conform with Rule 5 requirements.

1. Existing features that would add value to residential, commercial, natural, or manmade assets, such as trees, streams, vistas, historically significant items, and similarly irreplaceable assets, shall be preserved through careful and harmonious design.
2. Stripping of vegetation, regrading, or other development shall be done in such a way as to minimize erosion.
3. Development plans shall keep cut and fill operations to a minimum and ensure conformity with topography so as to create the least erosion potential and adequately handle the volume and velocity of surface water runoff.
4. Whenever feasible, natural vegetation shall be retained, protected, and supplemented.
5. The disturbed area and the duration of exposure shall be kept to a practical minimum.
6. Temporary vegetation and mulching shall be used to protect exposed critical areas during development.
7. The permanent final vegetation and structural erosion control and drainage measures shall be installed as soon as practical in the development.
8. Provision shall be made to effectively accommodate the increased runoff caused by changed soil and surface conditions during and after development. Where, necessary, the rate of surface water runoff will be structurally retarded.
9. Sediment in the runoff water shall be trapped until the disturbed area is stabilized by the use of debris basins, sediment basins, silt traps, or similar measures.
10. Design and construction of the drainage facilities shall be such that they will be durable and easy to maintain.

XII. Definitions

- A. For purposes of these guidelines, the following words shall have the meaning herein stated. Words in the singular number shall include the plural.
1. Building Commissioner – This refers to the Building Commissioner for the Town of Pittsboro.
 2. Cut – An excavation. The difference between a point on the original ground and a designated point of lower elevation on the final grade. Also, the material removed in excavation.
 3. Erosion – The removal of surface materials by the action of water, flow, and wind.
 4. Excavation – Any act by which earth, sand, gravel, rock, or other similar material is dug into, cut, quarried, uncovered, removed, displaced, relocated, or bulldozed, and shall include the conditions resulting therefrom.
 5. Detention Facility – A facility constructed or modified to restrict the flow of stormwater to a prescribed maximum rate, and to temporarily detain concurrent excess water that

accumulates behind the outlet. Detention facilities are dry-bottom storage facilities that temporarily contain stormwater runoff, which is released over time, resulting in a dry basin in non-rainfall periods.

6. Developer – As used in these guidelines, shall mean the owner of the land proposed to be developed, or his representative, who may be an individual, a partnership, a corporation, or an incorporated association of persons, such as a club.
7. Discharge – As used in this guideline, it is a flow rate, or rate of water flow, of a volume of water passing a point per unit of time. This flow rate is commonly expressed as cubic feet per second, millions of gallons per day, or gallons per minute.
8. Ditch – A man-made, open drainageway in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters, flow either continuously or intermittently.
9. Drainage – The removal of excess surface water or groundwater from land by means of ditches or subsurface drains.
10. Drainage Area – As used in this guideline, it is a watershed, or area draining into a watercourse at a given point. Watersheds are commonly broken down into subareas for the purpose of hydrologic modeling.
11. Drainageway – A natural or artificial stream, closed conduit, or depression that carries surface water. A drainageway may be either natural or man-made.
12. Duration – The time period of a rainfall event.
13. Easement – An authorization grant by a property owner for the use by another of any designated part of his property; for a clearly specified purpose.
14. Emergency Spillway – Usually a vegetated earth channel used to safely convey flood discharges from or around an impoundment facility.
15. Fill – Any act by which earth, sand, gravel, rock, or any other similar material is placed, pushed, dumped, pulled, transported, or moved to a new location above the natural surface of the ground or on top of the stripped surface and shall include the conditions resulting therefrom. The difference in elevation between a point on the original ground and a designated point of higher elevation of the final grade. The material used to make a fill.
16. Flood Plain – The area adjoining the river or stream which has been or may hereafter be covered by flood water.
17. Floodway – The channel of a river or stream and those portions of the flood plains adjoining the channel which are reasonably required to efficiently carry and discharge the peak flow of the regulatory flood of any river or stream.
18. Freeboard – A vertical distance between the elevation of the design high-water and the top of a dam or other water control device.
19. Invert – As used in this guideline, the inside bottom elevation of a culvert or other conduit.
20. Peak Discharge – The maximum instantaneous flow rate from a given storm condition at a specific location.
21. Off-Site – Any premises not located within the area of the property to be developed, whether or not in the same ownership of the applicant for development.
22. Plan Commission – Refers to the Pittsboro Plan Commission.
23. Rainfall Intensity – The rate at which rain is falling at any given instant, usually expressed in inches per hour.

24. Rational Method – A means of computing stormwater drainage flow rates (Q) by use of the formula $Q = CIA$, where C is a coefficient describing the physical drainage area, I is the rainfall intensity, and A is the tributary area.
25. Regulatory Flood – That flood having a peak discharge which can be equaled or exceeded on the average of once in a one hundred year period, as calculated by a method and procedure which is acceptable to and approved by the Indiana Department of Natural Resources; this flood is equivalent to a flood having a probability of occurrence of one percent in any given year.
26. Retention Facility - A facility constructed or modified to restrict the flow of stormwater to a prescribed maximum rate, and to temporarily detain concurrent excess water that accumulates behind the outlet. Retention facilities are wet-bottom storage facilities that have a permanent pool and a stormwater storage capacity above the normal pool to allow for temporary storage of stormwater runoff. The accumulated stormwater runoff is released at the controlled rate over time, and the retention facility will return to its normal pool elevation.
27. Riprap – Broken rock, cobble, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water.
28. Runoff – That portion of rainfall or snowmelt that flows from a drainage area on the land surface in open channels or in stormwater conveyance systems. Usually expressed as a rate of flow, or discharge, in cubic feet per second.
29. Runoff from a Fully Developed Area Upstream – The surface water runoff that can be reasonably anticipated upon maximum development of that area of the watershed located upstream from the subject tract, as permitted by prevailing zoning or any existing Master or Comprehensive Plan.
30. Sedimentation – The process that deposits eroded soils, debris, and other materials by the action of wind, water, or gravity on ground surfaces, in bodies of water, or in watercourses.
31. Settling Basin – An enlargement in the channel of a stream to permit the settling of debris and soil that is being carried in suspension.
32. Slope – The face of an embankment or cut section; any ground whose surface makes an angle with the plane of the horizon. Slopes are usually expressed in a percentage, based upon vertical difference in feet per 100 feet of horizontal distance.
33. Soil Stabilization – Chemical or structural treatment of an area of soil to increase or maintain its stability, reduce its erodibility, or otherwise improve its engineering properties.
34. Subsurface Drainage – The removal of excess water from the soil or from prepared beds by a system of underdrains.
35. Swale – A low-lying stretch of land which gathers or carries surface water runoff.
36. Time of Concentration – The travel time of a particle of water from the most hydraulically remote point in the contributing area to the point under study. This can be considered the sum of an overland flow time and times of travel in street gutters, storm sewers, drainage channels, and all other drainageways.
37. Topsoil – Surface soils and subsurface soils that presumably are fertile soils and soil materials, ordinarily rich in organic matter or humus debris. Topsoil is usually found in the uppermost soil layer that is called the “A Horizon.”
38. Town – As used in this guideline, this refers to the Town of Pittsboro or responsible Town officials with authority to act on behalf of the Town of Pittsboro.

39. Underdrain – A small diameter perforated pipe that allows the bottom of a detention basin, channel, or swale to drain; a drain that carries away groundwater or the drainage from prepared beds to which water or wastewater has been applied.
40. Watercourse – A permanent stream, intermittent stream, river, brook, creek, channel, swale, or ditch for water conveyance, whether natural or man-made.

SANITARY SEWER DESIGN STANDARDS

Sanitary sewer systems that are designed and constructed as part of a development that will be annexed into the Town of Pittsboro must satisfy Town standards. The following outlines requirements that must be met to gain Town approval of the project.

1. The developer of a new sanitary sewer system must obtain, at a minimum, a construction permit from the Indiana Department of Environmental Management (IDEM). Other permits/approvals that may be necessary are from the following agencies: Indiana Department of Natural Resources, Indiana Department of Transportation, U.S. Army Corps of Engineers, Hendricks County Highway Department, and Rule 5 permit (through IDEM). The Town requires that these approvals be obtained prior to the Town's approval of the project. Copies of all approval letters are to be submitted to the Town as part of the application package.
2. Gravity sanitary sewers are to be designed and constructed in accordance with the requirements of Specification Section 02731, Pittsboro Design & Construction Standards. Force mains are to be designed and constructed in accordance with the requirements of Specification Section 02732.
3. The underlying requirements for sanitary sewer design are as defined in the *Ten States Standards* and 327 IAC of the Indiana Code, most current version.
4. Sewers for residential developments are to be designed on the basis of 310 gallons/day per dwelling unit and a peaking factor of 4.0. Non-residential structures are to be determined on a case-by-case basis for the specific building use, in accordance with the indicated standards identified in item #3 above.
5. Sanitary sewers are to be constructed using polyvinyl chloride (PVC) pipe, SDR 26, in general. In instances where the sanitary sewer is located parallel to and less than 10 feet from a water line, the sanitary sewer shall be constructed of water-grade pipe, such as PVC C900 pipe. In instances where a sanitary sewer crosses a water main with a vertical separation of less than 18 inches, the same requirements are applicable.
6. Sewer trenches that must be located within five feet of a Town street/county road, or within 12 feet of a state road must be backfilled using granular backfill.
7. Sanitary sewers will be tested for watertightness immediately following installation using a method identified in Specification Section 02731, typically by an air test.
8. All gravity sanitary sewers are to be internally inspected by televising following their installation. A copy of the televising tape is to be provided to the Town.
9. The PVC sewers, being a flexible pipe, are to be tested for deformation by use of a mandrel of the appropriate size. This test cannot be conducted any earlier than 30 days from the date of installation.
10. Sanitary sewer manholes are to be tested for watertightness immediately following installation by a vacuum test, as specified in Section 02731.
11. A Town construction inspector shall periodically be on-site to observe construction practices and conformance with Town standards. The inspector shall be present at all sewer and manhole tests, and for sewer televising.
12. Sanitary sewer mains shall be placed within an easement.

II. CONSTRUCTION

SECTION 01001 - GENERAL REQUIREMENTS

1.1 DEFINITIONS

- A. Whenever used in these specifications the following terms have the meanings indicated which are applicable to both the singular and plural thereof:
1. Town - The Town of Pittsboro, represented by the Town Council, having the authority of approval of the plans, specifications and acceptance of the final construction.
 2. Engineer - Town Engineer or representative to act on behalf of the Town.
 3. Owner - Person or firm having control of the development site, and management of the project.
 4. Contractor - The person, firm or corporation with whom the developer has entered into an agreement for construction of the project.
 5. Project - The total construction of which the work to be provided may be the whole or part.
 6. Work - The entire completed construction or the various separately identified parts thereof required to be furnished.

1.2 WORK TO BE PERFORMED

Work to be performed shall be in accordance with drawings and specifications approved by the Town.

1.3 LOCAL LABOR AND MATERIALS

- A. Whenever possible, the Contractor, his subcontractors, material men, or others who employ labor, shall employ such labor locally.
- B. The Contractor shall purchase materials such as sand, cement, gravel, pipe, steel, lumber, etc., from local dealers wherever such local dealers' prices meet competitors' and where such materials meet the specifications.

1.4 SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

The Contractor shall be solely responsible for all obligations prescribed as employer obligations under Chapter XVII of Title 29, Code of Federal Regulations, Part 1926, otherwise known as "Safety and Health Regulations for Construction."

1.5 DISCOVERY OF HAZARDOUS MATERIAL

If, during the course of this work, the existence of hazardous material, including asbestos containing material, is observed in the work area, the Contractor shall immediately notify the Owner in writing. The Contractor shall not perform any work pertinent to the hazardous material prior to receipt of special instructions from the Owner and the Town of Pittsboro. Asbestos containing material includes transite pipe.

1.6 EASEMENTS

- A. The Developer will obtain right-of-way easements over and through certain private lands for the construction and rehabilitation. The width or limits of such rights-of-way will be defined by the Town before the work or construction shall begin. If the methods of construction employed by the Contractor are such as to require the use of land beyond the limits obtained, he shall make his own agreements with the property owners affected for the use of such additional land.
- B. In all such right-of-way easements, the Contractor shall be required to carefully remove the property owner's fences, or other obstacles to the construction procedure, and replace the same after the work is installed. The backfilling shall be to the grade of the existing ground level or to the grade as established by the property owner in the event the property owner permits the deposit of excess material upon such land.
- C. The cost of all such restoration of property shall be included in this work.

1.7 OPERATIONS WITHIN RIGHT-OF-WAY

In public thoroughfares, all operations of the Contractor, including those of temporary nature, must be confined within the applicable right-of-way limits after having obtained approval of the Town. If the methods of the construction employed by the Contractor are such as to require the use of land beyond the public thoroughfares, he shall make his own agreements with the property owners affected for the use of such additional.

1.8 PERMITS

- A. The Developer will obtain permits which relate to the completed facilities. Permits obtained by the Developer include permits from the following:
 - 1. Indiana Department of Environmental Management
 - 2. Department of Natural Resources
 - 3. Corps of Engineers
 - 4. Indiana Department of Fire Prevention & Building Safety

5. Indiana Department of Transportation
 6. Railroads
- B. The Contractor shall obtain permits which relate to construction procedures.
1. All necessary permits or licenses required from the State or County in connection with construction procedures under or along existing highways shall be obtained by and at the expense of the Contractor. The construction shall be performed by the Contractor in full accordance with any and all requirements of the State Highway Commission or County Road Commission, including those applying to barricades, watchmen, guarding, lighting, storage of supplies, equipment and excavated materials, method of backfilling, final grading, replacement of pavement or road surface, and all other conditions or requirements which may be stipulated by the State Highway Commission or County Road Commission, whether specifically shown on the drawings or mentioned in the specification.
 2. The Contractor shall obtain any blasting permits that may be required.

1.9 MAINTAINING TRAFFIC

- A. Before closing any thoroughfare, the Contractor shall notify and, if necessary, obtain a permit or permits from the duly constituted public authority having jurisdiction, state, county, or city.
- B. The Contractor shall notify the Town of his intention to close a particular street 72 hours in advance of the proposed closing. The Contractor shall place all proper detour signs and barricades prior to the actual street closing.
- C. During the construction, the Contractor shall be responsible for maintaining and protecting the pedestrian and vehicular traffic at all times on all streets involved and providing access to all residential and commercial establishments adjacent to the construction area. The Contractor shall furnish and maintain signage, barricades, flares, etc., in accordance with Indiana Manual on Uniform Traffic Control Devices. The signage, barricades, etc., must be in good condition.
- D. The Contractor shall conduct his work in such manner as not to unduly or unnecessarily restrict or impede normal traffic through the streets of the community. Insofar as it is practicable, do not locate excavated material and spoil banks in such manner as to obstruct traffic. Keep the traveled way of all street, roads, and alleys clear and unobstructed insofar as is possible. Do not use streets, roads, or alleys for the storage of

construction materials, equipment supplies, or excavated earth, except when and where necessary. If required by duly constituted public authority, the Contractor shall, at his own expense, construct bridges or other temporary crossing structures over trenches so as not to unduly restrict traffic. Such structures shall be of adequate strength and proper construction and shall be maintained by the Contractor in such manner as not to constitute an undue traffic hazard. Private driveways shall not be closed, except when and where necessary, and then only upon due advance notice to the Engineer and for the shortest practicable period of time, consistent with efficient and expeditious construction. The Contractor shall be liable for any damage to persons or property resulting from his work.

- E. Streets in which excavation has occurred shall be temporarily restored to receive traffic as soon as possible. Permission to close additional streets shall be denied the Contractor if, in the opinion of the Town or the Engineer, the restoration on streets where excavation has occurred has not progressed satisfactorily.

1.10 WALKS AND PASSAGEWAYS

The Contractor, when required, shall make provisions at cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise. Do not obstruct the sidewalks, gutters, or streets, or prevent in any manner the flow of water in streets. Use all proper and necessary means to permit the free passage of surface water along the gutters. The Contractor shall immediately cart away all offensive matter, exercising such precaution as may be directed by the Engineer. All material excavated shall be so disposed of as to inconvenience the public and adjacent tenants as little as possible and to prevent injury to trees, sidewalks, fences, and adjacent property of all kinds. The Contractor may be required to erect suitable barriers to prevent such inconvenience or injury.

1.11 WARNING LIGHTS AND ARROW BOARDS

The Contractor shall place sufficient warning lights and arrow boards on or near the work and keep them illuminated during periods of construction and reduced visibility (from twilight in the evening until sunrise) and shall be held responsible for any damages that any party or the Owner may sustain in consequences of neglecting the necessary precaution in prosecuting this work.

1.12 UTILITIES

- A. Temporary Removal: All existing utility systems which conflict with the construction of the work herein which can be temporarily removed and replaced shall be accomplished at the expense of the Contractor. Work

shall be done by the utility unless the utility approves in writing that the work may be done by the Contractor.

- B. Permanent Relocation of Utilities: Water mains, storm sewer inlets, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light and traffic standards, cable ways, signals, and other utility appurtenances located in the public right-of-way which would permanently interfere with the proposed improvements will be moved by the utility involved and paid for by the Contractor.
- C. Payment for Utilities: The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light, a gas energy, water service, and telephone service required for the construction of this Contract during its entire progress. He shall provide and pay for all temporary wiring, switches, connections, and meters.

1.13 DUST, NOISE, AND EROSION CONTROL

Dust shall be minimized by use of water and deliquescent salts. Noise shall be minimized by use of properly constructed and maintained equipment provided with suitable mufflers, snubbers, and other sound attenuating devices and supports. Construction activity shall be restricted to 7:00 a.m. to 7:00 p.m. Monday through Saturday, unless otherwise approved by the Town. Erosion shall be controlled in such manner that soil particles from the construction site are prevented from entering public waters or from being deposited on neighboring property, streets, and highways.

1.14 SUBMITTALS - CERTIFICATE OF COMPLIANCE

The Contractor shall submit to the Town a Certificate of Compliance from the manufacturer and/or supplier of each and every specified material or manufactured equipment item. The Certificate shall state that the material or the item of equipment to be furnished has been manufactured with materials in accordance with the applicable sections of all required codes, specifications, and standards as required by the specifications.

1.15 MANUFACTURER'S SERVICE TIME

- A. When a lift station or other equipment is to be furnished by the Contractor and maintained by the Town, service by the manufacturer is required to be furnished as part of the work and shall be at the Contractor's expense.
- B. The service provided shall be by a qualified representative to check the completed installation, place the equipment in operation, and instruct the Town's operators in the operation and maintenance procedures. Such

services are to be for a period of time and for the number of trips specified. A working day is defined as a normal 8-hour working day on the job and does not include travel time.

- C. The services shall further demonstrate to the Town's complete satisfaction that the equipment will satisfactorily perform the functions for which it has been installed.

1.16 GUARANTEE/WARRANTY

The Contractor shall provide a written or typed warranty for all equipment installed.

1.17 RECORD DRAWINGS

- A. Contractor shall prepare or be responsible for preparation and submittal of one (1) set of full size (24" x 36") record drawings in pdf format and one (1) electronic file in AutoCAD format.
- B. Record drawings shall be a full set of drawings showing all details of the sewer construction project reflecting any changes from the approved drawings and showing accurate locations of manholes, structure, sewers, house building services, utility crossings and other pertinent features.
- C. Record drawings shall be certified to accuracy by a registered professional Engineer.
- D. Record drawings shall be submitted to Town Clerk's Office within thirty (30) days after the completion of construction.

1.18 REVIEW AND INSPECTIONS – RESPONSIBILITY FOR COSTS AND FEES

All costs and fees of the Town Engineer, or his or her designated representative, for reviewing plats, development plans, specifications, field inspections of improvements or installations of infrastructure or any other aspects of subdivision or development review, shall be the responsibility of and paid by the subdivider or developer.

END OF SECTION 01001

SECTION 02101 - TEMPORARY EROSION AND DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This item shall consist of temporary control measures as shown on the plans or as ordered by the Owner during the life of a contract to control water pollution, soil erosion, and siltation through the use of berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.
- B. Temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.
- C. Temporary control may include work outside the construction limits such as borrow pit operations, equipment, and material storage sites, waste areas, and temporary plant sites.
- D. Erosion control design for crossing a legal drain shall be approved and constructed per the latest standards of the Hendricks County Surveyor's Office.

1.2 SUBMITTALS

Submit Erosion Control Plans and the SWPPP to the Town Engineer for review and approval.

PART 2 - PRODUCTS

2.1 GRASS

Only non-invasive grasses that will not compete with the grasses sown later for permanent cover shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover.

2.2 MULCHES

Mulches may be hay, straw, fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials.

2.3 FERTILIZER

Fertilizer shall be a standard 10-10-2 commercial grade and shall conform to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

2.4 OTHER

All other materials shall meet commercial grade standards and shall be approved by the Town before being incorporated into the project.

PART 3 - EXECUTION

3.1 GENERAL

- A. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.
- B. The Contractor shall be responsible for compliance to the extent that construction practices, construction operations, and construction work are involved.

3.2 SCHEDULE

Prior to the start of construction, the Contractor shall submit schedules for the installation of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, construction, paving, and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operations for the applicable construction have been accepted by the Engineer.

3.3 AUTHORITY OF OWNER

The Owner has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, to limit the surface area of erodible earth material exposed by excavation, borrow, and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment.

3.4 CONSTRUCTION DETAILS

- A. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the accepted schedule. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design state; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices but are not associated with permanent control features on the project.
- B. Where erosion is likely to be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.
- C. The Owner will limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make

such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

- D. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or are ordered by the Owner, such work shall be performed by the Contractor at his/her own expense.
- E. The Owner may increase or decrease the area of erodible earth material to be exposed at one time as determined by analysis of project conditions.
- F. The erosion control features installed by the Contractor shall be acceptably maintained by the Contractor during the construction period.
- G. Whenever construction equipment must cross watercourses at frequent intervals, and such crossings will adversely affect the sediment levels, temporary structures should be provided.
- H. Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into or near rivers, streams, and impoundments or into natural or manmade channels including storm sewer systems leading thereto.
- I.

END OF SECTION 02101

SECTION 02222 - EARTHWORK FOR UTILITIES

PART I - GENERAL

1.1 DESCRIPTION

- A. Scope: Specifications for the stripping of topsoil and vegetation, excavation, trenching, bedding, filling, backfilling, compaction, and related work in connection with the installation of water mains, gravity sanitary sewers, storm sewers, and force mains are included in this Section.
- B. Definitions
 - 1. Excavation: Removal of earth and rock to form a trench for the installation of a water main, gravity sanitary sewer, storm sewer, or force main.
 - 2. Earth: Unconsolidated material in the crust of the Earth derived by weathering and erosion. Earth includes:
 - a. Materials of both inorganic and organic origin;
 - b. Boulders less than 1/3 cubic yard in volume, gravel, sand, silt, and clay;
 - c. Materials which can be excavated with a backhoe, trenching machine, drag line, clam shell, bulldozer, highlift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.
 - 3. Rock: A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes:
 - a. Limestone, sandstone, dolomite, granite, marble, and lava;
 - b. Boulders 1/3 cubic yard or more in volume;
 - c. Materials which cannot be excavated by equipment which is used to remove earth overburden without the use of explosives, rock rippers, rock hammers, or jack hammers;
 - d. Materials which cannot be excavated with a backhoe, trenching machine, drag line, clam shell, bulldozer, high-lift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.
 - 4. Undercutting: Excavation of rock and unsuitable earth below the bottom of the pipe or conduit to be installed in the trench.
 - 5. Subgrade: Undisturbed bottom of a trench.

6. Bedding: Earth placed in trench to support pipe and conduit.
7. Backfill and Fill: Earth placed in trench from the top of bedding to finished grade, or to subbase of pavement.
8. Topsoil: Earth containing sufficient organic materials to support the growth of grass.

1.2 QUALITY ASSURANCE

- A. If blasting is required, the blasting supervisor shall have no less than five (5) years' experience in explosive demolition and excavation. The blasting supervisor and crews shall have all appropriate licenses for handling and use of explosives.
- B. A Blasting Monitoring and Control Program shall be developed by the Contractor, and submitted to the Engineer, prior to the commencement of blasting operations.
 1. The Blasting Monitoring and Control Program shall indicate the blasting area, the charge locations, number of explosive rounds at each charge location, the maximum charge per delay in pounds, and the maximum charge per round in pounds.

1.3 SUBMITTALS

- A. Submittals shall be as specified in the General Conditions.
- B. Submit the following:
 1. Materials test reports.
 2. Blasting supervisor's experience record.
 3. Blasting Monitoring & Control Program.
 4. Storage procedures for explosives.

1.4 JOB CONDITIONS

- A. All information given in the Contract Documents, including drawings relating to borings, materials encountered, and rock elevations, is from surveys performed by other consultants. Such information is furnished only for the information and convenience of the Contractor. The Engineer does not warrant or guarantee that the materials and conditions encountered during construction will be the same as indicated by the boring samples or by information shown on the drawings.
- B. Existing storm sewers, sanitary sewers, water mains, gas mains, electric ducts, telephone ducts, steam mains and other under-ground structures, lines, and their house connections have been shown on the plans according to the best available information. The exact location and protection of

these facilities and structures, their support and maintenance in operation during construction (in cooperation with the proper authorities), is the responsibility of the Contractor in the performance of his contract.

PART 2 - PRODUCTS

2.1 BEDDING

- A. Class I bedding shall be angular 6 to 12 mm (1/4 to 1/2 inch) graded stone, coral, slag, cinders, crushed stone or crushed shells.
- B. Class II bedding shall be coarse sands and gravels with maximum particle size of 20 mm (3/4 inch). Class II bedding includes variously graded sands and gravels containing small percentage of fines generally granular and non-cohesive, either wet or dry. Soil types GW (well-graded gravel), SW (well-graded sand), and SP (pea gravel and/or crushed stone mixed with sand) are included in this class.

2.2 BACKFILL

- A. General: Backfill shall be earth of such gradation and moisture content that the soil will compact to the specified density and remain stable. Unsuitable materials shall not be used.
- B. Cover Material: Pipe cover material shall consist of durable particles ranging in size from fine to coarse (No. 200 to 1 inch) in size in a substantially uniform combination. Unwashed bank run sand and crushed bank-run gravel will be considered generally acceptable. Bedding material may be used for cover material.
- C. Granular Backfill - Special Backfill: Granular backfill, when indicated on the plans or as ordered by the Engineer, shall be used for backfilling providing it meets the following soils classified by the Unified Soils Classification System ASTM D-2487 or the Indiana State Highway Standard Specification Section 211 - Special Fill and Backfill ("B" Borrow).

<u>Group Symbols</u>	<u>Typical Names</u>
GW	Well-graded gravels and gravel-sand mixtures, little or no fines
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
SW	Well-graded sands and gravelly sands, little or no fines
SP	Poorly graded sands and gravelly sands, little or no fines

- D. Gravel Backfill: When the material excavated from the trench is suitable for granular backfill, the Engineer reserves the right to order, in writing, the use of this excavated material in place of the granular backfill specified to be paid for as a separate pay item.
- E. Suitable Excavated Materials as Backfill: Excavated material shall be used when earth backfill is specified on the plans or where granular backfill is not specifically specified, provided that such material consists of loam, clay, or other materials which, in the judgement of the Engineer, are suitable for backfilling. Unsuitable backfill or frozen backfill material shall not be used. Suitable backfill shall be the following soils, classified by the Unified Soil Classification System, ASTM D-2487:

<u>Group Symbols</u>	<u>Typical Names</u>
GW	Well-graded gravels and gravel-sand mixtures, little or no fines
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well-graded sands and gravelly sands, little or no fines
SP	Poorly graded sands and gravelly sands, little or no fines
SM	Silty sands, sand-silt mixtures
SC	Clayey sands, sand-clay mixtures

<u>Group Symbols</u>	<u>Typical Names</u>
ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays

- F. Unsuitable Materials: Materials which are unsuitable for backfill include stones greater than 8 inches in their largest dimension, pavement, rubbish, debris, wood, metal, plastic, and the following soils, classified by the Unified Soil Classification System, ASTM D-2487:

<u>Group Symbols</u>	<u>Typical Names</u>
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
CH	Inorganic clays of high plasticity
OH	Organic clays of medium to high plasticity
PT	Peat, muck, and other highly organic soils

- G. Concrete Backfill: Concrete used for backfill around sewers, water mains, or other utility piping shall be Class B concrete.
- H. Cellular Concrete: Light weight cellular concrete may be used for filling of abandoned sewers as a grouting mixture for filling voids and as a substitute for backfill concrete in tunnels or casing pipes. The cellular concrete shall be produced by blending preformed foam with cement-sand grout slurry to produce a concrete having a fresh weight per cubic foot of not less than 75 pounds.

PART 3 - EXECUTION

3.1 EXISTING UTILITIES, STRUCTURES, AND PROPERTY

- A. All poles, fences, sewer, gas, water or other pipes, wires, conduits and manholes, railroad tracks, buildings, structures and property along the routes of water mains, force mains, and sewers shall be supported and protected from damage by the Contractor.

- B. Movable items such as mailboxes may be temporarily relocated during construction. Place movable items in their original location immediately after backfilling is completed, unless otherwise shown on the drawings. Replace movable items which are damaged during construction.
- C. The Contractor shall proceed with caution in the excavation and preparation of trenches so that the exact location of underground utilities and structures, both known and unknown, may be determined. The Contractor shall be responsible for the repair of utilities and structures when broken or otherwise damaged.
- D. Whenever, in the opinion of the Engineer, it is necessary to explore and excavate to determine the location of underground structures, the Contractor shall make explorations and excavations for such purpose.
- E. Wherever sewer, gas, water, or other pipes or conduits cross the trench, the Contractor shall support said pipes and conduits without damage to them and without interrupting this Contract. The manner of supporting such pipes, etc., shall be subject to the approval of the utility involved.
- F. When utility lines that have to be removed or relocated are encountered within the areas of operations, the Contractor shall notify the Engineer in ample time for the necessary measure to be taken to prevent interruption of the service.
- G. The Contractor shall so conduct the work that no equipment, material, or debris will be placed or allowed to fall upon private property in the vicinity of the work unless he shall have first obtained the property owner's written consent thereto and shall have shown said written consent to the Engineer.
- H. All excavated material shall be piled in a manner that will avoid obstructing sidewalks and driveways. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, fire and police call boxes, or other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural watercourses shall not be obstructed.
- I. All streets, alleys, pavements, parkways, and private property shall be thoroughly cleaned of all surplus materials, earth, and rubbish placed thereon by the Contractor.

3.2 CLEARING

- A. Clear and remove logs, stumps, brush, vegetation, rubbish, and other perishable matter from the project site as required to perform work.

- B. Do not remove or damage trees that do not interfere with the work. Completely remove trees required to be removed, including stumps and roots. Properly treat damaged trees which can be saved.
- C. Debris from the tree removal, including trunk, branches, leaves, roots and stumps, shall not be buried or burned on the job site, but must be completely hauled away and disposed of at the Contractor's expense.

3.3 STRIPPING AND STOCKPILING OF TOPSOIL

- A. Strip topsoil and vegetation from the excavated areas. Clean topsoil may be stockpiled for reuse as the upper 6 inches of the areas to be seeded.
- B. Do not intermix grass, weeds, roots, root mat, brush, and stones larger than 3 inches with stockpiled topsoil. Dispose of root contaminated topsoil.

3.4 PAVEMENT AND WALK REMOVAL

- A. Remove existing pavement and walks from the excavated areas. Remove excavated asphaltic and concrete materials from the job site as these materials are excavated.
- B. The width of pavement removed along the normal trench for the installation of pipe and structures shall not exceed the width of the trench by more than 12 inches on each side of the trench when the amount of pavement removed is less than 75% of the total existing pavement width. Remove all existing pavement when the excavation requires the removal of 75% or more of the total existing pavement width.
- C. Remove walks completely when excavation is along the length of a walk and requires the removal of part of the walk. Remove walks to existing joints in the walks when excavation crosses walks. If there are no joints in an existing walk, the width of walk removed shall not exceed the width of the trench by more than 12 inches on each side of the trench.
- D. Use methods to remove pavement and walks that will assure the breaking or cutting of pavement and walks along straight lines. The face of the remaining pavement and walk surfaces shall be approximately vertical.

3.5 EXCAVATING

- A. General: After stripping of topsoil and vegetation, perform excavations of every description regardless of material encountered within the grading limits of the project to lines and grades as indicated on the drawings or as otherwise specified.

1. Materials removed below the depths indicated without specific direction of the Engineer shall be replaced at no additional cost to the Owner, to the indicated excavation grade with satisfactory bedding materials placed and compacted.
- B. Dewatering: Keep excavations free from water until the water mains, force mains, sewers, structures, and appurtenances to be constructed in the excavations are completed and will safely withstand forces from water. Provide sufficient dewatering equipment and make satisfactory arrangements for the disposal of the water without undue interference with other work, damage to property, or damage to the environment.
1. Operate dewatering equipment ahead of pipe laying and keep the water level below the pipe invert until the pipe is secured by backfill.
- C. Trenching: Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.
1. Do not open more than 100 feet of trench in advance of the installed pipe, unless otherwise directed or permitted by the Engineer. Excavate the trench within 6 inches of full depth for a distance of at least 30 feet in advance of the pipe laying, unless otherwise directed or permitted.
 2. Contractor shall be responsible for the determination of the angle of repose of the soil in which the trenching is to be done. Excavate all slopes to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting, or where shoring or trench box is to be used.
 3. Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means. Give special attention to slopes which may be adversely affected by weather or moisture content.
 4. Flatten the trench sides when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.
 5. Shoring, sheeting, trench box, or other means shall be used to support sides of trenches in hard or compact soil when the trench is more than 5 feet in depth and 8 feet or more in length. Sides of trenches shall include embankments adjacent to trenches. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse but shall not be steeper than a 1 -foot rise to each 1/2-foot horizontal. Provide a bench of 4 feet

- minimum at the toe of the sloped portion of the trench wall when the outside diameter of the pipe to be installed is greater than 6 feet.
6. Use diversion ditches, dikes, or other suitable means to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Do not allow water to accumulate in an excavation. If possible, the grade should be away from the excavation.
 7. Excavations shall be inspected by a competent Contractor's representative after every rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins shall be increased, if necessary.
 8. Do not store excavated or other material nearer than 4 feet from the edge of any excavation. Store and retain materials as to prevent materials from falling or sliding back into the excavation. Install substantial stop log or barricades when mobile equipment is utilized or allowed adjacent to excavations.
 9. The width of trenches in earth for water main pipe, sewers, basin connections, house connections, and other drains up to and including 33 inches in internal diameter shall provide a clearance of not less than 8 inches or more than 10 inches on each side of the pipe. Trenches for pipe larger than 33 inches in internal diameter shall provide a clearance of not less than 10 inches or more than 14 inches on each side of the pipe.
 10. The maximum clear width of trenches in earth for manholes shall be the greatest external width of the structure plus the space necessary for the construction and removal of the forms and construction of masonry work.
 11. The design of the water main, force main, and/or sewer pipe and structures is predicated upon the width of trench specified in this Article. The Contractor shall be responsible for the provision and installation, at his own expense, of such remedial measures as may be directed by the Engineer, should the trench width limits specified in this Article be exceeded.
 12. Test the air in excavations in locations where oxygen deficiency or gaseous conditions are possible. Establish controls to assure acceptable atmospheric conditions. Provide adequate ventilation and eliminate sources of ignition when flammable gases are present. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, and basket stretcher, shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.
 13. Provide walkways or bridges with guardrails where employees or equipment are required or permitted to cross over excavations.
 14. Provide ladders where employees are required to be in trenches 4 feet deep or more. Ladders shall extend from the floor of the trench to at least 3 feet above the top of the excavation. Locate

ladders to provide means of exit without more than 25 feet of lateral travel.

15. Provide adequate barriers and physically protect all remotely located excavations. Barricade or cover all wells, pits, shafts, and similar excavations. Backfill temporary wells, pits, shafts, and similar excavations upon completion of exploration and similar operations.
- D. Quicksand: Carry on the work with utmost vigor and proceed with the work expeditiously when running sand, quicksand, or other bad or treacherous ground is encountered. Install bedding to support the pipe as directed by the Engineer.
 - E. Blasting: Removal of rock from the excavation may be facilitated by the use of controlled explosives.
 1. Blasting supervision and Blasting Monitoring and Control Programs shall meet the requirements of this Section.
 2. Storage procedures for explosives shall be developed by the Contractor and submitted to the Engineer before explosives are brought to the job site.

3.6 SHEETING

- A. The Contractor shall be responsible for construction means, methods, techniques, and procedures, and for providing a safe place for the performance of the work by the Contractor, Subcontractors, suppliers and their employees, and for access use, work, or occupancy by all authorized persons.
- B. The Contractor shall be solely responsible for all obligations prescribed as employer obligations under Chapter XVII of Title 29, Code of Federal Regulations, Part 1926, otherwise known as "Safety and Health Regulations for Construction."
- C. Adequate supporting systems, such as sheeting, shoring, piling, cribbing, and bracing shall be furnished and installed by the Contractor as required to protect existing buildings, utilities, and property from damage during the progress of the work.

3.7 STORAGE AND REMOVAL OF EXCAVATED MATERIAL

- A. Suitable excavated material required for filling and backfilling operations may be stockpiled in on-site locations as approved by the Engineer, until the material is ready to be placed.

- B. Remove unsuitable materials from the job site as unsuitable materials are excavated. Remove surplus suitable materials from the job site as trenches are backfilled.

3.8 TEMPORARY PLUGS

Prevent foreign matter from entering pipe while it is being installed. Do not place debris, tools, clothing, or other material in the pipe. Close the open ends of pipe by watertight plugs when pipe laying is not in progress. Remove any earth or other material that enters pipe, lateral pipe, or appurtenances through any open pipe end. Remove earth and other materials at no additional cost to the Owner.

3.9 BACKFILLING WATER MAIN AND FORCE MAIN TRENCHES

- A. Backfilling of water main and force main trenches shall meet the requirements of ANSI/AWWA C600, unless otherwise specified in this Section.
- B. Do not backfill trenches and excavations until all utilities have been inspected by the Owner's representative and until all underground utilities and piping systems are installed in accordance with the requirements of the specifications and the drawings. Required hydrostatic tests may be applied to the line either before or after the trench is backfilled, subject to the approval of the Engineer.
- C. Place and tamp bedding and backfill in a manner which will not damage pipe coating, wrapping, or encasement.
- D. Material from the trench subgrade to the centerline of the pipe shall be Class II bedding. Place bedding by hand or approved mechanical methods in layers of 8 inches loose depth. Compact bedding by hand tamping or with a power operated hand vibrating compactor. Deposit bedding in the trench for its full width on each side of the pipe simultaneously.
- E. Place pipe cover material from the centerline of the pipe to 12 inches over the pipe. Compact pipe cover material to the density required to allow backfill over the pipe cover material to be compacted to the density specified in this Article.
- F. Do not use the following materials for backfill:
 - 1. Unsuitable materials;
 - 2. Frozen materials;
 - 3. Materials which are too wet or too dry to be compacted to the densities specified in this Article.

- G. Trenches Requiring Special Backfill When Specified: Where the edge of the trench is 5 feet or less from the edge of the existing or proposed roadway pavement and trenches across roadways, driveways, utility crossing, or in areas to be paved or subjected to traffic, the trench shall be backfilled with Special Backfill. Backfill any trench specifically indicated on the drawings with Special Backfill. Place Special Backfill in lifts. Compact each lift of backfill to not less than 95% of the maximum dry density as determined in accordance with AASHTO T99, Method A. Compaction shall be by hand tamping or approved mechanical tamping devices, or in larger excavations by approved rollers. Do not compact backfill by puddling, unless permitted by the Engineer.
- H. Trenches in State Highway Right-of-Way: Where excavation occurs within the right-of-way of a state highway, all areas within 12 feet of the pavement edge shall be backfilled with Grade "B Borrow" Special Backfill. All areas beyond 12 feet shall be backfilled in the manner specified in the following paragraph.
- I. Trenches Not Requiring Special Backfill: Backfill trenches not requiring granular backfill with suitable excavated material. Place and compact backfill to produce an adequate foundation for the applicable paved or unpaved surface treatment. Fill and restore any settlement of the backfill. In paved areas, backfill shall be maintained to subbase elevation. In unpaved areas, backfill shall be mounded above finish grade to allow for settlement. Grade unpaved area to be restored 6 inches below finish grade after settlement of backfill and immediately before restoration of vegetated areas. Place 6 inches of topsoil over area to be restored.
- J. Trenches in Traveled Pavements: All cuts and trenches in paved streets or other paved areas shall be backfilled within suitable excavated material unless granular backfill is specifically indicated on the plans or ordered by the Engineer to within 12 inches of the street surface. The remainder of the trench is to be filled with crushed stone and compacted in place, prior to opening the street to traffic. The Contractor shall maintain the trenches, adding crushed stone and grading as necessary, until sufficient settlement has taken place and final restoration is made.

