

02700 – STORM DRAINAGE

(Last revised 3/27/14)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

| | | |
|---|---|--|
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| Part 3 – Execution | Laying Tolerance (pipe) | Precast MH Spec |
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| Concrete Block/Brick | Mortar | Rip Rap Placement |
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| Drainage Channel Grading | NCDOT Boxes (Acceptable) | Subdrain Installation |
| Drainage Structure Installation | RCP Spec | Weep Hole Construction |
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PART 1 - GENERAL

1.1 GENERAL

- A. The contractor shall furnish all labor, materials, tools, equipment and all else required for and to construct the improvements complete, tested and placed into satisfactory operation, in accordance with the contract drawings, these specifications, and the engineers' requirements under then. The contractor shall be responsible for furnishing details that are required, but not necessarily shown on the contract drawings, for the adequate and proper construction and operation of the design as required by the town of wake forest.
- B. Every item mentioned, described, specified and/or referred to in these specifications, and all items shown, indicated or inferred by the contract drawings, and such items as may normally be required for the construction of the systems shall be furnished and installed complete in every respect; tested in all manners required and/or necessary; and made ready for complete and regular services, as intended. The contractor shall furnish all materials and equipment of whatever nature.
- C. Insofar as possible, existing utilities must be kept in operation at all times. The contractor shall so organize and schedule his work as to cause the least inconvenience to the operation of the existing utilities. Should it become necessary to put any part of an existing system out of operation, the contractor, without cost to the owner, shall make such temporary connections, alterations, etc., as may be required to keep the existing utilities in operation.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

- B. Section 00825 – *Product Substitutions*
- C. Section 02210 – Trenching, Backfilling, and Compaction of Utilities
- D. Town of Wake Forest Pre-Approved Material/Product List
- E. NCDENR Division of Energy, Mineral and Land Resources, Land Quality Section's *North Carolina Erosion and Sedimentation Control Planning and Design Manual*.

1.3 SUMMARY

This section includes all equipment, labor, material, appurtenances, and services required for complete installation of storm drainage piping, ditches, structures, and specialties for municipal drainage systems.

1.4 DEFINITIONS

A. General

For the purposes of this specification, the following definitions refer to storm water drainage systems and structures that come under the authority of the Town of Wake Forest, North Carolina as specified within this section and other sections of this manual.

Public Storm Drainage System: Drainage systems and their appurtenances required for the conveyance of storm water from and across publicly maintained streets, roads, highways, and other public property and located within public rights-of-way and/or easements.

See also [paragraph 1.4, Definitions](#) of section 02210, *Trenching, Backfilling and Compaction of Utilities*.

B. The following are industry abbreviations for various pipe materials.

- 1) RCP: Reinforced Concrete Pipe

1.5 SUBMITTALS

- A. Submit shop drawings on all non-standard or alternate products/materials to the Town's Engineer in accordance with Section 00825 – *Product Substitutions*.
- B. Assuming products and their appurtenances listed on the Pre-Approved Material/Product List are being used, submit product data and shop drawings for the following.
 - 1) Non-standard size drop/curb inlets
 - 2) Head/end walls
 - 3) Concrete pipe specialties

1.6 QUALITY ASSURANCE

- A. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- B. The contractor shall comply with NCDENR Division of Energy, Mineral and Land Resources, Land Quality Section's North Carolina Erosion and Sedimentation Control Planning and Design Manual, latest revision.
- C. Piping materials shall be marked clearly and legible on the outside of each section of pipe and pipe end.
 - 1) Reinforced Concrete Pipe shall be marked as follows:
 - a. Pipe Class and wall type
 - b. Inside diameter of pipe product
 - c. Manufacturer name or trademark of manufacturer
 - d. Date of Manufacture
 - e. State assigned plant number
- D. For convenience, reference is made in succeeding paragraphs to specific portions of various standards. Also, modifications and additions are made. Neither the reference nor the modifications are intended to de-emphasize any other portion of the standards.
- E. It is the intent of this specification that whenever a procedure or technique is not called out herein, that the industry standard, as represented by ACI, ASTM or other appropriate recommendation, shall be used.
- F. Materials and operations shall comply with the latest revision of all applicable codes and standards listed below.

American Society for Testing and Materials (ASTM)

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| ASTM A48 (AASHTO M306) | Standard Specification for Gray Iron Castings |
| ASTM A536 | Standard Specification for Ductile Iron Castings |
| ASTM A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM C14 (AASHTO M86M) | Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe |
| ASTM C32 | Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale) |
| ASTM C33 | Standard Specification for Concrete Aggregates. |
| ASTM C55 | Standard Specification for Concrete Building Brick |

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| ASTM C76 (AASHTO M170) | Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C90 | Standard Specification for Loadbearing Concrete Masonry Units |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C 478 (AASHTO M199) | Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C655 (AASHTO M242) | Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe |
| ASTM C913 | Standard Specification for Precast Concrete Water and Wastewater Structures |
| ASTM C990 | Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM D698 | Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³) (Standard Proctor). |
| ASTM D1556 | Standard Method of Test for Density of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (Modified Proctor). |
| ASTM D2049 | Standard Method of Test for Relative Density of Cohesionless Soils |
| ASTM D2167 | Standard Method of Test for Density of Soil in place by the Rubber-Balloon Method |
| ASTM D2487 | Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). |
| ASTM D3740 | Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction |
| ASTM D4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table |
| ASTM D4254 | Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density |
| ASTM D4318 | Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. |

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| ASTM E329 | Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection |
| ASTM E548 | Standard Guide for General Criteria Used for Evaluating Laboratory Competence |

American Association of State Highway & Transportation Officials (AASHTO)

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|-------------|---|
| AASHTO M86M | Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe |
| AASHTO M170 | Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe. Three-to-one side slopes are required on flares. |
| AASHTO M198 | Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe (Withdrawn; ASTM C990 supersedes AASHTO M198) |
| AASHTO M199 | Standard Specification for Precast Reinforced Concrete Manhole Sections |
| AASHTO M242 | Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe |
| AASHTO M259 | Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers |
| AASHTO M273 | Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft of Cover Subjected to Highway Loadings |
| AASHTO M306 | Standard Specification for Drainage, Sewer, Utility, and Related Castings |

1.7 STANDARD ABBREVIATIONS

A. Materials and operations to comply with the latest edition of codes and standards listed:

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| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| ACPA | American Concrete Pipe Association |
| AISI | American Iron and Steel Institute |
| ASTM | American Society for Testing and Materials |
| BIA | Brick Institute of America |

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|------|---------------------------------------|
| CRSI | Concrete Reinforcing Institute |
| FEMA | Federal Emergency Management Agency |
| FS | Federal Specifications |
| HEC | Hydraulic Engineering Circular |
| NCMA | National Concrete Masonry Association |

Note: Designations such as ASTM, AASHTO, NCDOT, etc. referenced throughout this specification imply the latest revision.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Observe manufacturer's directions for delivery and storage of materials and accessories.
- B. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.
- C. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.
- D. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.
- E. Pipe Condition/Pipe Examination:
 - 1) **New Pipe Inspection – All pipe:** Inspect materials thoroughly upon arrival. Examine materials for damage. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications.
 - a. **Concrete Pipe:** Check bells and spigots closely for smoothness, roundness, and honeycombing (concrete pipe), which may be a source of infiltration. Check for cracks, chips, etc. on both ends. Reject any pipe that will not provide soil-tight seal or is otherwise structurally deficient.
 - 2) **Pre-Installation Inspection:** Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipes damaged or deemed not to conform to these specifications shall be rejected and removed from site.
 - a. **Concrete Pipe:** All concrete pipes in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells of rigid pipe must be true.

1.9 PROJECT CONDITIONS

Storm Drainage Manholes – No water mains shall pass through or come in contact with any part of a storm drainage manhole. A minimum of 3 feet of horizontal separation shall be maintained between water mains and storm drainage manholes unless otherwise approved by the Town's Engineer or City of Raleigh Public Utility Department. Interference/conflict manholes will not be permitted unless otherwise approved by same.

See also [paragraph 1.8 Project Conditions](#) of Section 02210, *Trenching, Backfilling and Compaction of Utilities*.