3.10 BACKFILLING SANITARY SEWER AND STORM SEWER TRENCHES

- A. Do not backfill trenches and excavations until all utilities have been inspected by the Owner's representative and until all underground utilities and piping systems are installed in accordance with the requirements of the specifications and the drawings.
- B. Place and tamp bedding and backfill in a manner which will not damage pipe coating, wrapping, or encasement.

- C. Bedding procedures for sanitary sewers and storm sewers shall be as specified in the Section for the applicable pipe material.
- D. If bedding does not cover the pipe, place pipe cover material from the top of bedding to 12 inches over the pipe. Compact pipe cover material to the density required to allow backfill over the pipe cover material to be compacted to the density specified in this Article.
- E. Do not use the following materials for backfill:
 - 1. Unsuitable materials;
 - 2. Frozen materials;
 - 3. Materials which are too wet or too dry to be compacted to the densities specified in this Article.
- F. Trenches Requiring Special Backfill When Specified: Where the edge of the trench is 5 feet or less from the edge of the existing or proposed roadway pavement and trenches across roadways, driveways, utility crossings, or in areas to be paved or subjected to traffic, the trench shall be backfilled with Special Backfill. Backfill any trench specifically indicated on the drawings with Special Backfill. Place Special Backfill in lifts. Compact each lift of backfill to not less than 95% of the maximum dry density as determined in accordance with AASHTO T99, Method A. Compaction shall be by hand tamping or approved mechanical tamping devices, or in larger excavations by approved rollers. Do not compact backfill by puddling, unless permitted by the Engineer.
- G. Trenches in State Highway Right-of-Way: Where excavation occurs within the right-of-way of a state highway, all areas within 12 feet of the pavement edge shall be backfilled with Grade "B Borrow" Special Backfill. All areas beyond 12 feet shall be backfilled in the manner specified in the following paragraph. Contractor must gain INDOT approval to performing any work in the State Right-of-Way.
- H. Trenches Not Requiring Special Backfill: Backfill trenches not requiring granular backfill with suitable excavated material. Place and compact backfill to produce an adequate foundation for the applicable paved or unpaved surface treatment. Fill and restore any settlement of the backfill. In paved areas, backfill shall be maintained to subbase elevation. In unpaved areas, backfill shall be mounded above finish grade to allow for settlement. Grade unpaved area to be restored 6 inches below finish grade after settlement of backfill and immediately before restoration of vegetated areas. Place 6 inches of topsoil over area to be restored.
- I. Trenches in Traveled Pavements: All cuts and trenches in paved streets or other paved areas shall be backfilled to the pavement subbase with washed No. 8 stone. The remainder of

the trench is to be filled with washed No. 8 stone and compacted in place, prior to opening the street to traffic. The Contractor shall maintain the trenches, adding crushed stone and grading as necessary, until sufficient settlement has taken place and final restoration is made.

3.11 MAINTAINING TRAFFIC

- A. Before closing any thoroughfare, the Contractor shall notify and, if necessary, obtain a permit or permits from the duly constituted public authority having jurisdiction, state, county, or city, which notice shall be given not less than 72 hours in advance of the time when it may be necessary in the process of construction to close such thoroughfare.
- B. The Contractor shall conduct his work in such manner as not to unduly or unnecessarily restrict or impede normal traffic through the streets of the community. Insofar as it is practicable, excavated material and spoil banks shall not be located in such manner as to obstruct traffic; and the traveled way of all streets, roads, and alleys shall be kept clear and unobstructed insofar as is possible and shall not be used for the storage of construction materials, equipment, supplies, or excavated earth, except when and where necessary. If required by duly constituted public authority, the Contractor shall, at his own expense, construct bridges or other temporary crossing structures over trenches so as not to unduly restrict traffic. Such structures shall be of adequate strength and proper construction and shall be maintained by the Contractor in such manner as not to constitute an undue traffic hazard. Private driveways shall not be closed except when and where necessary, and then only upon due advance notice to the Engineer and for the shortest practicable period of time consistent with efficient and expeditious construction. The Contractor shall be liable for any damages to persons or property resulting from his work.

3.12 WALKS AND PASSAGEWAYS

The Contractor, when required, shall make provisions at cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise, and shall not obstruct the sidewalks, gutters, or streets, nor prevent in any manner the flow of water in the latter, but shall use all proper and necessary means to permit the free passage of surface water along the gutters. The Contractor shall immediately cart away all offensive matter, exercising such precaution as may be directed by the Engineer. All material excavated must be so disposed of as to inconvenience the public and adjacent tenants as little as possible and to prevent injury to trees, sidewalks, fences, and adjacent property of all kinds. The Contractor may be required to erect suitable barriers to prevent such inconvenience or injury.

3.13 WARNING LIGHTS

The Contractor shall place sufficient warning lights on or near the work and keep them illuminated during periods of reduced visibility (from twilight in the evening until sunrise) and will be held responsible for any damages that any party or the Owner may sustain in consequences of neglecting the necessary precaution in prosecuting this work.

3.14 CLEANUP AND MAINTENANCE

- A. Cleanup the job site as backfilling is completed. Remove excess earth, rock, bedding, materials, and backfill materials. Remove unused piping materials, structure components, and appurtenances. Restore items moved, damaged, or destroyed during construction. Grade area to be restored. Leave backfill mounded over trenches which are not backfilled with Special Backfill. Cleanup and restoration specified in this paragraph shall be completed within 1,000 feet of excavation.
- B. Restoration of grass, bushes, trees, and other plants shall be completed by Contractor to original condition.
- C. Restoration of pavement and walks shall be specified in Section 02500, Paving and Surfacing. A temporary driving surface, such as crushed stone, shall be compacted in place in the trench area as backfilling is complete. Cold-mix asphalt patching material may be used as a temporary driving surface at the Contractor's option or when specifically called for in the plans or specifications. Temporary pavement shall not be more than 1,000 feet behind the excavation. When no existing pavement remains after excavation, a temporary compacted aggregate surfacing may be provided instead of the permanent pavement or a temporary cold-mix asphalt pavement. When the pavement is asphaltic concrete, placement of the asphaltic concrete surface course may be delayed until all other heavy construction is completed.
- D. Maintain the job site until the work has been completed and accepted. Fill trenches which settle when settlement is visible. Restore items damaged by construction or improper restoration. Keep dust conditions to minimum by the use of water, salt, calcium chloride, oil, or other means.

END OF SECTION 02222

SECTION 02224 - CONDUIT CONSTRUCTION - SPECIAL CROSSINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and install tunnels and casing pipes beneath streets, highways and railroads and do related work necessary to complete work shown or specified.
- B. Codes, specifications, and standards referred to by number or title in shall be adhered to, and this specification thereto. Latest revisions shall apply to all cases.
- C. Abbreviations: ASTM - American Society for Testing and Materials.

1.2 PERMITS

The permits for crossings shall be obtained by the Owner. The Contractor shall give notification to the Railroad, the Indiana Department of Transportation or other agency involved prior to the start of the work. Do not start work until all arrangements are completed and permission to start the work is given by the District Highway Engineer or other agencies involved.

1.3 TUNNEL WORK

Before beginning any work on tunnel sections, the Contractor shall submit plans and details describing the materials and methods he proposes to use to the Engineer for approval. Do not proceed with the work until such plans and methods have been reviewed for conformity with the approved permit.

1.4 BORINGS AND CASING

The Contractor shall be responsible for installing welded steel pipe casings as shown or specified, in accordance with approved jacking and boring methods. Do not proceed with the work until plans and methods have been reviewed for conformity with the approved permit by the Engineer. The review by the Engineer of any plan or method shall not relieve the Contractor of his responsibility in any way.

1.5 SUBMITTALS

- A. Submittals shall be as specified in the General Conditions and Section 01001, General Requirements.

- B. Submit the following:
 - 1. Plans and details describing materials and methods proposed by the Contractor for use in special crossings.
 - 2. Detailed design calculations and drawings of the proposed support systems for the tunnel construction, prepared and certified by a registered structural engineer.

1.6 GENERAL PROCEDURES

- A. The Contractor shall be prepared to attend all meetings and provide any necessary data, reports, information, details, and construction schedules as requested by the State Highway Department or any other involved agencies.
- B. The Engineer, State Highway Department, or other involved agencies shall review and modify, as necessary, the scheduling of any or all construction activities under the construction area in order to prevent interruption of traffic or service. The Contractor shall include the cost for such procedures in his bid and not be entitled to any change in contract amount from such procedures.
- C. All work shall be done in a careful, workmanlike manner to the satisfaction of both the proper officials and the Engineer.

PART 2 - PRODUCTS

2.1 PRIMARY TUNNEL LINER

- A. The primary liner for tunnel construction shall be steel liner plates or steel ribs and timber lagging. These shall be fabricated to permit in-place assembly of a continuous, safe support system as excavation of the tunnel progresses.
- B. The tunnel liner plates shall be fabricated from structural quality, hot-rolled, carbon steel sheets or plates conforming to ASTM A569. The liner plate shall be a type produced by a reputable manufacturer experienced in the tunnel liner field.
- C. Steel frames for the rib and wood lagging support system shall be fabricated from structural steel I or H shapes. Lagging shall be cut from clear, sound, hard woods. The dimensions of the lagging and spacing of

the steel ribs shall be determined by a registered professional engineer who has fully apprised himself of the job conditions.

- D. The support system shall be designed to properly support the anticipated load on the tunnel prior to installation of the conduit.

2.2 STEEL CASING

- A. Casing pipe and joints shall be of steel construction, capable of withstanding the load of railroad roadbed, track and traffic or the loads of pavement, subgrade and traffic, as applicable. The casing pipe and joints shall be constructed to prevent leakage of any matter from the casing or conduit throughout its entire length, except at open ends of the casing.
- B. The casing pipe shall be welded steel pipe, new and unused material, in accordance with ASTM A-139 Grade B for "Electric Fusion of Welded Steel Pipe," with a minimum yield of 35,000 psi. The inside diameter shall be at least 4 inches greater than the largest diameter of the conduit's main joint.
- C. The minimum wall thickness of the casing pipe shall be as shown in the following table:

Diameter of Casing	Minimum Wall Thickness	
	Under Highway	
	Inches	Millimeters
Under 14"	0.250	6
14"	0.250	6
16"	0.250	6
18"	0.250	6
20"	0.250	6
22"	0.250	6
24"	0.250	6
26"	0.250	6
28"	0.375	10
30"	0.375	10
32"	0.375	10
34"	0.375	10
36"	0.375	10
38"	0.375	10
40"	0.375	10
42"	0.375	10
Above 42"	0.500	13

- D. The exterior walls of casing shall be coated, after the welding of each joint has been completed, with protective coal tar epoxy or bitumastic material.
- E. When casing is installed without the benefit of a protective coating, and it is not cathodically protected, the wall thickness shown above shall be increased to the nearest standard size, a minimum of 0.063 inches greater than the thickness shown, except for diameters under 12-3/4 inches.
- F. The ends of the casing shall be suitably protected against the entrance of foreign material.

2.3 CONCRETE PIPE CASING

- A. Reinforced concrete pipe may be used as a casing pipe in an open-cut and jacking method of installation.
- B. Reinforced concrete pipe shall conform to ASTM C-76, Class V, Wall C.
- C. If concrete pipe is to be used for the jacking method, grout holes for pressure grouting shall be no smaller than 1-1/2-inch, spaced at approximately 3 feet around the circumference and approximately 4 feet longitudinally shall be cast into the pipe by the manufacturer.

2.4 CARRIER PIPE CASING SPACERS

- A. Casing spacers shall be polyethylene or stainless steel, manufactured by APSOR as approved by the Engineer.
- B. Polyethylene casing spacers shall be manufactured by injection molding using high density virgin polyethylene.
- C. Stainless steel casing spacers shall be 10 gauge, Grade T-304L with PVC liner.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF TUNNEL

- A. The Contractor shall be responsible for supporting the top and sides of the tunnel to the required lines and grades, with minimum loss of material from outside the supporting liner. He will also provide adequate lining and bracing for this. The review by the Engineer of any plan or method shall not relieve the Contractor of his responsibility in any way.

- B. Tunnel lining shall be installed to permit the installation of the conduit at exact line and grade shown on drawings and with the outside of the conduit at least 4 inches distant from the liner at all points.
- C. Excavation ahead of the liner shall not exceed the distance required to install a single section. All voids outside the liner and caused by the tunneling operation shall be packed full with a sand-cement grout mixture placed by pressure grouting, through suitable group openings placed in the liner by the manufacturer. Grouting shall be placed as the tunnel liner installation progresses to prevent any initial settlement of the material over the tunnel.
- D. Place a uniform mixture of 1:6 cement grout under pressure behind the liner plates to fill any voids existing between the liner plates and the undisturbed material. Grout holes for pressure grouting shall be no smaller than 1-1/2-inch pipe, spaced at approximately 3 feet around the circumference of the tunnel liners, and provided in every third ring. Grouting shall start at the lowest hole in each grout panel and proceed upwards simultaneously on both sides of the tunnel. Install a threaded plug in each grout hole as the grouting is completed at that hole.
- E. Grouting shall be kept as close to the heading as possible, using grout stops behind the liner plates if necessary. Grouting shall proceed as directed by the Engineer.
- F. As excavation for the tunnel advances, use suitable methods such as poling plates and breast boards to hold the heading in place.
- G. Remove all excavated material from the site as the work advances.
- H. All pipes 60 inches and larger in diameter shall be installed with the use of a tunneling shield, unless otherwise approved by the Engineer. Use a shield for pipes smaller than 60 inches in diameter when soil or other conditions indicate its need.
- I. The shield shall be of steel construction, designed to support railroad track or highway loading as specified in this Section, in addition to other loadings it must sustain. The advancing face shall be provided with a hood, extending no less than 20 inches beyond the face and extending around no less than the upper 240° of the total circumference. It shall be of sufficient length to permit the installation of at least one complete ring of liner plates within the shield before it is advanced for the installation of the next ring of liner plates.

3.2 CONSTRUCTION OF CASING PIPE - JACKING AND BORING METHOD

- A. The casing operation and installing shall proceed from a pit, excavated at a safe distance from the edge of the highway or railroad, and be constructed without interruption to highway or rail traffic.
- B. The conduit shall be installed inside a casing pipe of the length shown on the plans. Except as otherwise permitted by the Highway authorities, or other agencies involved, the casing pipe shall be bored or jacked into place, maintaining exact lines and grades as shown on the drawings for its entire length.
- C. The jacking pipe shall be constructed to provide not less than 20 feet of clearance between the side of the pit adjacent to the track or road and the centerline of the track or road measured at right angles. Open trenches shall be properly sheeted and braced when and where necessary to provide safe working conditions and protection for track, highway, roads, structures and utilities.
- D. During casing and conduit installation, provide and maintain pits for the work at locations shown on the plans or as directed by the Engineer. Excavation for pits shall be sheeted as necessary. Pits are to be backfilled when installation is complete. Excavation and backfilling shall be as specified in Section 02222, Earthwork for Utilities.
- E. Remove all excavated material and replace or change existing structures or utilities encountered to the satisfaction of the Engineer.

3.3 CONSTRUCTION OF CASING PIPE - OTHER METHODS

The installation of the casing pipe by methods other than the jacking method must be performed in a manner which meets with prior approval of the authorities. Any expense incurred in connection with the construction of the crossing, removal, replacement or maintenance resulting from the construction of the casing pipe and the conduit shall be at the expense of the Contractor.

3.4 INSTALLATION OF CARRIER PIPE

- A. The carrier pipe designated on the drawings shall be as specified in the appropriate Section for the type of carrier pipe, i.e., water main, gravity sanitary sewer, storm sewer, force main or electrical conduit.
- B. Jointing of the conduit pipe shall be as specified in the appropriate Section for the type of pipe material and joint fittings.

- C. As the work of installing the conduit progresses, fill the space between the outer shell of the conduit and the tunnel liner or casing with a grout suitable for its intended purpose. The Engineer shall have the right to limit the length of conduit placed in any one step before filling the space to ensure that said space is completely filled in a satisfactory manner.
- D. Place the conduit into and through the tunnel liner or steel casing at locations shown on plans. Employ suitable methods to maintain tight joints, to the satisfaction of the Engineer.
- E. Stainless steel or polyethylene casing spacers shall be used to center the carrier pipe inside the casing.
- F. Casing spacers shall be spaced a maximum of one foot from each side of the joint and a maximum of 12 feet between spacers for stainless steel, and 8 feet for polyethylene.
- G. Polyethylene spacers shall be used only with stainless steel, not ductile iron piping.

END OF SECTION 02224

SECTION 02310 - HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 SCOPE

- A. This Section contains the requirements for the installation of the force main using the horizontal directional drilling method.
- B. The minimum depth of soil cover above the crown of the force main pipe shall be 4 feet 6 inches.
- C. Codes, specifications and standards referred to by title or number in this specification shall be adhered to, and latest revisions shall apply in all cases.

1.2 QUALITY ASSURANCE

- A. The project superintendent on the horizontal directional drilling (HDD) portion of the work shall furnish satisfactory evidence that he has a minimum of five (5) years of HDD experience and shall have worked on at least two (2) HDD projects in similar ground conditions using similar equipment as required on this project. The machine operator shall have attended training sessions on the equipment to be utilized and shall have at least three (3) years of HDD experience and shall have operated similar machinery on at least one (1) HDD project using similar equipment.
- B. The Contractor shall establish and maintain quality control for operations under this section to assure conformance with contract requirements and shall maintain records of his quality control for materials, equipment, and construction operations including, but not limited to, the following:
 - 1. Check selected pipe material for conformance to contract specifications and to certification tests.
 - 2. Check manufacturer's requirements for proper pipe handling and storage.
 - 3. Review pipe installation procedure with the Owner's Representative.
- C. Perform hydrostatic test as specified in Section 02732.

1.3 SUBMITTALS

- A. Submittals shall be as specified in the General Conditions and Section 01001, General Requirements.
- B. Submit the following:
 - 1. Detailed description of the procedures including construction techniques.
 - 2. Literature describing in detail the drilling system to be used.
 - 3. Working Drawings:
 - a. Approximate layout of boring and receiving locations, and associated equipment at each location.
 - b. Electrical system.
 - c. Grade and alignment control system details.
 - d. Groundwater control provision of drilling equipment, if required.
 - 4. Certification from the pipe manufacturer that the pipe and pipe joints are manufactured for drilling installation and conform to current specifications.
 - 5. Qualifications and experience record of the drilling superintendent, and machine operators.
 - 6. As-built drawings showing actual location of installed pipe.

PART 2 - PRODUCTS

2.1 POLYETHYLENE PIPE

- A. Polyethylene piping and fittings shall be made of a high density polyethylene pipe compound with extra high molecular weight that meets the requirements for Type III, Grade P345 Polyethylene Material as defined in ASTM D-1248 (PE 3408). The minimum wall thickness of the polyethylene pipe shall be SDR 11.
- B. Joining Systems
 - 1. Pipes shall be jointed to one another and to polyethylene fittings by thermal butt-fusion or by socket fusion in accordance with ASTM D-2161.
 - 2. Joining of the pipes and fittings shall be performed in accordance with the procedures recommended by the pipe manufacturer. Depending upon the installation requirements and site location,

joining shall be performed within or outside the excavation. Joints between pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16 inch.

3. The tensile strength at yield of the butt-fusion joints shall not be less than the pipe. A specimen of pipe cut across the butt-fusion joints shall be tested in accordance with ASTM D-638.

C. Environmental Stress Cracking Resistance

1. When the environmental stress cracking resistance (ESCR) of the material is measured in accordance with ASTM D-1693, Condition B, the material shall withstand not less than 100 hours in 25 percent solution Igepal CO-630 or 1,000 hours in 100% Igepal CO-630 before reaching a 50 percent failure point (F50).

D. Tests

1. General - Tests for compliance with this Specification shall be made as specified herein and according to the applicable ASTM specifications. A certificate of compliance with these specifications, along with a report of each test, shall be furnished by the manufacturer for all material furnished under this specification. In addition, the purchaser may, at his own expense, witness inspection and test of the materials.
2. Tensile Properties - The tensile strength, yield strength, elongation and elastic modulus of the material shall be determined in accordance with ASTM D-638. ASTM D-638 shall be used to determine that the thermal butt-fusion joints are stronger than the materials joined.
3. Melt Index - The melt index of the polyethylene resin shall be determined in accordance with ASTM D-1238 and shall be equal, or between 0.1 g/10 min. and 1.0g/10 min.
4. Density - The density of the base polyethylene resin shall be determined in accordance with ASTM D-1505 and be equal or between .941/gcc and .055 g/cc.
5. Environmental Stress Cracking Resistance - The material shall be tested in accordance with ASTM D-1693, Condition B. The test reagent shall be Igepal CO-630 in 25 percent solution by volume. The specimens shall be in the solution not less than 100 hours before reaching a 50 percent failure point (F50).

E. Rejection

1. Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

PART 3 - EXECUTION

3.1 GENERAL

- A. The polyethylene piping and fittings shall be installed in accordance with ASTM D-2774, Underground Installation of Thermoplastic Pressure Piping, and with the guidelines and recommendations of the manufacturer.
- B. The pipe shall be installed in the location to the line and grade designed by the Contractor with the pipe joints neatly fused together.
- C. 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. Gutters, driveway, and street crossings shall be kept clear except when the latter are unavoidably obstructed by open trench.
- D. 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 expense.
- E. Pipe crossing alignment shall be laid out by land survey team confirming accurate horizontal distances, either physically measured or shot by Electronic Distance Measurement. Entry and exit points shall be located and marked with survey hubs or markers. Payment for survey mark-out shall be included in the Contractor's cost for horizontal directional drilling.
- F. 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 disturbing as little area as needed to accommodate workers and equipment, and to string, fuse, and inspect the pipe.
- G. A drilling fluid shall be used in connection with the installation of the proposed pipe into the hole. Prior to installation of the pipe into the hole, the Contractor should determine whether a cement or bentonite slurry shall be used as a supplement. If sub-surface conditions contain predominantly clayey soils, then the bentonite slurry should be used. Polymers can be used, if appropriate.

- H. Mud and slurry material displaced by the pipe during installation and during drilling operations shall be deposited in watertight containers and hauled off by a vacuum truck to a certified receiving site.

3.2 TESTS AND INSPECTIONS

A. Testing

- 1. All installed pipe shall be subjected to a watertightness test as provided in Section 02732, Article 3.8.

END OF SECTION 02310

SECTION 02500 – STREETS, DRIVEWAYS, AND OTHER RIGHT-OF-WAY
INFRASTRUCTURE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: This section covers all work involved in the installation of new pavement, walks, and curbs, and the repair and replacement of existing streets, roads, highways, drives, parking areas, curbs, gutters, sidewalks, and other paved areas damaged or destroyed during construction of the work included in this Contract.
- B. Related Work Specified in Other Sections
 - 1. Section 02222 Earthwork for Utilities Subgrade Preparation 2. Section 02902 Landscaping for Utilities Fine Grading & Seeding
- C. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the reference thereto. Except as specifically modified in this specification, paving and surfacing operations, materials and testing will comply with the most current revisions of applicable sections of the current Indiana Department of Transportation Standard Specifications (INDOTSS).
- D. Definitions
 - 1. Abbreviations
 - a. INDOTSS Indiana Department of Transportation's Standard Specifications.
 - b. AASHTO American Association of State Highway & Transportation Officials.
 - c. ACI American Concrete Institute.
 - d. ASTM American Society for Testing & Materials.
 - e. NRMCA National Ready Mix Concrete Association.
 - 2. Rock: A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes limestone, sandstone, dolomite, granite, marble, and lava.
 - 3. Subgrade: The prepared and compacted soil immediately below the pavement or walk system and extending to such depth as will affect the structural design.
 - 4. Subbase: The layer of specified or selected material of designed thickness placed on a subgrade to support a base course and surface course.

5. Base Course: The layer of specified or selected material of designed thickness placed on a subbase to support a binder or surface course.
6. Binder Course: The layer of specified or selected material of designed thickness placed on a base course to support a surface course.
7. Surface Course: The layer of specified or selected material of designed thickness placed on a subbase or base course to support the traffic load.

1.2 QUALITY ASSURANCE

- A. The Contractor shall employ and pay for the services of an independent testing laboratory (unless otherwise noted) to perform specific services and necessary field density tests. The Contractor shall demonstrate to the Engineer that proper compaction has been obtained and proper asphalt and concrete mix designs are in compliance with the specifications.
- B. Mixing Plant: Prior to placing any hot asphalt concrete pavement or Portland cement concrete pavement, the Contractor shall provide the Engineer the name and location of the bituminous mixing or concrete mixing plant and the type and composition of mixes the Contractor proposes to use in the work.
 1. Paving and surfacing shall comply with the tolerances specified in current INDOTSS.
- C. Asphalt and concrete pavement shall be installed by a contractor whose prime business is asphalt or concrete paving.

1.3 SUBMITTALS

- A. Submittals shall be as specified in the General Conditions and Section 01001, General Requirements.
- B. Submit the following:
 1. Name and location of bituminous mixing plant or concrete ready-mix plant. Mixing plants and equipment shall meet the requirements of current INDOTSS.
 2. Type and composition of proposed materials and mixes. Job mix formulas shall be prepared and submitted for approval to the Engineer in accordance with current INDOTSS. It shall include standard bituminous information including, but not limited to, aggregate gradation, binder content, maximum specific gravity, and air voids.

3. Certified copies of reports of tests specified in this Section and required by the referenced standards.

1.4 JOB CONDITIONS

- A. Do not place paving and surfacing materials on a wet surface, pumping subbase or when weather conditions would prevent the proper construction of paving and surfacing.
- B. Do not place aggregates on frozen subgrade. Do not place aggregates when air temperature is below 35°F.
- C. Bituminous materials are to be placed in accordance with current INDOT Standard Specifications.
- D. Discontinue placing concrete when a descending air temperature away from artificial heat reaches 40°F, and do not resume placing concrete until an ascending air temperature away from artificial heat reaches 35°F.
- E. Do not place paving and surfacing materials when natural light is not sufficient to properly observe work or operations.

1.5 CONSTRUCTION ENGINEERING

The Owner will furnish the Contractor with necessary information relating to lines and grades, including temporary benchmarks and reference points. The Contractor will be responsible for setting necessary construction stakes to establish the specified roadway line and grade. The Contractor shall be held responsible for the reasonable preservation of reference points set by the Engineer. Reestablishment of reference points due to the Contractor's negligence will be done by the Contractor at his expense.

1.6 GRADE ADJUSTMENT OF EXISTING STRUCTURES

- A. When grade adjustment of existing structures is required, the manhole frames, covers and gratings, and the gas and water valve boxes and covers, shall be removed and reconstructed to grade as required.
- B. On resurfacing work, the casting's and boxes shall be adjusted to grade after the last binder course has been laid and before placing the surface course.
- C. All castings, frames and valve boxes adjusted to grade shall be done in advance of the final paving and shall be paid for by the Contractor as part of the project, unless specifically identified as an item for payment in unit price contracts.

1.7 CONTRACTOR'S ORGANIZATION

- A. The Contractor shall be a firm whose prime business is asphalt or concrete paving. The Contractor shall have a competent supervisor on the site during the progress of the work, acting for the Contractor in all matters concerning the work. He shall have the authority to receive directions and act upon them for the Owner through the Owner's authorized representative.
- B. The Contractor shall keep a set of Plans and Specifications available on the site and in good condition.

1.8 TRAFFIC CONTROL

The Contractor shall plan construction operations so that existing local traffic access can be maintained. During the construction, he will also maintain appropriate use of barricades, lights, flagmen and other protective devices, whether specified for the project or required by the local governing authority. Traffic control devices used for maintenance of traffic shall comply with the Indiana Manual on Uniform Traffic Control Devices.

PART 2 - PRODUCTS

2.1 AGGREGATE

- A. Fine aggregates shall consist of natural sand or manufactured sand produced by crushing rock, shells, air-cooled blast furnace slag, or wet bottom boiler slag.
 - 1. Fine aggregates used in Portland cement concrete and bituminous pavements shall be free from injurious amounts of organic impurities. When subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be tested for effect of organic impurities on strength of mortar in accordance with AASHTO T 71. If the relative strength at 7 and 28 days, calculated in accordance with section 10 of T 71, is less than 95%, it shall be rejected.
- B. Coarse aggregates shall consist of clean, tough, durable fragments of crushed rock, crushed or uncrushed gravel or shells, or crushed and processed air-cooled blast furnace slag. These materials shall not contain more than 15% flat or elongated pieces and shall not contain particles with an adherent coating. Flat or elongated pieces will be described as pieces having a length in excess of four times its width.

- C. Coarse aggregates and fine aggregates shall comply with current INDOTSS.

2.2 BITUMINOUS MATERIALS

- A. Petroleum asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 347°F.
 - 1. Petroleum asphalt cement shall be PG Binder, grade PG 64-22.
 - 2. Petroleum asphalt emulsion shall be AE-60.
- B. Bituminous materials for prime coat shall consist of:
 - 1. Cut-back asphalt - MC-70; or
 - 2. Asphalt emulsion - AE-P.
 - 3. Materials shall conform to current INDOTSS.
- C. Bituminous materials for tack coat shall consist of:
 - 1. Asphalt emulsion - AE-T.
 - 2. Materials shall conform to current INDOTSS.
- D. Bituminous materials for seal coat shall consist of:
 - 1. Asphalt emulsion - RS-2, AE-90, AE-150, HFRS-2.
 - 2. Materials shall conform to current INDOTSS.
- E. Cover aggregate shall consist of:
 - 1. Coarse aggregates, Class A or B, size no. 8, 9, 11 or 12.
 - 2. Fine aggregate (natural sand only), size no. 23 or 24.
 - 3. Materials shall conform to current INDOTSS.

2.3 HOT MIX ASPHALT (HMA)

- A. Hot mix asphalt (HMA) shall consist of an intimate mixture of coarse aggregate, fine aggregate (including mineral filler if required), and asphalt cement or emulsion combined in proportions specified in current INDOTSS.
- B. When the use of one type or source of aggregate or binder is started, the use of that same type or source shall be continued for the entire lift being constructed, unless otherwise directed by the Engineer.

- C. The use of recycled materials, RAP or ARS, shall not be permitted unless otherwise directed and approved by Engineer.
- D. Preparation of HMA mixtures shall comply with the requirements of current INDOTSS.

2.4 PORTLAND CEMENT CONCRETE

- A. Cement shall be Portland cement and shall meet the requirements of ASTM Specification C 150, ACI 301, and ACI 318. Cement shall be Type 1 for normal use, Type I A where air entrainment is desired, or Type III or Type IIIA where high early strength is desired and authorized by the Engineer. Blended hydraulic cements which meet the requirements of ASTM Specification C 595 Type 1P Portland pozzolan cement may be used where a more watertight concrete is required. Fly ash may also be used as a partial cement replacement for Types 1 or 1A. Cement shall meet requirements specified in current INDOTSS.
- B. Regular fine and coarse aggregates shall meet the requirements of ASTM Specification C 33. Aggregate shall be crushed limestone with a maximum size of 3/4 inch, except in mass concrete the maximum size may be 1 1/2 inches.
 - 1. Lightweight fine and coarse aggregates shall meet the requirements of ASTM Specification C 330.
 - 2. Insulating fine and coarse aggregates shall meet the requirements of ASTM Specification C 332.
- C. Water shall be potable, clean, and free from injurious amounts of oils, acids, alkalis, organic materials, or other substances that may be deleterious to concrete or steel. A maximum of 500 mg/L of chloride ion may be present in the water.
- D. Air entraining admixtures shall meet the requirements of ASTM Specification C 260.
 - 1. Water reducing and retarding admixtures shall meet the requirements of ASTM C494, Type A or Type D; however, they shall contain no chlorides, be nontoxic after 30 days and compatible with the air entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's requirements. Furnish a compliance statement that the admixture used satisfies all requirements of this specification. Evidence that the admixture is included in the approved list of the current INDOTSS Division of Materials and Tests, in accordance

with current INDOTSS will satisfy the requirement for a compliance statement.

2. Fly ash shall meet the chemical and physical requirements of ASTM C 618 for mineral admixture Class F, except loss on ignition shall not exceed 6%. Fly ash shall be sampled and tested in accordance with ASTM C 311 prior to use.
- E. Reinforcing steel shall meet the requirements of ASTM Specification A 615, Grade 60.
1. Welded wire fabric or wire mesh shall meet the requirements of ASTM A 185.
 2. Reinforcing steel and appurtenances shall follow current INDOTSS.
- F. Preformed expansion joint filler shall meet the requirements of ASTM Specification D 1752, Type III.
1. Hot-poured elastic joint filler shall meet the requirements of ASTM Specification D 1190.
 2. Waterproof expansion joint filler shall meet the requirements of ASTM Specification D 1850.
 3. Joint materials specified in current INDOTSS may be used, if approved by the Engineer.
- G. Concrete pavement shall be wet cured by using burlap, waterproof blankets, or ponding; or by using a membrane compound. If the membrane method is used, the compound shall be Type 2, complying with AASHTO M 148 for white pigmented compound. A pressure sprayer capable of applying a continuous uniform film to the pavement surfaces will be required.
- H. Dowel bars shall be smooth, round bars of plain billetsteel conforming to ASTM A615, Grade 40, and free of any deformation or foreign material that would restrict slippage in concrete. Dowel bars shall be coated as required by current INDOTSS. For expansion joints, each bar shall be provided with a metal cap, or approved plastic cap, on one end that will provide for ample movement of the slabs.
1. Dowel bars and assemblies shall conform to the requirements of current INDOTSS.
- I. Concrete base shall meet the requirements of INDOTSS Section 307.
- J. Reinforced concrete pavement shall meet the requirements of current INDOTSS.

- K. Reinforced concrete for sidewalks and steps shall meet the requirements of current INDOTSS.
- L. Reinforced concrete for curbing shall meet the requirements of current INDOTSS.

2.5 UNDERDRAINS

Underdrain material shall be 4-inch polyethylene perforated pipe meeting ASTM F405 specification and shall be per current INDOTSS.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor is responsible to provide equipment, workmanship and materials required to achieve a finished product that meets these specifications.
- B. Use compaction equipment suitable to the material being placed. Compacting equipment shall include at least one piece of equipment capable of providing a smooth even surface on the pavement surface course.
- C. Prior to placing paving and surfacing materials, shape subgrade as required to produce finished pavement grades and cross-sections shown on drawings.
- D. Do not place paving and surfacing material before subgrade is reviewed and accepted by the Engineer. Do not place paving and surfacing materials on a frozen or muddy subgrade.
- E. Compact subgrade to not less than 100% of its maximum density as determined in accordance with AASHTO T99.
- F. Provide adequate drainage at all times to prevent water from standing on subgrade, pavement or walks.

3.2 SUBGRADE

- A. The subgrade material and testing shall comply with current INDOTSS before placement of subbase.
- B. Lime Stabilization

1. Lime stabilization shall be required for street construction if the subgrade does not pass a proof roll test.
2. Lime stabilization, if utilized at the Contractor's option, shall be performed in compliance with the town's standard specification on "Lime Kiln Dust Modification." A copy of the specification is available through the Town Street Superintendent's Office.
3. No modification in pavement structure design and/or decrease in pavement thickness shall be permitted in conjunction with the use of a lime-modified subgrade.

3.3 SUBBASE PREPARATION

Provide 8 inches of subbase in locations where pavement is to be placed on a material other than Special Backfill. Subbase shall meet the requirements of current INDOTSS.

3.4 AGGREGATE BASE, SURFACE, OR SHOULDERS

- A. Aggregate base, surface, or shoulders shall consist of crushed rock or gravel. The aggregate type shall be suitable for the area in which the project is located. The aggregate thickness shall be as shown on the drawings and as specified herein.
- B. Aggregate shall be Type "0" mix, unless otherwise specified by the Engineer.
- C. Compacted aggregate materials and construction shall conform to current INDOTSS.
- D. If the required thickness of the aggregate (Type 0) exceeds 4 inches, the material shall be placed and compacted in separate lifts no less than 2 inches nor more than 4 inches of compacted depth. If Type P aggregate is used, it may be placed in individual lifts with a thickness of up to 6 inches.
- E. If spreading devices are used which will ensure proper depth and alignment, forms will not be required; otherwise, forms shall be required. Forms shall be of wood or steel, adequate in depth, straight, of uniform dimensions and equipped with positive means for holding the form ends rigidly together and in line. Segregation of material shall be avoided by any spreading method used. No payment will be made for aggregate placed beyond the dimensions shown on the drawings.
- F. Compact material in each lift after material is spread and shaped. Compact material to not less than 100% of maximum dry density as determined by AASHTO T99. Use construction procedures, including

sufficient wetting and number of passes, to ensure specified density is attained.

- G. The Contractor shall employ an independent testing laboratory to perform field density tests to demonstrate proper compaction of aggregate surface pavement, if requested by the Engineer.
- H. In a brick surfaced street, unless specifically excepted and pending the structural adequacy of any remaining brick, the Contractor may remove all brick and enough base material to allow full width repaving using either a bituminous or concrete pavement; or of providing a HMA base and HMA intermediate for the full depth of the brick across the trench and then replace the entire street with 1 inch of HAC surface.
- I. Unless otherwise approved by the Town Engineer, the minimum section (excluding subgrade) of reinforced concrete shall be 6 inches of compacted #53, Type "0" aggregate base and 6 inches of 4,000 psi
- J. Unless otherwise approved by the Town Engineer, for a street with a brick base and an asphalt surface, the replacement section shall be full depth asphalt from the bottom of the brick base to the top of the asphalt surface. The top 1 inch shall be #11 HMA surface.
- K. Unless otherwise approved by the Town Engineer, for a street with a concrete base and an asphalt surface, the replacement section shall be a new concrete base, not less than 6 inches thick with #5 HMA base to within 1 inch of the existing grade and then 1 inch of #11 HMA surface.
- L. Unless otherwise approved by the Town Engineer, chip and seal pavements shall have 8 inches of compacted aggregate base (#53, Type "0" crushed stone) and 1 inch processed bituminous coated aggregate pavement placed and rolled as specified in current INDOTSS.
- M. Unless otherwise approved by the Town Engineer, gravel pavement shall be replaced with 6 inches of #53, Type "0" compacted stone or gravel aggregate as specified in current INDOTSS.

3.5 HOT MIX ASPHALT

- A. This work shall consist of constructing one or more courses of HMA base, intermediate, and wedge leveling or surface mixtures on a prepared foundation in accordance with these specifications and in reasonably close conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

1. If the required finished depth of any course is to exceed three times the top size of the aggregate used as shown by actual screen analysis, the course shall be constructed in two or more lifts, as directed.
 2. Mix type shall be as indicated on the drawings, without exception, unless otherwise approved in writing by the Engineer.
 - a. Job mix formulas shall be prepared and submitted for approval to the Engineer in accordance with current INDOTSS. The job mix formula shall include standard bituminous mixture information including, but not limited to, aggregate gradation, binder content, maximum specific gravity, and air voids.
 3. Materials and construction requirements shall comply with the requirements of current INDOTSS.
- B. If the previously constructed course is granular, a prime coat will be required.
1. Apply prime coat uniformly at a rate of 0.25 to 0.80 gallon per square yard depending on condition of surface and amount of loose aggregate.
 2. Apply prime coat with a pressure distributor. Temperature of prime coat shall not exceed 150°F.
 3. Squeegee excess prime coat from the subbase surface. Correct deficient or skipped area.
 4. Prime coat shall be placed in accordance with current INDOTSS.
- C. Place and spread bituminous base mixture with a bituminous paver. In areas inaccessible to a paving machine, place and spread bituminous base mixture by other acceptable mechanical or hand methods.
- D. Tack coat shall be placed on existing bituminous or concrete surfaces before a new lift of bituminous material is added. Apply tack coat uniformly at a rate of 0.06 gallon per square yard (0.000252 ton per square yard).
1. Patch and clean existing surface. The surface shall be free of irregularities and provide a reasonably smooth and uniform surface to receive the tack coat. Remove and replace unstable corrugated areas with suitable patching materials.
 2. Tack coat shall be placed in accordance with current INDOTSS.
 3. Placement and compaction of hot mix asphalt (HMA) shall conform to current INDOTSS.

- E. Place binder used for wedging or leveling, approaches and feathering by mechanical methods or acceptable hand methods for placing and spreading in accordance with current INDOTSS.

3.6 SEAL COAT AND COVERING AGGREGATE (CHIP AND SEAL)

- A. Application shall be as follows:

<u>Seal Type</u>	<u>Cover Aggregate Size Number</u>	<u>Rate of Application per Square Yard</u>	
		<u>Aggregate Pounds</u>	<u>Bituminous Material Gallons at 60°F</u>
1-Single Application (only AE-90 or AE-150)	23, 24	12-15	0.12-0.16
2-Single Application	12	14-17	0.29-0.33
5-First Application	11	16-20	0.36-0.40
Second Application	12	16-19	0.33-0.37

- B. Seal coat and covering aggregate shall be placed in accordance with current INDOTSS.

3.7 PORTLAND CEMENT CONCRETE PAVEMENT

- A. Portland cement concrete pavement shall consist of a coarse aggregate base (if required) and a reinforced or unreinforced Portland cement concrete surface, as shown on the drawings
 - 1. Use No. 53, Type "0" coarse aggregate for subbase, unless otherwise shown or specified.
 - 2. Pavement cross-section shall be as shown on drawings.
- B. Where an aggregate base course is shown or specified, it shall be constructed in accordance with Article 3.3 of this specification.
- C. Portland cement concrete pavement operations and materials shall comply with current INDOTSS unless otherwise specified by the Engineer.
 - 1. Alternate equipment to that specified in current INDOTSS shall be allowed provided that line, grade, surface, smoothness and other requirements of the specifications are met. The equipment used shall be subject to the approval of the Engineer.
 - 2. Expansion and contraction joints shall be installed as indicated on the drawings or as required by INDOTSS. Expansion joints shall

- be required whenever new concrete abuts fixed objects or existing concrete surfaces, whether or not shown on the drawings.
3. Keyway construction, load transfer devices, tie bars and slab and ear reinforcement shall be installed as indicated on the drawings.
 4. Unless otherwise shown on the drawings, the final finish of concrete pavement shall be by brooming, as set out as Method 1 in current INDOTSS to form a transverse skid-resistant finish.
 5. The Contractor shall always have materials available to protect the surface of concrete against rain. These materials shall consist of burlap, curing paper or plastic sheeting.
 6. New concrete pavement shall be protected by the Contractor until opening to traffic is approved by the Engineer. It shall not be opened to traffic until the field-cured concrete has attained a flexural strength of 550 psi, or a compressive strength of 3,500 psi. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Before opening to traffic, the pavement shall be cleaned and permanent lane markings applied to the pavement.

3.8 WALKS

- A. Walks shall consist of a coarse aggregate subbase and a reinforced concrete surface. Use No. 24 fine aggregate for subbase unless otherwise approved by the Town Engineer. Concrete shall be Class "A", 4,000 psi concrete.
- B. Subbase shall be 4 inches thick, and concrete shall be 4 inches thick, unless otherwise approved by the Town Engineer.
- C. Compact subbase to not less than 95% of maximum dry density, as determined in accordance with AASHTO T99.
- D. Proportion, mix, and place concrete as specified in current INDOTSS. Walks shall have a broom surface finish. Edge all outside edges of walk and all joints with a 1/4 inch radius edging tool.
- E. Unless otherwise shown on the drawings, walks shall be divided into sections not more than five feet in length by dummy joints formed by a jointing tool with a 1/4-inch radius.
- F. Form construction joints around all abutting structures and appurtenances such as manhole, utility poles, hatches, and hydrants. Install 1/2 inch thick pre-molded expansion joint filler in construction joints. Expansion joint material shall extend for the full depth of the walk.
- G. If existing sidewalk is to be removed and replaced with new sidewalk or new sidewalk extended from existing sidewalk, the existing sidewalk shall

be removed to the nearest joint of suitable quality or as directed by the Engineer.

3.9 CURBS

- A. The construction of curbs, combination curb and gutter, and integral curb and gutter shall be in accordance with these specifications and as shown on the plans and shall be in reasonably close conformance with the lines and grades shown on the plans or as directed by the Engineer.
- B. Excavation for curbs shall be made to the required depth, and the subgrade or base upon which the curb is constructed shall be compacted to a firm, even surface to not less than 95% of maximum dry density as determined in accordance with AASHTO T99.
- C. Concrete for curbs shall be Class A, 4,000 psi, as specified previously for Concrete Pavement.
- D. The curbs shall be constructed by the use of wood or metal forms; or, if approved by the Engineer, the curb may be constructed using a curb slipform machine. Forms, if used, shall be straight, free from warped or bent sections, and shall extend for the entire depth of the curb and shall be securely held in place so that no deviation from alignment and grade will occur during placement of concrete. The concrete shall be consolidated by vibration or other acceptable methods. The top of the curb shall be floated smooth and the top outer corner rounded to a 1/4 inch radius.
- E. The face, top, and gutter of curbs shall not have deviations or irregularities of more than 1/4 inch when checked with a 10-foot straightedge.
- F. Construction joints shall be placed at 10-foot intervals, unless otherwise shown or directed by the Engineer. The joint shall be uniform, of 1/8 to 1/4 inch in width, and to a depth of approximately 2-1/2 inches. The joint may be saw cut or formed by approved removable strips providing a straight joint at right angles to the length of curb. Joints shall be filled with specified bituminous joint filler material. Construction joints shall be formed around all abutting structures such as inlets and shall be as specified previously.
- G. As soon as possible after placing and finishing of concrete, the curbing shall be moistened and kept moist for three days or cured with the use of a specified membrane compound.
- H. If existing curb is to be removed and replaced with new curb or new curb extended from existing curb, the existing curb shall be removed to the nearest joint of suitable existing curb or as directed by the Engineer.

- I. During the placement of new concrete curb, utility marking shall be embossed into the top of the curb. The marking shall be a 2-inch high letter stamped into the concrete before the concrete sets up. The letters shall be located perpendicular from the utility feature that is being marked. The letters shall be as follows:
 1. G = Gas
 2. C = Conduit
 3. SS = Sanitary Sewer Service Lateral
 4. MH = Sanitary Manhole
 5. W = Water
 6. V = Water Valve
 7. D = Subsurface or Base Drain
 8. S = Storm Sewer

3.10 LANE STRIPING

- A. Lane striping is to be in accordance with all applicable standards of current INDOTSS and the construction plans.
- B. Parking lots are to be striped with standard white road paint. Spaces to be striped shall be 9 feet 0 inches wide by 18 feet 0 inches long with 4 inch wide stripes.
- C. Contractor will not permit traffic on any new pavement surface prior to striping.
- D. Contractor will clean the new pavement surface to remove all dust, dirt, mud and debris prior to striping.

3.11 TESTING FOR HOT MIX ASPHALT (HMA)

- A. The Contractor shall employ and pay for the services of a competent independent testing laboratory to take cores at selected locations and perform described tests. Compaction requirements for HMA mixtures placed in accordance with current INDOTSS shall be controlled by in place density determined from cores cut from the compacted pavement. A minimum of two cores per section shall be cut for each course of each material or as directed by the Engineer. Sections are defined as a maximum of 1000 Mg (1041 ton) of BAIA base or intermediate or 600 Mg (624 ton) of HMA surface. The transverse core location shall be located so that the edge of the core will be no closer than 75 min (3 inches) from a confined edge or 150 min (6 inches) from a non-confined edge of the course being placed.

- B. For compaction of BMA mixtures with quantities less than 100 Mg (104 ton) per day, acceptance may be visual as determined by the Engineer.
- C. The Contractor along with their independent testing lab representative shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 150 mm (6 inches) in diameter pavement sample. Each HMA course shall be cored within one work day of placement. Damaged core(s) shall be discarded and replaced with a core from a nearby location as selected by the Engineer.
- D. The Contractor, in the presence of the Engineer, shall mark the core to define the course to be tested. If the defined area is less than 1.5 times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing as determined by the Engineer. Within one work day of coring operations the Contractor shall clean, dry, refill and compact the core holes with suitable material approved by the Engineer.
- E. The Contractor's testing lab representative shall take immediate possession of the cores. If the cores are subsequently damaged, additional coring within the specific section(s) will be required at locations to be determined by the Engineer.
- F. Each core shall be tested within one work day of coring operation to determine thickness, bulk specific gravity, aggregate gradation and binder content. Test results shall then be transmitted either verbally or by other means to both the Contractor and the Engineer for verification before each subsequent bituminous lift is placed.
 - 1. Average thickness of the cores shall not vary from the plan thickness more than 12.5 mm (0.5 inch) for HMA base and intermediate course(s) and 6.25 mm (0.25 inch) for BMA surface course(s) for acceptance in accordance with current INDOTSS.
 - 2. The bulk specific gravity shall be determined in accordance with AASHTO T166 or AASHTO T 275. The in place density of a section for a mixture shall be expressed as:

$$\text{Density \%} = (\text{BSG}/\text{MSG}) \times 100$$

Where:

BSG = bulk specific gravity as determined from independent testing laboratory
 MSG = maximum specific gravity as reported on job mix formula.

3. The calculated density of the cores shall not be less than 90% nor more than 96% a set out above. Test results which are outside stated limits shall be considered and adjudicated as a failed material in accordance with current INDOTSS.
- G. The Contractor's independent testing laboratory representative shall determine the aggregate gradation and binder content of the core samples in accordance with ITM 571. Aggregate gradation shall be within tolerances set forth in current INDOTSS and binder content shall be within ± 0.5 percent from the job mix formula. Test results which are outside the stated limits shall be considered and adjudicated as a failed material in accordance with current INDOTSS.
- H. A copy of all core test results shall be submitted to the Engineer for verification of specification compliance within one calendar week of core testing.
- I. The Contractor shall make the following tests at no additional cost to the Owner, and they shall be as specified in this Article and requested by the Engineer. Perform tests in accordance with the following ASTM Specifications:

<u>Test</u>	<u>ASTM Specification</u>
Slump	C143
Air Content	C173
Test Cylinders	C31 or C513
Core Samples	C42
Fly Ash	C311

1. Measure slump each time test beams or cylinders are to be made and at any other time requested by the Engineer. The slump shall be as specified in current INDOTSS, or as otherwise specified herein, unless specifically excepted by the Engineer.
2. Measure air content each time test beams or cylinders are to be made and at any other time requested by the Engineer. The field test may be omitted if the air content is known prior to taking samples. The field test may not be omitted if fly ash is used in the mix.
3. Concrete paving mixes shall comply with guidelines of current INDOTSS and shall meet the testing requirements of Section 501.03 (a). However, in lieu of forming test beams as described in Section 501.03 (a) 2, the Contractor may substitute cylinder tests as follows:

- a. Make test cylinders in sets of four. Field cure one cylinder and break at seven days. Laboratory cure the remaining three cylinders and break at 28 days. The Contractor shall be responsible for handling and transportation of cylinders.
- b. If fly ash is used in the mix, a total set of seven cylinders shall be taken. The additional three cylinders shall be laboratory cured and broken at 56 days, if the 28-day strength does not meet specifications.
- c. Make one set of test cylinders for each 100 cubic yards, or fraction of 100 cubic yards, of concrete placed; or at other times requested by the Engineer.
- d. Unless otherwise specified, concrete shall have a 28-day compressive strength of 4,000 psi, as demonstrated by laboratory tests of cylinders.

3.12 PROTECTION

- A. Maintain compacted aggregate subbase and surface true to line and grade and required density. Maintain subbase until prime coat is placed. Maintain surface until job is complete.
- B. Do not permit vehicular traffic of any kind on any bituminous course until the bituminous mixture has hardened sufficiently not to be distorted beyond specified tolerances. Remove any foreign material which is on the surface of any course before the course is rolled or any subsequent course is placed.
- C. Do not permit traffic on concrete pavement or walks until concrete has developed sufficient strength not to be marked or damaged. Do not permit vehicular traffic on concrete for at least 14 days.
- D. Repair or replace damaged pavement and walks to the satisfaction of the Engineer.

3.13 CLEANUP

Clean up the job site following pavement and surfacing restoration. Remove all rubbish, excess materials, temporary structures, and equipment. Leave the work in a neat and presentable condition.

3.14 RAISED PAVEMENT MARKER

After water mains, hydrants, and valves are installed, there shall be a raised pavement marker installed along the center line of the street, offset to the side of the hydrant and perpendicular to each hydrant. The raised pavement marker

“RPM” shall be a blue reflector and as specified in the current INDOTSS.

3.15 SIGNAL PRE-EMPTION

All new traffic lights shall be provided with signal preemption equipment. The signal preemption equipment shall be manufactured by 3M Opticom, in accordance with Pittsboro Fire Department standards.

3.16 FIRE LANES

- A. Approved fire lanes shall be provided for every facility, building or portion of a building hereafter constructed or moved into as deemed necessary by the Fire Chief or his authorized representative. Existing facilities and buildings shall be asked for voluntary compliance of this ordinance if deemed necessary by the Fire Chief or his authorized representative.
- B. The owner, manager or agent of a retail, commercial, industrial, or public building shall be responsible to insure that fire lanes are maintained and that there are no obstructions to the ingress and egress of fire department or other emergency vehicles and personnel for protection of persons and property.
- C. Fire lanes shall be of hard surface concrete or asphalt and shall be established in the driving lane closest to the building.
- D. A fire lane must be marked with the words “Fire Lane No Parking” or “No Parking Fire Lane” in white letters a minimum of twelve (12) inches in height and a stripe of at least four (4) inches in width, in conformance with the Indiana Manual on Uniform Traffic Control Devices. The words and stripe must extend twelve (12) feet from the sidewalk or curb.
- E. Signs designating the fire lanes shall read, “Fire Lane No Parking” or “No Parking Fire Lane”. Said signs shall be twelve (12) inches wide by eighteen (18) inches high and have red letters on a white reflective background. Said signs shall also be placed every 100 feet along the sidewalk or curb with a minimum of one at each end of said fire lane.

PART 4 - TABLES

TABLE 1 - DESIGN STANDARDS FOR STREETS

Street Type	Design Speed (Mph)	R-O-W Width (Ft)	Street Width (Ft) ¹	Maximum Grade (%)	Minimum Grade (%)	Min. Radius Horizontal Curve (Ft)	Min. Length Tangent (Ft) ²	Min. Vertical Curve Length (Ft) ³		Corner Radius (Ft)	Cul-De-Sac Transition Radius
								SAG	CREST		
Local	30	60	30	8.0	0.5	300	100	40*A	30*A	25	--
Collector	30	80	36	5.0	0.5	300	150	40*A	30*A	40	--
Arterial	40	110	52	4.0	0.5	675	200	70*A	80*A	40	--
Cul-de-sac											
Residential	--	R=50	R=38	--	0.5	--	--	--	--	--	R=60
Other	--	R=60	R=50	--	0.5	--	--	--	--	--	R=100

¹ Street width is defined as distance from back of curb to back of curb. Curb and gutter width is 2 feet.

² Distance between reverse curves.

³ Vertical curve length is defined by multiplying the algebraic difference (A) in grade by the value shown on the table.
 $A = |G_2 - G_1|$ where G_2 is the exit grade and G_1 is the entrance grade.

PART 5 - FIGURES

5.1 STANDARD PAVEMENT DETAILS

Refer to The Town of Pittsboro Standard Construction Details.

END OF SECTION 02500

SECTION 02501 - STANDARDS OF ROADWAY GEOMETRIC DESIGN

PART 1 - GENERAL

1.1 Secondary Plats shall conform to the following requirements and standards:

A. Minimum Pavement Width

1. Minimum pavement widths, to be installed at the subdivider's expense, shall be per the Unified Development Ordinance.
2. In all industrial areas, the minimum pavement width shall be 24 feet with 8 feet of shoulder on each side of the pavement with "No Parking" on the shoulders.

B. Street Grades, Curves, and Sight Distances

1. The minimum vertical grade for all streets shall be 0.5%.
2. Maximum Vertical Grades
 - a. The maximum vertical grade for Primary Arterials and Secondary Arterials shall be 5.0%.
 - b. The maximum vertical grade for Collectors shall be 8%.
 - c. The maximum vertical grade for Local Roads or Streets shall be 8%.
 - d. The first 25 feet of an intersecting roadway, from the outer edge of a through roadway, shall be designed with a two percent (2%) downward grade. With a sag vertical curve situation, the two percent grade shall connect with the remaining street profile grade using a minimum vertical curve length of 50 feet. This sag vertical curve may start at the edge of the through roadway. With a crest vertical curve at the approach to an intersection, the two percent downward grade shall extend 25 feet from the edge of the through roadway and the crest vertical curve can begin at that point. The length of the crest vertical curve shall meet the requirements of the 1990 AASHTO Standards for crest vertical curves.
3. Vertical curves shall be designed to meet or exceed 1990 AASHTO Standards for sag and crest vertical curves as shown in Tables III-40 and III-42.
 - a. Local Roads or Streets shall have a design speed of 30 mph.
 - b. Collectors shall have a design speed of 30 mph.

- c. Primary Arterials and Secondary Arterials shall have a minimum design speed of 40 mph.
4. Horizontal centerline curve radius shall meet or exceed the most current AASHTO Standards and shall correspond to the following design speeds:
 - a. Local Roads or Streets and Collectors shall have a design speed of 30 mph and require a 300 foot minimum centerline radius.
 - b. Primary Arterials and Secondary Arterials shall have a design speed of 40 mph and require a 675 foot minimum centerline radius.
 - c. Tangent distance between reverse curves shall be 100 feet.
 5. The maximum length cul-de-sac length shall be 600 feet measured along the centerline from the intersection at the origin to the center of circle. Each cul-de-sac shall have a terminus of circular shape with minimum right-of way diameter of 100 feet for residential use and 120 feet for industrial use.

C. Intersections

1. At street and alley intersections, property line corners shall be rounded by an arc, the minimum radius of which shall be 20 and ten (10) feet respectively. In business districts, a chord may be substituted for such arc.
2. Street curb intersections shall be rounded by radii of at least 25 feet. A radius of 40 feet shall be used at the intersection with a Primary Arterial, Secondary Arterial or Collector street.
3. The above minimum radii shall be increased when the angle of street intersection is less than 90 degrees.
4. Intersections of more than two (2) streets at one point will not be allowed.
5. Street jogs with centerline offsets of less than 125 feet shall not be permitted.
6. All streets shall intersect at 90 degrees whenever possible for a minimum distance of 100 feet; however, in no instance shall they intersect at less than 80 degrees onto Primary Arterials, Secondary Arterials, or Collectors; or at less than 70 degrees onto Local Roads or Streets.
7. The following paragraphs shall be required as provisions of restrictive covenants of all Secondary Plats to which they apply:
 - a. No fence, wall, hedge, tree or shrub planting which obstructs sight lines and elevations between three (3) and nine (9) feet above the street shall be placed or permitted to remain on any corner lot within the triangular area formed

by the street right-of-way lines and a line connecting points 40 feet from the intersection of said street lines 40 feet for Collectors and Local Roads and Streets; and 75 feet for Primary Arterials and Secondary Arterials, or in the case of a rounded property corner, from the intersection of the street right-of-way lines extended.

b. The same sight line limitations shall apply to any lot within ten (10) feet of the intersection of a street right-of-way line with the edge of the driveway pavement or alley line. No driveway shall be located within 75 feet of the intersection of two streets.

8. At the intersection of any proposed Local Road or Street with a Primary Arterial, Secondary Arterial, or Collector, acceleration and deceleration lanes, passing blisters or left turn lanes shall be provided on the Primary Arterial, Secondary Arterial, or Collector.

D. Easements

1. Where alleys are not provided, easements for utilities shall be provided. Such easements shall have minimum widths of 20 feet, and where located along lot lines, one-half the width shall be taken from each lot.

2. Where a subdivision is traversed by a watercourse, drainage ditch, channel, or stream, adequate areas for storm water or drainage easements shall be allocated for the purpose of widening, deepening, sloping, improving or protecting said watercourses in accordance with the requirements of the County Drainage Board or the Pittsboro Utilities Department.

3. The subdivider shall be encouraged to design for the placement of utility lines underground, following the required standards and specifications established by each utility company. The location of each underground utility system shall be shown by appropriate easement lines on the proposed plat.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 02501

SECTION 02502 - STANDARDS OF ROADWAY CONSTRUCTION

PART 1 - GENERAL

1.1 Road construction shall conform to the following requirements and standards:

A. Streets, General

1. Streets and alleys shall be graded, surfaced, and improved to the dimensions required by the cross-sections and the work shall be performed in the manner prescribed in Section 2500 and the Indiana Department of Transportation (INDOT) Standard Specifications.
2. Prior to placing the street and alley surfaces, adequate subsurface drainage (underdrains) for the street shall be provided by the subdivider. Underdrain pipe shall conform to Section 2500 and the INDOT Standard Specifications.
3. Concrete and bituminous asphalt paving mixes shall comply with specifications contained in Section 2500.
4. Before any bond covering a street installation is released, the Pittsboro Public Works Director or duly authorized representative may request that core borings of the street be provided, at the subdivider's expense, for thickness determination.
5. Prior to the acceptance of asphalt streets, the subdivider shall employ and pay for the services of an independent testing laboratory to take cores at selected locations and perform Marshall stability, flow and density test, and percent of compaction determination on completed asphalt work if so directed by the Pittsboro Public Works Director or duly authorized representative.
6. Prior to acceptance of concrete streets, subdividers must provide satisfactory test results from an independent testing laboratory to the Pittsboro Public Works Director or duly authorized representative
7. A developer may request permission from the Pittsboro Public Works Director to delay the installation of the 1-inch surface layer of asphalt until the binder layer of asphalt has had sufficient time to prove its durability under the stress of heavy construction traffic, but not to exceed one (1) year. The developer shall be required to submit a separate performance bond to cover the cost of the installation of the 1-inch surface layer of asphalt.
8. All traffic control devices shall comply with guidelines and requirements of the current edition of the Indiana Manual on Uniform Traffic Control Devices.

B. Subgrade for Street Pavements

1. Preparation

- a. After all earth work is substantially complete and all drains installed, the subgrade shall be brought to the lines and grades shown on the plans.
- b. Unless otherwise provided, the upper six (6) inches of all subgrade shall be uniformly compacted to at least 95 percent standard density as determined by the provisions of AASHTO, T99, "Compaction and Density of Soils". During subgrade preparation and after its completion, adequate drainage shall be provided at all times to prevent water from standing on the subgrade. Subgrades shall be so constructed that it will have uniform density throughout. After compaction and final grading, the subgrade shall be finished with a three-wheel roller weighting not less than ten (10) tons. For areas not accessible to the roller, the required compaction shall be obtained by using mechanical tampers.
- c. All soft yielding or otherwise unsuitable material which will not compact properly shall be removed. All rock encountered shall either be removed or broken off to conform with required cross sections. Any holes or depressions resulting from the removal of such unsuitable material shall be filled with approved material and compacted to conform with the surrounding subgrade surface. No placement of pavement shall be permitted on uninspected or unapproved subgrade and, at no time, when the subgrade is frozen or muddy. No hauling shall be done nor equipment moved over the subgrade when its condition is such that undue distortion results. If these conditions are present, the subgrade shall be protected with adequate plank runways, mats, or other satisfactory means if hauling is to be done thereon.
- d. The subgrade shall be prepared sufficiently in advance to facilitate proper inspection of final elevations and compactions by the Pittsboro Public Works Director or duly authorized representative.
- e. All utility and drainage excavations under pavement shall be backfilled with sand around pipes, and #53 stone compacted to street level. These locations shall be illustrated on construction drawings submitted to the Pittsboro Department of Public Works.

2. Rigid Pavement Construction - When concrete is placed, the subgrade shall be properly dampened. Concrete pavement shall be constructed in accordance with Section 2500 and INDOT Standard Specifications.
- C. Pavement Section - Typical pavement sections shall conform to the cross sections as shown per the Town of Pittsboro Standard Details The use of alternative cross sections shall be approved by the Pittsboro Public Works Director.
- D. Curbs and Gutters
1. Wherever a proposed subdivision lies adjacent to or in proximity of other developed areas currently provided with curbs and gutters or that have more than three (3) lots per acre of land plotted into lots, the subdivider shall provide curb and gutter on each side of the street surface in the proposed subdivision.
 2. Curbs and gutters shall comply with the standard details. As an alternate, curb sections which comply with INDOT standard details will be permitted upon approval of the Pittsboro Department of Public Works.
 3. All curb and gutter sections placed on Primary Arterials, Secondary Arterials, or Collectors shall be of the barrier type. Roll-type curb and gutter sections will be permitted for Local Roads and Streets.
 4. Curbs and gutters shall be constructed according to Section 2500:
 - a. The minimum grade of any street gutter shall be not less than three-tenths percent (0.3%).
 - b. Inlet grates shall be heavy duty type recommended for bicycle traffic. Reference Section 2721.
- E. Sidewalks, Curb Ramps and Multi-Use Paths
1. Sidewalks shall be constructed per the Town's standard details drawings.
 2. Curb ramps shall comply with current INDOTSS.
 3. Multi-use paths shall be constructed per the Town's Standard Details.
 4. When sidewalks or pathways cross major street intersections within or adjacent to a subdivision, necessary traffic control devices such as painted crosswalks and signs shall be installed at the subdivider's expense.
 5. If not located within public rights-of-way, easements of at least ten (10) feet in width shall be provided for sidewalks, pedestrian paths, or bicycle paths.

- F. Easements - Whenever possible, easements for poles or underground conduits for electrical power, or telephone lines shall be provided along rear lot lines.

- G. Plans - Construction plans for improvements to be installed shall be furnished in accordance with the specifications of the Pittsboro Department of Public Works and/or, when appropriate, to the Hendricks County Highway Department. Such plans must receive all appropriate approvals before improvements are installed. Upon completion of streets and alleys improvements, as-built plans shall be filed with the Pittsboro Department of Public Works and when appropriate, to the proper governing body of Hamilton County. All construction plans shall include the following:
 - 1. Horizontal geometry of each proposed street, with centerline and curb radii shown.
 - 2. The profile of each proposed street, with grades indicated, and lengths of vertical curves.

3. The cross-section of each proposed street, showing the width of pavement, the location and width of sidewalks, and the location and size of utility mains.

- H. Inspection - Prior to starting any construction, arrangements shall be made for inspection of work to ensure compliance with plans and specifications approved by the Pittsboro Department of Public Works or, when appropriate, the Hendricks County Highway Department.

- I. All construction must be approved by the Pittsboro Public Works Director and notice of construction must be given to the Pittsboro Public Works Director, or duly authorized representative, 48 hours prior to beginning work.

- J. Allowable Modifications - Where unusual or exceptional factors or conditions exist, the Pittsboro Department of Public Works may allow minor modifications of any provision of this Section. When such modifications are allowed, a detailed written statement of the reasons for such modifications shall be attached to all copies of construction plans.

PART 2 - PRODUCT

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 02502

SECTION 02503 - STANDARDS OF UTILITY CONSTRUCTION

PART 1 - GENERAL

1.1 MINIMUM STANDARDS FOR SANITARY SEWERS

- A. Wherever possible, sanitary sewer systems along streets shall be located on the opposite side of the street from water mains.
- B. As the sanitary sewer system is installed, sewer lines shall be marked with a 2" x 4" or other acceptable stake, with a height allowing a minimum of 6'-0" above grade. Stake shall have the uppermost section painted green, and marked with the letter "S" to indicate sewer line placement.

1.2 MINIMUM STANDARDS FOR WATERMAINS

- A. Water main supply system for subdivisions and industrial/business parks shall be "looped" to allow for both a primary and secondary water supply into the site.
- B. Wherever possible, water main systems along streets shall be located on the opposite side of the street from sanitary sewer lines.
- C. Lateral connections should be installed in conjunction with installation of water mains. If laterals are not installed at time of water main placement, particularly at cul-de-sac streets, the water main system shall be designed to wrap around not less than 75% of the outside turning circle of the cul-de-sac.
- D. As the water main system is installed, water lines shall be marked with a 2" x 4" or other acceptable stake, with a height allowing a minimum of 6'-0" above grade. Stake shall have the uppermost section painted blue, and marked with the letter "W" to indicate water line placement.

1.3 MINIMUM STANDARDS FOR STORM SEWERS

As the storm sewer system is installed, storm sewer lines shall be marked with a 2" x 4" or other acceptable stake, with a height allowing a minimum of 6'-0" above grade. Stake shall have the uppermost section painted red, and marked with the letters "SS" to indicate subsurface drain line placement.

1.4 MINIMUM STANDARDS FOR FIRE HYDRANTS

- A. Fire hydrants shall have two 2-1/2 inch nozzles and one 5-inch stortz nozzle. 2-1/2 inch nozzle threads and fire hydrant opening direction shall

be consistent with existing fire hydrants within the local fire department protection area.

- B. Residential areas – Fire hydrants shall be located at each intersection with intermediate hydrants no farther than three hundred (300) feet apart in all residential subdivisions, subdivision sections, and any other residential areas.
- C. Industrial/Business areas – Fire hydrants shall be located at each intersection with intermediate hydrants no farther than three hundred (300) feet apart and no farther than three hundred (300) feet from the farthest point of any building in all Industrial, Business, and Commercial areas

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 02503

SECTION 02504 – ADJACENT ROADWAY IMPROVEMENTS

PART 1 - GENERAL

1.1 Roadways adjacent to proposed developments shall conform to the following requirements and standards:

A. Adjacent Roadway Improvements

1. Developers shall be responsible for improvements to the existing roadway(s) that front their property. These improvements shall include, but are not limited to, the following items:
 - a. Construction of acceleration lanes, deceleration lanes, and passing blisters for each entrance or street intersection.
 - b. In order to construct adequate passing blisters, right-of-way shall be obtained which has a width consistent with the Hendricks County Thoroughfare Plan. A minimum of 500 feet full width right-of-way centered on the entrance or street intersection shall be obtained. The developer is responsible for the purchase of the right-of-way, at fair market value. The Town will offer assistance in obtaining right-of-way if the initial purchase offer is unsuccessful. A written offer to the property owner is required.
 - c. The existing two (2)-lane roadway(s) that front the property shall be widened and overlaid in accordance with Town Standards.
2. Additional improvements may be required depending on field conditions and as determined by the Town Public Works Director or his representative.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 02504

SECTION 02558 - IDENTIFICATION/LOCATION TAPE

PART 1 - GENERAL

1.1 SCOPE

Furnish and install identification/location and warning tape over the centerline of buried non-metallic piping.

PART 2 - PRODUCTS

2.1 IDENTIFICATION TAPE

A. Identification/Location Tape

1. Identification/location tape shall be manufactured of inert polyethylene so as to be highly resistant to alkalis, acids and other destructive agents found in soil, and shall have a minimum thickness of four mils. Tape width shall be a minimum of three inches and a maximum of six inches and shall have background color specified below, imprinted with black letters. Imprint shall be as specified below and shall repeat itself a minimum of once every two feet for entire length of tape.
2. Identification/location tape shall include a solid foil core which can be detected by cable locator.
3. Warning tape shall be as described above except no solid foil is required.

B. Tape background colors and imprints shall be as follows:

<u>Imprint</u>	<u>Background Color</u>
"Caution - Water Line Buried Below"	Blue
"Caution - Sanitary Force Main Buried Below"	Green

C. Identification tape shall be as follows:

1. For PVC Water Pipe: Terra Tape Sentry Line or approved equal.
2. For PVC Sanitary Force Main Pipe: Terre Tape Sentry Line or approved equal.

Products above are as manufactured by Reef Industries, Inc., Houston, Texas.

PART 3 - EXECUTION

3.1 INSTALLATION OF IDENTIFICATION TAPE

- A. Identification tape shall be installed over all buried non-metallic piping in accordance with the manufacture's installation instructions and as specified herein.
- B. Identification tape shall be installed one foot over centerline of pipe unless otherwise noted on plans.
- C. Warning tape shall be installed two feet below final grade over centerline of pipe.

END OF SECTION 02558

PRESSURE AND LEAKAGE TESTS FOR MAIN EXTENSIONS

WORK ORDER: _____

PROJECT: _____

DATE: _____ TEST MADE BY: _____
(Developer's Representative)

COMPANY EMPLOYEE: _____

Pressure Test

Normal Operating Pressure (N.O.P.) _____ psi

If N.O.P. <200 psi: _____ + 100 psi = _____ psi

If N.O.P. >200 psi: _____ x 1.5 = _____ psi

TIME: _____ psi AT THE BEGINNING OF TEST: _____

_____ psi AT THE END OF TEST: _____

Leakage Test (complete if pressure drops more than 5 psi)

Volume of water to return pressure to within 5 psi of beginning test pressure: _____ gal.

Allowable leakage $\leq \frac{SD\sqrt{p}}{133,200} =$ _____ gph.

S = length of pipe tested (ft); D = nominal diameter of pipe (in); p = test pressure (psi)

COMPANY EMPLOYEE SIGNATURE: _____

SECTION 02660 - WATER MAINS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and install pipe, fittings, valves, hydrants and appurtenances necessary to complete work shown or specified.
- B. Codes, specifications and standards referred to by title or number in this specification shall be adhered to, and latest revisions shall apply in all cases.
- C. Definitions
 - 1. Abbreviations
 - a. ANSI - American National Standards Institute.
 - b. ASTM - American Society for Testing & Materials.
 - c. AWWA - American Water Works Association.
 - 2. All pipe, fitting and valve sizes and references to pipe diameter on the drawings or in the specifications are intended to be nominal size or diameter and shall be interpreted as such.

1.2 QUALITY ASSURANCE

- A. Mark pipe, fittings, valves and hydrants according to the applicable specification or standard.
- B. The Contractor shall test and disinfect water mains constructed under this Contract, as specified in this Section.
- C. The Town shall collect samples of water from water mains constructed after the piping has been disinfected. The Town will submit the samples to the applicable regulatory agency for bacteriological analysis. Collection and submittal of these samples shall meet the requirements of the applicable regulatory agency. If samples do not pass the requirements of the bacteriological analysis, the water main will be disinfected and sampled again. This procedure will be followed until the samples pass the analysis.
- D. A performance test may be required by the Public Works Director, at any time, for each crew installing water mains. The Contractor shall perform these tests at no additional cost to the Owner. When required by the

Public Works Director, the Contractor shall test a given section of water main installed by a given crew. The section shall be a continuous section of water main which can be isolated by valves shown on the drawings. The Contractor shall not install water mains in other sections until the first section has been successfully tested.

PART 2 - PRODUCTS

2.1 GENERAL

All pipe, fittings, valves, hydrants and appurtenances shall be as shown on the drawings or as required by the manufacturer's and ANSI/AWWA specifications. All pipe, fittings, valves, hydrants and appurtenances shall be new and unused.

2.2 BURIED WATER MAIN PIPE AND FITTINGS

A. Ductile Iron Water Mains (3" and Larger)

1. Pipe

- a. Ductile iron pipe shall meet the requirements of ANSI/AWWA C151/A21.51. Design and manufacture pipe for the pressure class listed plus 100 psi surge pressure. Additionally, a safety factor of 2.0 and a depth of cover, indicated on the drawings or as required by the manufacturer's and ANSI/AWWA specifications, shall be included. Minimum thickness class shall be as follows:

<u>Size Range</u>	<u>Pressure Class</u>
4" – 12"	350
14" – 20"	250

- b. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI/AWWA C111/A21.11. Restrained joints shall be Lok-Ring, Lok-Fast, Lok-Tyte, or equal,

2. Fittings

- a. Fittings shall be ductile iron. Fittings for standard size pipe shall meet the requirements of ANSI/AWWA C110/A21.10. Compact or short body fittings 3 inches through 16 inches shall meet the requirements of ANSI/AWWA C153/A21.53. Design and manufacture fittings for a pressure rating of at least 150 psi.

- b. Fitting joints shall be mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI/AWWA C111/A21.11. Thrust block all mechanical joints as indicated on the drawings or as required by the manufacturer's and ANSI/AWWA specifications. Pipe connecting to restrained joint fittings shall be restrained as indicated on the drawings or as required by the manufacturer's and ANSI/AWWA specifications.
3. Adapters
- a. Adapters from ductile iron water mains to flange joint valves or fittings shall be ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure class rating of 150 psi.
 - b. Adapter ends connecting to ductile iron water mains shall be one of the following: plain end, push-on joint, mechanical joint or restrained push-on joint. Adapters with plain ends, push-on joints or mechanical joints may be used where restrained joints are not required. Adapters shall have restrained push-on joints where restrained joint piping is required, as indicated on the drawings. Mechanical joints and restrained push-on joints shall meet the requirements of ANSI/AWWA C111/A21.11. Restrained joints shall be Lok-Ring, Lok-Fast, Lok-Tyte or as approved by the Public Works Director.
 - c. Adapter ends connecting to flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
4. Line the inside surfaces of all pipe, fittings and adapters with single layer cement mortar lining. Cement mortar lining and seal coating shall meet the requirements of ANSI/AWWA C104. Coat the outside surfaces of all pipe, fittings and adapters with a bituminous coating, complying with ANSI/AWWA C151.
5. Gaskets for mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA C111/A21.11.
6. Nuts and Bolts
- a. Nuts and bolts for mechanical joints shall be high strength, heat treated, alloy steel. Nuts shall be hexagon nuts, bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA C111/A21.11.
 - b. Nuts and bolts for restrained push-on joints shall meet the requirements of the joint manufacturer.

7. Polyethylene encasement for ductile iron water mains shall be installed and shall meet the requirements of ANSI/AWWA C105/A21.5. Installation of the polyethylene encasement shall be omitted if written approval is made by the ductile iron pipe manufacturer and/or the Public Works Director.
- B. Polyvinyl Chloride Water Mains (3" to 8")
1. Pipe
 - a. Polyvinyl chloride pipe shall meet the requirements of ANSI/AWWA C900, Class 150/DR18. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge pressure. Additionally, a safety factor of 2.0 and a depth of cover, indicated on the drawings or as required by the manufacturer's and ANSI/AWWA specifications, shall be included.
 - b. Polyvinyl chloride pipe shall have ductile-iron-pipe-equivalent outside diameter.
 - c. Pipe joints shall be push-on type and meet the requirements of ANSI/AWWA C900. Do not use solvent-cement joints.
 2. Fittings
 - a. Fittings shall be ductile iron and meet the requirements of ANSI/AWWA C110. Design and manufacture fittings for a pressure rating of 150 psi.
 - b. Line the inside surfaces of fittings with cement mortar lining and bituminous seal coating shall meet the requirements of ANSI/AWWA C104/A21.4. Coat outside surfaces of fittings with bituminous coating. Outside coating shall meet the requirements of ANSI/AWWA C110.
 - c. Fitting joints shall be mechanical joints. Mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
 - d. Mark each fitting. Marking shall meet the requirements of ANSI/AWWA C110.
 3. Adapters
 - a. Adapters from polyvinyl chloride water mains to victaulic, flange joint valves or fittings shall be ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 150 psi.

- b. Line the inside surfaces of adapters with a single cement mortar lining. Cement mortar lining and seal coating shall meet the requirements of ANSI/AWWA C104/A21.4. Coat outside surfaces of adapters with bituminous coating, complying with ANSI/AWWA C110.
 - c. Adapter ends connecting to polyvinyl chloride water mains shall have plain ends or mechanical joints. Mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
 - d. Adapter ends connecting to victaulic, flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
4. Gaskets
- a. Gaskets for polyvinyl chloride push-on joints shall meet the requirements of ANSI/AWWA C900.
 - b. Gaskets for mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11 and ASTM F477.
5. Nuts and bolts for mechanical joints shall be high strength, heat treated, alloy steel. Nuts shall be hexagon nuts, and bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA C111/A21.11.

2.3 PIPE AND FITTINGS SMALLER THAN 3-INCH

- A. Pipe shall be Type K drawn copper and shall meet the requirements of ASTM B88.
- B. Fittings and couplings shall be cast bronze and shall meet the requirements of ASTM B16.18. Construct and manufacture fittings and couplings for a pressure rating of 150 psi.
- C. Unions shall be bronze and shall meet the requirements of ASTM B16.18. Design and manufacture unions for a pressure rating of 150 psi.
- D. Flanges for connection of screwed joint pipe to flange joint valves or fittings shall be 125-16 cast iron, screwed companion flanges, complying with both ASTM A126 and ANSI B16.1.
- E. Tape for screwed joints shall be teflon.
- F. Gaskets for flange joints shall be 1/16-inch thick, full face and conform to ANSI/AWWA C111/A21.11. Gaskets shall be rubber or as approved by the Public Works Director.

- G. Bolts for flange joints shall be steel, heavy hexagon head machine bolts. Nuts shall be steel, semi-finished, heavy hexagon nuts. Nuts and bolts shall meet the requirements of ASTM A307 for Grade B and be zinc-coated alloy steel.