1.10 SERVICE INTERRUPTION

For service interruption, operation of valves, taps, fire hydrant operation, etc, contact the City of Raleigh Public Utilities Operations Division at 919.996.2737 between the hours of 7:30 AM and 4:00 PM. After 4:00 PM, call the after hour's emergency number at 919.829.1930. Provide a minimum of 48 hours notice or desired utility interruption or necessary operation of valves or hydrants.

Refer to the following link regarding service interruption:
<http://www.raleighnc.gov/home/content/PubUtilAdmin/Articles/WaterandSewerFAQs.html>

For any other utility, contact the applicable utility agency.

1.11 COORDINATION

- A. Coordinate tie-in to municipal or NCDOT junction boxes or catch basins with the Town's Engineer the NCDOT District Engineer.
- B. Coordinate water and sewer service interruption with the City of Raleigh Public Utilities Department.
- C. At the direction of the Town's Engineer and/or City of Raleigh Public Utilities Department, temporary pumping/bypass of sewerage flow may be required to be provided.
- D. Traffic Signals: When traffic signals, loops, or their appurtenances are likely to be damaged or interfere with construction, coordinate temporary operation with the NCDOT or other applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks' notice prior to anticipated disturbance or interruption. At the discretion of the Town's Engineer, the notice may be required to be published in the newspaper.
- E. Repair Of Pavement Markings: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.
- F. Benchmark/monument protection: Protect and maintain benchmarks, monuments or other established reference points and property corners. If disturbed or destroyed, they must be replaced at contractor's expense by a licensed Professional Surveyor to full satisfaction of owner/Town of Wake Forest.
- G. Before digging, contact "NC One Call" at 811 for location services.

1.12 PUBLIC CONVENIENCE



The contractor shall at all times so conduct his work as to ensure the least possible inconvenience to the general public and the residents in the vicinity of the work. Fire hydrants on or adjacent to the work shall be kept accessible to firefighting equipment at all times. Temporary provisions shall be made by the Contractor to ensure the proper functioning of all gutters, sewer inlets, drainage ditches, and irrigation ditches, which shall not be obstructed except as approved by the Town's Engineer.

Refer to the Town of Wake Forest Noise Ordinance by visiting the following link: <http://www.wakeforestnc.gov/residents-noiseordinance.aspx>

1.13 TRAFFIC CONTROL

- A. When working within any NCDOT System road or highway, conform to the *Manual On Uniform Traffic Control Devices*, latest revision (MUTCD) as well as the NCDOT Standard Specifications For Roads And Structures, latest revision.
- B. Traffic maintenance shall comply with the latest revision of the NCDOT Standard Specifications For Roads And Structures, Division 9 – *Signing* and Division 11 – *Work Zone Traffic Control*, as well as other applicable sections.
- C. A traffic control plan shall be submitted to the Town's Engineer or NCDOT (if applicable) for approval.
- D. When traffic signals or their appurtenances are likely to be damaged or interfere with the construction, coordinate temporary operation with the NCDOT or the Town's Engineer. Provide 1 weeks' notice prior to anticipated disturbance or interruption.
- E. Whenever it becomes necessary to leave a section of trench open after completion of the day's work, the contractor shall provide barricades and lights to protect the public. Operate warning lights during hours from dusk to dawn each day and as otherwise required for inclement weather and visibility.
- F. Any work performed on a municipal public right-of-way or easement is required to obtain an encroachment permit from the Town of Wake Forest. A copy of the approved permit is required to be on the project site at all times.

1.14 EROSION AND SEDIMENTATION CONTROL AND NPDES MONITORING, CONTROLS, AND LIMITATIONS FOR PERMITTED DISCHARGES

Refer to the Town of Wake Forest UDO for Erosion and Sedimentation Control requirements; Chapter 12.

<http://www.wakeforestnc.gov/data/sites/1/media/residents/planning/development%20services/currentudo.pdf>

PART 2 - PRODUCTS

2.1 PIPE:

2.1.1. CONCRETE PIPE

- A. Reinforced Concrete PIPE

Reinforced concrete culvert pipe shall meet the requirements of AASHTO M170 for the class of pipe called for on the plans. The design wall thickness shall be the wall thickness shown in AASHTO M170 for the applicable class and wall.—RCP shall be a minimum of Class III, Wall. Concrete pipe joints shall be tongue and groove type unless otherwise specified. RCP shall conform to the requirements of applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.