2.4 VALVES

A. Butterfly Valves

1. Butterfly valves and operators shall meet the requirements of AWWA Standard C504. Valves and operators shall be Class 150B.
2. Buried butterfly valves shall have mechanical joints. Mechanical joints shall meet the requirements of AWWA C111. Butterfly valves installed above ground or in structures shall have flange joints as specified in AWWA Standard C504. Nuts, bolts, and gaskets for flange joints shall meet the requirements of ANSI/AWWA C110. Nuts and bolts shall be cadmium plated. Gaskets shall be full face and shall be red rubber, or equal.
3. Each buried butterfly valve shall have a manual operator and a 2-inch operating nut. Valve opening direction shall be consistent with operation of existing valves in the waterworks in which the valves are installed, unless otherwise directed by the Engineer.
4. Each butterfly valve installed above ground or in a structure shall have a manual operator and handwheel.

B. Gate Valves

1. Buried gate valves 4-inches and larger shall be full ductile iron body, epoxy fusion bonded inside and out, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500 or C509 and have mechanical joint ends. Mechanical joints and joint accessories shall comply with ANSI/AWWA C111/A21.11. Valve opening direction shall be consistent with operation of existing valves in the waterworks where the valves are installed, unless otherwise directed by the Public Works Director.
2. Three-inch buried gate valves shall be full ductile iron body, epoxy fusion bonded inside and out, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500 or C509; except, ends shall be screwed. Screwed ends shall conform to ANSI B16.3. Valve opening direction shall be consistent with operation of existing valves in the waterworks where the valves are installed, unless otherwise directed by the Public Works Director.
3. Gate valves 4-inches and larger installed above ground or in structures shall be full ductile iron body, epoxy fusion bonded

inside and out, outside screw and yoke gate valves. Valves shall correspond to ANSI/AWWA C500 or C509. Outside screw and yoke gate valves shall have flange joint ends and malleable iron handwheels. Flange joints and accessories shall be as specified in ANSI/AWWA C110. Nuts and bolts shall be zinc-coated alloy steel. Gaskets shall be full face and rubber, or as approved by the Public Works Director.

4. Gate valves smaller than 4-inch installed above ground or in structures shall be bronze, 125 lb. S.W.P. double disc, screwed-in bonnet, rising stem, inside screw gate valves with screwed ends and malleable iron handwheels. Valves shall meet the requirements of federal specifications WASTEWATER-V-54d for Class A, Type III Valves.
- C. Buried valves 2-inch and smaller shall be curb stops. Curb stops shall meet the applicable requirements of ANSI/AWWA C800, ASTM B-62 for 85-5-5-5 composition bronze, and USAS B2.1. Curb stops shall be Mueller H-10283, Ford B11 Series, or as approved by the Public Works Director.
- D. Tapping Valves
1. Tapping valves shall comply with both ANSI/AWWA C500 or C509 and have flange mechanical joint ends. Double disc gate valve gates, gate rings and body-seat rings shall be oversized to permit entry and exit of tapping machine cutters.
 2. Valve end connecting to tapping sleeve shall have a flange for bolting to the sleeve. The flange shall have a tongue which fits a recess in the sleeve. Tongues shall meet the requirements of MSS SP-60. Resilient seated gate valves having a port diameter equal to or exceeding 1/4 inch over nominal diameter shall not require a tongue. Flange dimensions and drilling shall meet the requirements of ANSI B16.1. Nuts, bolts, and gaskets for flange joints shall meet the requirements of ANSI/AWWA C110. Nuts and bolts shall be zinc-coated alloy steel, and gaskets shall be rubber, or as approved by the Public Works Director. Mechanical joints and accessories shall meet the requirements of ANSI/AWWA C111/A21.11. A full nominal diameter cutter shall be used for tapping.
Tapping valves 14-inch and smaller shall be installed vertically. Tapping valves 16-inch and larger shall be installed horizontally and shall have bypass valves. Tapping valves installed horizontally shall have rollers and tracks. Valves 16-inch and larger shall have gear operators with enclosed gear cases suitable for buried service. Gear cases shall be extended type or totally

enclosed type. Extended type gear cases shall have bolted side plates to cover stem and stuffing box.

- E. Air and Vacuum Valves: Air and vacuum valves shall be as follows:

<u>Size</u>	<u>Specification</u>
½"	Apco No. 141WD, Val-Matic 100DWS, or equal
1"	Apco No. 142WD, Val-Matic 101DWS, or equal
2"	Apco No. 144WD, Val-Matic 102DWS, or equal
3"	Apco No. 146WD, Val-Matic 103DWS, or equal
4"	Apco No. 1604/152, Val-Matic 104DWS, or equal
6"	Apco No. 1606/153, Val-Matic 106DWS, or equal

2.5 VALVE BOXES

- A. Valve boxes for butterfly valves and gate valves shall be cast iron. Valve boxes shall be two piece or three piece type. Each two piece box shall be complete with bottom section, top section and cover. Each three piece box shall be complete with base, center section, top section and cover. Valve boxes shall be extension type with slide or screw type adjustment. Each base and bottom section shall be the proper size for the valve served. Each valve box assembly shall be the proper length for the valve served. The minimum thickness of metal shall be 3/16-inch. Cast the word "WATER" in each valve box cover.
- B. Valve boxes for curb stops shall be cast iron. Curb boxes shall be extension type. Each curb box shall be complete with foot piece, curb box and lid. Curb box shall be the following or as approved by the Public Works Director:

<u>Curb Stop Size</u>	<u>Foot Piece</u>	<u>Curb Box with Lid & Plug</u>
¾"	Mueller H-10391	Mueller H-10316
1"	Mueller H-10392	Mueller H-10316
1 ½"	Mueller H-10394	Mueller H-10336
2"	Mueller H-10395	Mueller H-10336

2.6 FIRE HYDRANTS

- A. Fire hydrants shall be dry-barrel, compression shutoff, traffic model and comply with ANSI/AWWA C502. Main valve size shall be 5-1/4 inch. Inlets shall be 6-inch mechanical joint. Each hydrant shall have two 2-1/2-inch nozzles and one 5-inch Storz pumper nozzle. Nozzle threads and hydrant opening direction shall be consistent with existing fire hydrants in the waterworks in which the fire hydrants are installed, unless otherwise

directed by the Public Works Director. Each hydrant shall be the proper length for the water main to which the hydrant is connected. Fire hydrant coating shall meet the requirements of ANSI/AWWA C502 and shall be coated red. Public Works Director. Hydrants shall be Mueller Model No. A42356Y Storz. Fire Hydrants shall be the color of safety yellow for Town hydrants and red for private hydrants.

- B. Fire Hydrant Placement – Fire Hydrants shall be placed no farther apart than 300 feet in all residential subdivisions, subdivision sections, and other residential areas in which dwelling density meets or exceeds three dwelling units per gross acre. Fire hydrants shall be placed no further apart than 300 feet in all Industrial, Business, and Commercial areas, and all Industrial, Business, and Commercial uses. Such requirement shall be in full force and effect unless explicitly exempted by the Chief of the local fire department. For residential uses with densities less than three dwelling units per gross acre, the requirements as established in Table No. III-B-A of the Uniform Fire Code shall apply. Where there is any ambiguity or dispute concerning the interpretation of this requirement, the decision of the Chief of the local fire department shall prevail subject to appeal.

2.7 SPRINKLER SYSTEMS

Multi-family developments, duplexes, and hotels/motels shall be required to have sprinkler systems installed in the attics of said structure as approved by the Chief of the local fire department. Such requirement shall be in full force and effect unless explicitly exempted by the Chief of the local fire department. Where there is any ambiguity or dispute concerning the interpretation of this requirement, the decision of the Chief of the local fire department shall prevail subject to approval.

2.8 TAPPING SLEEVES

- A. Tapping sleeves shall be stainless steel split sleeves. Each sleeve shall have a branch connection with a flange end. The inside diameter of each branch shall be over-sized to permit entry and exit of tapping machine cutters. Each flange shall have a recess to center a tapping valve. Recesses shall meet the requirements of MSS SP-60. Flange dimensions and drilling shall meet the requirements of ANSI B16.1. The sleeve dimensions shall be such that the sleeves will not leak when installed on cast iron, ductile iron, or polyvinyl chloride pipe with outside diameters shown in ANSI/AWWA Standards.
- B. Tapping sleeves for 4-inch through 16-inch pipe shall be mechanical joint type. Design and manufacture tapping sleeves for a working pressure of 200 psi.

- C. Tapping sleeves for 18-inch and larger pipe shall be mechanical joint type. Design and manufacture tapping sleeves for a working pressure of 150 psi.

2.9 TAPPING SADDLES

- A. Design and manufacture tapping saddles for a working pressure of 200 psi. Saddle bodies shall be stainless steel. Saddle straps shall be corrosion resistant steel alloy. Saddle gaskets shall be positively confined O-ring gasket. The sleeve dimensions shall be such that the sleeves will not leak when installed on cast iron, ductile iron, or polyvinyl chloride pipe with outside diameter shown in ANSI/AWWA Standards.
- B. Each saddle used for making a wet connection shall have a branch connection with a flange end. The inside diameter of each branch shall be oversized to permit entry and exist of tapping machine cutters. Each flange shall have a recess to center a tapping valve. Recesses shall meet the requirements of MSS SP-60. Flange dimensions and drilling shall meet the requirements of ANSI B16.1.
- C. Each saddle used for making a dry connection shall have a branch connection with a flange or mechanical joint end. Flange dimensions and drilling shall meet the requirements of ANSI B16.1. Nuts and bolts for flange joints shall meet the requirements of ANSI/AWWA C110 and be zinc-coated alloy steel. Gaskets shall comply with ANSI/AWWA C110, be full face and rubber, or as approved by the Public Works Director. Mechanical joints and accessories shall meet the requirements of ANSI/AWWA C111/A21.11.
- D. Gaskets used to seal joints between saddle bodies and tapped pipes shall be O-ring type, circular in cross section, and made of natural or synthetic rubber with a Durometer Hardness of 70 ± 5 .

2.10 FLANGE-MECHANICAL JOINT ADAPTERS

Flange-mechanical joint adapters shall be Dresser Style 127, Smith-Blair Type 912 or as approved by the Public Works Director.

2.11 AIR AND VACUUM VALVE CHAMBERS

- A. Air and vacuum valve chambers shall be 4-foot diameter precast concrete manhole barrels with precast concrete flat slab tops. Precast manhole barrels shall meet the requirements of ASTM C478.
- B. Air and vacuum valve chamber access frames and cover shall be Neenah R-1915-G, or equal. Cast the word "WATER" in each cover.

2.12 WATER SERVICES

- A. Pipe shall be seamless copper tubing and shall meet the requirements of ASTM B88, Type "K."
- B. Fittings and Couplings: Couplings for copper tubing shall be copper to copper or copper to iron, as required, and shall meet the applicable requirements of AWWA C800, ASTM B-62 for 85-5-5-5 composition bronze, and ANSI B2.1. Fittings and couplings shall be Ford Products, Pack Type Compression Joints, or equal.
- C. Service connections made to a PVC water main shall be made using a stainless steel saddle with a corporation stop.

PART 3 - EXECUTION

3.1 INSPECTION

Inspect water main pipe, fittings, valves, hydrants, and appurtenances prior to installation. Promptly remove damaged or unsuitable products from the job site. Replace damaged or unsuitable products with undamaged and suitable products.

3.2 LAYING OF WATER MAINS

- A. Proper tools and facilities shall be provided and used by the Contractor for safe working conditions.
- B. Lay and maintain pipe to the lines and grades shown on the drawings or to the minimum depth specified in this Article. Install fittings, valves and hydrants in the locations shown on the drawings.
- C. When the exact location of buried utilities is unknown and piping is to be constructed parallel and close to said utilities, adjust the alignment of the piping to least interfere with these utilities. This applies unless otherwise shown on the drawings or specified by the Public Works Director.
- D. Water mains shall be laid at least 10 feet horizontally from any existing sanitary sewer or sewage force main. The distance shall be measured from edge to edge of the pipe. Water mains crossing sanitary sewer or sewage force mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer or force main. The 18-inch separation shall apply whether the water main is over or under the sewer or force main. Lay water mains at crossings of sewers and force mains so a full length of water main pipe is centered on the sewer or force main whenever possible. No water main

shall pass through or come in contact with any part of a sanitary sewer manhole.

- E. All piping shall be laid at a depth that provides at least 4'-6" of cover. Cover shall be measured as the vertical distance from the top of the pipe to the finish grade elevation.
- F. Laying of water mains shall meet the requirements of ANSI/AWWA C600, unless otherwise specified in this Section.
- G. Shape the bottom of the trench to give uniform circumferential support of the lower quarter of each pipe.
- H. Do not lay pipe in water or when the trench or weather conditions are unsuitable for proper installation.
- I. As each length of pipe is placed in a trench, joint the pipe being laid to the previously laid pipe. Bring the pipe to correct line and grade. Secure the pipe in place with bedding tamped under the pipe. Tamp bedding up to the centerline of the pipe.
- J. Deflection from a straight line or grade shall not exceed the limits specified in this Section. If the alignment requires joint deflections in excess of the allowable deflection per joint, furnish and install fittings or a sufficient number of shorter lengths of pipe.
- K. Provide thrust restraint at horizontal and vertical deflection fittings and at tees, plugs, tapping sleeves and tapping saddles. Restraint shall be concrete thrust blocking or restrained joint piping.
- L. Where concrete thrust blocking is used, cover the fitting to be blocked with visqueen or a heavy duty grease to prevent adherence of the concrete to the fitting.
- M. Block the open end of the pipe at the close of each day's work to prevent contamination from dirt or rain water and entry of any animal or foreign material.
- N. Lower pipe, fittings, valves and hydrants into the trench by hand, hoists or ropes or other suitable tools or equipment that will not damage products, coatings or linings. Do not drop or dump pipe, fittings, valves, or hydrants into the trench.
- O. Water main designs that require crossing a county legal drain shall be approved and constructed per the latest standards of the Hendricks County Surveyor's Office.

3.3 SETTING VALVES, VALVE BOXES AND FIRE HYDRANTS

- A. Clean the interiors of valves and hydrants of foreign matter before installation. Tighten stuffing boxes. Inspect valves and hydrants in opened and closed positions to ensure all parts are in working condition.
- B. Set valves and valve boxes plumb. Center valve boxes on the valves or valve operators. Locate valves outside the area of roads and streets where feasible. Tamp backfill around each valve box to a distance of 4 feet on all sides of the box or to the undisturbed trench face if less than 4 feet.
- C. Set hydrants plumb with the pumper nozzle facing the street. The centerline of the outlet nozzles shall be at least 18 inches or at most 30 inches above finished grade at a hydrant. Install hydrant extensions where required to bring hydrant to proper elevation. Set each hydrant upon a slab of stone or concrete not less than 4 inches thick and 15 inches square. Wedge the side of each hydrant opposite the pipe connection against the undisturbed trench face to prevent the hydrant from blowing off the branch connection. Compact the backfill around each hydrant to finish grade. Furnish and install a gate valve and valve box in each hydrant branch connection. In the field, apply two coats of red polyurethane epoxy to the fire hydrants installed.

3.4 CONNECTING TO EXISTING MAINS

- A. The Contractor shall locate and verify exact size of all existing mains, both horizontally and vertically. Additionally, allow adequate time, after location and prior to making new connections, for changes in the connection location and size. Backfill excavation immediately after main is located and measured.
- B. Make each wet connection with a tapping valve and tapping sleeve. Install and hydrostatically test each tapping valve and tapping sleeve assembly prior to tapping existing water main. Inspect each tapping valve prior to tapping existing water main. Open and close tapping valves, and inspect tapping valves in opened and closed positions to ensure all parts are in working condition. Inspect each tapping valve immediately before connecting tapping machine to ensure the tapping valve is open. Install watertight plug on the tapping valve outlet and backfill excavation if existing water main is not tapped within 48 hours after installing tapping valve and tapping sleeve or tapping saddle assembly. Install watertight plug on the tapping valve outlet and backfill excavation if new water main is not connected to tapping valve within 48 hours after making tap in existing water main.

- C. Make each dry connection with fittings and valves indicated on the drawings. Furnish and install sleeves required to complete connections. All required pipe, fittings, valves, tools, and equipment shall be at the connection site prior to starting connection. Wash interior of new pipe, fittings, and valves with a solution containing 50 mg/l of chlorine prior to making connection. Make connections at night and on weekends when required. The Owner will operate existing valves. Install sufficient water main and restrain joints so existing water mains can be up in service immediately after connection is completed. Inspect joints and eliminate leaks immediately after connection is completed and existing mains are put in service. Install watertight plugs on open ends of pipe and valves, and backfill excavation if new water main is not connected to dry connection within 48 hours after completing dry connection.

3.5 JOINTING

A. Ductile Iron Push-on Joints

1. Pipe must be cleaned and installed as specified by the manufacturer and ANSI/AWWA C600 requirements. Additionally, all lumps, blisters, excess bituminous coating and foreign material must be removed from the bell and spigot end of each pipe.
2. For restrained push-on joints, move the loose retainer ring into position against the retainer bar on the spigot end of the pipe being installed. Loosely assemble the joint bolts and nuts.
3. Deflect pipe after jointing, if deflection is required. The amount of deflection shall not exceed the limits shown in the following table:

<u>Pipe Size</u>	<u>Maximum Deflection Angle</u>	<u>Maximum Deflection Based Upon 18-Foot Pipe Length</u>
4"	5°	18-1/2"
6"	5°	18-1/2"
8"	5°	18-1/2"
10"	5°	18-1/2"
12"	5°	18-1/2"

4. For restrained push-on joints, pull the nuts to a uniform tightness by hand or with a short wrench. Do not pull the spigot of the pipe being installed against the back of the bell of the receiving pipe. Engage at least a full nut on each bolt when joint deflection is required.

B. Polyvinyl Chloride Push-on Joints

1. Pipe must be cleaned and installed as specified by the manufacturer's requirements. Additionally, all joints must be free of all foreign material.
2. Deflect the pipe after jointing, if deflection is required. The amount of deflection shall not exceed the limits recommended by the pipe.

C. Mechanical Joints

1. Pipe must be cleaned and installed as specified by the manufacturer and ANSI/AWWA C600 requirements. Additionally, all lumps, blisters, excess bituminous coating and foreign material must be removed from the bell and spigot end of each pipe.
2. Evenly tighten the nuts using a torque wrench. The torque shall be within the range listed in the following table:

<u>Pipe Size</u>	<u>Bolt Size</u>	<u>Torque Range</u>
4" thru 24"	3/4"	75 to 90 ft.-lb.

3. Deflect pipe, fittings or valves after jointing, if deflection is required. The amount of deflection shall not exceed the limits shown in the following table:

<u>Pipe Size</u>	<u>Maximum Deflection Angle</u>	<u>Maximum Deflection Based Upon 18-Foot Pipe Length</u>
4"	8° - 18'	31"
6"	7° - 7'	27"
8"	5° - 21'	20"
10"	5° - 21'	20"
12"	5° - 21'	20"
14"	3° - 35'	13-1/2"
16"	3° - 35'	13-1/2"
18"	3° - 0'	11"
20"	3° - 0'	11"
24"	2° - 23'	9"

D. Shouldered Type Joints

1. Pipe must be cleaned and installed as specified by the manufacturer and ANSI/AWWA C600 requirements.

Additionally, all lumps, blisters, excess bituminous coating and foreign material must be removed from the bell and spigot end of each pipe.

2. The tightening torque shall not exceed the limits recommended by the joint manufacturer.
3. Deflect pipe, fittings, adapters or valves after jointing, if deflection is required. The amount of deflection shall not exceed the limits recommended by the joint manufacturer.

E. Threaded Joints

1. Pipe must be cleaned and installed as specified by the manufacturer and ANSI/AWWA C600 requirements. Additionally, all lumps, blisters, excess bituminous coating and foreign material must be removed from the bell and spigot end of each pipe.
2. Do not overtighten joints.
3. Backing off made-up threaded joints to facilitate fit-up or alignment will not be permitted

F. Flange Joints

1. Pipe must be cleaned and installed as specified by the manufacturer and ANSI/AWWA C600 requirements. Additionally, all lumps, blisters, excess bituminous coating and foreign material must be removed from the bell and spigot end of each pipe.
2. Do not overtorque nuts and bolts.

3.6 RESTRAINING AND SUPPORTS

A. Thrust Blocking

1. Construct thrust blocks of concrete having a 28-day compressive strength of at least 2,000 psi.
2. Lubricate fitting surfaces to prevent bonding between fittings and thrust blocks.
3. Construct thrust blocks between fittings and undisturbed soil. The area of thrust blocking bearing on undisturbed soil shall be at least the area indicated on the drawings. Construct thrust blocking so pipe and joints are accessible for repair and joint flexibility is not impaired.

- B. Restrained joint piping shall be as specified in this Section. Distance from fitting to end of restraint shall not be less than that indicated on the drawings.

C. Mechanical Joint Rod Restraint

1. Mechanical joint rod restraint shall be from fitting to fitting.
2. The number of rods shall conform to the following table:

<u>Pipe Size</u>	<u>Rod Size</u>	<u>Minimum No. of Rods</u>
4"	3/4"	2
6"	3/4"	2
8"	3/4"	4
10"	3/4"	4
12"	3/4"	6
14"	3/4"	6
16"	3/4"	8
18"	3/4"	8
20"	3/4"	10
24"	3/4"	16

D. Pipe Supports

1. Furnish and install supports required to hold pipe, fittings and valves at the lines and grades indicated on the drawings, without causing strain upon pipe, fittings and valves.
2. Support piping by suitable saddle stands, concrete piers or hangers.
3. Locate supports where necessary, at least 8 feet on center.

3.7 AIR AND VACUUM VALVE CHAMBERS

- A. Install air and vacuum valve chambers as indicated on the drawings.
- B. Mortar for joints and plastering shall consist of one part Portland Cement and two parts fine sand. Lime may be added to the mortar used for brick work. Add lime in an amount of not more than 20% of the volume of cement. Complete fill joints between precast chamber sections. Joints shall be smooth and free from surplus mortar on the inside surface of the chamber. Plaster brick at the top of chambers with 1/2-inch of mortar.
- C. Set frames and covers so the top of the cover will be flush with finished grade.
- D. Vent air and vacuum valve outlets to the surface. Terminate vent outlets 3 feet above finished grade. Screen vents to prevent the entrance of insects. Paint air and vacuum valve vents yellow.

3.8 HYDROSTATIC TEST

- A. Hydrostatic tests shall be performed on all water mains installed. The Contractor shall make arrangements with the Town Engineer and/or Town Representative for scheduling each test. Each test shall be performed on the day mutually agreed upon and in the presence of the Town Engineer and/or Town Representative.
- B. The Contractor shall furnish equipment, temporary piping, pumps, fittings, gauges, and operating personnel necessary to conduct the tests. Water for testing may be obtained from the Owner.
- C. The water mains may be tested in sections between valves when there is one or more intermediary valves in a water main.
- D. Test procedures shall meet the requirements of AWWA Standard C600.
- E. Each section of water main shall be complete, and thrust blocks shall have been in place for not less than 10 days prior to being tested.
- F. Expel all air from the water main test section during the filling of the main and prior to the application of test pressure. Tap the water main at high points, if necessary, to release all air from the water main. Plug taps after the test is successfully completed. Plugs shall be watertight.
- G. Test water mains at a static pressure of 150 pounds per square inch over a period of two consecutive hours. The test will be considered successful when the pressure drop over the test period is 5 pounds per square inch or less. If the pressure drop exceeds 5 pounds per square inch.

3.9 FLUSHING

- A. Flush water mains and fire hydrants prior to disinfection. Flush water mains with a flushing velocity of at least 2.5 feet per second. Following are flows required to provide a flushing velocity of 2.5 feet per second:

<u>Pipe Size</u>	<u>Inside Diameter</u>	<u>Flow at a Velocity of 2.5 Feet per Second</u>
½"	0.622"	2.4 gpm
¾"	0.824"	4.2 gpm
1"	1.05"	6.8 gpm
1¼"	1.38"	12 gpm
1½"	1.61"	16 gpm
2"	2.07"	27 gpm
2½"	2.47"	38 gpm

3"	3.07"	58 gpm
4"	4"	98 gpm
6"	6"	220 gpm
8"	8"	390 gpm
10"	10"	620 gpm
12"	12"	880 gpm
14"	14"	1,200 gpm
16"	16"	1,600 gpm
18"	18"	2,000 gpm
20"	20"	2,500 gpm
24"	24"	3,600 gpm

B. Flush water mains and hydrants until the water discharged is clear.

3.10 DISINFECTION

- A. Disinfect all new and repaired water mains prior to placing them in service. Disinfect pipe, fittings, valves and hydrants with a chlorine solution containing 50 mg/l \pm 5 mg/l of available chlorine.
- B. The chlorinating material shall be calcium hypochlorite . Calcium hypochlorite shall have 70% available chlorine by weight, and sodium hypochlorite shall have 5.25% to 14.7% available chlorine. Placing chlorine tablets in the mains during construction is not an acceptable method of disinfection. The following table shows the quantity of hypochlorite required to produce 50 mg/l of available chlorine per 100 feet of pipe.

<u>Pipe Size</u>	<u>Inside Diameter</u>	<u>Chlorine Gas</u>	<u>Pounds</u>	<u>Ounces</u>
			Cal. Hycl. (70%)	Cal. Hycl. (70%)
½"	0.622"	0.00066	0.0094	0.015
¾"	0.824"	0.0012	0.0017	0.026
1"	1.05"	0.0019	0.0027	0.043
1 ¼"	1.38"	0.0032	0.0046	0.074
1 ½"	1.61"	0.0044	0.0063	0.10
2"	2.07"	0.0073	0.010	0.17
2 ½"	2.47"	0.010	0.015	0.24
3"	3.07"	0.016	0.023	0.37
4"	4"	0.027	0.039	0.62
6"	6"	0.061	0.087	1.4
8"	8"	0.11	0.16	2.5
10"	10"	0.17	0.24	3.9
12"	12"	0.24	0.35	5.6
14"	14"	0.33	0.48	7.6
16"	16"	0.44	0.62	10

<u>Pipe Size</u>	<u>Inside Diameter</u>	<u>Chlorine Gas</u>	<u>Pounds</u>	<u>Ounces</u>
			<u>Cal. Hycl. (70%)</u>	<u>Cal. Hycl. (70%)</u>
18"	18"	0.55	0.79	13
20"	20"	0.68	0.97	16
24"	24"	0.98	1.40	22
30"	30"	1.5	2.2	34
36"	36"	2.2	3.1	50
42"	42"	3.0	4.3	69
48"	48"	3.9	5.6	90
54"	54"	5.0	7.2	110

- C. Tap water mains where required to inject chlorine solution into all pipe, fittings, valves and hydrants installed and repaired. Inject chlorine solution into water mains. Leave the chlorine solution in the water mains for 24 hours or longer. Open and close valves in lines being disinfected several times during contact period. Following the contact period, flush the water mains with potable water until the chlorine residual is 1.0 mg/l or less.
- D. Bacteriological Tests - The water main shall be tested for bacteriological quality after disinfection and final flushing. Two or more successive sets of bacteriologically satisfactory samples taken at 24-hour intervals must be recorded before the facilities are released for use. Bacteriological testing shall meet the requirements of the applicable regulatory agency. Disinfection shall be repeated if the piping is not bacteriologically acceptable. Repeat disinfection and testing until the mains are approved for service by the applicable regulatory agency. All water main dead ends shall also be tested.
- E. Hose connections on fire hydrants shall not be used for collecting samples. Contact the applicable regulatory agency for sampling criteria and procedures.
- F. The time for disinfection, bacteriological testing, and approval of the main for service shall be included in the contract time.
- G. The Contractor shall be responsible for disposal of chlorinated disinfection waters. If the water is discharged in an open channel or storm sewer, the Contractor shall dechlorinate the disinfection waters to 0.05 mg/L of total chlorine.

3.11 COMPLETION SCHEDULING

Complete water mains as they are installed. Test, flush, sterilize, and place in service each part of the water main which is complete and can be placed in

service without preventing work to continue on uncompleted parts of the new water mains.

PART 4 – FIGURES

4.1 STANDARD DETAILS

Refer to the Town of Pittsboro Standard Construction Details.

END OF SECTION 02660

SECTION 02721 - STORM SEWERS

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers all work necessary for the construction of the storm sewer piping systems and related items complete, including catch basins and inlet drains, manholes, junction chambers, diversion chambers, outfall structures, and miscellaneous structures.
- B. This section shall be used only when non-watertight joints will be allowed, and hydrostatic or air testing will not be required for storm sewers unless because of suspected leakage or other problems the town Engineer deems necessary.
- C. This specification covers the following types of materials for storm sewers, culverts, underdrains, inlet drains, conduits, and miscellaneous applications:
 - 1. Reinforced Concrete Pipe and Fittings
 - 2. Polyvinyl Chloride Pipe (PVC)
 - 3. Corrugated Metal Pipe
 - 4. Structural Plate Arches
 - 5. Aluminum or Aluminized Steel Pipe and Structural Plate
 - 6. Multi-Plate Pipe and Pipe Arches
 - 7. Corrugated Polyethylene Pipe
- D. Sewer pipe shall be of the size shown on the drawings and shall meet all requirements of these specifications.
- E. This specification requires project plans and construction specifications to be submitted to and approved by all appropriate regulatory agencies prior to beginning any work.

1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible.

1.3 SUBMITTALS

Before construction and preferably before fabrication, the Contractor shall submit to the town Engineer for approval calculations on the thickness or strength class and drawings showing pipe lengths, joints, and other construction and installation details. All pipe furnished under this Contract shall be fabricated only in accordance with the drawings and these specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

The town and its Engineer may, at their option, specify a material to be used on the drawings; and the developer or Contractor shall furnish and install the pipe material or materials specified and will only offer other equal materials.

2.2 REINFORCED CONCRETE PIPE AND FITTINGS

- A. Reinforced concrete pipe and fittings shall conform to ASTM C76, latest revision, for circular pipe and ASTM C507 for elliptical pipe.
- B. Reinforced concrete pipe and fittings for normal conditions shall be reinforced in accordance with ASTM C76, Class III, Wall B (minimum). Acceptance shall be on the basis of Subsection 4. 1.1 of ASTM C76.
- C. Circumferential reinforcing in circular pipe shall be required. No elliptical reinforcing or combination of elliptical and circumferential reinforcing or part circular reinforcing shall be permitted in circular pipe.
- D. Concrete pipe shall be steam cured and shall not be shipped from point of manufacture for at least five days after having been cast.
- E. Joints shall conform to the requirements of ASTM C443. Gaskets shall be of an oil resistant type having a maximum swell of 90% when tested in accordance with ASTM D471. Lubricant for jointing shall be approved by gasket manufacturer.
 - 1. All rubber gasket similar to and equal to "Press-Seal" or "Tylox" conforming to ASTM Designation C443, latest revision. The gasket shall be attached to the spigot of the pipe and shall be the sole element depended upon to make the joint flexible and practically watertight.
 - 2. Butyl mastic joint sealant in rope or trowel applied form specifically made for permanently sealing joints in tongue and groove concrete sewer pipe. The material shall adhere tightly to the pipe surface and form a tight, flexible joint. The material shall have been in use for at least five years. Test results and material

specifications shall be submitted to the town Engineer and shall have been approved prior to use on the project.

2.3 POLYVINYL CHLORIDE PIPE AND FITTINGS

Polyvinyl chloride (PVC) pipe and fittings shall comply with ASTM D 3034.

2.4 CORRUGATED METAL PIPE AND PIPE ARCHES

A. The following specifications shall govern the manufacture of the corrugated steel pipe and pipe arches.

1. Specifications for Zinc Coated (galvanized) Steel Sheets (ASTM A444).
2. Manufacture of Corrugated Steel Culverts and Underdrains (AASHTO M-36).
3. Structural Plate for Pipe, Pipe Arches, and Arches (AASHTO M-167).
4. Bituminous Coated Corrugated Steel Pipe and Arches (AASHTO M- 190).
5. Sheet Material (ASTM A525).

B. Bituminous Coated Welded Seam Helically Corrugated Steel Pipe

The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3-inch pitch by 1/2-inch depth. Each pipe shall have two annular corrugations rolled in each end. After the ends are rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch as required by AASHTO M- 190 for Type A coating.

C. Bituminous Coated and Paved Invert Welded Seam Helically Corrugated Steel Pipe

1. The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3-inch pitch by 1/2-inch depth. Each pipe shall have two annular corrugations rolled in each end.
2. After the ends are rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch. In addition, bituminous material shall be applied to form a smooth pavement in the bottom 25% of pipe and in the bottom 40% of pipe arch as required by AASHTO M- 190 for Type C coating.

D. Smooth Lined Welded Seam Helically Corrugated Steel Pipe

1. The pipe shall be fabricated from flat coils. The base metal, spelter coating, and fabrication shall meet the applicable requirements of AASHTO M-36. Corrugations shall be 2-2/3-inch pitch by V2-inch depth. Each pipe shall have two annular corrugations rolled in each end. Each pipe shall have two lifting lugs welded to the outside of the pipe.
2. After the ends have been rolled, the pipe shall be coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inch as required by AASHTO M-190 for Type A coating. The pipe shall be centrifugally lined on the inside with bituminous material to form a smooth surface which fills the corrugations to a minimum thickness of 1/8 inch above the crests of the corrugations. The bituminous lining material shall meet the requirements of AASHTO M-190.

2.5 CORRUGATED METAL PIPE COUPLINGS

Bituminous Coated Pipe Couplings: Coupling bands shall be the same base metal and spelter coating as the pipe. Bands shall be 0.064-inch thick and 10-1/2 inches wide. Bands shall be bituminous coated and shall have two corrugations 7-5/8 inches center to center. Bands 12-inch diameter through 30-inch diameter shall be one-piece, and 36-inch diameter through 96-inch diameter shall be two-piece. Band laps 12-inch diameter through 48-inch diameter shall be joined by one galvanized bar, bolt, and strap connector. Band laps 54-inch diameter through 96-inch diameter shall be joined by two galvanized bar, bolt, and strap connectors.

2.6 ALUMINUM OR ALUMINIZED STEEL CORRUGATED PIPE AND STRUCTURAL PLATES

A. Aluminum Alloy Structural Plate

1. Aluminum alloy plates and fasteners intended for use in the construction of structural plate pipe and pipe arch for storm sewers shall meet the applicable requirements of AASHTO M-219. The plate shall be fabricated from aluminum alloy 5052 H141. The chemical composition of the plates shall conform to ASTM B209 alloy 5052.
2. The corrugations shall have a pitch of 9 inches plus or minus 3/8 inch and depth of 2-1/2 inches plus or minus 1/8 inch. The inside crown radius of the corrugations shall be not less than 2 inches.
3. The structural plate pipe or arches shall be assembled in accordance with the manufacturer's erection instructions and in accordance with the drawings.

B. Aluminized Steel Pipe and Arches

1. Aluminized coated corrugated steel pipe and pipe arch intended for use in the construction of storm sewers shall meet the applicable requirements of AASHTO M-36. Sheet material shall meet the latest revision of ASTM A525 and AASHTO M-274. The coils from which the pipe is produced shall be coated with 1.0 ounce per square foot of commercially pure aluminum.
2. Pipe shall be furnished circular or as a pipe-arch shape as required and shall be fabricated with helical corrugations and a continuous welded seam extending from end to end of each length of pipe.
3. Each end of each pipe with the welded seam shall have two annular corrugations reformed to permit joining with hugger bands.
4. Coupling bands shall be hugger bands.

2.7 MULTI-PLATE PIPE AND PIPE ARCHES

- A. Multi-plate pipe and pipe arch structures shall be in accordance with AASHTOM-167. They shall be made with steel sections with corrugations 6 inches wide by 2 inches deep running at right angles to the section.
- B. Bolts and nuts shall be special heat-treated galvanized 3/4-inch diameter bolts in accordance with ASTM specifications.
- C. Multi-plate pipes and pipe arches shall be designed in accordance with the manufacturer's design criteria and in accordance with the drawings.
- D. Detailed instructions regarding erection shall be furnished by the manufacturer.

2.8 CORRUGATED POLYETHYLENE PIPE AND FITTINGS

- A. Pipe Materials: Corrugated polyethylene pipe shall comply with the requirements for materials, test methods, dimensions, and marking in accordance with AASHTO M-252 for pipe diameters 4" - 10", AASHTO M-294 for pipe diameters of 12" - 48", and AASHTO MP7 for 54" and 60".
- B. The resin material shall meet ASTM D3350 cell classification 335400C.
- C. Pipe Joints: The pipe lengths shall be connected using a gasketed, bell and spigot joint. This joint shall consist of either a factory installed, gasketed double bell polyethylene coupling, a factory welded bell or integral bell. The spigot end of the pipe shall be furnished with a factory

installed elastomeric profile "O-ring" rubber gasket that meets ASTM F-477.

- D. The pipe shall be shipped with a removable wrap to protect the gasket. Provide lubrication to the joint prior to pushing together. At least two (2) corrugations of the spigot end must insert into the bell end.
- E. Certification: All HDPE pipe shall be certified through the Plastic Pipe Institute (PPI) Third Party Certification Program. All HDPE pipe delivered and installed shall bear the Third Party Administered PPI Seal.

2.9 MANHOLES AND OTHER STRUCTURES

- A. Manholes shall be constructed of monolithic concrete or precast manhole sections. Precast manhole sections shall conform to requirements of ASTM Specification C478, latest revision.
- B. Materials for manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall comply with the following:
 - 1. Cement shall be Portland cement and shall meet the requirements of ASTM Specification C150, ACI 301, and ACI 318. Concrete for precast manhole sections shall be 3000 psi concrete. Monolithic manholes shall use 4000 psi concrete. Ready-mix concrete shall conform to ASTM C94, Alternate 2. Maximum size of aggregate shall be 3/4 inch. Slump shall be between 2 and 5 inches.
 - 2. Forms for chamber and structures shall be plywood or other approved material. Steel forms shall be used for the inside face of monolithic concrete manholes.
 - 3. Reinforcing steel shall conform to ASTM A615, Grade 60 deformed bars, or ASTM A616 Grade 60 deformed bars.
 - 4. Mortar Materials:
 - a. Sand - ASTM Designation C144, passing a No. 8 sieve.
 - b. Cement - ASTM Designation C150, Type 1.
 - c. Water - shall be potable.
 - 5. The manufacturer shall provide openings for sewers entering and leaving the manhole. Any additional openings needed to be made in the field shall be made by drilling holes at least 1/2 inch in diameter with a maximum spacing of 3 inches.
 - 6. Manhole castings shall be of good quality cast iron and/or ductile iron, conforming to ASTM Designation A48. Castings shall have a total weight of not less than 355 pounds and shall conform to the design of the manhole casting as shown on the standard detail

sheet. Castings shall have three bolt holes equally spaced around base of frame and shall be securely anchored to cone section with three 3/8-inch bolts, nuts, and washer.

7. Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. The manhole steps shall equal or exceed OSHA requirements.
8. Any other special manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall be constructed as detailed on the drawings.

2.10 DRAIN INLETS

Cast iron or ductile iron frames and gratings for drain inlets shall be as shown on the drawings. Bearing surfaces shall be clean and shall provide uniform contact. Castings shall be tough, close-grained gray iron, sound, smooth, clean, free from blisters, blow holes, shrinkage, cold shuts, and all defects and shall conform to ASTM A48 Class No. 30-B. During construction, precautionary measures, such as adequate screening of grates, shall be maintained to deter earth and other materials from entering the drains.

PART 3 - EXECUTION

3.1 INSPECTION AND REJECTION OF PIPE

- A. The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the town Engineer. Such inspection may be made at the place of manufacture or on the work after delivery, or at both places; and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements even though sample pipes may have been accepted as satisfactory at the place of manufacture.
- B. Prior to being lowered into the trench, each pipe shall be carefully inspected and those not meeting the specifications shall be rejected and at once removed from the work.
- C. The town Engineer shall have the right to cut cores from such pieces of the concrete pipe as he desires for such inspection and tests as he may wish to apply.
- D. Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer of the pipe.

- E. The town Engineer shall also have the right to take samples of concrete after it has been mixed, or as it is being placed in the forms or molds, and to make such inspection and tests thereof as he may wish.
- F. Any pipe which has been damaged after delivery will be rejected and replaced solely at the Contractor's expense.

3.2 HANDLING PIPE

Each pipe section shall be handled into its position in the trench only in such manner and by such means as the town Engineer approves as satisfactory. As far as practicable, the Contractor will be required to furnish slings, straps, and other approved devices to permit satisfactory support of all parts of the pipe when it is lifted.

3.3 NOTICE TO ENGINEER

The town Engineer shall be notified when the pipes are to be laid in the trench. At least 15 feet of the pipe shall, under ordinary circumstances, be laid before covering begins.