RCP Class III or IV shall also meet ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

Gasketed joints in concrete pipe shall meet the requirements of paragraph [2.2.5, *Preformed Plastic Gaskets*](#).

B. PIPE MARKINGS – MARKING FOR MATERIAL SPEC COMPLIANCE

- 1) All concrete pipe to be used shall be either etched “RC X” (where X represents the class pipe) or marked visibly and legibly according to the following:
 - a. Stamp location: spigot end of pipe on inside.
 - b. Stamp size stenciled letters: 1-1/2” in height minimum.
 - c. Code: Class 3 Reinforced Concrete: TWF-RC-3
 - d. Code: Plain Concrete: TWF-P
 - e. Stamp color: Fluorescent orange or red.
- 2) Unmarked pipe will be allowed only if the manufacturer furnishes a certified statement on the entire shipment and etchings are placed on each pipe joint.

2.2 PRECAST CONCRETE STRUCTURES

2.2.1. PRECAST UNDERGROUND CONCRETE UTILITY STRUCTURES

- A. Structures of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C913, *Standard Specification for Precast Concrete Water and Wastewater Structures* and ASTM C858, *Standard Specification for Underground Precast Concrete Utility Structures*, latest revision with preformed butyl rubber joint sealant meeting ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed flexible Joint Sealants*, latest revision. Type Concrete used in the construction of the Utility Structures shall have a minimum 28-day compressive strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Unless shown otherwise on the drawings, structures are to have steps. Steel reinforcing shall conform to the requirements of ASTM C857, *Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures*, latest revision. Structures shall be designed for an HL93 (equivalent to HS20-44) loading in traffic areas. See the *Town of Wake Forest Pre-Approved Material/Product List* for a list of acceptable manufacturers and models.

- B. Concrete to be minimum 4000 PSI. Provide all reinforcing steel which meets ASTM A615 for grade 60 and welded wire fabric conforming to ASTM A185. Welded wire fabric may be substituted for rebar as long as the same area of steel is provided.
- C. There shall be additional reinforcing provided at all openings.
- D. Place lift holes or pins in accordance with OSHA standard 1926.704.
- E. Provide Precast structures over 3'-6" in depth with steps as directed by the Town's Engineer.
- F. All junction boxes that are not grated are to be manufactured to receive manhole iron castings (blind manholes are not permitted).

2.2.2. CATCH BASIN DROP INLETS & COMBINATION CURB OPENING INLETS

- A. Catch basin drop inlet or combination curb inlet boxes may be either precast reinforced concrete or concrete block. Precast inlet boxes shall conform to the requirements of [paragraph 2.2.1, Precast Underground Concrete Utility Structures](#), as well as all applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*. Refer to [Standard Details 2.50, 2.51, 2.54, 2.55, and 2.56](#).
- A. Inlet grates shall conform to the requirements of [paragraph 2.3.9, Miscellaneous Gray Iron Castings](#), and the applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.
- B. Catch basin grates and curb opening inlet hoods are to be embossed with the words "Dump No Waste! Drains to Waterway." Castings shall also contain an embossed trout symbol. See [Standard Detail 2.71 and 2.72](#).
- C. See the *Town of Wake Forest Pre-Approved Material/Product List* for a list of acceptable manufacturers and models.

2.2.3. PRECAST REINFORCED CONCRETE MANHOLES

- A. Precast reinforced concrete manholes shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, latest revision and AASHTO M199. Either an "O" ring joint conforming to the requirements of ASTM C443 *Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets* or joints conforming to ASTM C990 *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants* may be used.

Type Concrete used in the construction of the manholes shall have a minimum 28-day compressive strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33 *Standard Specification for Concrete Aggregates* and ASTM C94 *Standard Specification for Ready-Mixed Concrete*. Manholes shall have monolithic base and eccentric cone flattop as applicable. Structures are to have steps. Manholes will have extended bases with appropriate reinforcing as directed by the Town's Engineer. See the *Town of Wake Forest Pre-Approved Material/Product List* for a list of acceptable manufacturers and models.