3.4 LAYING PIPE

- A. All pipe shall be reinspected for soundness and damage due to handling immediately before being lowered into the trench. Any pipe found to be unsound or damaged will be rejected and shall be removed immediately from the site of the work.
- B. All pipe shall be laid accurately to the required line and grade as shown on the drawings, and in the manner prescribed by the pipe manufacturer and appropriate ASTM Specifications, to form a close, concentric joint with the adjoining pipe and to bring the invert of each section to the required grade. The supporting of pipe on block will not be permitted.
- C. Pipe laying shall proceed upgrade, beginning at the lower end of the sewer.
- D. Practically watertight work is required, and the Contractor shall construct the sewers with the type of joint specified.
- E. All pipe shall be laid to the line and grade as shown on the drawings. Variations from a uniform line and grade as shown on the drawings shall be cause for the line to be rejected.
- F. The ends of the pipe shall be satisfactorily cleaned just before laying, and the joint shall be made in a satisfactory manner in accordance with the

recommendations of the manufacturer on particular type of joint and the directions of the town Engineer. All joint work shall be done by experienced workmen.

- G. All pipe shall be bedded as described in this specification under Pipe Bedding. Bell holes shall be excavated in advance of pipe laying so the entire pipe barrel will bear uniformly on the prepared subgrade.
- H. Each length of pipe shall be mechanically pulled "home" with a winch or come-along against the section previously laid and held in place until the trench and bedding are prepared for the next pipe section. Care shall be taken in laying the pipe so not to damage the bell end of the pipe. Mechanical means consisting of a cable placed inside the pipe with a winch, jack, or come-along shall be considered to pull the pipe home where pushing the pipe will not result in a joint going completely home and staying in place.
- I. The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade.
- J. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipe line to prevent flotation of the pipe line. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed at the Contractor's expense.

3.5 PIPE BEDDING AND HAUNCHING

- A. Each pipe section shall be laid in a firm foundation of bedding material and haunched and backfilled with care.
- B. Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures are recommended.
 - 1. When Angular 60 to 12 mm (1/4 to 1/2-inch) clean graded stone, slag or crushed stone material is used for bedding, little or no compaction is necessary due to the nature of the angular particles. A depth of 4 to 6 inches is generally sufficient to provide uniform bedding. If Class I material is used for bedding, it must also be utilized for haunching up to or higher than the spring line of the pipe to avoid loss of side support through migration of Class H haunching material into the bedding.

2. Take care with coarse sands and gravels and maximum size 20 mm (3/4- inch) material, to provide a uniformly compacted bedding. Excavate the bedding material or place it to a point above the pipe bottom, deter mining such point by the depth of loose material resulting in the preparation of the bedding and the amount of compaction that will be required to bring the material to grade. Use hand or mechanical tamping to compact the bedding material to a minimum 85% Standard Proctor Density.
 3. Slightly damp material will generally result in maximum compaction with a minimum of effort. If water is added to improve compaction or if water exists in the trench, take care to avoid saturation of Class 11 material, which could result in additional stability problems. Check grade of bedding after compaction.
- C. Bedding material shall have a minimum thickness beneath the pipe of 4 inches (100 mm) or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.
- D. The rigid pipe, such as concrete, or ductile iron, backfill between the bedding material and a plane 12 inches (300 nun) over the top of the pipe shall be hand placed finely divided earth, free from debris and stones, or granular backfill if required.
- E. For flexible pipe, corrugated metal pipe, the placement of embedment material or haunching around the pipe must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. If crushed stone, pea gravel, or graded gravel or sand is used to backfill between the bedding material and a plane 12 inches (300 mm) over the top of the pipe, it shall be hand placed. If fine sand, silt, or clayey gravels are used for initial backfilling over the pipe, the material shall be hand placed in 6 to 8-inch layers and hand compacted on both sides of the pipe to an elevation 12 inches (300 mm) over the top of the pipe. Care should be taken so not to compact directly over the pipe.
- F. In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation. No additional payment shall be made for stabilizing yielding subsoils.
- G. Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum of 6 inches (150 mm) crushed stone bedding placed prior to pipe installation. Additional payment for rock excavation

shall be made on "unit cost" projects only, and as prescribed under basis for payment.

3.6 CONCRETE CRADLE (CLASS "A" BEDDING)

Concrete cradles shall be constructed of Class "B" concrete and of the design shown on the detailed drawings.

3.7 MANHOLES AND OTHER STRUCTURES

- A. Manholes and other structures are to be constructed at locations shown on the drawings and in accordance with the following specifications:
1. Precast concrete manhole sections shall conform to ASTM Designation C478, except as modified herein:
 - a. The joint design of the precast sections shall consist of a bell or groove on one end of the unit of pipe and a spigot or tongue on the adjacent end of the joining section.
 - b. The joint shall consist of a flat rubber gasket attached to the spigot end of the precast manhole section and shall conform to Sections 6.1.6, 6.1.7 and 9 of ASTM Designation 443, latest revision.
 2. Openings in manhole sections for sewer connections shall be cut at the point of manufacture and shall be circular or horseshoe shaped with grooved or roughened surfaces to improve mortar bond. Any additional holes cut in the field shall be accomplished in a manner approved by the town Engineer.
 3. Manhole bases shall be cast-in-place concrete, reinforced as shown on the Standard Detail Sheet. Manhole bases shall be cast on a minimum of 6 inches of compacted crushed stone.
 4. Manhole channels or inverts shall be preformed and poured with Class "B" concrete to the spring line of the connecting pipe. The finished invert shall be a semi-circular shaped smooth channel directing the flow to the downstream sewer.
 5. Manhole frames and lids shall weigh not less than 355 pounds and be of good quality cast iron, conforming to ASTM Designation A48 and as shown on Detail #2 on the Standard Detail Sheet. Unless specifically designated otherwise, manhole castings shall be the non-locking type. All manhole frames shall be cast or drilled with three holes equally spaced around base of frame and shall be securely anchored to cone section with three 3/8-inch bolts, nuts, and washers. The joint between the casting frame and cone section shall be fully mortared or gasketed and coated with a

coal tar epoxy coating upon reaching its final set to become a watertight joint.

6. Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. Steps shall be placed as shown on the drawings.

3.8 FINAL SEWER CLEANING

- A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by the town Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.
- B. Upon the town Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.9 CLOSED CIRCUIT TELEVISION INSPECTION

- A. All sections of sewer shall be inspected by closed circuit television.
- B. All unacceptable conditions found during television inspection must be corrected by the Contractor and re-televised.
- C. Unacceptable conditions are conditions that adversely affect the ability of the system to function as designed or to be properly maintained and may include, but are not limited to, the following:
 1. Protruding taps
 2. Cracked or faulty pipe
 3. Misaligned or deformed pipe
 4. Debris in line
 5. Infiltration / exfiltration
 6. Excessive gaps at joints
 7. Bellies or sags with a depth greater than or equal to 10% (or a maximum of 3 inches) of pipe diameter and/or a length greater than 25 feet.
- D. See specification section 02750 Sewer Televising for procedures.

PART 4 - FIGURES

4.1 STANDARD DETAILS

Refer to the Town of Pittsboro Standard Construction Details.

END OF SECTION 02721

SECTION 02731 - GRAVITY SANITARY SEWERS

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers all work necessary for the installation of gravity sanitary sewers and related items complete, including manholes, junction chambers, diversion chambers, house/building services, grease traps, and miscellaneous concrete structures.
- B. Sewer pipe shall be the size shown on the drawings prepared and certified by a registered professional Engineer and shall meet all requirements of these specifications. Drawings and specifications shall be submitted to and be approved by the Pittsboro Town Council prior to any construction.
- C. All food establishments shall install grease traps.

1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible.

1.3 SUBMITTALS

Before construction and preferably before fabrication, the Contractor shall submit to the Engineer for approval calculations on the thickness or strength class and drawings showing pipe lengths, joints, and other construction and installation details. All pipe furnished under this Contract shall be fabricated only in accordance with the drawings and these specifications. Contractor shall submit shop drawings for all material to be used for approval by the Town Engineer before commencing with construction.

1.4 QUALITY ASSURANCE

- A. Performance Tests: The Contractor shall test all gravity sewers constructed under the Contract. The Contractor shall constantly check horizontal and vertical alignment. Testing for vertical deflection in the case of non-rigid pipe and sewer watertightness testing in the case of all gravity sewers and hydrostatic testing of ductile iron pipe shall be as specified in this Section.

- B. Line and Grade Requirements: The Contractor shall provide assurance to the Engineer or the Engineer's representative that the sewer is laid accurately to the required line and grade as shown on the drawings. The Contractor shall utilize a laser beam instrument to lay and check the alignment and grade between manholes. Before proceeding with the next section of sewer, the last section shall be checked for proper line and grade. Variations from a uniform line and grade as shown on the drawings and described below shall be cause for the line to be rejected.
1. Variance from established line and grade shall not be greater than $\frac{1}{32}$ of an inch per inch of pipe diameter and not to exceed $\frac{1}{2}$ inch, provided that such variation does not result in a level or reverse sloping invert; provided also that the variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed $\frac{1}{64}$ inch per inch of pipe diameter or $\frac{1}{2}$ inch maximum.
- C. Test Sections
1. Initial Performance Test: An initial performance and leakage test will be performed on the first sections of sanitary sewer constructed of approximately 600 feet in length of each size and type sewer material installed. No additional sewer pipe shall be installed until the first section of sewer of each size and type of sewer material has satisfactorily passed the test for line and grade and the leakage test.
 2. Subsequent Performance Testing: After the initial performance test and leakage test and as work progresses, the Engineer may designate additional sections for testing as conditions in his opinion warrant. If a review of the Contractor's workmanship leads the Engineer to question whether or not the tolerances and standards specified are being met, the Engineer reserves the right to select other locations and lengths to be tested. The Engineer shall notify the Contractor of the location where a test is to be required not later than 15 days after the sewer installation has been completed. Unless otherwise authorized, the Contractor shall arrange to commence the test within 15 days after the sewer has been installed or 15 days after receiving notification by the Engineer, whichever date is later.
 3. Final Performance Testing for Acceptance: Before acceptance of all new sanitary sewers, the Contractor and the Engineer or the Engineer's representative shall check all sewers, even if previously checked, for accurate alignment and grade. Also, all sanitary sewers shall be tested as specified in Articles 3.9 through 3.13 of this Section for watertightness. The program of testing whether by

infiltration, exfiltration, air testing, or vacuum testing shall be determined by the Engineer.

1.5 LENGTH OF OPEN TRENCH

Except by permission of the Engineer, not more than 450 feet of trench shall be opened at any one time. Not more than 30 feet of trench may be opened in advance of the completed pipe laying operation, and not more than one street crossing may be obstructed by the same trench at any one time.

1.6 RELATION TO WATER MAINS

- A. Sewers must be laid at least 10 feet horizontally from any existing or proposed water main. The distance is to be measured edge to edge. Should specific conditions prevent this separation, the Contractor shall notify the Engineer for specific instructions regarding the treatment of the separation. Special conditions may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18 inches above the top of the sewer. It may be necessary to install 150 psi water main pipe and joints as sewer pipe for the congested areas.
- B. Whenever the sewer crosses a water main, it should be laid at least 18 inches below the main, or the water main should be relaid with fittings to cross over the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints.
- C. When it is not possible to obtain proper horizontal and vertical separation as stipulated above, the sewer pipe shall be ductile iron at the crossing or a concrete saddle installed at the crossing. The pipe shall be pressure tested to assure watertightness prior to backfilling. Maximum distance between sewer pipe joints and water pipe shall be provided where vertical separation is a problem.

PART 2 - PRODUCTS

2.1 GENERAL

All pipe, fittings and appurtenances shall be new, unused and as shown on the drawings or as required by the manufacturer and ANSI/AWWA or ASTM Specifications.

2.2 SEWER PIPE 15 INCHES OR SMALLER

- A. Sewers 15 inches in diameter or smaller shall be polyvinyl chloride pipe or ductile iron pipe.
- B. Polyvinyl Chloride Pipe and Fittings
 - 1. Polyvinyl chloride pipe and fittings shall conform to ASTM D3034 SDR 26, Type PSM, latest revision.
 - 2. Maximum diameter of PVC sewer pipe to be used is 15 inches.
 - 3. Joints on PVC sewer pipe shall be the integral bell type gasketed joint designed so that when assembled the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with manufacturer's recommendations. The joint shall comply with the physical requirements of ASTM D3212, and the gasket shall be the only element depended upon to make the joint flexible and watertight.
 - 4. All PVC Pipe entering a manhole shall have a manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe at the manhole. If flexible entry type manhole system is used, the waterstop gasket is not required.
- C. Ductile Iron Pipe and Fittings: Ductile iron pipe and fittings shall conform to the requirements of ANSI/ASTM A746, Ductile Iron Gravity Sewer Pipe.
 - 1. Thickness class requirements of ductile iron pipe to be used in conveyance of sanitary sewage by gravity shall be minimum thickness of Class 350 unless otherwise noted for standard length pipe.
 - 2. Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A2110/C110.
 - 3. Inside surfaces of all pipe, fittings and adapters shall be lined with cement mortar and a bituminous seal coat. Cement mortar lining and bituminous seal coat shall meet the requirements of ANSI/AWWA A21.4/C104.
 - 4. Ductile iron pipe and fittings shall be push-on type conforming to ANSI A21.11 (AWWA C111), latest revision. Fittings shall be ductile iron and shall comply with ANSI Specification A21.10, latest revision, with mechanical joints for 150 psi working pressure.

2.3 SEWER PIPE 18 INCHES AND LARGER

- A. Sewers 18-inches in diameter and larger shall be ductile iron or large diameter polyvinyl chloride pipe.

B. Ductile Iron Pipe

1. Ductile iron pipe and fittings shall conform to the requirements of ASTM A746.
2. Thickness class requirements of ductile iron pipe to be used to convey sanitary sewage by gravity shall be determined by methods specified in ASTM A746.
3. Outside surfaces of the pipe and fittings shall have a bituminous coating complying with ANSI/AWWA C151/A21.51 and ANSI/AWWA C110/A21.10.
4. Inside surfaces of all pipe, fittings and adapters shall be lined with cement mortar and a bituminous seal coat. Cement mortar lining and bituminous seal coat shall meet the requirements of ANSI/AWWA C104/A21.4.
5. Ductile iron pipe joints shall be push-on type, conforming to ANSI/AWWA C111/A21.11. Fittings shall be ductile iron and comply with ANSI/AWWA C110, with mechanical joints designed for 150 psi working pressure.

C. Large Diameter Polyvinyl Chloride Pipe

1. Large diameter solid wall polyvinyl chloride pipe shall conform to ASTM F679, SDR 26.
2. Joints shall be the integral bell type with a locked in sealing ring meeting the requirements of ASTM D3212.

2.4 FITTINGS

- A. Fittings such as wyes, tees, and bends shall be made in such a manner as will provide strength and watertightness at least equal to the class of the adjacent main line pipe to which they are jointed and shall conform to all other requirements specified for pipe of corresponding class and internal diameter. Joints shall be of the same type as used on the adjoining pipe.
- B. Fabricated branches for wyes and tees shall be securely attached to the wall of the pipe in a watertight manner and shall be flush with the inside surface of the pipe. The branches shall have their axes perpendicular to the longitudinal axis of the pipe. Pipe reinforcement shall not be interrupted beyond a radial distance of 3 inches outside of the fitting.

2.5 MANHOLES AND OTHER STRUCTURES

- A. Manholes shall be constructed of monolithic concrete or precast manhole sections. Precast manhole sections shall conform to requirements of ASTM Specification C478, latest revision.

1. Materials for manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall comply with the following:
 - a. Concrete for precast manhole sections shall be 3000 psi concrete. Monolithic manholes shall use 4000 psi concrete. Ready-mix concrete shall conform to ASTM C94 Alternate 2. Maximum size of aggregate shall be 1-1/2 inches. Slump shall be between 2 and 4 inches.
 - b. Forms for chamber and structures shall be plywood or other approved material. Steel forms shall be used for the inside face of monolithic concrete manholes.
 - c. Reinforcing steel shall conform to ASTM A615, Grade 40 deformed bars, or ASTM A616, Grade 40 deformed bars.
 - d. Mortar Materials
 - (1) Sand - ASTM Designation C144, passing a No. 8 sieve.
 - (2) Cement - ASTM Designation C 150, Type 1.
 - (3) Water - shall be potable.
 - e. All joints shall be fully sealed and waterproofed. Rubber gaskets for precast concrete manhole sections shall meet the requirements of ASTM C443. The gasket shall be the sole element depended upon to make the joint flexible and watertight.
 - f. Openings in manhole section for sewer connections shall be cast into the manhole at the point of manufacture as specified by the connector manufacturer. A flexible pipe-to-manhole connector shall be employed in the connections of the sanitary sewer pipe to precast manholes. The connector shall be the sole element relied on to assure a flexible, watertight seal of the pipe to the manhole. The connector shall be constructed solely of polyisoprene or natural rubber and shall meet and/or exceed the requirements of ATM C923. The resilient connectors shall be A-Lok Products, Inc., Press-Seal Gasket Corporation, or similar manhole connectors approved by the Engineer. Openings shall be a minimum of 6 inches above the manhole base.
 - g. In the field, any additional openings needed shall be made by core drilling and booted as approved by the Engineer. A flexible pipe-to-manhole connector shall be employed in the connection of the sanitary sewer pipe to precast manholes. The connector assembly shall be the sole

element relied on to assure a flexible watertight seal of the pipe to the manhole. The rubber gasket shall be constructed solely of polyisoprene or natural rubber and shall meet/exceed the requirements of ASTM C923. If metal, the internal expansion sleeve and the external compression clamps shall be constructed of Series 304 or Series 305 non-magnetic stainless steel and shall utilize no welds in its construction.

- h. Precast manhole sections shall be steam cured and shall not be shipped from the point of manufacture for at least five days after having been cast. The exterior surface of each section shall be thoroughly coated with a coal tar epoxy type coating as manufactured by TNEMEC Co, Tnemec-46H413 Hi-Build TnemeTar; or approved equal by the Engineer. Final dry mils thickness shall be a minimum of 12 mils. Monolithic concrete manholes and other concrete structures shall be cured for a minimum of seven days and then coated in the field with a coal tar epoxy type coating as mentioned above.
- i. Manhole castings shall be of good quality cast iron and/or ductile iron, conforming to ASTM Designation A48. Castings shall have a total weight of not less than 335 pounds and shall conform to the design of the manhole casting as shown on the standard detail sheet. Castings shall have three bolt holes equally spaced around base of frame and shall be securely anchored to cone section to provide a water tight-fit with three or four 3/8-inch stainless steel bolts and expansion shields. Unless specifically designated otherwise, manhole castings shall be the non-locking type.
- j. Manhole steps shall be made from a steel reinforcing rod encapsulated in a copolymer polypropylene resin. The manhole steps shall equal or exceed OSHA requirements. Manhole steps manufactured by M. A. Industries, Inc., PS-1-PF, Clay & Bailey Mfg. Co., or equal, are acceptable.
- k. Any other special manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall be constructed as detailed on the drawings.
- l. The Contractor may, at his option, furnish and install a combination precast concrete base and first section with precut openings for services. Detailed drawings shall be submitted to the Engineer prior to manufacture.
- m. Precast manhole sections shall have a lifting eye cast into the wall for lifting the section. Lifting holes through the precast section will not be allowed.

2.6 GREASE TRAP

Grease trap tank shall be constructed of 6000 psi concrete. All tank joints shall be sealed watertight with butyl rubber extrudible preformed gasket material. All outside riser ring surfaces shall be waterproofed 1/8" with trowelable grade butyl rubber back plaster. Refer to Standard Construction Details.

PART 3 - EXECUTION

3.1 INSPECTION AND REJECTION OF PIPE

- A. The quality of all materials, the process of manufacture, and the finished pipe shall be subject to inspection and approval by the Engineer. Such inspection may be made at the place of manufacture or on the work after delivery, or at both places; and the pipe shall be subject to rejection at any time on account of failure to meet any of the specifications' requirements even though sample pipes may have been accepted as satisfactory at the place of manufacture.
- B. Prior to being lowered into the trench, each pipe shall be carefully inspected, and those not meeting the specifications shall be rejected and at once removed from the work.
- C. The Town or its representatives shall have the right to cut cores from such pieces of the concrete pipe as he desires for such inspection and test as he may wish to apply.
- D. Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer of the pipe.
- E. The Town or its representatives shall also have the right to take samples of concrete after it has been mixed, or as it is being placed in the forms or molds, and to make such inspection and tests thereof as he may wish.
- F. Any pipe which has been damaged after delivery will be rejected and replaced.

3.2 HANDLING PIPE

Each pipe section shall be handled into its position in the trench only in such manner and by such means as the Engineer approves as satisfactory. As far as practicable, the Contractor will be required to furnish slings, straps, and other approved devices to permit satisfactory support of all parts of the pipe when it is lifted.

3.3 NOTICE TO ENGINEER

The Town Engineer shall be notified when the pipes are to be laid in the trench. At least 15 feet of the pipe shall, under ordinary circumstances, be laid before covering begins.

3.4 LAYING PIPE

- A. All pipe shall be reinspected for soundness and damage due to handling immediately before being lowered into the trench. Any pipe found to be unsound or damaged will be rejected and shall be removed immediately from the site of the work.
- B. All pipe shall be laid accurately to the required line and grade as shown on the drawings, and in the manner prescribed by the pipe manufacturer and appropriate ASTM Specifications, to form a close, concentric joint with the adjoining pipe and to bring the invert of each section to the required grade. The supporting of pipe on block will not be permitted
- C. Pipe laying shall proceed upgrade, beginning at the lower end of the sewer.
- D. Practically watertight work is required, and the Contractor shall construct the sewers with the type of joint specified.
- E. All pipe shall be laid to the line and grade as shown on the drawings. Variations from a uniform line and grade as shown on the drawings shall be cause for the line to be rejected.
- F. The ends of the pipe shall be satisfactorily cleaned just before laying, and the joint shall be made in a satisfactory manner in accordance with the recommendations of the manufacturer on particular type of joint and the directions of the Engineer. All joint work shall be done by experienced workmen.
- G. PVC (polyvinyl chloride) gravity sewer pipe and fittings, ASTM Designation D3034 SDR 26, shall be installed in accordance with the directions contained in ASTM Designation D2321. Only materials classified as Class I will be acceptable for bedding, haunching, and initial backfill of the pipe placed and compacted in accordance with ASTM D2321.
- H. Joints on PVC pipe shall be the integral bell type gasketed joint designed so that when assembled the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in

accordance with the manufacturer's recommendations. The gasket shall be the only element depended upon to make the joint flexible and watertight.

- I. All PVC pipe entering a manhole shall have manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe. If flexible entry type manhole system is used, the waterstop gasket is not required.
- J. All PVC pipe shall have a deflection test performed by the Contractor in the presence of the Engineer or his representative.
- K. All pipe shall be bedded as described in this specification under Pipe Bedding. Bell holes shall be excavated in advance of pipe laying so the entire pipe barrel will bear uniformly on the prepared subgrade.
- L. Each length of pipe shall be mechanically pulled "home" with a winch or come-along against the section previously laid and held in place until the trench and bedding are prepared for the next pipe section. Care shall be taken in laying the pipe so not to damage the bell end of the pipe. Mechanical means consisting of a cable placed inside the pipe with a winch, jack, or come-along shall be considered to pull the pipe home where pushing the pipe will not result in a joint going completely home and staying in place. Pushing the pipe home shall be done by means of a block and push bar. Use of hydraulic excavating equipment as the means of pushing or moving the pipe to grade will not be permitted.
- M. The Contractor shall use laser beam equipment to maintain accurate alignment and grade. A qualified operator shall handle the equipment during the course of construction. If bending of the laser beam due to air temperature variations or dust in the air is apparent "within the pipe" units, a fan shall be provided to circulate the air. However, air velocity shall not be so excessive as to cause pulsating or vibrating of the beam. Survey instruments may be used for checking alignment and grade if questions arise about the accuracy of the work.
- N. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipe line to prevent flotation of the pipe line. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any such open end of unplugged branch must be removed.
- O. The Contractor shall conduct a leakage test as described in Sewer Tests of the specification on the first section of sewer of each size and type sewer material installed. No additional sewer pipe shall be installed until the

first reach of sewer of each size and each type sewer material has satisfactorily passed the leakage test.

- P. The Contractor shall prevent all ground water and surface water from entering the existing sewer system during construction of a new sewer or force main extension.
- Q. Sanitary sewer designs that require crossing a county legal drain shall be approved and constructed per the latest standards of the Hendricks County Surveyor's Office.

3.5 PIPE BEDDING AND HAUNCHING

- A. Each pipe section shall be laid in a firm foundation of bedding material and haunched and backfilled with care.
- B. Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures are recommended.
 - 1. When Class I material is used for bedding, little or no compaction is necessary due to the nature of the angular particles. A depth of 4 to 6 inches is generally sufficient to provide uniform bedding.
- C. Bedding material shall have a minimum thickness beneath the pipe of 4 inches (100 mm) or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.
- D. For rigid pipe, such as concrete or ductile iron, backfill between the bedding material and a plane 12 inches (300 mm) over the top of the pipe shall be hand placed finely divided earth, free from debris and stones, or granular backfill if required.
- E. For flexible pipe such as PVC, the placement of embedment material, consisting of bedding, haunching, and initial backfill, must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. Class I material, as defined in specification Section 02222, Article 2.01, paragraph A, shall be used as embedment material for flexible pipe. Bedding thickness shall be as specified in paragraph C of this Section. The haunching material (the material from the bedding to the pipe springline) and initial backfill (the material from the pipe springline to a plane 12 inches over the top of pipe), shall be hand placed. Care must be taken to not cause damage by compacting the material directly over the pipe.

- F. In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation.
- G. Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum of 6 inches (150 mm) crushed stone bedding placed prior to pipe installation.
- H. Manholes and Other Structures
 - 1. Manhole bases shall be cast-in-place concrete, reinforced as shown on the Standard Detail Sheet, or monolithic base and first section combination. Manhole bases shall be cast or placed on a minimum of 6 inches of compacted crushed stone.
 - 2. Manhole channels or inverts shall be preformed and poured with Class "B" concrete to the spring line of the connecting pipe. The finished invert shall be a semicircular shaped smooth channel directing the flow to the downstream sewer.
 - 3. All manhole frames shall be cast or drilled with four holes equally spaced around base of frame and securely anchored to cone section with three or four (4) 3/8-inch stainless steel bolts, nuts and washers. The joint between the casting frame and cone section shall be sealed with a pliable butyl rubber and coated with a coal tar epoxy coating upon reaching its final set to become a watertight joint.

3.6 HOUSE/BUILDING SERVICES

- A. The Contractor shall install 6-inch diameter house/building service sewer, as shown on the Standard Detail Sheet. The house/building service shall extend from a "wye" or "tee" fitting in the main sewer line to the property line or easement line, unless otherwise stated.
- B. The Contractor shall contact the individual property owners for the preferred location of the house/building service to best suit the property owner's needs. If the Contractor is unable to contact the property owner in advance of laying the main sewer by or across the property, the Contractor shall so notify the town's Engineer in writing.
- C. Fittings for house/building service connections on a main line sewer 15 inches in diameter or smaller shall be tees or 45-degree wyes and shall be of the same material as the main line sewer. Intrusion of house/building services into the flow way of the main line sewer shall not be permitted.
- D. House/building services and connections on main line sewers greater than 15 inches in diameter shall be of a type that will maintain the structural

integrity of the main line sewer and provide a watertight connection. Intrusion of house/building services into the flow way of the main line sewer shall not be permitted.

- E. Six-inch lateral pipe shall connect to the main line sewer at an angle of 15 degrees to 45 degrees from the spring line and shall include the necessary bends and straight pipe sections to reach the property line at the elevations specified. A pipe stopper or a bell cap shall be placed on/in the last bell. This stopper or bell cap should be compatible with the type of infiltration/exfiltration test performed on the sewer.
- F. The Contractor shall furnish and use the proper fittings, couplings, and adapters suited to make the transition between different pipe materials which will maintain the structural integrity and the watertightness of the entire sewer system. Refer to the Standard Construction Details for service lateral connection.
- G. At the discretion of the town's Engineer, when and where he feels that improper installation practices are suspected, or questionable bedding materials and methods are employed, or where the installations are severe, the Contractor will have to perform deflection testing on the 6-inch house laterals as specified in Article 3.9.
- H. Backfill around fittings and lateral pipe shall be carefully placed and compacted to prevent damage from backfill settlement and shall be installed in same manner as described for sewer installation.
- I. The Contractor shall mark the end of each house lateral with a 5/8-inch steel rod 5 feet long placed vertically over the end of the lateral. The rod shall be painted green and left sticking above the existing ground not more than 1 inch.
- J. The Contractor shall keep accurate horizontal and vertical location measurements of each house/building service installed. The location of all house/building services shall be shown on record drawings as noted in Section 1.17 Record Drawings. The accuracy of the measurements shall be the Contractor's responsibility.

3.7 STUBS, CONNECTIONS, BULKHEADS, AND MISCELLANEOUS ITEMS OF WORK

- A. Where special junction chambers are to be constructed or where existing sewers carrying sanitary sewage are encountered, the Contractor shall provide and maintain temporary connections to prevent a nuisance.

- B. Where called for shop connections and stubs for future sewer connections shall be provided.
- C. New sewer connections to existing manholes shall be neatly made by core-drilling and installing a flexible pipe-to-manhole connector providing a watertight connection.
- D. The Contractor shall not connect any existing sewers or house/building services prior to the completion of the exfiltration/infiltration tests, air tests, and acceptance of the sewer without the written permission of the Engineer.

3.8 VERTICAL DEFLECTION TESTING

For PVC pipe, the entire length of installed mainline pipe shall be tested for acceptance with an approved go-no-go mandrel under the observation of the Engineer. The testing shall be conducted after the final backfill has been in place for at least 30 days. No pipe shall exceed a deflection of 5%. The deflection test shall be run using a mandrel having a diameter equal to 95% of the inside diameter of the pipe in accordance with ASTM D3034 Appendixes. The pipe shall be measured in compliance with ASTM D-2122. All pipe exceeding the allowable deflection shall be replaced, repaired, and retested.

3.9 INFILTRATION LIMITS

- A. Maximum infiltration/exfiltration limits for all new sanitary sewers shall not exceed 50 gallons per inch of diameter per mile of pipe per 24 hours for any section of the system. All sections of the sewer shall be tested, and any sections not meeting this infiltration standard shall be repaired and retested.
- B. The Contractor shall note the special provision under Article 3.04, paragraph 0, that the first section of sewer of each size and type of sewer shall be given a satisfactory leakage test before proceeding with any additional construction.

3.10 SEWER WATERTIGHTNESS TESTING

- A. Tests for watertightness shall be conducted on all installed sewers in the presence of and in the manner accepted by the Engineer. The Contractor shall furnish and install all equipment necessary for the sewer tests.
- B. Watertightness tests shall be conducted on short sections of the sewer as soon as the manholes have been constructed and the backfilling completed.

- C. Where the section tested is in excess of the allowable limits, the Contractor shall correct the construction of the sewer so that the section tested is within the allowable limit. All methods and materials used in the repair shall be approved by the Engineer.
- D. The program of testing shall fit the conditions as determined by the Engineer using Air Test for Leakage.
 - 1. The Air Test for Leakage
 - a. The air test for leakage shall be used to test sewer watertightness on all sewer pipe unless otherwise noted.
 - b. The ends of the sewer section being tested shall be sealed and properly blocked. The seal at one end shall have an orifice through which to pass air into the pipe. An air supply shall be connected to the orifice at one end of the section. The air supply line will contain an off-on gas valve and a pressure gauge having a range from 0 to 25 psi. The gauge shall have minimum divisions of 0.10 psi and shall have an accuracy of the nearest ± 0.1 psi. The seals at each manhole shall be properly blocked to prevent displacement while the line is under pressure.
 - 2. Procedure for Conducting a Low Pressure Air Test
 - a. Clean pipe to be tested by propelling a snug fitting inflated ball through the pipe by water pressure or other adequate method. This step is important because it not only flushes out construction debris, but the water used to flush the ball through the pipe dampens the pipe wall. The rate of air loss through pipe wall permeation can be significant on dry pipes.
 - b. Plug all pipe outlets with pneumatic plugs having a sealing length equal to or greater than the diameter of the pipe to be tested. The pneumatic plug shall be able to resist internal testing pressures without requiring external bracing.
 - c. Once the pipe outlet plugs are securely in place, pressurized air is introduced to the system. The air shall be fed through a single control panel with three individual hose connections as follows:
 - (1) from control panel to pneumatic plugs for inflation in sewer pipe;
 - (2) from control panel to sealed line for introducing the pressurized air;

(3) from sealed line to control panel. This line will enable continuous monitoring of the air pressure rise in the sealed line.

- d. The air shall be introduced slowly to the section of pipe under evaluation until the internal air pressure is raised to 4.0 psig greater than the hydrostatic pressure head created by the existence of groundwater that is over the pipe section.
- e. A minimum of two minutes shall be provided for the air pressure to stabilize to conditions within the pipe. (This stabilization period is necessary for variations in temperature to adjust to the interior pipe conditions.) Air may be added slowly to maintain a pressure to 3.5 to 4.0 psig for at least two minutes.
- f. After the stabilization period, when the pressure reaches exactly 3.5 psig, the stopwatch shall be started; and when the pressure reaches 2.5 psig, it is stopped. The portion of the line being tested shall be acceptable if the time in minutes for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than the time shown in the following table.

Pipe Diameter, In.	Minimum Time, min:s	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s			
			100 ft	200 ft	300 ft	400 ft
4	3:46	0.380 L	3:46	3:46	3:46	3:46
6	5:40	0.854 L	5:40	5:40	5:40	5:42
8	7:34	1.520 L	7:34	7:34	7:36	10:08
10	9:26	2.374 L	9:26	9:26	11:52	15:49
12	11:20	3.418 L	11:20	11:24	17:05	22:47
15	14:10	5.342L	14:10	17:48	26:42	35:36
18	17:00	7.692 L	17:00	25:38	38:27	51:16
21	19:50	10.470 L	19:50	34:54	52:21	69:48
24	22:40	13.674 L	22:47	45:34	68:22	91:10
27	25:30	17.306 L	28:51	57:41	86:32	115:22
30	28:20	21.366 L	35:37	71:13	106:50	142:26
33	31:10	25.852 L	43:05	86:10	129:16	172:21
36	34:00	30.768 L	51:17	102:34	153:50	205:07

- (1) In areas where the groundwater is above the top of the pipe, the test pressures shall be increased by 0.433 per foot of groundwater. (e.g., if the groundwater is 11-1/2 feet, the 3.5 to 2.5 pressure drop will be increased by 5 psi. The time then will be measured for a pressure drop from 8.5 psi to 7.5 psi.) Groundwater level will be determined by one of the procedures outlined in this Section.

3. Safety Precautions During Air Test

- a. The air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.
 - b. As a safety precaution, pressurizing equipment should include a regulator set at perhaps 10 psi to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.
4. For sewers 30-inches and greater in diameter, joint testing is an acceptable method of testing. Joint testing shall be accomplished by isolating each joint and applying low pressure air. The line shall be acceptable if each joint passes the air test. The joint will be considered acceptable if the air pressure being applied to the joint drops less than 1 psi in three minutes. The air pressure applied shall be 4 psi over and above the groundwater back pressure. Groundwater shall be compensated by increasing the 4 psi test pressure by 0.433 for each foot of groundwater. It is the Contractor's responsibility to determine the groundwater level.

3.11 MANHOLE VACUUM TESTING

- A. A vacuum test shall be conducted by the Contractor on all manholes to ensure watertightness and manhole integrity.
- B. The equipment required to conduct a vacuum test on manholes includes inflatable pipe plugs, test head, vacuum pump, flexible air hose, and a vacuum gage. The test equipment shall be capable of drawing a vacuum of 10-inch Hg. The equipment shall be designed specifically for the

purpose of testing manholes and shall be as manufactured by P.A. Glazier, Inc., Worcester, Massachusetts 10002, or equal.

- C. The procedure for conducting an air test on manholes shall be in accordance with the following procedure:
1. Each manhole shall be tested immediately after setting the casting and prior to backfilling around the structure.
 2. All lift holes shall be plugged with non-shrink grout.
 3. All pipes entering the manhole shall be securely plugged and adequately braced against the inside of the manhole to prevent being drawn out of the pipe.
 4. The test head shall be placed on the inside of the casting frame and sealed with an inflatable seal.
 5. A vacuum of 10 inches of mercury (Hg) shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than the following:

<u>Manhole Size</u>	<u>Minimum Test Time</u>
48"	60 seconds
60"	75 seconds
72"	90 seconds

3.12 CLOSED CIRCUIT TELEVISION INSPECTION

- A. All sections of sewers shall be inspected by closed circuit television.
- B. All unacceptable conditions found during television inspection must be corrected by the Contractor and re-televised.
- C. Unacceptable conditions are conditions that adversely affect the ability of the system to function as designed or to be properly maintained and may include, but are not limited to, the following:
 1. Protruding taps
 2. Cracked or faulty pipe
 3. Misaligned or deformed pipe
 4. Debris in line
 5. Infiltration / exfiltration
 6. Excessive gaps at joints
 7. Bellies or sags with a depth greater than or equal to 10% (or a maximum of 1-1/2 inches) of pipe diameter and/or a length greater than 25 feet.

- D. The Contractor shall clean the sewer, where required, one section at a time.
- E. The cost of this work shall be included as part of the bid, and no additional compensation will be made to the Contractor.
- F. See Specification Section 02750 Sewer Televising for procedures.

3.13 RECORD DRAWINGS

- A. The Contractor shall prepare or be responsible for the preparation and submittal of record drawings as described in Section 01001, Article 1.17.
- B. Record drawings shall be certified to accuracy by a registered professional Engineer.

PART 4 - FIGURES

4.1 STANDARD DETAILS

Refer to the Town of Pittsboro Standard Construction Details.

ENDE OF SECTION 02731

SECTION 02732 - FORCE MAINS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Specifications for force main pipe, fittings, valves, and appurtenances are included in this Section.
- B. Definitions: All pipe, fitting and valve size, and all reference to pipe diameter on the drawings or in the specifications are intended to be nominal size or diameter and shall be interpreted as such.
 - 1. AWWA, where used in these specifications, shall mean American Water Works Association.
 - 2. ANSI, where used in these specifications, shall mean American National Standard Institute.
 - 3. ASTM, where used in these specifications, shall mean American Society for Testing & Materials.
- C. These specifications cover the following types of material:
 - 1. Ductile Iron.
 - 2. Polyvinyl Chloride (PVC).
 - 3. Polyethylene Pipe.

1.2 PIPE MARKING

Each length of pipe shall bear the name or trademark of the manufacturer, the location of the plant, and the date of manufacture. Each length shall likewise be marked to designate the class or strength of the pipe. The marking shall be made on the exterior or interior of the pipe barrel near the bell or groove end and shall be plainly visible.

1.3 RELATION TO WATER MAINS

- A. Sanitary force mains must be laid at least 10 feet horizontally from any existing or proposed water main. The distance to be measured edge to edge. Should specific conditions prevent this separation, the Contractor shall notify the Engineer for specific instructions regarding the treatment of the separation.
- B. Whenever the force main crosses a water main, it should be laid to provide a minimum vertical distance of 18 inches between the outside of the force

main and the outside of the water main. The force main can be either above or below the water main.

PART 2 - PRODUCTS

2.1 GENERAL

All pipe, fittings, valves, and appurtenances shall be as shown on the drawings and specified in this Section. All pipe, fittings, valves, and appurtenances shall be new and unused.

2.2 DUCTILE IRON PIPE

- A. Ductile iron pipe shall meet the requirements of ANSI Specification A21.51 (AWWA Standard C 15 1) and the additional requirements specified herein. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2 and a depth of cover indicated on the drawings and specified in this Section. Minimum thickness pressure class shall be class 150.
 - 1. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be Lok-Fast, Lok Tyte, or equal.
 - 2. Mark each length of pipe. Marking shall include pipe class, casting period, manufacturer's name or trademark, and year of manufacture. Marking shall meet the requirements of ANSI Specification A21.51 (AWWA Standard C151).
- B. Lining and Coating: Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51 /C151 and ANSI/AWWA A21.10/C110.

2.3 PVC PIPE

- A. Polyvinyl Chloride (PVC) Force Mains
 - 1. Pipe
 - a. Polyvinyl chloride pipe shall meet the requirements of AWWA Standard C900. The color of the pipe shall be blue. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2 and a depth of cover indicated on the drawings and specified in this Section. The dimension ratio shall not be greater than 18.

- b. Polyvinyl chloride pipe shall have cast-iron-pipe-equivalent outside diameter.
 - c. Pipe joints shall be push-on type. Joints shall meet the requirements of AWWA Standard C900. Do not use solvent cement joints.
 - d. Mark each length of pipe. Markings shall meet the requirements of AWWA Standard C900.
- 2. The inside surface of the pipe for pipe 4 inches and larger shall be mechanically grit blasted to white metal and then lined with a virgin polyethylene material having a nominal thickness of 40 mils or a two- component coal tar epoxy compound (Duraline) having a nominal thickness of 45 mils.
 - 3. The linings shall have a minimum dry film thickness of 40 to 45 mils. The thickness shall generally equal or exceed 40 to 45 mils throughout the pipe, except at the ends where the thickness may taper for a distance of 4 inches to a minimum 10 mils thickness.

2.4 POLYETHYLENE PIPE

- A. All pipe and fittings to be incorporated into the work shall be made from virgin polyethylene pipe compound material. The pipe shall possess a minimum dimension ratio (DR) of 11 with an Iron Pipe Size (IPS) outside diameter.
- B. The polyethylene resin compound shall contain antioxidants and be stabilized with carbon black against ultra-violet degradation to provide protection during processing and subsequent weather exposure. Pipe shall have permanently extruded green stripe on four (4) sides.
- C. Pipe and fittings shall be made of a high density polyethylene pipe resin, PE3408, possessing a minimum cell classification of 345434C as defined in the latest revision of ASTM D3350 for high density polyethylene pipe and manufactured to the standards of ASTM F-714.
- D. Pipe made from polyethylene resins shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters or other deleterious faults.
- E. The pipe shall be jointed together by conventional fusion methods or by using electrofusion couplings or connectors with tensile strength equivalent to that of the pipe being joined.

2.5 FITTINGS

- A. Fittings shall be ductile iron. Fittings shall meet the requirements of ANSI/AWWA C110. Design and manufacture fittings for a pressure rating of 150 psi.
 - 1. Fitting joints shall be restrained mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be used instead of thrust blocking. Restrained joints shall be Lok-Fast, TR Flex, Lok-Ring, or equal. Pipe connecting to restrained joint fittings shall also have restrained joints as indicated on the drawings and specified in this Section.
 - 2. Mark each fitting. Marking shall meet the requirements of ANSI/AWWA C110.

2.6 ADAPTERS

- A. Adapters from polyvinyl chloride force mains to victaulic or flange joint valves or fittings shall be ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 150 psi.
- B. Line the inside surfaces of adapters with cement mortar lining and bituminous seal coating. Cement mortar lining and bituminous seal coating shall meet the requirements of ANSI/AWWA C104/A21.4. Coat outside surfaces of adapters with bituminous coating. Outside coating shall meet the requirements of ANSI/AWWA C110.
- C. Adapter ends connecting to polyvinyl chloride force mains shall have plain ends or mechanical joints. Mechanical joints shall meet the requirements of ANSI/AWWA C111/A21.11.
- D. Adapter ends connecting to victaulic or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
- E. Adapters from ductile iron force mains to victaulic or flange joint valves or fittings shall be cast iron or ductile iron. Adapters shall meet the requirements of ANSI/AWWA C110. Design and manufacture adapters for a pressure rating of 150 psi.
 - 1. Adapter ends connecting to ductile iron force mains shall have plain ends, push-on joints, mechanical joints, or restrained push-on joints. Adapters with plain ends, push-on joints, or mechanical joints may be used where restrained joints are not required. Adapters shall have restrained push-on joints where restrained joint piping is required as indicated on the drawings and specified

in this Section. Mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA A21.11 /C111. Restrained joints shall be Lok-Fast, Lok-Tyte, or equal.

2. Adapter ends connecting to victaulic or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.
 3. Gaskets
 - a. Gaskets for polyvinyl chloride push-on joints shall meet the requirements of AWWA Standard C900.
 - b. Gaskets for mechanical joints shall meet the requirements of ANSI/AWWA C111 /A21.11.
 4. Nuts and bolts for mechanical joints shall be high strength, heat treated, cast iron. Nuts shall be hexagon nuts. Bolts shall be tee head bolts. Nuts and bolts shall meet the requirements of ANSI/AWWA C111 /A21.11.
 - a. Nuts and bolts for restrained push-on joints shall meet the requirements of the joint manufacturer.
- F. Gaskets for mechanical joints and push-on joints shall meet the requirements of ANSI/AWWA A21.11/C111.
- G. Polyethylene encasement for ductile iron force mains, when specifically called for on the drawings, shall meet the requirements of ANSI Specification A21.5 (AWWA Standard C105).

2.7 VALVES AND VALVE BOXES

- A. Eccentric Type Plug Valves: Plug valves shall be nonlubricated eccentric type with resilient faced plugs having mechanical joint or flanged ends.
1. Port areas of 4-inch to 20-inch valves shall be at least 80% of full pipe area. Port area for 24-inch and larger valves shall be at least 70% of full pipe area.
 2. Valve seats, valve plug stem sleeves and plug stem bushings shall be fabricated of materials which are corrosion and abrasive resistant. The corrosion resistance shall be such that exposure over a period of five years to domestic wastewater, industrial wastewater, domestic sludges or industrial sludges containing sulfuric acid, hydrochloric acid, acetic acid, mineral oils, vegetable oils, polymers, esters or acetones shall not result in sufficient corrosion to interfere with the serviceability of the plug valve.

3. Seals shall be capable of being replaced while the line and valve remain in service, if under submerged conditions, thereby eliminating the need to take process units out of service.
 4. All exposed nuts, bolts, springs, and washers shall be plated with corrosion resistant material. Means of actuation shall be by lever, gear actuator, tee wrench, extension stem, or floor stand, as indicated.
 5. All plug valves shall be equipped with an underground operator.
 6. Plug valves 10-inch and larger shall be equipped with gear actuators. All gearing shall be enclosed and lubricated with seals provided on all shafts to prevent entry of dirt and fluid into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve positions, and an adjustable stop shall be provided to set closing torque. Valve stop shall be positive and shall not move due to repeated operation of the valve.
 7. Valves shall be DeZurik Series 100, Dresser Style 800 X-Centric, or equal.
- B. Gate Valves: Buried gate valves 4-inch and larger shall be full iron body, epoxy fusion bonded inside and out, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500 and shall have mechanical joint ends. Mechanical joints and joint accessories shall meet the requirements of ANSI/AWWA A21.11/C111. Valve opening direction shall be consistent with operation of existing valves in the utility in which the valves are installed, unless otherwise directed by the Engineer.
1. Three-inch buried gate valves shall be iron body, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500, except ends shall be screwed. Screwed ends shall meet the requirements of ANSI B 16.3. Valve opening direction shall be consistent with operation of existing valves in the utility in which the valves are installed, unless otherwise directed by the Engineer.
 2. Gate valves 4-inch and larger installed above ground or in structures shall be iron body, outside screw, and yoke gate valves. Valves shall meet the requirements of ANSI/AWWA C500, except those parts of ANSI/AWWA C500 only applicable to non-rising stem gate valves and wrench nuts. Outside screw and yoke gate valves shall have flange joint ends and malleable iron handwheels. Flange joints and accessories shall meet the requirements of ANSI/AWWA C110. Nuts and bolts shall be cadmium plated. Gaskets shall be full face and shall be velumoid, or equal.
 3. Gate valves smaller than 4-inch installed above ground or in structures shall be bronze, 125 lb. S.W.P. double disc, screwed-in bonnet, rising stem, inside screw gate valves with screwed ends

and malleable iron handwheels. Valves shall meet the requirements of Federal Specification WW-V-54d for Class A, Type III valves.

- C. Valve boxes for plug valves and gate valves shall be cast iron. Valve boxes shall be two piece or three piece type. Each two piece box shall be complete with bottom section, top section, and cover. Each three piece box shall be complete with base, center section, top section, and cover. Valve boxes shall be extension type with slide or screw type adjustment. Each base and bottom section shall be the proper size for the valve served. Each valve box assembly shall be the proper length for the valve served. The minimum thickness of metal shall be 3/16 inch. Valve box cover shall be blank with no wording.

2.8 SEWAGE AIR AND VACUUM VALVES

- A. Sewage combination air and vacuum valves shall be as follows:

<u>Size</u>	<u>Specification</u>
2" x 1"	Apco No. 401 SC, Val-Matic Co. No. 301 BWA, or equal
2" x 2"	Apco No. 402 SC, Val-Matic Co. No. 302 BWA, or equal
3" x 3"	Apco No. 403 SC, Val-Matic Co. No. 303 BWA, or equal

2.9 AIR AND VACUUM VALVE CHAMBERS

- A. Air and vacuum valve chambers shall be 4-foot diameter precast concrete manhole barrels with precast concrete flat slab tops. Precast manhole barrels shall meet the requirements of ASTM C478.
- B. Air and vacuum valve chamber access frames and cover shall be Neenah R-1915- G, or equal. Cast the word "SEWER" in each cover.

2.10 BURIED INDICATING TAPE

SEE SPECIFICATION SECTION 02558

PART 3 - EXECUTION

3.1 HANDLING AND CUTTING PIPE

- A. Pipe and fittings shall be handled carefully to avoid cracking or abrasion of the pipe coating.
- B. Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no

such fracture can be seen, shall be marked as rejected and removed at once from the work.

- C. In any pipe showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used may be perfectly sound. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack.
- D. All cutting shall be done with a machine having steel cutters or knives adapted to the purpose. All cut ends shall be examined for possible cracks caused by cutting.

3.2 INSTALLATION OF PIPING

- A. All piping shall be installed to accurate lines and grades and shall be supported, guided, or anchored as shown, as specified, or as necessary.
- B. Restrained joints shall be provided at vertical and horizontal deflection points, tees, and crosses, or as directed by the Engineer.
- C. All piping installations shall be done in a neat and workmanlike manner.
- D. Install identification/location tape over all new non-metallic force main piping. See specification section 02558 "Identification/Location Tape" for material and installation requirements.

3.3 LAYING PIPE AND FITTINGS

- A. No defective pipe or fittings shall be placed in the work, and any piece found to be defective after having been placed shall be removed and replaced by a second piece and at the expense of the Contractor.
- B. Every pipe and fitting shall be cleaned of all debris, dirt, and other foreign material before being laid, and shall be kept clean until accepted in the completed work.
- C. When bell and spigot pipe is laid, the bell of the pipe shall be cleaned of tar or other obstruction and wiped out before the clean spigot of the next pipe is inserted into it. The new pipe shall then be shoved home firmly against the back of the bell and securely held until the joint has been completed.

3.4 PIPE BEDDING AND HAUNCHING

- A. Each pipe section shall be laid in a firm foundation of bedding material and haunched and backfilled with care.
- B. Prior to pipe installation, carefully bring bedding material to grade along the entire length of pipe to be installed. To provide adequate support for the pipe, the following bedding procedures are recommended.
 - 1. When Class I material is used for bedding, little or no compaction is necessary due to the nature of the angular particles. A depth of 4 to 6 inches is generally sufficient to provide uniform bedding. If Class I material is used for bedding, it must also be utilized for haunching up to or higher than the spring line of the pipe to avoid loss of side support through migration of Class II haunching material into the bedding.
- C. Bedding material shall have a minimum thickness beneath the pipe of 4 inches (100 mm) or one-eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one-sixth of the outside diameter of the pipe.
- D. The rigid pipe, such as concrete or ductile iron, backfill between the bedding material and a plane 12-inches (300 mm) over the top of the pipe shall be hand placed finely divided earth, free from debris and stones, or granular backfill if required.
- E. For flexible pipe such as PVC, the placement of embedment material, consisting of bedding, haunching, and initial backfill, must be done with care. The ability of the pipe to withstand loading in a trench depends a large part on the method employed in its installation. Crushed stone shall be used to backfill between the bedding material and a plane 12-inches over the top of pipe, and shall be hand placed. Care must be taken to not cause damage by compacting the material directly over the pipe.
- F. In yielding subsoils, the trench bottom shall be undercut to the depth necessary and backfilled with graded, crushed stone to form a firm foundation. No additional payment shall be made for stabilizing yielding subsoils.
- G. Where excavation occurs in rock or hard shale, the trench bottom shall be undercut and a minimum of 6-inches (150 mm) crushed stone bedding placed prior to pipe installation. Additional payment for rock excavation shall be made on "unit cost" projects only, and as prescribed under basis for payment.

3.5 JOINTING

A. Polyvinyl Chloride (PVC) Push-On Joints

1. Clean the bell and spigot of the pipe sections being joined. Wipe the outside of each spigot and inside of each bell clean of all dirt and other foreign matter. Wipe each bell and spigot dry. Wipe each gasket clean of all dirt, dust, and other foreign matter.
2. Seat a gasket in the bell of the receiving pipe. Thoroughly lubricate the spigot end of the pipe being installed. Use the lubricant furnished by the pipe manufacturer. Center the spigot end of the pipe being installed in the bell of the receiving pipe. Support the pipe being installed so the pipe being installed is jointed along the centerline of the receiving pipe. Push or pull the pipe being installed home. After jointing, check the gasket to ensure the gasket has not pushed out of its seat and the gasket is uniformly compressed around the pipe.
3. Deflect pipe after jointing, if deflection is required. The amount of deflection shall not exceed the limits recommended by the pipe manufacturer.

B. Mechanical Joints

1. Remove lumps, blisters, and excess bituminous coating from the bell and spigot end of each iron pipe, fittings, and valve. Wire brush the outside of each iron pipe or fitting spigot and inside of each bell. Wipe each bell, spigot, and ring gland clean of all dirt, oil, grease, and other foreign matter. Wipe each bell, spigot, and ring gland dry. Wipe each gasket clean of all dirt, dust, and other foreign matter.
2. Brush each spigot and gasket with soapy water. Slip a ring gland followed by a gasket over the spigot. Center the end of the pipe, fitting, or valve being installed on the end of the receiving pipe, fitting, or valve. Support the pipe, fitting, or valve being installed so the pipe, fitting, or valve being installed is jointed along the centerline of the receiving pipe, fitting, or valve. Push or pull the pipe, fitting, or valve being installed home. Push the gasket into position. Move the gland into position against the face of the gasket. Loosely assemble the joint bolts and nuts. Evenly tighten the nuts using a torque wrench. The torque shall be within the range listed in the following table:

<u>Pipe Size</u>	<u>Bolt Size</u>	<u>Torque Range</u>
4" thru 24"	3/4"	75 to 90 ft.-lb.

3. Deflect pipe, fittings, or valves after jointing, if deflection is required. The amount of deflection shall not exceed the limits shown in the following table:

Pipe Size	Maximum Deflection Angle	Maximum Deflection Based Upon 18-Foot Pipe Length
4"	8°-18'	31"
6"	7°-7'	27"
8"	5°-21'	20"
10"	5°-21'	20"

C. Flange Joints

1. Remove antirust coating from machined surfaces. Clean joint surfaces of the pipe, fittings, and valves being joined. Wipe surfaces clean of all dirt, oil, grease, and other foreign matter. Wipe surfaces dry. Wipe each gasket clean of all dirt, dust, and other foreign matter.
2. Align the flange of the pipe, fitting, or valve being installed with the flange of the receiving pipe, fitting, or valve. Support the pipe, fittings, and valves being joined so the flanges are properly aligned. Lubricate bolts and nuts with a graphite and oil mixture prior to installation of bolts and nuts. Install gasket between the flanges. Loosely assemble bolts and nuts. Check gasket to ensure the gasket is in proper position. Evenly tighten bolts and nuts. Tighten bolts and nuts so the joint will not leak. Do not overtorque bolts and nuts.

3.6 RESTRAINING AND SUPPORTS

A. Thrust Blocking

1. Construct thrust blocks of concrete having a 28-day compressive strength of not less than 2,000 psi.
2. Lubricate fitting surfaces to prevent bonding between fittings and thrust blocks.
3. Construct thrust blocks between fittings to be restrained and undisturbed soil. The area of thrust blocking bearing on undisturbed soil shall not be less than the area indicated on the drawings. Construct thrust blocking so pipe and joints are accessible for repair and joint flexibility is not impaired.

B. Restrained Joint Piping: Restrained joint piping shall be as specified in this Section. Distance from fitting to end of restraint shall not be less than that indicated on the drawings.

C. Pipe Supports

1. Furnish and install supports required to hold pipe, fittings, and valves at the lines and grades indicated on the drawings and without strain upon pipe, fittings, and valves.
2. Support exposed piping by suitable saddle stands, concrete piers, or hangers.
3. Locate supports where necessary and not less than 8 feet on center.

3.7 HYDROSTATIC TEST

- A. A leakage test must be successfully performed on the new force main in accordance with the following provisions:
 1. Said test shall include all force main in this contract as shown on the drawings. The Contractor shall make arrangements with the Engineer for scheduling the test after the piping has been accepted as being ready for testing. All concrete thrust blocks shall have been in place for a period of at least ten days prior to the test. The test shall be performed on the day mutually agreed upon and in the presence of the Engineer.
 2. Water for testing will be obtained by the Contractor at his cost. The Contractor shall furnish all necessary equipment, piping, pumps, fittings, gauges, and operating personnel to properly conduct the test. The system shall be tested in conformance with Section 13 of AWWA Specification C600 at static pressure of 100 pounds per square inch over a period of not less than eight consecutive hours. The system will not be acceptable until all leaks have been repaired to the satisfaction of the Engineer.
 3. At the option of the Contractor, the force main may be tested in sections approximately 500 feet in length (subject to the approval of the Engineer); and upon satisfactory completion of the leakage test, the trench shall be backfilled as specified.
 4. During the filling of the pipe and before the application of the specified test pressure, all air shall be expelled from the pipe line, if necessary, by means of taps at points of highest elevation; and after completion of the test, the taps shall be tightly plugged, unless otherwise specified.

END OF SECTION 02732

SECTION 02750 - SEWER TELEVISION

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers all work necessary for the cleaning and televising of sanitary and storm sewers to determine the water tightness, connections, alignment, grades and locations of service.
- B. The type equipment required for the work and the methods of accomplishing the work, as well as the type of materials to be incorporated into the work, are covered in this Section.
- C. The Contractor shall introduce enough water into sewer pipe to indicate bellies or sags in line being televised.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIRED

- A. The Contractor shall furnish all labor, electronic equipment, and technicians to perform the closed circuit television inspection of the sewers. Operation of the equipment is to be controlled from above ground with a skilled technician at the control panel in the television studio, controlling the movement of the television camera through the sewer in either direction.
- B. The color television camera shall be one specifically designed and constructed for the purpose of televising sewers. The color camera shall have a high resolution lens capable of spanning 360 degrees circumference and 270 degrees on horizontal axis to televise sewer lines 8 inches in diameter and larger. Focal distance shall be adjustable through a range of 1 inch to infinity. The purpose of the rotating head camera is to view all service connections and to locate all defects, as well as any questionable problem areas. The camera shall be mounted to a self-propelled crawler/transporter.
- C. Camera lighting quality shall be suitable to provide a clear, continuously in focus picture of the entire inside periphery of the sewer pipe for all conditions encountered during the work. The camera shall be able to operate efficiently in 100% humidity conditions. The camera, television monitor, and all other necessary components of the video system shall be capable of producing a minimum 350-line resolution color video picture.

- D. The view seen by the television camera shall be transmitted to a digital video file and a color monitor of not less than 17 inches. The TV camera shall have the capability of transmitting a color picture with not less than 600 lines of resolution, the monitor and digital video file shall have the capability of receiving same. The monitor and digital video file shall be located inside a mobile TV studio.
- E. Contractor shall supply digital video to client on 700 mb compact disks in the following format:
 - 1. Minimum 640 x 480 pixel dimension
 - 2. Minimum 24 fps (frames per second)
 - 3. Indexed chapters to allow instant access to points of observation
 - 4. Cross-platform compatible to allow for viewing on any operating system
- F. The Contractor's mobile studio shall be large enough to accommodate up to three people for the purpose of viewing the monitor while the inspection is in progress. The Town's representative shall be present during televising.
- G. The Contractor will provide two clear copies per tape of the video/television inspection to the Town with complete log sheets.
- H. The technician will provide audio input at the time of inspection pointing out cracks, root intrusion, broken tile, infiltration and any other items pertinent to the evaluation of the sewer line.
- I. After completion of each section of the sewer inspection, the Contractor shall furnish to the Town a computerized report. This report will be generated by an onboard computer and printer and will provide commentary on fault areas. The report will also describe all other pertinent findings regarding service connections, breaks or cracks in pipes, bellies or sags, infiltration, and other items of interest.

PART 3 - EXECUTION

Not Used

END OF SECTION 02750

SECTION 02902 - LANDSCAPING FOR UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install topsoil, fertilizer, seed, mulch, sod, trees, bushes, ornamental plants, fencing, mail boxes, planters, and related items necessary to complete work shown or specified.
- B. The Contractor shall repair or replace lawn areas, trees, and ornamental plants damaged or destroyed during construction of the work included in this Contract, unless otherwise shown on the drawings. The Contractor shall repair or replace fences, mail boxes, planters, and other items damaged or destroyed during construction of the work included in this Contract, unless otherwise shown on the drawings.
- C. Lawn areas include grassed areas which are cut and maintained on a routine basis. Lawn areas include lawns at homes and businesses and grass shoulders of streets, roads, and highways.
- D. Replacement of underbrush in fields and woods, along farm fences and roads, and in similar areas is not required, unless otherwise shown on the drawings.

1.2 JOB CONDITIONS

- A. Seed between February 15 and June 1 and between August 15 and November 1. Do not sow seed during adverse weather conditions. Do not broadcast seed during high wind. Do not sow seed when the moisture content of the soil is too low or too high for seed germination.
- B. Plant trees and ornamental plants during the proper time and under the proper conditions for the particular tree or plant.

PART 2 - PRODUCTS

2.1 LAWN PRODUCTS

- A. Limestone: Limestone shall be agricultural grade with a minimum total neutralizing power of 90. At least 40% of the limestone shall pass a No. 100 sieve, and at least 90% shall pass a No. 8 sieve.
- B. Fertilizer: Fertilizer shall be 12-12-12 grade.

C. Seed:

1. Seed mix shall be as follows:

<u>Seed Description</u>	<u>Percent by Weight</u>
Kentucky Blue Grass (<i>Poa pratensis</i>)	35 to 40
Kentucky 31 Fecuse (<i>Festuca arundinacea</i> var. KY 3 1)	30 to 35
Perennial Rye (<i>Lolium multiflora</i>)	30 to 35

2. Seed shall not contain more than 5% inert matter. Seed shall not contain objectional weeds.

D. Mulch: Mulch shall be straw, grass, hay, pine needles, or wood fiber. Straw shall be threshed straw of cereal grain such as oats, wheat, barley, rye, and rice. Mulch shall not contain objectional weed seeds or other material that might be detrimental to the planting being established.

E. Asphalt Adhesive: Asphalt adhesive shall be emulsified asphalt. Adhesive shall meet the requirements of ASTM D977 for Grade SS-1.

2.2 SOD

Provide strongly rooted sod, not less than two years old and free of weeds and undesirable native grasses. Provide only sod capable of growth and development when planted (viable, not dormant). Provide sod composed principally of Kentucky Bluegrass (*Poa pratensis*).

2.3 TOP SOIL

- A. Provide new topsoil that is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 1 inch in any dimension, and other extraneous or toxic matter harmful to plant growth.
- B. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at project site. Obtain topsoil only from naturally, well drained sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.

2.4 FENCE AND OTHER PRODUCTS

Replacement fence, mail boxes, planters, and other items shall be new and unused. Fence, mail boxes, planters, and other items shall be the same type as the

items removed. Fence, mail boxes, planters, and other items shall be of equal quality to the items removed when the items removed were new.

PART 3 - EXECUTION

3.1 GRADING

Fine grade all non-paved areas disturbed during construction. Areas shall be smooth and uniform. Finish elevations and grades shall be the same as elevations and grades prior to construction, unless otherwise shown on the drawings.

3.2 PREPARATION OF PLANTING SOIL

- A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
- B. Mix specified soil amendments and fertilizers with topsoil at rates specified. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.
- C. "Schedule of Planting Soil Mixture Requirements" is attached at end of this section.
- D. For pit and trench type backfill, mix planting soil prior to backfilling, and stockpile at site.
- E. For planting beds and lawns, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.
 - 1. Mix lime with dry soil prior to mixing fertilizer.
 - 2. Apply phosphoric acid fertilizer (other than that constituting a portion of complete fertilizers) directly to subgrade before applying planting soil and tilling.

3.3 SEEDING

- A. Loosen the seed bed, if not loose, to a depth of from 1 to 2 inches below finished grade.
- B. Seeds and fertilizers can be sown with standard agricultural drills. Grass seeds may be sown broadcast or with a special seeder attachment on agricultural drills, but shall not be covered with more than 1/2-inch of soil, whether drilled or raked in. If not covered by the drill, all uncovered seed shall, immediately after sowing, be slightly raked or harrowed to cover the seed.

- C. Apply fertilizer in the amount of 20 pounds per 1,000 square feet.
- D. Sow grass seed at the rate of not less than four pounds per 1,000 square feet.
- E. Apply adequate mulching material following seeding and fertilizing.
- F. Keep seeded and fertilized areas adequately watered until germination of all seed is completed and uniform grass cover is accomplished.

3.4 PREPARATION OF SODDED AREAS

- A. Prior to preparation of areas to be sodded, remove existing grass, vegetation, and turf. Dispose of such material outside of Owner's property. Do not turn over any removed material into the soil being prepared for sodding.
- B. Loosen subgrade of areas to be sodded to a minimum depth of 4 inches. Remove stones over 1-1/2 inch in any dimension and sticks, roots, rubbish, and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.
- C. Place 4 inches of topsoil to be sodded.
 - 1. Spread planting soil mixture to minimum depth required to meet lines, grades, and elevations shown, after light rolling and natural settlement.
 - 2. Place approximately one-half of total amount of planting soil required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil.
 - 3. Allow for sod thickness in areas to be sodded.
- D. Grade areas to be sodded to smooth, even surface with loose, uniformly fine texture. Roll and rake and remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.
- E. Moisten prepared areas to be sodded before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.
- F. Restore areas to be sodded to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.5 SODDING

- A. Sod areas indicated on drawings to be sodded.
- B. Loosen the surface to a depth of 1 to 2 inches and rake area before sod is placed. Remove clods, lumps, boulders, and debris.
- C. Apply limestone at a rate of 25 pounds per 1,000 square feet. Apply fertilizer at a rate of 10 pounds per 1,000 square feet.
- D. Lay sod strips by hand. Fit sod to surrounding grade and fixed objects. Butt sod strips together so there are no open joints. Tamp or roll sod after initial watering. The sod shall have a smooth even surface after tamping and rolling.
- E. Stake or peg sod when the sodded area has a slope of less than 4 feet horizontal to 1 foot vertical.
- F. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen.

3.6 PLANTING TREES AND OTHER PLANTS

- A. Plant trees and other plants in the proper manner for the particular tree or plant being planted.
- B. Keep trees and plants properly watered until growth is assured.

3.7 FENCING AND OTHER RESTORATION

- A. Locate fences, mail boxes, planters, and other items in the same location that the item had been prior to construction. Erect wire and board fences plumb and on straight lines. Set mail boxes, posts, poles, and similar items plumb. Restore planters and similar items to the same shape the items had been prior to construction.
- B. Wire fences shall have the proper tension for the type of wire fence restored. Other fences and items shall be properly erected or constructed.

3.8 CLEAN-UP

Cleanup the job site following landscaping. Remove rubbish, excess materials, temporary structures, and equipment. Leave the work in a neat and presentable condition.

END OF SECTION 02902

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and place plain and reinforced concrete and do related work necessary to complete work shown or specified.
- B. Codes, Specifications, and Standards: Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the references thereto. Latest revisions shall apply in all cases.
 - 1. Following is a partial list of American Concrete Institute publications which are applicable to concrete construction:
 - a. ACI 318 Building Code Requirements for Reinforced Concrete.
 - b. ACI 211.1 Recommended Practice for Selecting Proportions for Normal Weight Concrete.
 - c. ACI 211.2 Recommended Practice for Selecting Proportions for Structural Lightweight Concrete.
 - d. ACI 347 Recommended Practice for Concrete Formwork.
 - e. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - f. ACI 308 Recommended Practice for Curing Concrete.
 - g. ACI 306 Recommended Practice for Cold Weather Concreting.
 - h. ACI 305 Recommended Practice for Hot Weather Concreting.
 - i. ACI 304 Recommended Practice for Measuring, Mixing, and Placing Concrete.
 - j. ACI 503.1 Standard Specification for Bonding Hardened Concrete, Steel, Wood, Brick, and Other Materials to Hardened Concrete with a Multi-Component Epoxy Adhesive.
 - k. ACI 503.2 Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive.

1.2 QUALITY ASSURANCE

A. Testing Laboratory Services: The Contractor shall employ and pay for the services of an independent testing laboratory to perform specific services and necessary tests as outlined below:

1. Tests: Establish each proposed design mix prior to placing the first concrete at the job site. Make a set of four test cylinders for each proposed mix. Break one cylinder from each set at seven days. Break the remaining cylinders at 28 days. A mix will be considered satisfactory if the average strength of three 28-day breaks equals or exceeds the specified 28-day strength. Adjust the design mix and repeat the test procedure if the average strength of three 28-day breaks is less than the specified 28-day strength.

B. Tolerances: Finish concrete shall meet the following tolerances:

1. Variations from Plumb: $\pm 1/4$ -inch per 10 feet but not more than 1 inch
2. Variations from Level or Indicated Grade: $\pm 1/4$ -inch per 10 feet but not more than $1/2$ -inch
3. Variations from Horizontal: $\pm 1/4$ -inch per 10 feet but not more than $1/2$ -inch
4. Variations in Size and Locations of Openings or Sleeves: $1/4$ -inch
5. Variation in Steps Flight of Stairs:
 - a. Riser: $\pm 1/8$ -inch
 - b. Tread: $\pm 1/4$ -inch
6. Variation in Steps Consecutive Steps:
 - a. Riser: $\pm 1/16$ -inch
 - b. Tread: $\pm 1/8$ -inch
7. Reinforcing Steel Placement: $\pm 3/8$ -inch

1.3 SUBMITTALS

A. Submittals shall be as specified in the General Conditions.

B. Submit the following:

1. Manufacturer's Certificate of Compliance certifying compliance with the applicable specifications and standards.
2. Certified copies of test reports of concrete mixes required by the applicable standards.

3. Shop and placing drawings, bending diagrams, and mill test reports for reinforcing steel bars for cast-in-place concrete structures.
4. Samples of waterstops, vapor barrier, and perimeter insulation.
5. For concrete restoration and repair work, submit complete description of proposed method of repair, including sequence of work, dimensions, method of surface preparation, protection of existing structures and materials.
6. Sample and test reports of fly ash.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for the delivery, storage, and handling of products.
- B. Promptly remove damaged or unsuitable products from the job site. Replace damaged products with undamaged products. Replace unsuitable products with suitable products.

1.5 JOB CONDITIONS

- A. Follow methods outlined in ACI 306 if concrete is to be placed when the atmospheric temperature is expected to be less than 40°F.
- B. Calcium chloride will not be considered for approval as an accelerating admixture during cold weather construction.
- C. Follow methods outlined in ACI 305 if concrete is to be placed when the atmospheric temperature is expected to exceed 90°F.
- D. Manufacturer's recommendations shall be strictly followed in regard to atmospheric temperature limitations during application of epoxy or acrylic polymer modified concrete materials.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cement shall be Portland cement and shall meet the requirements of ASTM Specification C 150, ACI 301, and ACI 318. Cement shall be Type I for normal use, Type 1A where air-entrainment is desired, or Type III or Type IIIA where high early strength is desired and authorized by the Engineer. Blended hydraulic cements which meet the requirements of ASTM Specification C-595 Type 1-P Portland-pozzolan cement may be used where a more watertight concrete is required. Fly ash may also be used as a partial cement replacement for Types 1 or 1A.

B. Aggregate

1. Regular fine and coarse aggregates shall meet the requirements of ASTM Specification C 33. Aggregate shall be crushed limestone with a maximum size of 3/4 inch, except in mass concrete the maximum size may be 1-1/2 inches.
2. Lightweight fine and coarse aggregates shall meet the requirements of ASTM Specification C 330.
3. Insulating fine and coarse aggregates shall meet the requirements of ASTM Specification C 332.

C. Water shall be potable, clean, and free from injurious amounts of oils, acids, alkalis, organic materials, or other substances that may be deleterious to concrete or steel. A maximum of 500 mg/L of chloride ion may be present in the water.

D. Admixtures

1. Air-entraining admixtures shall meet the requirements of ASTM Specification C 260.
2. Water-reducing and retarding admixtures shall meet the requirements of ASTM Specification C 494, Type A or Type D, except that they shall contain no chlorides, shall be non-toxic after 30 days, and shall be compatible with the air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's requirements. Furnish a compliance statement that the admixture used satisfies all requirements of this specification.
3. Fly ash shall meet the chemical and physical requirements of ASTM C 618 for mineral admixture Class F, except loss on ignition shall not exceed 6%. Fly ash shall be sampled and tested in accordance with ASTM C 311 prior to use.

E. Reinforcement

1. Reinforcing steel shall meet the requirements of ASTM Specification A 615, Grade 60.
2. Welded wire fabric or wire mesh shall meet the requirements of ASTM A 185.

F. Joint Filler

1. Preformed expansion joint filler shall be chosen to suit the job requirements as follows:
 - a. Type A: Asphalt filler for unsealed expansion or isolation joints in sidewalks, driveways, floor slabs on-grade, and elsewhere as indicated on the drawings. Filler shall meet the requirements of ASTM Specification D994.
 - (1) Sealtight asphalt expansion joint filler, as manufactured by W. R. Meadows, Inc., Elgin, Illinois, or approved equal, will be acceptable.
 - b. Type B: Self-expanding cork filler for standard or waterproof sealed expansion joints in walls, slabs, and elsewhere as indicated on the drawings. Sealing shall be installed in accordance with the details shown on the drawings. Filler shall meet the requirements of ASTM Specification D1752, Type III.
 - (1) Sealtight self-expanding cork expansion joint filler as manufactured by W. R. Meadows, Inc., Elgin, Illinois, or approved equal, will be acceptable.
2. Hot-poured elastic joint filler shall meet the requirements of ASTM Specification D1190.
 - a. Sealtight No. 164, as manufactured by W. R. Meadows, Inc., Elgin, Illinois, or approved equal, will be acceptable.

G. Waterstops shall meet the requirements of Corps of Engineers CRD-C572. Waterstops shall be of the configurations as shown on the standard detail drawings or as specified.

H. Curing Compounds: Curing compounds shall meet the requirements of ASTM Specification C 309, Type I.

I. Epoxy Adhesive and Grout

1. Epoxy adhesive and grout shall be epoxy-resin systems meeting the requirements of ASTM C 881 and the additional requirements herein.

2. The proper type, grade, and class (ASTM C 881) shall be chosen to suit the job requirements as follows:
 - a. Type
 - (1) I - For bonding hardened concrete and other materials to hardened concrete and setting anchor bolts and reinforcing bars in hardened concrete.
 - (2) II - For bonding freshly mixed concrete to hardened concrete.
 - (3) III - For bonding skid resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy concrete.
 - b. Grade
 - (1) 1 - For crack injection and spray application, light viscosity.
 - (2) 2 - For brush application, medium viscosity.
 - (3) 3 - For trowel or caulking gun application, non-sagging heavy viscosity for filling voids and gaps.
 - c. Class
 - (1) A - For use below 40°F.
 - (2) B - For use between 40°F and 60°F.
 - (3) C - For use above 60°F.
 - d. Color: All epoxy adhesives and grouts shall be concrete gray or clear if they will be visible on the final concrete surface.
3. The epoxy material shall consist of a two-component system conforming to the following requirements:
 - a. Properties of mixed components shall meet the following requirements:
 - (1) Solids content: 100% by weight
 - (2) Pot life: 30 minutes (minimum) @ 75°F
 - (3) Contact time: 2 hours @ 75°F
 - (4) Tack free time: 4 hours minimum @ 75°F

- b. Properties of cured material shall meet the following requirements:
 - (1) Neat Binder
 - (a) Tensile Strength ASTM D-638: 3200 psi minimum @ 14 days, 75°F cure
 - (b) Tensile Elongation ASTM D-638 (Modified): 1% minimum @ 14 days, 75°F cure
 - (c) Compressive Strength ASTM D-695: 12,000 psi minimum @ 14 days, 75°F
 - (d) Compressive Modulus: 400,000 psi minimum @ 28 days, 75°F
 - (e) Water Absorption: 1% by weight, maximum 14 days 75°F cure 24 hours immersion
 - (2) Grout: One part Binder to three-and-quarter parts Aggregate by loose volume
 - (a) Compressive Strength ASTM C-109 (Modified) (2" Cubes): 12,000 psi minimum @ 28 days, 75°F cure
 - (b) Compressive Modulus (Modified): 1,250,000 psi minimum @ 28 days, 75°F cure
- c. Aggregate shall meet the requirements of the resin manufacturer.
- d. Chemical acceptance for SPI Classification -2- ('A' Component).
 - (1) The cured system shall meet the requirements of the U.S. Department of Agriculture for use in food processing plants.
 - (2) The cured system shall meet the requirements of U.S. Government regulations requiring water extractables of less than 0.5 MG per square inch of exposed surface for potable water containers. Tests for water extractables shall meet the requirements of the Environmental Control Administration of the U.S. Public Health Service.

- e. The following epoxy manufacturers' products, or equal products, will be considered for approval:
 - (1) SIKADUR as manufactured by Sika Chemical Corp., Lyndhurst, New Jersey.
 - (2) EPOTOX as manufactured by Toch Division, Carbolina, St. Louis, Missouri.
 - (3) SONOBOND as manufactured by Sonneborn-Contech, Minneapolis, Minnesota.
 - (4) PROBOND as manufactured by Protex Industries, Denver, Colorado.

J. Modified Concrete

- 1. Polymer Modified Concrete: The purpose of this specification is to describe a two-component, polymer-modified, cementitious, fast-setting, trowel grade, structural repair mortar. This system shall be used on horizontal, vertical, and overhead surfaces, on grade, above and below grade on concrete and mortar.
 - a. The polymer-modified cementitious system shall consist of a factory preproportioned two-component system whose components conform to the following requirements:
 - (1) Component A shall be a liquid polymer emulsion of an acrylic copolymer base and additives. This acrylic copolymer shall have the following properties:
 - (a) Ph: 4.5 - 6.5
 - (b) Minimum Film Forming Temperature: Approx 68°F
 - (c) Tear Strength: Approx. 990-1420 psi
 - (d) Elongation at Break: 500-900%
 - (e) Particle Size Range: Less than 0.1 micron
 - (2) Component B shall be a blend of selected Portland cements, specially graded aggregates, organic accelerator, and admixtures for controlling setting time, water reducers for workability, and a corrosion inhibitor.
 - (3) The component ratio A:B shall be as required by the manufacturer. The system shall not contain chlorides, nitrates, added gypsum, added lime, or high alumina cements. The system shall be noncombustible, either before or after cure.

- (4) Typical properties of mixed components:
 - (a) Application Time (Working Time): 15 min. after combining components
 - (b) Finishing Time: 20-60 min. after combining components
 - (c) Color: Concrete Gray

- (5) Typical properties of cured material:
 - (a) Abrasion Resistance: 6 times that of controlled concrete
 - (b) Bond Strength (Pull off Method): 100% concrete substrate failure
 - (c) Modulus of Elasticity: 4.5×10^6
 - (d) Surface Scaling (De-icing salt solution freeze/thaw): No deterioration after 120 cycles
 - (e) Compressive Strength 2 hours 50% RH: 150 minimum
 - (f) Compressive Strength 28 days 50% RH: 5,500 psi minimum
 - (g) Flexural Strength 28 days 50% RH: 1,300 psi minimum
 - (h) This system shall conform with ECA/USPHS Standards for surface contact with potable water.
 - (i) This system shall not produce a vapor barrier.
 - (j) This system shall be thoroughly compatible with concrete.

2. Epoxy-Modified Concrete: The purpose of this specification is to describe a two-component, 100% solids, liquid epoxy-resin system which is formulated as an additive to Portland cement concrete or mortar mixes to produce a high strength structural repair concrete or mortar. This system shall be applicable for use on horizontal, vertical, and overhead surfaces, on grade, above or below grade.

- a. The concrete or mortar mix shall be in accordance with the manufacturer's recommendations. Cement, aggregate, sand, and water shall meet the requirements specified elsewhere in this Section.
- b. If the color of the cured epoxy modified concrete does not reasonably match the color of the existing concrete to the satisfaction of the Engineer, the Contractor shall apply an

approved surface coating, suitable for the intended exposure of the patched area, to blend the patchwork into the surrounding concrete.

c. The following manufacturer's products, or equal products, will be considered for approval:

- (1) SIKADUR 362 as manufactured by Sika Corp., Lyndhurst, New Jersey.
- (2) DURALGUARD Modifier E Gel as manufactured by Dural International Corp., Deer Park, New York.