See [Standard Detail 2.60](#).

2.2.4. CONCRETE FLARED END SECTIONS

- A. Concrete flared end sections shall meet all applicable requirements of AASHTO M170 except those pertaining to design. All concrete flared end sections shall be reinforced. The concrete used in flared end sections shall be air entrained and shall attain strength of 3500 psi when tested in accordance with AASHTO T22. 3:1 slopes are required on flared ends.

2.2.5. PREFORMED PLASTIC GASKETS (JOINT SEALER)

- A. Preformed plastic gaskets shall meet federal specification SS-S-00210 (210-a) *Sealing Compound, Preformed Plastic, For Expansion Joints And Pipe Joints*, Type 1, Rope Form or Type 2, Flat Type and ASTM C990. Sag or flow resistance and chemical resistance shall meet ASTM C990 *Standard Specification For Joints For Concrete Pipe, Manholes, And Precast Box Sections Using Preformed Flexible Joint Sealants*, latest revision. Preformed butyl gaskets shall be used with structures meeting ASTM C478, ASTM C990 and AASHTO M199. Minimum rope diameter to be 3/4-inch or as required for the size structure.

2.2.6. WEEP HOLE PIPE

- A. Weep hole pipe shall be minimum schedule 40 PVC meeting ASTM D1785 *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120* or D2665 *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings*.

2.3 MISCELLANEOUS

2.3.1. BEDDING

- A. See section [paragraph 2.1.2 Pipe Bedding](#) of Specification Section 02210, *Trenching, Backfilling, and Compaction of Utilities*.

2.3.2. BRICK

- A. Clay Brick (not permitted in the building of drainage structures): Brick shall be hard clay, grade SW (earth contact/freezing), ASTM C 32, *Standard Specification for Sewer and Manhole Brick (made from clay or shale)* and AASHTO M91. Use brick of uniform standard commercial size, with straight and parallel edges and square corners that are burned hard and entirely true, free from injurious cracks and flaws, tough, strong, and having a clear ring when struck together. The sides, ends, and faces of all brick shall be plane surfaces at right angles and parallel to each other. Brick of the same manufacturer shall not vary more than +/- 1/16-inch in thickness, plus or minus 1/8-inch in width and +/- 1/4-inch in length.
- B. Concrete Brick: Concrete brick shall meet the requirements of ASTM C55 for Grade S-II except that the absorption of brick used in minor drainage structures shall not exceed 10 pcf.

2.3.3. CONCRETE BUILDING BLOCK

- A. Solid Concrete Building Block: Use concrete building block that meets the requirements of ASTM C90¹. Block is to be free of chips and cracks. The Town's Engineer may require that the block be pink in color to indicate compliance with NCDOT specifications.
- B. Solid Concrete Block: Solid concrete block to be used in lieu of clay brick for minor drainage structures shall meet the requirements of ASTM C139, *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*. Except that the nominal dimensions shall be 4"x8"x16".

2.3.4. MISCELLANEOUS CONCRETE

- A. Concrete classes (NCDOT) to design compressive strength at 28 days (f_c):

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| Class AA | General | 4,500-psi |
| Class A | General | 3,000-psi |
| Class B | Massive or Lightly Reinforced | 2,500-psi |

- B. Ready mixed concrete shall comply with ASTM C94, *Standard Specification For Ready-Mixed Concrete*. All exposed concrete shall be air entrained. Concrete strength shall be as specified on standard details and drawings. Unless otherwise specified, all concrete shall be Class A, minimum.

2.3.5. MORTAR FOR CONCRETE BLOCK & BRICK

- A. Mortar shall be Type M, ASTM C270, *Standard Specification for Mortar for Unit Masonry* and ASTM C144, *Standard Specification for Aggregate for Masonry Mortar*. Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No mortar that has stood beyond 45 minutes shall be used.

When specified by the Town's Engineer, grout for cellular fill of block or voids shall be comprised of 3000-psi ready mix concrete with pea gravel aggregate. Do not provide air entrainment unless specified by the Town's Engineer.