K. Type 1 Grout

1. Type 1 grout shall be expansive grout.
2. The grout shall be composed of selected silica sands, modified cements, pozzolanic, plasticizing, and water reducing admixtures.
3. The grout shall be entirely non-metallic and shall be suitable for both interior and exterior applications.
4. The grout shall be a one-step product delivered to the job site in bags containing a premixed formulation requiring only the addition of water prior to use.
5. The physical properties of the grout shall meet the following requirements:
 - a. Initial Set (ASTM C 1910): 45 min.
 - b. Final Set (ASTM C 191): 180 min.
 - c. Compressive Strength (ASTM C 109):
 - (1) 24 hours: 5,000 psi
 - (2) 3 days: 6,000 psi
 - (3) 7 days: 8,000 psi
 - (4) 28 days: 10,000 psi
 - d. Volume Change (ASTM C 827):
 - (1) 24 hours: +0.032%
 - (2) 3 days: +0.033%
 - (3) 7 days: +0.035%
 - (4) 28 days: +0.035%
 - e. Tensile Strength:
 - (1) 24 hours: 400 psi
 - (2) 3 days: 460 psi
 - (3) 7 days: 550 psi
 - (4) 28 days: 600 psi

6. The following grout manufacturers' products, or equal products, will be considered for approval:
 - a. SONOGROUT as manufactured by Sonneborn-Contech, Minneapolis, Minnesota.
 - b. FIVE STAR GROUT as manufactured by U.S. Grout Corp., Old Greenwich, Connecticut.
 - c. SET NON-SHRINK GROUT as manufactured by Set Products, Macedonia, Ohio.
 - d. SEALTIGHT 588 as manufactured by W. R. Meadows, Elgin, Illinois.

- L. Bonding Agents: The following bonding agent manufacturers' products, or equal products, will be considered for approval:
 1. EPOXTITE BINDER as manufactured by Construction Products Div., W. R. Grace & Co., Cambridge, Massachusetts.
 2. SIKADUR HI-MOD EPOXIES as manufactured by Sika Chemical Corp., Lyndhurst, New Jersey.
 3. SONOBOND as manufactured by Sonneborn-Contech, Minneapolis, Minnesota.

- M. Cement Based and Acrylic Polymer Compounds: The following cement based or acrylic polymer compound manufacturers' products, or equal products, will be considered for approval:
 1. THOROSEAL as manufactured by Standard Dry Wall Products, Inc., Miami, Florida.
 2. LATEX LIQUID FLOOR as manufactured by the Camp Co., Inc., Chicago, Illinois.

2.2 CONCRETE

A. General

1. Concrete shall be Class A, B, C, or D as specified in this Article. All concrete shall be assumed to be Class A, unless specifically excepted.
2. The slump of all concrete shall be not more than 5 inches or less than 2 inches unless specifically excepted by the Engineer.
3. The air content by volume of all concrete shall be 6% plus or minus 1%.
4. Class A concrete shall contain a water-reducing and retarding admixture, unless specifically excepted. Use of a water-reducing

and retarding admixture in Class B, C, or D concrete is optional. Use of a retarding admixture with fly ash concrete is optional.

5. Do not exceed the water-cement ratio of the design mix which includes all water added. The water-cement ratio shall not exceed 0.45. The water cement ratio shall be based on the total cementitious materials content.
6. The water reducing and retarding admixture shall be in accordance with the manufacturer's requirements.
7. Class A concrete shall have a minimum cement content of 564 lbs./cubic yard.
8. An approved fly ash may be added to the cement in Class A or B concrete in an amount not to exceed 15% by weight of cement, provided all applicable requirements for these classes of concrete are met and proposed mix designs are approved.

B. Class A Concrete

1. Class A concrete shall be structural concrete with a 28-day compressive strength of 4,000 psi.
2. Proportion Class A concrete in accordance with ACI 211.1.

C. Class B Concrete

1. Class B concrete shall be plain concrete with a 28-day compressive strength of 2,000 psi.
2. Proportion Class B concrete in accordance with ACI 211.1.

D. Class C Concrete

1. Class C concrete shall be structural lightweight concrete with a 28-day compressive strength of 3,000 psi.
2. Proportion Class C concrete in accordance with ACI 211.2.
3. The maximum density shall be 115 pcf.

E. Class D Concrete

1. Class D concrete shall be insulating concrete with a 28-day compressive strength of 140 psi.
2. The minimum density shall be 24 pcf.

- F. Type 2 Grout: Type 2 grout shall be cement mortar grout. The grout shall be composed of cement, fine aggregate, coarse aggregate, and water. Proportion materials to produce a grout which is suitable for the intended application.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

- A. Subgrade shall be free of sawdust, debris, water, ice, snow, frozen material, extraneous oil, mortar, or any other substances that may be deleterious to the concrete.
- B. Clean rock surfaces by air-water cutting, wet sandblasting, or wire brush scrubbing. Wet rock surfaces immediately prior to placement of concrete.
- C. Earth surfaces shall be firm and damp.
- D. Do not place Class A concrete on mud, dried earth, uncompacted fill, or frozen subgrade. Mud mats of Class B concrete will be permitted upon written approval of the Engineer.
- E. When Class A concrete is to be placed on highly pervious materials which might allow flowing groundwater to damage fresh concrete, the contact surface shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete.

3.2 FORMWORK

- A. All formwork shall be done in accordance with recommended practices contained in ACI 347.
- B. Forms shall be of wood, plywood, steel, or other approved materials and shall be mortar-tight.
- C. Construct forms and associated falsework so finished concrete conforms to the dimensions and contours shown on the drawings.
- D. Form surfaces shall be smooth and free from holes, dents, sags, or other irregularities.
- E. Coat forms with a non-staining oil before being set in place.
- F. Metal ties or anchorages within the forms shall be equipped with cones, she-bolts, or other devices that permit their removal to a depth of at least 1 inch without injury to the concrete.
- G. Remove forms in a manner and at such time to ensure complete safety of the structure. Do not remove supporting forms or shoring until sufficient strength has been developed in the concrete to support weight and load.

3.3 REINFORCING STEEL

- A. Reinforcement shall be free from excessive amounts of scale, rust, form oil, or any other coating that will reduce bond.
- B. Cut and bend reinforcement in accordance with recommended practices contained in ACI 315.
- C. Bar supports shall conform to standards recommended in ACI 315.
- D. Any dowel or lap shown on the drawings and not dimensioned and any splices required but not shown shall be the minimum allowable Class C tension splice according to ACI 318, based on Grade 60 steel reinforcing and 4,000 psi 28-day concrete.
- E. A mat of steel shall be considered as two layers of reinforcing bars forming a grid. When one mat of steel is to be placed in a wall or slab, place the mat in the center of the section unless specifically excepted. When two mats of steel are to be placed in a wall or slab, place one mat in each face of the section utilizing the minimum allowable clear distance per ACI 318, unless specifically excepted.

3.4 CONCRETE

- A. General: Measure and mix concrete in accordance with ACI 614.
- B. Class A Concrete
 - 1. Concrete shall be Class A concrete, unless otherwise shown on the drawings or specified in this Section.
 - 2. No measurable amount of water shall pass through structural concrete when a head of water equal to 12 inches of depth per inch of concrete is applied.
 - 3. Use one brand of cement only in concrete which will have exposed surfaces.
- C. Class B Concrete: Fillets shall be Class B concrete, unless fillets are constructed monolithic with walls or slabs. Mud mats shall be Class B concrete, unless specifically excepted.
- D. Class C Concrete: Use Class C concrete where shown on drawings.
- E. Class D Concrete
 - 1. Insulating concrete on roofs shall be Class D concrete.

2. Class D concrete shall not be less than 1 inch or more than 8 inches thick.
3. Application of Class D concrete shall meet the requirements of the concrete manufacturer.
4. Limit foot traffic on new concrete until roof material has been applied.

F. Ready-Mixed Concrete

1. Mix, deliver, and place ready-mixed concrete in accordance with ASTM Specification C 94.
2. Discharge concrete from a truck within 1-1/2 hours after water has been added to the mix in the truck.
3. The delivery ticket shall contain the cubic yards in the load, the percent of air, the total number of bags of cement in the load, and the total gallons of water in the load. Copy of delivery ticket shall be given to the Engineer's representative.
4. Water may be added at the job site if the water-cement ratio after the addition of the water does not exceed the water-cement ratio of the applicable design mix. When water is added at the job site, there shall be a minimum of 1- 1/2 minutes of mixing per each cubic yard remaining in the truck.

G. Site-Mixed Concrete

1. Thoroughly mix site-mixed concrete in an approved type batch mixer having a capacity of not less than 1/2 cubic yard. The volume of the mixed batch shall not exceed the manufacturer's rated capacity of the mixer.
2. The mixing time for each batch, after addition of water to cement and aggregate, shall not be less than 1-1/2 minutes for each 1 cubic yard of materials. Operate the mixing drum at the speed for which it was designed, provided the speed is more than 14 rpm and less than 20 rpm.

3.5 WATERSTOPS

- A. Waterstops shall be placed in all walls and floor slabs where earth or air is on one side and fluid on the other side.
- B. Waterstops shall be placed in all walls and floors slabs where it is possible to isolate one tank or structure from each other.
- C. Waterstops will not be placed in divider walls where fluid is on either side, except in the case where tank or structure can be isolated.

3.6 EQUIPMENT MOUNTING PADS

All floor mounted equipment shall be installed on a minimum 4" concrete pad as shown on standard detail drawings. Type 1 grout shall be used on all equipment mounting pads, unless otherwise directed by the Engineer.

3.7 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304. Provide chutes, drop pipes, and other placing equipment properly designed and appropriate for the intended use to prevent segregation of coarse aggregate.
- B. Remove construction debris and extraneous matter from within the forms.
- C. Remove temporary struts, stays, bracing, and blocks serving to hold the forms in correct shape and alignment until concrete is placed.
- D. Place concrete on clean, damp surfaces, free from running or standing water.
- E. Deposit concrete in approximately horizontal layers, not to exceed 18 inches.
- F. Consolidate concrete by means of mechanical vibrating. Insert and remove vibrators vertically at regular intervals to ensure uniform consolidation. Do not use vibrators to transport concrete inside the forms. Internal vibrators shall maintain a speed of not less than 7,000 impulses per minute when in operation. At least one standby vibrator shall be on hand at all times during placing.

3.8 CURING

- A. Prevent concrete from drying for a period of 7 days after it is placed.
- B. Curing may be accomplished by any of the approved methods as listed in ACI 308.
- C. Concrete with fly ash may require longer curing time. Curing shall be continuous for a minimum of 7 days or for the time necessary to attain 70% of the specified compressive strength, whichever is greater.

3.9 EPOXY ADHESIVE AND GROUT

- A. Use epoxy-resin system in accordance with ACI 503.1 when it is required to grout reinforcing bars or non-expansive anchors into existing concrete.

- B. Use epoxy-resin system in accordance with ACI 503.2 when it is required to bond fresh (plastic) concrete to hardened concrete.
- C. Joining of new and old concrete shall meet the requirements of the epoxy-resin system manufacturer.
- D. Install reinforcing bars and non-expansive anchors as follows:
 - 1. Non-expansive anchors shall be threaded at least the full length of the embedded portion.
 - 2. Concrete strength shall be a minimum of 3,000 psi before starting the embedment procedure.
 - 3. Embedment length shall be a minimum of 10 times the nominal anchor or bar diameter but not less than 6 inches.
 - 4. Diameter of hole shall be a minimum of 1/2 inch and a maximum of 1-1/2 inches greater than the anchor or bar, bolt-head diagonal or washer diameter, whichever is greater.
 - 5. Vacuum or blow out the hole using oil-free compressed air when a dry drilling method is used.
 - 6. When the drilling process requires the use of water, carefully wash out the hole after drilling to remove residue of drilling slurry. Hole should then be dried if possible.
 - 7. Condition materials to approximately 75°F for ease of mixing and handling of grout prior to mixing epoxy-resin system.
 - 8. Premix components for one minute with mixing paddle attached to low speed (400-600 rpm) electric drill. Pour equal volumes of each component into clean pail. Mix to uniform color. Add approximately a third of the aggregate; mix for another minute. Add remaining aggregate; continue mixing for two to three minutes until grout is thoroughly blended. Move drill continuously to thoroughly mix components. Keep paddle below surface of material to avoid whipping air into mix. Mix only that quantity which can be placed within 30 minutes.
 - 9. Anchors or bars shall be clean, dry, degreased, and free of rust and scale.
 - 10. Vertical Installation
 - a. Anchor bolts, dowels, and reinforcing bars may be installed by either of the following methods:
 - (1) Pour grout to a predetermined level in bolt hole and insert bolt into grout. Work bolt up and down while tapping lightly to ensure complete embedment.
 - (2) Insert bolt and pour grout into annular space between bolt and hole.

- b. Use templates or wedges to hold bolts, dowels, or reinforcing bars in position until grout sets.
11. Horizontal Installation: Install anchor bolts, dowels, and reinforcing bars as follows:
- a. Place grout using a hand- or power-operated caulking gun with a large-diameter tip and polyethylene-tube extension. Install grout to a predetermined depth in bolt hole; insert bolt in grout. Work back and forth, up and down to ensure complete embedment. Pack grout in tightly at the surface; trowel even with the concrete. Position bolt, dowel, or bar in center of drill hole with template or wedges until grout sets.

3.10 MODIFIED CONCRETE

A. Surface Preparation

- 1. Remove all loose deteriorated concrete, soil, dirt, and any deleterious material down to sound concrete. Undercut concrete a minimum of ½ inch. Do not featheredge patch material.
- 2. Sandblast or wirebrush clean concrete and reinforcing steel.
- 3. Moisten surface and allow to dry until damp.

B. Epoxy Modified Bond Coat: Prior to placing epoxy modified concrete or mortar, coat surface of existing concrete and reinforcing steel with epoxy modified bond coat in accordance with the manufacturer's recommendations.

C. Curing: Immediately after placing patch material, cover with wet burlap or polyethylene sheeting for a minimum of 24 hours and protect from heat, sunlight, and wind.

3.11 TYPE 1 GROUT

- A. Use Type 1 grout in all areas where the grout could be expected to have some structural requirements such as under column base plates, and all equipment mounting pads.
- B. Grout storage, handling, mixing, and placing shall meet the requirements of the grout manufacturer.
- C. The clearance between foundations and base plates or equipment bases shall not be less than 1 inch for each 16 inches the grout must flow horizontally.

- D. All areas to be grouted shall be clean and free of oil, grease, dirt, and contaminants. Remove all loose material. Provide air relief openings where required to avoid entrapment of air. All metal components to be in contact shall be derusted and free of paint or oils. All concrete to come into contact with the grout shall be rough finished and shall be thoroughly saturated by dampening or soaking prior to placement of grout. Remove excess water from holes and voids.
- E. Use forming procedures that allow proper and complete placement of the fluid grout, including the use of head forms. Support elements to be anchored so that no movement is possible. Remove support only after grout has hardened sufficiently. Pretreat wood surfaces that can absorb moisture with forming oils. Cut back edges of concrete to be grouted which are less than 1-inch thick to form a uniform butt.
- F. Place grout in accordance with standard grouting procedures and recommendations of ACI for placing and curing of concrete. Use chains, rods, or tamping devices to compact grout tightly, completely removing all air voids. Place grout quickly and continuously, striking off exposed areas. Cure finished grout by standard methods.
- G. Grout protection shall meet the requirements of the grout manufacturer.

3.12 TYPE 2 GROUT

- A. Use Type 2 grout for leveling courses, screeded toppings for tank base slabs, and other similar applications.
- B. The grout shall be composed of cement, fine aggregate, coarse aggregate, and water. Proportion the materials to produce a grout that is suitable for the intended application.
- C. Use a bonding agent to bond the grout to the surface receiving the grout. Use of the bonding agent shall meet the requirements of the bonding agent manufacturer's requirements.
 - 1. The surface to which grout is applied shall be clean and sound. Remove oil, grease, and similar substances. Remove unsound concrete, loose material, and foreign matter by scarifying or other mechanical means. Etch all concrete, whether new or old, with a 1:1 muriatic acid solution (approximately 14%) and thoroughly rinsed with water to remove all traces of acid.
 - 2. Mix and place bonding agent according to bonding agent manufacturer's instructions.

3.13 FINISHING

- A. All concrete and grout surfaces shall be true and even, and shall be free from open or rough spaces, depressions, or projections.
- B. Accurately screed exposed surfaces of concrete to grade and then float prior to final finishing. Do not use excessive floating or trowel while concrete is soft. Do not add dry cement or water to the surface of screeded concrete to expedite finishing.
- C. After removal of forms, remove all bulges, fins, form marks, or other irregularities that may adversely affect the appearance or function of the concrete.
- D. Clean and patch all cavities left by form ties or any other device. Use expansive grout for patching.
- E. Finish concrete in accordance with the following schedule, unless specifically excepted.

<u>Surface</u>	<u>Finish</u>
All exposed vertical surfaces from 6 inches below grade or minimum operating level	Smooth rubbed finish
Floor slabs of tanks and channel floors	Smooth floated finish
Floor slabs of tanks or channel floors which will receive leveling grout	Brushed finish
Interior building floors not receiving fluid applied resilient flooring	Steel trowel finish
Interior building floors which will receive fluid applied resilient flooring	Brushed finish
Leveling grout for tank slabs and channel floors	Screeded with steel trowel finish
Exterior horizontal traveled surfaces	Brushed finish
Exposed exterior horizontal surfaces except as listed above	Smooth rubbed finish

- F. Cement based or acrylic polymer compounds will be considered as an alternative to rubbing. Preparation and application shall meet the requirements of cement based and acrylic polymer compound manufacturers.

3.14 TESTING

- A. The Contractor shall employ and pay for the services of an Independent Testing Laboratory to perform the following tests as specified below and as requested by the Engineer.

- 1. Perform tests in accordance with the following ASTM Specifications:

<u>Test</u>	<u>ASTM Specifications</u>
Slump	C 143
Air Content	C 173
Test Cylinders	C 31 or C 513
Core Samples	C 42
Fly Ash	C 311

- B. The Contractor and the Engineer's representative shall measure slump each time test cylinders are to be made and at any other time requested by the Engineer. The slump limits given herein-before shall not be exceeded unless specifically excepted by the Engineer.
 - C. Measure air content each time test cylinders are to be made and at any other time requested by the Engineer. The field test may be omitted if the air content is known prior to taking samples. The field test may not be omitted if fly ash is used in the mix.
 - D. Make test cylinders in sets of four. Field cure one cylinder. Break field cured cylinder at seven days. Laboratory cure the remaining three cylinders from each set of four. Break laboratory cured cylinders at 28 days. The Contractor shall be responsible for handling and transportation of cylinders. If fly ash is used in the mix, a total set of seven cylinders shall be taken. The additional three cylinders shall be laboratory cured and broken at 56 days, if the 28 day strength does not meet specifications.
 - E. Make one set of test cylinders for each 50 cubic yards, or fraction of 50 cubic yards, of concrete placed, or at other times requested by the Engineer.

- F. Fly ash shall be sampled and tested as specified in ASTM C 311 prior to use as an admixture in concrete.

END OF SECTION 03300

SECTION 11319 - SUBMERSIBLE LIFT STATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: Furnish and install one submersible, non-clog lift station and all appurtenances necessary to complete same as shown or specified.
 - 1. The lift stations shall be complete with submersible sewage pump motors, discharge elbows, access hatch, guide system, piping, valves, electrical controls, and appurtenances as shown on drawings. All components of the lift station shall be furnished by one manufacturer.
- B. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the references thereto. Latest revisions shall apply, unless otherwise specified. Where used in these specifications, the following acronyms shall represent:
 - 1. ANSI - American National Standards Institute.
 - 2. ASTM - American Society for Testing & Materials.
 - 3. HI - Hydraulic Institute.
 - 4. NEMA - National Electric Manufacturer's Association.

1.2 QUALITY ASSURANCE

- A. The pumping unit manufacturer shall test each pump for mechanical and electrical correctness.
- B. Perform field tests specified in this Section.

1.3 SUBMITTALS

- A. Submittals shall be submitted to the town of Pittsboro.
- B. Submit the following:
 - 1. Manufacturer's Certificate of compliance certifying compliance with the referenced specifications and standards.
 - 2. Shop drawings with performance data and physical characteristics.
 - 3. Manufacturer's installation instructions.
 - 4. Manufacturer's operation and maintenance material and manuals.
 - 5. Certified copies of test reports.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for the delivery, storage, and handling of products.
- B. Load and unload all pumps, motors, and appurtenances by hoists or skidding. Do not drop products. Do not skid or roll products on or against other products. Pad slings and hooks in such a manner to prevent damage to products.
- C. The pumps furnished shall be packaged in such a manner as to provide ample protection from damage during handling, shipment, and outdoor storage at the lift station site. All openings shall be capped with dustproof closures and all edges sealed or taped to provide a dust-tight closure.
- D. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish complete a submersible lift stations consisting of submersible non-clog sewage pumps, motors, piping, valves, reinforced concrete wet well, electrical controls, guide system, and other appurtenances as specified in this Section and as shown on the drawings.
- B. Pumping units shall meet the requirements of HI standards.
- C. Pump materials shall meet the requirements of the latest editions of the following specifications:

<u>Material</u>	<u>ASTM or ANSI Designation</u>
Cast Iron	A-48 Class 30
Stainless Steel	ANSI Type 316L, 304, and 431
Bronze	B-144 Class 3B
Hot Rolled Steel	A 107-50-T Gr. 1015.20 Cu.Min.
Cold Rolled Steel	A 108-50-T Gr. 1141 Turned, Ground & Polished
Pipe	ANSI A21.51

- D. Where applicable specifications are not designed herein, supply high class commercial grades of materials that meet the requirements specified and which are satisfactory to the Engineer.

2.2 PUMP DESIGN

- A. Pumps shall be capable of handling raw, unscreened sewage and 3-inch spherical solids.
- B. The design shall be such that the pump unit will be automatically and firmly connected to the discharge piping when lowered into place on its mating discharge connection, which shall be permanently installed in the wet well.
- C. The pump shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastenings to be disconnected. For this purpose, there shall be no need for personnel to enter the wet well.
- D. Each pump shall be fitted with a stainless steel lifting chain of adequate strength and length to permit raising and lowering the pump for inspection and removal. The lifting system must permit the pump to be removed in one continuous motion, without intermediate hooking.
- E. The pump, with all its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.

2.3 PUMP CONSTRUCTION

- A. All major parts, such as stator casing, oil casing, sliding bracket, volute and impeller, shall be gray cast iron, Class 30, with smooth surfaces devoid of blow holes and other irregularities. All surfaces coming in contact with sewage shall be protected by an approved coating resistant to sewage. All exposed bolts and nuts shall be 304 stainless steel.
- B. The wear ring shall consist of a stationary ring made of nitrile rubber molded with a steel ring insert which is drive-fitted to the volute inlet and rotating stainless steel ANSI 304 ring which is drive-fitted to the impeller eye.
- C. The impeller shall be gray cast iron of a non-clogging design capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications. The impeller shall be constructed with a long throughlet without acute turns. The impeller shall be dynamically balanced. Static and dynamic balancing operations shall not deform or weaken it. The impeller shall be slip fit to the shaft and key driven. Non-corroding fasteners shall be used.

1. The volute shall be of single piece design and shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller.
- D. Pump shall be provided with a mechanical rotating shaft seal system consisting of two totally independent seal assemblies running in an oil reservoir having separate, constantly hydro-dynamically lubricated lapped seal faces. The (lower) seal unit between the pump and the oil chamber shall contain one stationary and one positively driven rotating tungsten-carbide ring.
- E. The (upper) seal unit between the oil sump and motor housing shall contain one stationary tungsten-carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by a spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. Shaft seals which are lubricated by oil and not the pumped liquid may utilize carbon and ceramic, Type 21, to be considered equal. The shaft sealing system shall be capable of operating when the pump is submerged to depths of/or pressures equivalent to 65 feet. No seal damage shall result from operating the pumping unit out of its liquid environment for extended periods of time. The pump shall be capable of operating for 24 hours in a dry condition without damage to the pump motor or mechanical seal.
- F. The pump shaft shall be stainless steel ANSI 420 stainless steel.
- G. The cable entry water seal design shall be such that precludes specific torque requirements to ensure a watertight and submersible seal. The cables shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit with cable and housing; strain relief and sealing of the cable is done separately within the body; the cable entry junction chamber and the motor shall be separated by a stator lead sealing gland or terminal board. Epoxy filled terminal housing shall be considered equal providing individual wire leads are spliced in the motor terminal housing and the individual splice caps are filled with epoxy; such construction shall not require a terminal board to isolate the motor interior and the pump top.
- H. All mating surfaces of major parts shall be machined and fitted with nitrile O-rings where watertight sealing is required.
- I. Machining and fitting shall be such that sealing is accomplished by automatic compression in two planes and O-ring contact made on four surfaces. Square rings which provide the controlled compression of an O-ring and the ease of assembly of a flat gasket shall be considered equal.

- J. Tolerances of all parts shall be such that allows replacement of any part without additional machining required to ensure sealing as described above.
- K. Each unit shall be provided with an adequately designed cooling system. Thermal radiators integral to the stator housing, cast in one unit, are acceptable. Units which utilize an oil-filled motor and which operate considerably cooler than air-filled motors shall not require additional cooling to be considered equal. Thermal radiators integral to the stator housing, cast in one unit, are acceptable. Where water jackets alone or in conjunction with radiators are used, separate circulation shall be provided. Cooling media channels and ports shall be nonclogging by virtue of their dimensions. Provision for external cooling and flushing shall be provided.
- L. Internal thermal sensors shall be required on each pump motor. Thermal sensors shall be used to monitor stator temperatures. There shall be one for each phase group in the motors. These shall be used in conjunction with and supplemental to external motor overcurrent protection, and they shall be located in the control panel. The internal thermal sensors shall show and/or sound an alarm and automatically shutdown the pump before motor damage occurs.
- M. Moisture sensing probes shall be installed in the mechanical seal cavity of each pump unit. These probes shall sense the intrusion of the pumped liquid into the seal cavity, send a signal to the panel mounted alarm device, and shut the pump down immediately. The alarm device shall be activated until the pump is removed from service/or repair.

2.4 GUIDE SYSTEM

- A. A sliding guide bracket shall be an integral part of the pump unit. The volute casing shall have a machined discharge flange to automatically and firmly connect with the cast iron discharge connection which, when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting Range without the need of adjustment, fasteners, clamps, or similar devices.
- B. Installation of a pump unit to the discharge connection shall be the result of a simple linear downward motion of the pump unit guided by two guide rails, a T- bar, or other suitable guide system.
- C. Guide rail pipes shall be constructed using 304 stainless steel or reinforced fiberglass material.
- D. No other motion of the pump unit, such as tilting or rotating, shall be required. No portion of the pump unit shall bear directly on the floor or

wet well. There shall be no more than one 90 degree bend allowed between the volute discharge flange and station piping.

2.5 MOTOR

- A. The pump motor shall be housed in an air-filled, watertight casing and shall have moisture resistant Class F 155°C insulation. Oil-filled motors shall be considered equal providing they are the standard design of a U.S. manufacturer and do not utilize a heat shrunk, pressed in stator assembly. Thermal switches set to open at 120°C shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with supplemental to external motor overload protection and shall be connected to the control panel. The motor shall be NEMA design B and designed for continuous duty, capable of sustaining a minimum of 10 starts per hour. No motor winding damage shall result from operating the pumping unit out of its liquid environment for extended periods of time.
- B. Pump motor cable installed shall be suitable for submersible pump applications and this shall be indicated by a code or legend permanently embossed on the cable. Cable sizing shall conform to NEC specifications for pump motors and shall be of adequate size to allow motor voltage conversion without replacing the cable. Unless otherwise noted, provide adequate cable to complete the installation shown on the drawings.

2.6 ACCEPTABLE PUMP MANUFACTURER

The Flygt Pumps

2.7 CONTROLS

- A. The pump station shall be provided with a NEMA 4X stainless steel starter panel, which shall be sized to accommodate starters and controls for specified pumps. The present pump size shall be as indicated in the pump data sheet below. The starter panel shall consist of, but not be limited to, the following:
 - 1. NEMA 4X stainless steel enclosure, with padlocking hasp and staple, and provided with matching stainless steel drip shield.
 - a. The bottom of the enclosure shall be provided with two 1/2-inch drains located at opposite sides of the enclosure, similar to Crouse-Hinds No. ECD 17.

- b. The top of the enclosure shall be provided with two 1/2-inch breathers located at opposite sides of the enclosure, similar to Crouse-Hinds No. ECD 16.
 - c. The enclosure shall be provided with an internal mounting panel and a swing-out panel.
 - d. The interior of the enclosure shall be provided with properly sized industrial grade corrosion inhibitors.
 - e. The enclosure shall be provided with thermostatically controlled, properly sized condensate heater. The heater shall be mounted on the lower portion of the enclosure internal mounting panel.
 - f. The enclosure shall be provided with a door limit switch actuated panel fluorescent light, which shall be similar in construction to Hoffman Catalog No. A-LFDA2.
 - g. All wiring within the enclosure shall be installed in a plastic wiring duct. Low level signal wiring shall not be mixed with high voltage (110 Volts AC or greater) wiring within the same duct.
 - h. All wiring within the enclosure shall be terminated at terminal blocks; splices shall not be permitted within the enclosure.
 - i. All conduit entry into the enclosure, originating from the wetwell, shall be sealed to prevent moisture and gas vapors from entering the enclosure.
 - j. All low level signal wiring (mA DC) shall be twisted shielded cable types.
2. The enclosure shall be sized to house all electrical equipment described herein, including, but not limited to the telephone dialer as specified herein.
 3. The incoming power wiring shall be terminated at distribution lugs and shall be provided with voltage surge arresters to protect all equipment mounted within the enclosure from switching surges and lightning induced surges. Voltage surge arresters shall be located in the enclosure in such a manner as to facilitate inspection and replacement of units if damaged.
 4. Power within the panel shall be distributed further through thermal magnetic circuit breakers and motor circuit protectors, which shall be accessible from the front of the swing-out panel without opening the swing-out panel. Provide the following:
 - a. A motor circuit protector for each pump starter.
 - b. A circuit breaker for a 480/120 Volt AC transformer (only if the incoming power is 480 Volts AC). The circuit breaker shall have a minimum interrupting rating of 25,000 Amperes.

5. If the incoming power is greater than 120/240 Volts AC, provide a transformer which shall step down the incoming power to 120 Volts AC. The transformer shall be high efficiency type, with 1050 Celsius temperature class, extra regulation and low losses. The minimum size of the transformer shall be 1.0 KVA. The primary feeder of the transformer shall be protected by the circuit breaker described above. The transformer shall be sized to provide power to all 120 Volt AC loads listed below.
6. The 120 Volt AC power within the enclosure shall be further distributed through single pole, 15 Ampere circuit breakers, with 10,000 A.I.C. A dedicated circuit breaker shall be required for each of the following items:
 - a. Motor control circuit.
 - b. Panel light and thermostatically controlled enclosure heater described above.
 - c. Convenient receptacle.
 - d. An alarm beacon light fixture.
 - e. Omni-site telemetry unit.
 - f. Generator block heater.
 - g. Battery Charger.
 - h. Battery Heater
7. Provide a duplex convenient receptacle unit, which shall be mounted within the starter enclosure, accessible from the front of the swing-out panel. The receptacles shall be 15 Ampere, GFI (Ground Fault Interrupting) types.
8. Each starter power feed shall be provided with magnetic only motor circuit protector. The motor circuit protectors shall be as follows:
 - a. They shall be provided with adjustable instantaneous trips.
 - b. As a minimum, they shall be rated 25,000 A.I.C. (Amperes Interrupting Capacity). The size, voltage and configuration shall be as required.
 - c. The motor circuit protectors shall be accessible from the front of the swing-out panel without opening the swing-out panel.
9. Motor starters shall be NEMA rated, full-voltage, non-reversing type. I.E.C. rated motor starters shall not be acceptable. The starters and thermal overloads shall be sized according to the motor nameplate data.
10. Provide a duplex pump alternator, which shall automatically sequence the operation of the pumps.

11. Control devices shall be industrial grade oiltight and watertight types. Each pump shall be provided with the following controls, which shall be visible from the front of the swing-out panel, with the enclosure door opened:
 - a. An H-O-A selector switch.
 - b. An amber "FAIL" pilot light.
 - c. An amber "SEAL FAILURE" pilot light.
 - d. A red motor "RUN" pilot light.
 - e. A green motor "OFF" pilot light.
 - f. A "RESET" push button.
 - g. A non-resettable elapsed time meter.

12. Each starter shall be provided with the following:
 - a. A minimum of two sets of normally open starter auxiliary contacts.
 - b. A minimum of two sets of normally closed starter auxiliary contacts
 - c. One set of normally open auxiliary overload alarm contacts.

13. Control circuits shall be designed such that the pump station will operate as follows:
 - a. When the H-O-A selector switch is in the "H" position, the pump motor shall run.
 - b. When the switch is in the "0" position, the pump motor shall be off.
 - c. When the switch is in the "A" position, the pump shall operate automatically as described below.
 - d. The amber "FAIL" light shall be energized when the starter thermal overload relay trips, or when the motor winding temperature detector trips.
 - e. The amber "SEAL FAILURE" light shall be energized when the seal failure contacts trip.

14. Pump motors shall be provided with motor high winding temperature and seal failure detector.
 - a. The detector circuit shall shut down the motor and energize the pump "FAIL" pilot light when the motor winding temperature detector trips. The motor shall remain shut down until its' associated "RESET" push button is depressed.

- b. The detector circuit shall energize the "SEAL FAILURE" pilot light when the seal failure detector trips. The seal failure detector shall automatically reset when moisture is no longer detected in the motor housing.
 - 15. The following single-pole double-throw (SPDT) dry contacts shall be provided for remote monitoring purposes:
 - a. Pump failure status of each pump motor, which shall include the following conditions:
 - (1) Starter thermal overload.
 - (2) Motor winding temperature high.
 - (3) Seal failure.
 - b. Wet well high level condition, which shall include contacts from the high level float switch and from the electronic pump controller high level alarm.
 - c. Level sensor failure from the electronic Dump controller.
 - 16. Their wiring shall be terminated at terminal blocks, grouped and dedicated to remote monitoring.
 - 17. The system shall be provided complete with electro-mechanical relays as necessary to achieve the intended operation as described herein.
- B. The pump station shall be provided with the following types of level control systems:
- 1. Pump station less than 15 feet in depth shall be provided with four float switches, to control the pump operation:
 - a. High level alarm float switch.
 - b. Start lag pump float switch.
 - c. Start lead pump float switch.
 - d. Low level shutdown float switch.
 - 2. Pump station deeper than 15 feet in depth shall be provided with the following pump control systems:
 - a. High level alarm float switch.
 - b. Low level shutdown float switch.
 - c. Submersible hydrostatic pressure type level sensor.
 - d. Electronic pump controller.

- C. The pump station shall be provided with float switches, which shall be constructed as follows:
1. The float switches shall be watertight, encapsulated mercury switch type, encased in a chemical-resistant polypropylene casing.
 2. Each float switch shall be suspended on its own cable, which shall be long enough to reach the bottom of the wet well. The switch shall be weighted with enamel coated cast iron weight to permit the float to pivot for proper operation.
 3. All installation hardware shall be of 316 stainless steel.
 4. The float switch elevations shall be adjustable over the entire wet well depth.
 5. The pump station shall be provided with a high level alarm float switch and a low level emergency shutdown float switch.
- D. The pump station shall be provided with a submersible hydrostatic pressure type level sensor and an electronic pump controller. The system shall be constructed as follows:
1. The hydrostatic pressure type level sensor shall be submersible type, suspended on its cable, which upper end shall be secured as shown on the drawings.
 2. The level sensor shall be mounted on pipe assemblies as shown on the drawings.
 3. The level sensor tip shall be suspended not lower than 12 inches above the wet well floor.
 4. The level sensor shall be as follows:
 - a. The sensor range shall be selected based on the wet well depth.
 - b. The sensor output shall be 4 to 20 mA DC proportional to water level, 2-wire type, with loop power supply of 12 to 40 Volts DC.
 - c. All exposed parts shall be constructed of 316 Stainless Steel
 - d. The sensor shall be filled with Silicon Oil
 5. The electronic pump controller shall be mounted in the starter panel enclosure, and shall be visible from the front of the swing-out panel, with the enclosure door opened. The electronic pump controller shall be as follows:
 - a. The electronic pump controller shall accept a 4 to 20 mA DC, 2-wire level signal, and shall indicate the wet well level digitally in direct engineering units (feet).

- b. The unit shall provide a minimum of four pump control outputs, with independent adjustment for each starting and stopping setpoint. Each level setpoint shall be indicated digitally in direct engineering units.
- c. In addition to the pump control outputs, the unit shall provide outputs for the following points:
 - (1) High Water Alarm
 - (2) Low Water Alarm
 - (3) Level Sensor Failure or signal loss
- d. A built-in adjustable time delay for each actuation point shall be provided to permit level signal to stabilize before control actions are initiated.
- e. Power to the unit shall be 120 Volts AC.
- f. Interposing relays shall be provided for each control output, to provide signal isolation.
- g. The electronic pump controller shall be ESSEX Engineering Corporation, model 2410, or equal.

E. Pump Automatic Operation

- 1. When the pumps are in the automatic mode, (their mode selector switches are in the "A" position), the pumps shall alternate through the following sequence: lead and lag. The level setpoints at which each pump starts and stops in sequence shall be field adjustable through the front panel of the electronic pump controller.
- 2. The station shall be provided with a back-up high level alarm float switch. When level in the wet well rises to the float elevation, both pumps shall be forced to ran.
- 3. The station shall be provided with back-up low level shut down float switch. When level in the wet well falls to the float elevation, the switch shall open, both pumps shall be forced to shut down.

F. Provide an alarm beacon light, which shall be energized on high water alarm condition only. The alarm beacon light shall be as follows:

- 1. The beacon light shall be watertight, suitable for outdoor installation and provided with a red lens.
- 2. The light source shall be high intensity strobe type, with light intensity of 1,000,000 (1 -million) peak candle power.
- 3. The beacon light shall be mounted on top of the starter panel enclosure using water tight conduit hub, similar to Myers ST- 1, T&B 40 1, or OZ-Gedney CHM-50T.

- G. Acceptable Manufacturers:
1. Motor starters and control components: Allen Bradley.
 2. Circuit breakers and motor circuit protectors: Square "D".
 3. Electronic pump controller: ESSEX Engineering Corporation, model 410.
 4. Level sensor: Ametek, model 575.
 5. Beacon light: Federal Signal "Fireball 2".
 6. Alternator: Furnas.
- H. Provide with Omni-Site XF-50 Micro RTU. Coordinate installation and monitoring points with the Town of Pittsboro.

2.8 PIPING MATERIALS

- A. Ductile iron pipe shall meet the requirements of ANSI Specification A21.51 (AWWA Standard C 15 1). Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2 and a depth of cover indicated on the drawings and specified in this Section. Minimum thickness class shall be 350.
- B. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Restrained joints shall be Lok-Ring, Lok-Fast, Lok-Tyte, or equal.
- C. Fittings shall be cast iron or ductile iron. Fittings shall meet the requirements of ANSI/AWWA C110. Design and manufacture fittings for a pressure rating of 150 psi. Fitting joints shall be mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI/AWWA A21.11/C111. Thrust blocking or restrained joints may be as required or necessary.
- D. Gate valves 4-inch and larger shall be full ductile iron body, epoxy fusion bounded inside and out, non-rising stem gate valves. Valves shall meet the requirements of ANSI/AWWA C500 or C509 and shall have mechanical joint ends. Exposed bolts and nuts shall be stainless steel. Joint accessories shall meet the requirements of ANSI/AWWA C11/A21.11. Valve opening direction shall be counter-clockwise.
1. Gate valves 4-inch and larger installed in structures shall be full ductile iron body, outside screw, and yoke gate valves. Valves shall meet the requirements of ANSI/AWWA C500 or C509, except those parts of ANSI/AWWA C500 or C509 only applicable to non-rising stem gate valves and wrench nuts. Outside screw and yoke gate valves shall have flange joint ends and malleable iron handwheels. Flange joints and accessories shall meet the

requirements of ANSI/AWWA C110. Nuts and bolts shall be stainless steel. Gaskets shall be full face and shall be red rubber or equal.