2.3.6. PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement*.

2.3.7. GEOTEXTILE FABRIC:

- A. Geotextile fabric shall be protected from mud, dirt, dust, sunlight, and debris during transport and storage. Material shall be inert to commonly encountered chemicals; resistant to mildew, rot, insects, and rodents; and biologically and thermally stable. Geotextile fabric for subsurface installation shall not be exposed to direct sunlight for more than 24 hours before or during installation.
- B. Filter fabric for rip rap: filter fabric for rip rap and rip rap beddings shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 2 Engineering Fabric.

¹ Type I/Type II unit designation eliminated in ASTM C90 in 2000.

- C. Fabric for subsurface drains: non-woven needle-punched fabric for subsurface drains shall conform to Section 1056 – *Engineering Fabrics* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision for Type 1 Engineering Fabric.

2.3.8. MANHOLE FRAMES AND COVERS

- A. Standard frames and covers: manhole frames and covers shall meet ASTM A48 *Standard Specification For Gray Iron Castings*, Class 35B, traffic frame and cover. Castings to be designed for a minimum HS-20 load. See the *Town of Wake Forest pre-approved material/product list* for a list of acceptable manufacturers and models. Standard manhole frames and covers shall be manufactured to the dimensions and configurations shown on Standard Detail 2.70 and shall have a minimum of four 1-inch diameter holes in the flange of the frame. Manholes castings may be either bituminous coated or plain. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Weights shall not vary more than 5%+/- of the weight shown on [Standard Detail 2.70](#).
- B. Cast-in-place frames and covers: manhole frames and covers shall meet ASTM A48 *Standard Specification For Gray Iron Castings*, Class 35B, traffic frame and cover. See the *Town of Wake Forest Pre-Approved Material/Product List* for a list of acceptable manufacturers and models. Frames shall be plain un-coated. Manhole covers may be either bituminous coated or plain. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking.
- C. Covers are to be embossed along the perimeter with the words “Storm Water” and “Dump No Waste. Drains to Waterway.” See [Standard Detail 2.70](#).
- D. See the *Town Of Wake Forest Pre-Approved Material/Product List* for a list of acceptable manufacturers and models.

2.3.9. MISCELLANEOUS GRAY IRON CASTINGS

- A. Catch basin frames and grates: supply gray iron castings meeting the requirements of ASTM A48 *Standard Specification For Gray Iron Castings*, Class 35B of AASHTO M306 as manufactured by Capitol Foundry, US Foundry or East Jordan Iron Works. Castings to be designed for a minimum HS-20 load. Boldly fillet castings at angles, and provide rises that are sharp and perfect. No sharp, un-filleted angles or corners are permitted. Provide castings that are true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blowholes, and other defects affecting their strength and value for the service intended. Welding is not allowed for the purpose of making a casting structurally sound. Welding for cosmetic or other purposes is not allowed without approval of the Town’s Engineer. The iron material used in products provided shall have a minimum recycled material content of 75%. The recycled material shall consist of post-consumer material.

2.3.10. REINFORCING STEEL

- A. Reinforcing steel shall conform to ASTM A615 *Specification For Deformed Billet-Steel Bars For Concrete Reinforcement*, grade 60.

2.3.11. RIP RAP AND RIP RAP BEDDING

- A. Rip rap and rip rap bedding shall conform to Section 1042 – *Rip Rap Material* of the NCDOT *Standard Specifications For Roadways And Structures*, latest revision for Class A, B, 1 and 2 rip rap.

2.3.12. SUBSURFACE DRAINAGE

- A. Subsurface drains shall conform to section 1044 – *Subsurface Drainage Materials* Of The NCDOT *Standard Specifications For Roadways And Structures*, latest revision.

2.3.13. MISCELLANEOUS STORMWATER APPURTENANCES

- A. All miscellaneous stormwater appurtenances including but not limited to endwalls, headwalls, and flared end sections shall conform to all applicable sections of the latest revision of the NCDOT *Standard Specifications for Roads and Structures*.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. See [paragraph 3.1 Preparation](#) of Specification Section 02210 *Trenching, Backfilling and Compaction of Utilities*.