2. Gate valves shall be as manufactured by Waterous, U.S. Valve, or equal.

E. Single disc, swing check valves, 4-inch and larger, shall be used in sewage pump stations and shall be iron body, bronze-mounted, swing check, bolted cover, flanged ends, 125 psig working pressure, AWWA Standard C508, suitable for use in a horizontal position. Flanges shall conform in dimensions and drilling to ANSI B 16.1.

1. Swing check valves shall have outside weight and lever.

2.9 CONCRETE WET WELL AND VALVE VAULT

A. The Contractor shall furnish and install a monolithic concrete or precast manhole type wet well as indicated on the drawings. Pump and related equipment shall be installed and/or mounted as shown.

B. A concrete valve vault shall be furnished and installed to house the valves and appurtenances.

C. Precast manhole sections shall conform to requirements of ASTM Specification C478.

D. Contractor may offer wet well sections conforming to ASTM C-76, Class IV, Wall B pipe sections if shown on the drawings.

2.10 ALUMINUM COVERS

A. Frame shall be 1/4-inch extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior. Cover leaf shall be 1/4-inch aluminum reinforced with aluminum stiffeners as required. Stainless steel hinges shall be bolted to underside and pivot on all stainless bolts and hardware shall be used. The cover shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release and close the cover with one hand. Covers shall be built to withstand a live load of 150 pounds per square foot, and equipped with a snap lock and removable handle. When closed, covers shall not protrude above the operating surface in which they are installed. Factory finish shall be aluminum lacquer. Surface contacting concrete shall have bituminous coating.

B. Covers shall be diamond pattern plate.

- C. Aluminum covers shall be Bilco Type K or KD, Dur-red Products Type SLA, DLA or TLA, or equal.
- D. When flush mounted covers are finished, provide two wrenches for opening covers.
- E. Valve vault cover shall be water tight with drain system.
- F. The Contractor shall provide padlocks for new wet well and valve vault covers. The locks shall be keyed alike with a lock provided by the Owner.

2.11 PORTABLE HOIST

- A. Furnish a manually operated portable hoist for removing the submersible pumps specified from the lift stations. The capacity of the hoist shall be 1/2 ton. The hoist shall have an adjustable boom which shall be able to swing easily when fully loaded. The hoist shall roll on precision bearing trolley wheels. The combination hoist and trolley shall be designed so that the pump can be lifted out of the deepest wet well of the lift stations shown.
- B. Provide and install surface-mounted stainless steel floor sockets for the portable hoist at appropriate locations such that all pumps under this section may be removed by insertion of the portable hoist into floor sockets. All anchor bolts shall be stainless steel.
- C. The portable hoist and all floor sockets shall be furnished by one manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

Inspect all pumps, motors, and appurtenances prior to installation in the work. Promptly remove damaged or unsuitable products from the job site. Replace damaged or unsuitable products with new, undamaged and suitable products.

3.2 INSTALLATION

- A. Install the submersible pumps in accordance with the drawings and manufacturer's written instructions.
- B. The discharge elbow of each pump shall be securely anchored to the wet well base and properly aligned with the guide system and upper guide bracket.

- C. The discharge piping shall be properly anchored and supported inside the manhole.
- D. All electrical work shall be done by a qualified electrician and shall conform to the National Electric Code.

3.3 TESTING

Each pump shall be fully tested in accordance with manufacturer's written instructions, including flow test at pump's rated capacity. Certified copies of the test results shall be furnished with each pumping unit. Record the test voltage and amperage measurements.

3.4 WARRANTY

- A. The pump manufacturer shall warrant the pumps being supplied to the Owner against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, the manufacturer shall replace certain parts which shall become defective through normal use and wear or a progressive schedule of cost for a period of five years; parts included are the mechanical seal, impeller, pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all units. The warranty shall not start until the equipment has been placed in operation for beneficial use as determined by the Owner.
- B. The manufacturer shall provide the services of a factory trained representative for a period of one day at each lift station to perform initial start-up of the pumping station, to instruct operating personnel in the operation and maintenance of the equipment, and to demonstrate satisfactorily the performance of each piece of equipment.
- C. All equipment supplied and installed under this item of the specifications shall meet the requirements of the Occupational Safety & Health Act of 1970.

END OF SECTION 11319

SECTION 13860 – OUTDOOR WARNING SIREN

PART 1 – GENERAL

1.1. DESCRIPTION

- A. Furnish and install pole mounted siren to provide a signal for warning the community with a warning for life threatening weather conditions, civil defense, or general public warning.
- B. Various types of sirens are listed in Part 2 – Products. Developer shall provide products as required by the Town of Pittsboro.

1.2 QUALITY ASSURANCE

- A. The manufacturer of the siren shall test each siren for mechanical and electrical correctness.
- B. The field tests specified in this Section shall be performed.

1.3 SUBMITTALS

- A. Submittals shall be submitted to the Town of Pittsboro.
- B. The following submittals shall be provided:
 - 1. Manufacturer’s Certificate of Compliance certifying the unit’s compliance with the referenced specifications and standards.
 - 2. Shop drawings with performance data and physical characteristics
 - 3. Manufacturer’s installation instructions.
 - 4. Manufacturer’s operation and maintenance material manuals.
 - 5. Certified copies of test reports.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for the delivery, storage, and handling of products.
- B. Load and unload the sirens and appurtenances by hoists or skidding. Do not drop products. Do not skid or roll products on or against other products. Pad slings and hooks in such a manner to prevent damage to products.
- C. The sirens furnished shall be packaged in such a manner as to provide ample protection from damage during handling, shipment, and outdoor storage at the installation site. All openings shall be capped with weather-resistant closures and all edges sealed or taped with a rain-tight closure.

- D. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Furnish complete siren installations consisting of the siren, controller, antenna, electrical service, pole and other appurtenances as specified in this Section and as shown on the drawings.
- B. Where applicable specifications are not designated herein, supply high-class commercial grades of materials that meet the requirements specified and which are satisfactory to the Town of Pittsboro.

2.2 TYPE 1A SIREN

- A. The siren shall be powerful enough to provide an audible signal for a minimum radial distance of 1.0 mile. The anechoic certified signal strength shall be a minimum of 127 dBC at 100 feet. The siren shall operate from an AC power source only.
- B. The siren shall be capable of providing three distinct warning signals:
 - 1. Steady signal: 750 Hz frequency
 - 2. Wail: 470 – 705 Hz, 10 sec. sweep rate
 - 3. Fast wail: 600 – 705 Hz, 3.5 sec. sweep rate
- C. The design shall be a motor operated rotating siren. The siren motor shall be a DC 6HP series wound motor operating from 48VDC or full-wave rectified AC, 100 Amps nominal. The rotating motor shall be a DC 1/3 HP permanent magnet motor operating from 48VDC or full-wave rectified AC, 3 amps nominal.
- D. The siren shall be suitable for outdoor installation and be provided with a weather resistant coating.
- E. The siren shall be operational within an operating temperature range of minus 30°C to plus 60° C.
- F. The rotating siren shall have a rotation of 2 – 8 RPM (adjustable).
- G. The siren shall be provided with a controller to operate the siren and rotating motors from an electrical service of either 208VAC, or 220/240VAC. The controller shall be a NEMA type 3R enclosure and come complete with transformer/rectifier and control contactors for the motors. The developer shall verify the proper operating voltage available for the siren with the electric utility and the manufacturer.

2.3 TYPE 1B SIREN

- A. The siren shall be powerful enough to provide an audible signal for a minimum radial distance of 1.0 mile. The anechoic certified signal strength shall be a minimum of 127 dBC at 100 feet. The siren shall operate from a battery backed-up AC power source.
- B. The siren shall be capable of providing three distinct warning signals:
 - 1. Steady signal: 750 Hz frequency
 - 2. Wail: 470 – 705 Hz, 10 sec. sweep rate
 - 3. Fast wail: 600 – 705 Hz, 3.5 sec. sweep rate
- C. The design shall be a motor operated rotating siren. The siren motor shall be a DC 6HP series wound motor operating from 48VDC or full-wave rectified AC, 100 Amps nominal. The rotating motor shall be a DC 1/3 HP permanent magnet motor operating from 48VDC or full-wave rectified AC, 3 amps nominal.
- D. The siren shall be suitable for outdoor installation and be provided with a weather resistant coating.
- E. The siren shall be operational within an operating temperature range of minus 30°C to plus 60° C.
- F. The rotating siren shall have a rotation of 2 – 8 RPM (adjustable).
- H. The siren shall be provided with a controller to operate the siren and rotating motors from an electrical service and in the event of power failure, to operate for a minimum of 15 minutes on battery back-up. The controller shall be a NEMA type 4 enclosure and come complete with battery chargers, control contactors for the motors and a NEMA 3R battery enclosure. Provide batteries as recommended by the manufacturer. Provide a NEMA type 4 enclosure with transformer/rectifier components for operation of the siren from the AC power source. The developer shall verify the proper operating voltage available for the siren with the electric utility and the manufacturer.

2.4 TYPE 2 SIREN

- A. The siren shall be powerful enough to provide an audible signal for a minimum radial distance of 0.5 miles. The anechoic certified signal strength shall be a minimum of 115 dBC at 100 feet. The siren shall operate from an AC power source.
- B. The siren shall be capable of providing three distinct warning signals at an output frequency of 675Hz: Steady, Wail, and Fast Wail.

- C. The design shall be a motor operated omnidirectional siren. The siren motor shall be a 7.5HP AC motor. Provide a NEMA constructed motor contactor in a NEMA 4 enclosure for control of the siren motor.
- D. The siren shall be suitable for outdoor installation and be provided with a weather resistant coating.

2.5 CONTROLLER

- A. The controller shall be a radio receiver/decoder and timer with relay outputs.
- B. The relay microprocessor based controller shall contain the following features;
 - 1. Synthesized radio receiver (Low Band, High Band, UHF).
 - 2. Two-tone sequential and DTMF.
 - 3. Four individually programmable output relays.
 - 4. Push buttons for local control of four (4) pre-set signals and a cancel button.
 - 5. Contact closure inputs for landline control
 - 6. Diagnostic LED's
 - 7. RS232 programming port
 - 8. Operates at 120 or 240 VAC, 50/60 Hz
- C. The controller shall be activated by and operate on the Hendricks County Emergency Management frequency.
- D. Optional Software for controller shall be programmable from any IBM-compatible computer with an RS232 port. Provide software if required by the Town of Pittsboro. The programming options for the controller shall include:
 - 1. Radio receiver frequency
 - 2. Two-tone sequential decode tones
 - 3. DTMF decode digits
 - 4. Independent control of output relay timing patterns
 - 5. Programming of a minimum of six control timing sequences
 - 6. Activation of control functions from any combination of six two-tone sequential and/or DTMF tones
- E. When a Type 1B siren is required by the Town of Pittsboro, the controller shall operate from the batteries to ensure operation of the siren in the event of a power outage.
- F. Provide an antenna for the radio controller matched to the frequency used by Hendricks County Emergency Management.

2.6 ELECTRICAL EQUIPMENT

- A. Provide NEMA Type 3R heavy duty fused disconnect switch for the service entrance disconnect. Coordinate the size of the service with the siren manufacturer and the electric utility.
- B. All conduit shall be rigid galvanized steel. Minimum size conduit shall be 3/4”.
- C. All power and control wiring shall be stranded copper conductors with type THHN/THWN insulation.
- D. Ground rods shall be copper clad steel with minimum dimensions of 3/4” diameter by 10’ long.
- E. The Grounding Electrode Conductor shall be a minimum of #4 AWG stranded bare copper.
- F. Equipment grounding conductors shall be stranded copper conductors with green insulation, type THHN/THWN.

2.7 POLES

- A. Provide a Class 2 wood utility pole for an effective mounting height of 50’ for the siren.
- B. The pole shall be installed straight and shall be capable of withstanding a sustained wind velocity of 120 MPH.

2.8 ACCEPTABLE SIREN AND CONTROLLER MANUFACTURER

- A. The Federal Signal Corporation

PART 3 – EXECUTION

3.1 INSPECTION

Inspect all components prior to installation. Promptly remove damaged or unsuitable products from the job site. Replace damaged or unsuitable products with new, undamaged, and suitable products.

3.2 INSTALLATION

- A. Install the siren and controller in accordance with the drawings and the manufacturer’s written instructions.
- B. All electrical work shall be done by a qualified electrician and shall conform to the National Electric Code.
- C. Provide an equipment ground conductor between all electrical components on the pole. Do not use conduit as the grounding means.

- D. Install all equipment with stainless steel hardware.
- E. All electrical conduit shall be installed in through the bottom of the enclosures to prohibit rain from entering the enclosures. Do not install conduit through the top of the siren control enclosures.
- F. All equipment supplied and installed under this item of the specifications shall meet the requirements of the Occupational Safety & Health Act of 1970.

3.3 TESTING

- A. Each siren installation shall be fully tested in accordance with the manufacturer's written instructions. Certified copies for the test results shall be furnished with each siren unit.
- B. The manufacturer shall provide the services of a factory-trained representative for a period of one day at each siren installation to perform initial start-up of the siren, to instruct operating personnel in the operation and maintenance of the equipment, and to demonstrate satisfactorily the performance of each piece of equipment.

3.4 WARRANTY

- A. The siren manufacturer shall warrant the sirens and controllers being supplied to the Town of Pittsboro against defects in workmanship and materials for a period of five years under normal use, operation, and service. The warranty shall be in published form and apply to all units. The warranty shall not start until the equipment has been placed in operation for beneficial use as determined by the Town of Pittsboro.

SECTION 16495 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less. It includes the following items:

1. Automatic transfer switch (ATS).

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Shop drawings or published product data for each transfer switch, including dimensioned plans, sections, and elevations showing minimum clearances; conductor entry provisions; gutter space; installed features and devices; and materials lists.
- C. Wiring diagrams, elementary or schematic, differentiating between manufacturer- installed and field-installed wiring.
- D. Single-line diagrams of transfer switch units showing connections between automatic transfer switch, power source, and load, plus interlocking provisions.
- E. Operation and maintenance data for each type of product, for inclusion in Operating and Maintenance Manual specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions.
- F. Manufacturer's certificate of compliance to the referenced standards and tested short-circuit closing and withstand ratings applicable to the protective devices and current ratings used in this Project, as indicated and as specified in paragraph "Tested Fault Current Ratings."

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms are experienced in manufacturing equipment of the types and capacities indicated and have a record of successful in- service performance.
- B. Emergency Service: Manufacturer maintains a service center capable of providing emergency maintenance and repairs at the Project site with an 8-hour maximum response time.
- C. Comply with NFPA 70, "National Electrical Code," for components and installation.
- D. Comply with NFPA 110, "Standard for Emergency and Standby Power Systems," for components and installation.
- E. UL Compliance: Comply with UL Standard 1008, "Automatic Transfer Switches," except where requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Kohler Co.
 - 2. Onan Corp.
 - 3. Russelectric, Inc.

2.2 TRANSFER SWITCH PRODUCTS, GENERAL

- A. Number of Poles and Voltage Ratings:
 - 1. 600 volt, 100 amp, 3 pole, 3 wire, 60 hertz for 480 Volt lift stations.
 - 2. 240 volt, 100 amp, 3 pole, 3 wire for 120/240 volt lift stations.
 - 3. Units smaller than 600 amperes do not have different current ratings for different classes or mixtures of loads, including 100 percent tungsten filament lamp or 100 percent inductive load.
- B. Tested Fault-Current Ratings: Closing and withstand ratings exceed the indicated available rms symmetrical fault current at the equipment terminals based on testing according to UL Standard 1008, conducted at full-rated system voltage and 20 percent power factor. Rate each product

for withstand duration time as follows when tested for rated short-circuit current correlated with the actual type of circuit protective device indicated for transfer switches for this Project:

- C. Short Circuit Current: All components of the transfer switch assembly shall be designed to withstand the short circuit currents available, 42,000 symmetrical amperes minimum.
- D. The control module shall be supplied with a protective cover and be mounted separately from the transfer switch for ease of maintenance. The module's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance and inherent digital communications capability. Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts. The control module shall be connected to the transfer switch by an interconnecting wire harness. The harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance.
- E. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 deg C to 70 deg C.
- F. Resistance to Damage by Voltage Transients: Components meet or exceed voltage surge withstand capability requirements when tested according to ANSI C37.90.1, IEEE Guide for Surge Withstand Capability (SWC) Tests. Components meet or exceed voltage impulse withstand test of NEMA ICS 1.
- G. Neutral Switching: Where a neutral is supplied to the transfer switch, provide full current capacity neutral switching.
- H. Transfer Switch Operation Time: The operating transfer time of all main contacts in either direction shall not exceed one-sixth of a second.
- I. Enclosures: NEMA 4X, conforming to UL Standard 508, "Electric Industrial Control Equipment," except as otherwise indicated.
- J. Heater: Within enclosure of units exposed to outdoor temperature and humidity conditions, connect thermostat within enclosure to control heater.

- K. Factory Wiring: Train and bundle factory wiring and identify consistently with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designated terminals accommodate field wiring.
 - 2. Power Terminals Arrangement and Field Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Terminals: Pressure-type, suitable for copper or aluminum conductors of sizes indicated.
 - 4. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 - 5. Harnessing between transfer switch and control panel shall have built-in disconnect for routine maintenance.

- L. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid mechanism, mechanically and electrically interlocked in both directions. Switches using components of molded-case circuit breakers or contactors are not acceptable.

- M. Switch Action: Mechanically held in both directions for double-throw switches.

- N. Overcurrent devices are not part of switch products.

2.3 AUTOMATIC TRANSFER SWITCHES (ATSSs)

- A. Comply with Level 1 equipment according to NFPA 110, "Standard for Emergency and Standby Power Systems."

- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning.

- C. Manual Switch Operation: Transfer time is same as for electrical operation.

- D. Maintenance Operating Handle: A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to stop the contacts at any point throughout the entire travel to properly in-spect and service the contacts when required.

- E. In-Phase Monitor: Include factory-installed and factory-wired internal in-phase monitor relay. The relay controls transfer so it occurs when the 2 sources are synchronized in phase. The relay compares phase relationship and frequency difference between the normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if the transfer can be completed within 60 electrical degrees. In-phase

transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage. The in-phase monitor shall operate when transferring in either direction.

2.4 AUTOMATIC TRANSFER SWITCH FEATURES

- A. Normal Source Voltage Sensing: Normal source close differential voltage sensing shall be provided on all phases. The pickup voltage shall be field adjustable from 85% to 100% of nominal, and the dropout voltage shall be field adjustable from 75% to 98% of the pickup value. The factory shall set the transfer to emergency to be initiated upon reduction of normal source to 85% of nominal voltage, and retransfer to normal shall occur when normal source restores to 95% of nominal.
- B. Emergency Source Voltage/Frequency Sensing: Independent three phase voltage and frequency sensing of the emergency source. The pickup voltage shall be field adjustable from 85% to 100% of nominal. Pickup frequency shall be field adjustable from 90% to 100% of nominal. Factory set so the transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
- C. Momentary Outage Time Delay: A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 6 seconds and factory set at 3 seconds.
- D. Transfer-To-Emergency Time Delay: A time delay on transfer to emergency, for controlled timing of load transfer to emergency. The time delay shall be field adjustable from 0 to 5 minutes and factory set at 0 minutes.
- E. Retransfer-To-Normal Time Delay: A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 30 minutes.
- F. Engine Cool-Down Time Delay: An unloaded running time delay for emergency generator cooldown. The time delay shall be field adjustable from 0 to 60 minutes and factory set at 5 minutes.
- G. Test Switch: A maintained test switch to simulate normal source failure.
- H. Switch Position Pilot Lights: Signal lights to indicate when the automatic transfer switch is connected to the emergency source or the normal source.

- I. Unassigned Switch Position Auxiliary Contacts: Two spare auxiliary contacts that are closed when the automatic transfer switch is connected to normal and two spare auxiliary contacts that are closed when the automatic transfer switch is connected to emergency. Contacts shall be rated 10 amps, 480 volts, 60 hertz AC.
- J. Source-Available Indicating Lights: Supervise sources via the transfer switch normal and emergency source-sensing circuits. Indicate normal and emergency sources available.
- K. Engine Starting Contacts: One isolated normally closed and 1 isolated normally open. Contacts are gold flashed or gold plated and rated 10 amperes at 32 V d.c. minimum.
- L. Engine-Generator Exerciser: Solid-state programmable time switch starts engine- generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiate exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory-set periods are for 7 days and 20 minutes, respectively. Exerciser features include:
 - 1. Exerciser transfer selector switch, which permits selection between exercise with and without load transfer.
 - 2. Push button programming controls with digital display of settings.
 - 3. Integral battery operation of time switch when normal control power is not available.

2.5 FINISHES

Enclosures: Manufacturer's standard enamel over corrosion- resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

Factory test components, assembled switches, and associated equipment to ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for conformance with specified requirements. Perform dielectric strength test conforming to NEMA ICS 1-109.05.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Panel Mounting of Transfer Switches: Level and anchor the unit to the panel.

3.2 WIRING TO REMOTE COMPONENTS

Match the type and number of cables and conductors to the control and communications requirements of the transfer switches used. Increase raceway sizes at no additional cost to the owner if necessary, to accommodate required wiring. Control wiring shall be installed in separate conduit from power wiring.

3.3 CONNECTIONS

Tighten factory-made connections, including connectors, terminals, bus joints, mountings, and grounding. Tighten field-connected connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values. When manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A.

3.4 GROUNDING

Make equipment grounding connections for transfer switch units as indicated and as required by the NEC.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory- authorized service representative to supervise field tests.
- B. Preliminary Tests: Perform electrical tests as recommended by the manufacturer and as follows:
 - 1. Check for electrical continuity of circuits and for short circuits.
- C. Field Tests: Give 7-day advance notice of the tests and perform tests in presence of owner's representative.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Tests: As recommended by the manufacturer and as follows:
 - 1. Operational Tests: Demonstrate interlock, sequence, and operational function for each switch at least 3 times.
 - a. Simulate power failures of normal source to ATs and of emergency source with normal source available.

- b. Verify time-delay settings and pick-up and drop-out voltages.
- F. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets the specified requirements.
- G. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measured insulation and contact resistances and time delays.

3.6 DEMONSTRATION

Training: Furnish the services of a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 2 hours of instruction scheduled 7 days in advance.

END OF SECTION 16495

SECTION 16620 - PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes a packaged diesel or natural gas engine generator system including engine generator set, cooling system, fuel system, combustion air intake and engine exhaust systems, starting system, and the following additional features:
 - 1. Weatherproof housing.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 16 Section "Transfer Switches" for transfer switches, including sensors and relays, to initiate automatic starting and stopping signals for engine generator set.

1.3 DEFINITIONS

Power Output Rating: Gross electrical power output of generator set minus total power requirements of electric motor-driven accessories normally constituting part of the engine assembly.

1.4 SYSTEM DESCRIPTION

- A. System Includes: Standby-rated, automatically started diesel or natural gas engine coupled to an a.c. generator unit. Engine and generator are factory-mounted and - aligned on a structural steel skid. Subsystems and auxiliary components and equipment are as indicated.
- B. Functional Description: When the mode selector switch on the control and monitoring panel is in the "automatic" position, remote control contacts in one automatic transfer switch initiate the starting and stopping of the generator set. When the mode selector switch is placed in the "on" position, the generator set starts manually. The "off" position of the same switch initiates shutdown of the generator set. When the unit is running,

specified system or equipment failures or derangements automatically shut the unit down and initiate alarms. Operation of a remote emergency stop switch also shuts down the unit.

1.5 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- B. Product data for products specified in this Section. Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components.
- C. Maintenance data for system and components for inclusion in Operating and Maintenance Manual specified in Division 1. Include the following:
 - 1. Lists: Tools, test equipment, spare parts, and replacement items recommended to be stored at the site for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Detailed Operating Instructions: Cover operation under both normal and abnormal conditions.
- D. Shop Drawings: Detail fabrication, piping, wiring, and installation of the field-installed portions of the system. Include general arrangement drawings showing locations of auxiliary components in relation to the engine generator set and duct, piping, and wiring connections between the generator set and the auxiliary equipment. Show connections, mounting, and support provisions and access and working space requirements.
- E. Sound Performance Data: Submit data for the specific engine/ generator set and exhaust silencer to be used for this project, taking into account the specific exhaust piping layout. Verify that the installation will comply with the sound attenuation requirements as specified under paragraph "2.9 A" of these specifications.
- F. Wiring Diagrams for System: Show power and control connections and distinguish between factory-installed and field-installed wiring.
- G. Factory Test Reports: For units to be shipped for this Project showing evidence of compliance with specified requirements.
- H. Field Test Report: Record of tests specified in Part 3.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms experienced in manufacturing equipment of the types and capacities indicated that have a record of successful in-service performance.
 - 1. Emergency Service: System manufacturer maintains a service center capable of providing training, parts, and emergency maintenance and repairs at the Project site with 4 hours maximum response time.
- B. Comply with NFPA 30, "Flammable and Combustible Liquids Code."
- C. Comply with NFPA 37, "Standard for Stationary Combustion Engines and Gas Turbines."
- D. Comply with NFPA 70, "National Electrical Code."
- E. Comply with NFPA 110, "Standard for Emergency and Standby Power Systems."
- F. Listing and Labeling: Provide system components of types and ratings for which are listed and labeled.
 - 1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
- G. Engine Exhaust Emissions: Comply with applicable Federal, State, and local government requirements.
- H. Single-Source Responsibility: Obtain engine generator system components from a single supplier with responsibility for entire system.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is made safe from such hazards.

1.8 EXTRA MATERIALS

- A. Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels describing contents. Deliver extra materials to the Owner.
 - 1. Fuses: 1 for every 10 of each type and rating, but not less than 1 of each.

2. Pilot Lights: 2 for every 6 of each type used, but not less than 2 of each.
3. Filters: 1 set each of lubricating oil, fuel, and combustion air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Engine Generator Sets:
 - a. Kohler Co.
 - b. Cummins/Onan Corp, Electrical Products Div.
2. Storage Batteries:
 - a. Deka
 - b. Olympian
3. Battery Chargers:
 - a. LaMarche Mfg. Co.
 - b. Master Control Systems, Inc.

2.2 SYSTEM SERVICE CONDITIONS

A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5F to 104°F (-15°C to 40°C).
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

2.3 ENGINE GENERATOR SYSTEM

- A. General: System is a coordinated assembly of compatible components.
- B. Ratings: The generator shall be sized to start one pump of _____ horsepower plus 5 kilowatts of load at 0.8 power factor, 480 volt, 3 phase, 60 hertz, within 25% voltage dip, as measured using an oscilloscope.

- C. Ratings: The generator shall be sized to start one pump of _____ horsepower plus 5 kilowatts of load at 240 volt, 1 phase, 60 hertz, within 25% voltage dip, as measured using an oscilloscope.
- D. Output Connections:
 - 1. 3 phase, 4 wire for 480Y/277 volt services.
 - 2. 1 phase, 3 wire for 120/240 volt services.
- E. Safety Standard: Comply with ASME B15.1, "Safety Standard for Mechanical Power Transmission Apparatus."
- F. Nameplates: Each major system component is equipped with a conspicuous nameplate of the component manufacturer. Nameplate identifies manufacturer of origin and address, and the model and serial number of the item.
- G. Resistance to Seismic Forces: Internal and external supports for components, supports, and fastenings for batteries, wiring, and piping are designed to withstand static or anticipated seismic forces, or both, in any direction. For each item, use a minimum force value equal to the weight of the item.

2.4 SYSTEM PERFORMANCE

- A. Voltage Regulation: 1 percent of rated output voltage from no load to full load.
- B. Frequency Regulation: 0.25 percent of rated frequency from no load to full load.
- C. Steady-State Frequency Stability: When the system is operating at any constant load within the rated load, there are no random speed variations outside the steady-state operational band and no regular or cyclical hunting or surging of speed.
- D. Output Waveform: At no load, the harmonic content measured line-to-line or line-to-neutral does not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor determined according to NEMA MG1, "Motors and Generators," does not exceed 50.
- E. Sustained Short-Circuit Current: For a 3-phase bolted short circuit at the system output terminals, the system will supply a minimum of 300 percent of rated full load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.

- F. Temperature Rise of Generator: 130°C rise by resistance above a 40°C ambient.
- G. Nonlinear Load Performance: System performance is not degraded from that specified in this Article by continuous operation, with the load current having a minimum total harmonic content of 15 percent rms, and minimum single harmonic content of 10 percent rms.
- H. Starting Time: Maximum total time period for a cold start, with ambient temperature at the low end of the specified range, is 10 seconds. Time period includes output voltage and frequency settlement within specified steady-state bands.

2.5 ENGINE GENERATOR SET

Skid: Adequate strength and rigidity to maintain alignment of the mounted components without dependence on a concrete foundation. Skid is free from sharp edges and comers. Lifting provisions are arranged to facilitate lifting with slings without damaging any components.

2.6 ENGINE

- A. Comply with NFPA 37, "Stationary Combustion Engines and Gas Turbines."
- B. Fuel: Diesel fuel oil grade DF-2 or natural gas.
- C. Maximum Speeds: Engine - 1800 rpm.
- D. Lubrication System: Pressurized by a positive displacement pump driven from the engine crankshaft. The following items are mounted on the engine or skid:
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 microns and smaller while passing full flow.
 - 2. Oil Cooler: Maintains lubricating oil at the manufacturer's recommended optimum temperature throughout 2 hours of operation of the generator set at 110 percent of system power output rating.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without the use of pumps or siphons or special tools or appliances.
- E. Diesel Engine Fuel System: Use diesel engine fuel systems only if natural gas is not available at the site. Comply with NFPA 30, "Flammable and Combustible Liquids." System includes:

1. Integral Injection Pumps: Driven by the engine camshaft. Pumps are adjustable for timing and cylinder pressure balancing.
 2. Main Fuel Pump: Mounted on the engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 3. Fuel Oil Filters: Ahead of the injection pumps.
 4. Relief/Bypass Valve: Automatically regulates pressure in the fuel line and returns excess fuel to the source.
- F. Natural Gas Engine Fuel System includes: Natural gas engine fuel systems shall be used if natural gas is available at the site.
1. Unit mounted electric solenoid fuel shut-off valve.
 2. Flexible fuel line.
 3. Secondary Fuel pressure regulator.
- G. Jacket Coolant Heater: Electric type, factory-installed in the jacket coolant system. Unit is rated and thermostatically controlled to maintain an engine block temperature of 90°F (32°C). Provide an oil pressure cutout to turn the heater off when the engine is running. Provide shut-off valves on the engine side to allow for replacement of the heater and hoses without draining the system.
- H. Speed Governor: Adjustable isochronous type, with speed sensing.

2.7 ENGINE COOLING SYSTEM

- A. Description: Closed-loop, liquid-cooled, with radiator factory-mounted on engine generator set skid and integral engine-driven coolant pumping.
- B. Radiator: Factory-piped and -rated for specified coolant.
- C. Coolant: Solution of 50 percent ethylene glycol and 50 percent water.
- D. Coolant Hose: Flexible assembly with nonporous rubber inside surface and aging, ultraviolet, and abrasion-resistant fabric outer covering.
 1. Rating: 50 psi (345 kPa) maximum working pressure with 180°F (82°C) coolant, and noncollapsible under vacuum.
 2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 DIESEL FUEL SUPPLY SYSTEM

- A. System complies with NFPA 30, "Flammable and Combustible Liquids Code," and NFPA 37, "Standard for Stationary Combustion Engines and Gas Turbines."
- B. Fuel Storage Tank: Double wall subbase fuel tank sized to support the generator set for a period of 24 hours at 100% of rated load.

2.9 ENGINE EXHAUST SYSTEM

- A. Muffler: Located within the enclosure.
- B. Connections from Engine to Exhaust System: Flexible section of seamless stainless steel pipe.
- C. Per NFPA-37, exhaust pipes shall be of wrought iron or steel and of sufficient strength to withstand the service. Exhaust pipes shall be installed with clearances of at least 9 inches to combustible material. Exhaust pipes passing directly through combustible roofs shall be guarded at the point of passage by ventilated metal thimbles which extend not less than 9 inches above and not less than 9 inches below roof construction and which are at least 6 inches in diameter larger than the vent pipe. Exhaust pipes, passing directly through combustible walls or partitions, shall be guarded at the point of passage by one of the following methods:
 - 1. Metal ventilated thimbles not less than 12 inches larger in diameter than the exhaust pipe; or
 - 2. Metal or burned fire clay thimbles built in brickwork or other approved fireproofing materials providing not less than 8 inches of insulation between the thimble and combustible material.

2.10 STARTING SYSTEM

- A. Description: 12 or 24 volt DC electric with negative ground and including the following items:
 - 1. Components: Sized so they will not be damaged during a full engine- cranking cycle.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from the engine flywheel without binding.
 - 3. Cranking Cycle: The battery shall have an ampere-hour capacity for two complete cranking periods consisting of three cranking cycles of 15 seconds crank and 15 seconds rest each. After one cranking period, the cranking circuit is de-energized and must then be reset before cranking can be resumed.
 - 4. Batteries: Industrial Lead-Acid type, maximum of 10 cells for 12 volt systems or 20 cells for 24 volt systems.

5. Battery Heater: 120 Volt battery heater to maintain batteries at 50°F.
6. Battery Cable: Size as recommended by the generator set manufacturer. Include required interconnecting conductors and connection accessories.
7. Battery Charger: Current limiting, automatic equalizing and float charging-type designed for operation from a 120 volt, 60 Hz supply source, and compatible with the specific batteries being provided for this project. Unit complies with UL 508, "Electrical Industrial Control Equipment," and includes the following features:
 - a. Operation: High equalizing charging rate of 3 amps for generators rated 20 KW and below, 10 amperes for generators rated above 20 KW is initiated automatically after the battery has lost charge until an adjustable equalizing voltage is achieved at the battery terminals. The unit then automatically switches to a lower float-charging mode, and continues operating in that mode until the battery is discharged again. Charger shall be equipped with a field adjustable automatic equalizing timer (adjustable from 0 to 24 hours). The timer shall operate in the equalize mode once every 30 days for the set time period.
 - b. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
 - c. Ammeter and Voltmeter: 1 % accuracy, flush mounted in door. Meters indicate charging rates.
 - d. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing "low battery voltage" indication on control and monitoring panel. Also include sensing of high battery voltage and loss of a.c. input or d.c. output of battery charger. Either of these conditions closes contacts that provide "battery charger malfunction" indication at system control and monitoring panel.
 - e. Enclosure and Mounting: NEMA Class 1 wall-mounted cabinet.

2.11 CONTROL AND MONITORING

- A. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages are grouped on a common UL-listed control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator set vibration. Features include:

1. Generator Circuit Breaker: Molded case type. One auxiliary contact shall be provided for indication of breaker "open" position to provide indication. One alarm contact shall be provided for indication of breaker "tripped" position to provide indication.
 2. Shunt Trip Device: For generator breaker, connected to trip breaker when generator set is shut down by protective devices.
- B. Indicating and Protective Devices, and Controls: Include the following:
1. A.C. Voltmeter.
 2. A.C. Ammeter.
 3. A.C. Frequency Meter.
 4. Ammeter/Voltmeter Phase Selector Switch or Switches.
 5. Engine Coolant Temperature Gage.
 6. Engine Lubricating Oil Pressure Gage.
 7. Running Time Meter.
 8. Generator Voltage-Adjusting Rheostat.
 9. "Manual-Off-Automatic" Switch.
 10. Emergency Stop Shutdown.
 11. High Engine Water Temperature Pre-Alarm.
 12. High Engine Water Temperature Shutdown Device.
 13. Low Oil Pressure Pre-Alarm.
 14. Low Oil Pressure Shutdown Device.
 15. Overspeed Shutdown Device.
 16. Overcrank Alarm.
 17. Low Engine Water Temperature Alarm (Below 75F).
 18. Low Fuel Level Alarm.
 19. Generator Switch Not In Auto Alarm.
 20. Low Battery Voltage Alarm.
 21. Battery Charger Malfunction Alarm.
 22. System Ready Indication.
 23. Emergency Breaker Open Indication.
 24. Generator Power Indication.
 25. Common Failure Relay.
 26. Common Pre-Alarm Relay
- C. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- D. Remote Emergency Stop Switch: Flush wall-mounted except as otherwise indicated and prominently labeled. Pushbutton is protected from accidental operation.

2.12 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1, "Motors and Generators," and specified performance requirements.
- B. Drive: Generator shaft is directly connected to the engine shaft. Exciter is rotated integrally with generator rotor.
- C. Electrical Insulation: Class F.
- D. Station Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Excitation uses no-slip or collector rings, or brushes, and is arranged to sustain generator output under short circuit conditions as specified.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state-type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output voltage operating band.

2.13 OUTDOOR GENERATOR SET ENCLOSURE

- A. Description: Sound Attenuated Weatherproof steel housing. Measured sound level, according to the "DEMA Test Code for the Measurement of Sound from Heavy-Duty Reciprocating Engines" at a distance of 10 meters is 65 dB "A" or less. Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools.
- B. Fixed Louvers: At air inlet and discharge. Louvers prevent entry of rain and snow.
- C. Automatic Dampers: At air inlet and discharge. Dampers are closed to reduce engine and battery heat loss in cold weather when unit is not operating.

- D. Air Flow Through Housing: Adequate to maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at the top of the range specified under "System Service Conditions."

2.14 FINISHES

- A. Outdoor Enclosures: Polyurethane enamel over corrosion-resistant pretreatment and manufacturer's compatible standard primer.

2.15 SOURCE QUALITY CONTROL

- A. Project-Specific Equipment Tests: Test engine generator set and other system components and accessories prior to shipment. Test items individually and assembled and connected as a complete system at the factory in a manner equivalent to that required at the Project site. Record and report test data. Conform to the following:
 - 1. Test Equipment: Use instruments calibrated within the previous 12 months and with accuracy directly traceable to the National Institute of Standards and Technology (NIST).
 - 2. Hydrostatic Test: Perform on radiator, heat exchanger, and engine water jacket.
 - 3. Generator Tests: Conform to IEEE 115, "Test Procedures for Synchronous Machines."
 - 4. Complete System Continuous Operation Test: Includes nonstop operation for a minimum of 4 hours, including at least 1 hour each at 1/2 load and 3/4 load, and 2 hours at full load. If unit stops during the 4-hour test, repeat the complete test. Record the following minimum data at the start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during the balance of the test:
 - a. Lubricating oil temperature and pressure.
 - b. Generator load current and voltage, each phase.
 - c. Generator system net output kW.
 - 5. Complete System Performance Tests: Include the following to demonstrate conformance to specified performance requirements:
 - a. Single-step load pickup.
 - b. Transient and steady-state governing.
 - c. Transient and steady-state voltage performance.
 - d. Safety shutdown devices.

6. Observation of Test: Provide 2-week advance notice of tests and opportunity for observation of test by Owner's representatives.
7. Report test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The engine generator shall be mounted on a steel skid base with channel cross members and shall have sufficient rigidity to allow transportation and handling of the entire unit. Vibration isolators shall be supplied and located between the steel skid base and the engine generator. Utilize flexible conduit connections between all incoming and outgoing conduits.
- B. Field Installation of Piping and Ductwork: As indicated on the drawings.
- C. Maintain minimum working space around components according to manufacturer's shop drawings and NEC.
- D. Manufacturer's Field Services: Arrange and pay for the services of a factory- authorized service representative to supervise the installing, connecting, testing, and adjusting of the unit.

3.2 FIELD QUALITY CONTROL

- A. Tests: Perform the tests listed below according to manufacturer's recommendations upon completion of installation of system. Use instruments bearing records of calibration within the last 12 months, traceable to NIST standards, and adequate for making positive observation of test results. Include the following tests:
 1. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
 2. Battery Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 3. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 4. Simulation of malfunctions to verify proper operation of local and remote protective, alarm, and monitoring devices.

5. Load Bank Test: Includes nonstop operation for a minimum of 4 hours, including at least 1 hour each at 1/2 load and 3/4 load, and 2 hours at full load. If unit stops during the 4-hour test, repeat the complete test. Record the following minimum data at the start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during the balance of the test:
 - a. Lubricating oil temperature and pressure.
 - b. Generator load current and voltage, each phase.
 - c. Generator system net output kW.
 6. Load Test: Run unit at 100 percent of available building load for a minimum of 1 hour, with at least 1 pump running for a minimum of 5 minutes. Record voltage, frequency, load current, battery-charging current, power output, oil pressure, and coolant temperature periodically during the test.
- B. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.3 CLEANING

Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.4 DEMONSTRATION

- A. Training: Arrange and pay for the services of a factory- authorized service representative to demonstrate adjustment, operation, and maintenance of the system and to train Owner's personnel.
- B. Conduct a minimum of 2 hours of training as specified under Instructions to Owner's Employees in the Project Closeout Section of these Specifications.
- C. Schedule training with at least 7-day advance notice.

END OF SECTION 16620