3.2 PIPE BEDDING AND BACKFILL CLASS DEFINITIONS

- A. **Pipe Bedding Definitions:** See [Standard Detail 2.53](#) for Concrete Pipe. See also [paragraph 2.1.2 Pipe Bedding of Specification](#) and [paragraph 3.5.10 Bedding Condition](#) Section 02210 *Trenching, Backfilling and Compaction of Utilities*.
- B. **Backfill Material Class Definitions:** See [Standard Detail 2.53](#) for Concrete Pipe. See also [paragraph 2.1.1 Trench Backfill Material Classification](#) of Specification Section 02210 *Trenching, Backfilling and Compaction of Utilities*.

3.3 EXCAVATING, TRENCHING AND BEDDING

A. General:

Excavate, trench and bed for storm drainage structures in accordance with 02210 - Trenching, Backfilling and Compaction of Utilities and the following specifications.

Storm sewers shall be laid to line and grade as established by the designing Engineer where shown on the plans or as directed. All pipelines and structures will be constructed by the use of competent workmen under the supervision of experienced foremen. Great care shall be taken to obtain well-aligned and tight pipelines in order to assure good flow.

B. Bedding Rigid Pipe

- 1) Trench Width: Trench width shall be per [Standard Detail 2.53](#) unless approved otherwise by the Town's Engineer.
- 2) Pipe Bedding: Refer to [Standard Detail 2.53](#), Table 2 for acceptable bedding material and depth.

Generally, a stone bedding is not required *unless* the subgrade conditions are either wet, a stone cushion is needed between a hard subgrade and the pipe, or a stone bedding is called for by the Town's Engineer.

When bedding stone is required, the bottom of the excavated pipe trench shall be located as directed by the Engineer and to a depth specified by the Engineer but the depth shall be no less than 4-inches below the bottom of the pipe for pipes 24-inches or smaller in diameter. Based on the Installation Type, the trench subgrade will be thoroughly compacted as specified in Table 2 of [Standard Detail 2.53](#). If specified density of subgrade cannot be achieved, improve the trench subgrade by the placement of foundation stone sufficient upon which to place the pipe bedding as specified on [Standard Detail 2.53](#) and to a depth determined by the Town's Engineer. The stone material shall be placed to assure no foreign matter is enveloped in the stone mat. Stone for such purpose shall be of uniform size - not less than that specified in [Standard Detail 2.53](#) - the width of the mat shall be the width of the trench.

- 3) *In wet areas only or unless specified or directed otherwise by the Town's Engineer*, all but the bottom 2 inches of the pipe joint (as measured across the diameter of the pipe) shall be sealed using a butyl resin gasket.
- 4) **Bedding in Rock:** See [paragraph 3.5.6.F Cushioning Pipe in Rock](#) in Specification Section 02210 *Trenching, Backfilling and Compaction of Utilities* and [Standard Detail 2.53](#).
- 5) Throughout the entire length of the pipe, provide a bedding surface for the pipe with a firm foundation of uniform density. See [Standard Detail 2.53](#) for storm drain installation and bedding requirements based on Type of Installation (Type 1, 2, 3 or 4). Compact bedding as applicable.
- 6) Provide bell holes and depressions for pipe joints of only the length, depth, and width required for making the particular pipe joint properly.
- 7) Minimum cover over pipe shall be 6 inches **in** non traffic areas. Where pipe has less than 12-inches of cover below a roadbed, the pipe shall be reinforced with a concrete bedding.

3.4 LAYING PIPE

A. General:

- 1) Prior to placing pipe, carefully examine each:

Promptly set aside defective pipe and damaged pipe. See [paragraph 1.8 Product Delivery, Handling and Storage](#) for other elements.

- a. Clearly identify defects.
- b. Do not install defective pipe or damaged pipe.
- c. Verify product meets specs. See [paragraph 2.1.1.B Pipe Markings](#) for required pipe markings/certifications.

- d. Pipe with varying wall class must not be mixed between manholes or boxes.
 - e. Unless otherwise noted on plans or directed by Engineer, do not exceed bury limitations shown in Fill Height Table as shown on [Standard Detail 2.53](#).
- 2) **Pipe Alignment:** Place pipe to the grades and alignment indicated within a tolerance of 1:1000 vertical and 1:500 horizontal, unless otherwise directed by the Town's Engineer. Horizontal curves will be allowed for large pipe (greater than 48 inches in diameter) where pipe has been manufactured with a beveled end.
 - 3) **Directional Changes in Pipe:** Use manholes for changes in direction of gravity lines. The Town's Engineer may permit horizontal curves in pipe alignment for pipe greater than 48 inches in diameter where pipe has been manufactured with a beveled end.
 - 4) **Joining Pipe of Different Size or Material:** A drainage structure box is required at all pipe intersections (vertical and horizontal) and changes in pipe size or pipe material. Unless otherwise approved by the Town's Engineer, lateral taps and branches are not permitted without a junction box.
 - 5) At the direction of the Town's Engineer, the invert grade between structures shall be cambered by an amount sufficient to prevent the development of sag or back slope in the flow line. The Town's Engineer will determine the amount of camber to be used.
 - 6) **Stringing out Pipe:** When pipe is strung out during unloading, it shall be set on high ground and in a position to prevent silt deposits, storm water, or other matter from entering the pipe prior to its placement in the trench.
 - 7) Provide adequate facilities for lowering pipe safely into the trenches.
 - 8) Do not place pipe in water, or place pipe when trench or weather is unsuitable for such work.
- B. **OSHA Trench Protection:** Excavation shall be performed in accordance with OSHA Standard 29 CFR Part 1926, "Safety and Health Regulations for Construction," Subpart P "Excavations," Standard Number 1926.650, latest revision *and in accordance with [paragraph 3.5.1.C OSHA Trench Protection](#)* of Specification Section 02210 *Trenching, Backfilling and Compaction of Utilities*.

3.5 PIPE JOINTS & PIPE LAYING

3.5.1. CONCRETE PIPE

A. Laying concrete Pipe:

- 1) Only proper and suitable tools and appliances for the safe and convenient handling, raising, lowering and laying of pipes and fittings shall be used. Pipe and fittings shall be carefully handled and lowered into the trench. Workmen shall not be located either below or in pipe being moved, raised or lowered. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced at the Contractor's expense.

- 2) Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled.
- 3) **Pipe Laying Direction:** Place piping beginning at low point and progress uphill. Place pipe by proceeding upgrade with the **spigot ends** of *bell and spigot pipe*, and the **tongue ends** of *tongue and groove pipe*, pointing in the direction of flow. Place on grade, with unbroken continuity in invert, horizontally and vertically, and on alignment as indicated on plans. Place bell or groove ends of piping facing upstream. Install gaskets, seals, sleeve, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Where open joints are left in the invert per [paragraph 3.5.1.E.4.a.iii, Wet Areas](#), wrap joint with a non-woven Geotextile fabric around as specified in.
- 4) The ends of pipe shall abut against each other in such manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipeline.
- 5) Special care shall be taken to ensure that the pipes are well bedded on a solid foundation, and no pipe shall be brought into position until the preceding length has been thoroughly embedded and secured in place.
- 6) As each joint is laid, visually inspect to be certain that no jointing compound gasket, or trash is protruding from the joint or lying inside the pipe.
- 7) As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade. The greatest care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.
- 8) The Contractor, at his own expense, shall make good any defects due to settlement. Bell holes shall be dug sufficiently large to ensure the making of proper joints. Water shall not be allowed to rise in the excavation until the joint material has been placed and/or received its set. Except at the points where the bottom of pipe is left open, the greatest care shall be used to secure water tightness throughout the rest of the joint and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.
- 9) Whenever a pipe requires cutting, to fit into the line or to bring it to the required location, the work shall be done in satisfactory manner, so as to leave a smooth end, and without extra compensation. The Engineer may require 6 and 8-foot joints if equipment and conditions warrant.
- 10) Lifting holes shall be plugged according to the manufacturer's recommendations. A sheet of geo-fabric shall be placed over the plugged lifting hole and pipe extending 18" from either side of the hole.

B. Pipe Displacement by construction machinery/installation:

- 1) Use all means necessary to avoid displacement of, and injury to, pipe and structures while compacting by rolling or operating equipment parallel to the pipe.

- 2) Movement of construction machinery over a culvert or storm drain, prior to, during and after backfilling and compaction, is solely at the Contractor's risk.
- C. Temporary Suspension of Work: When the trench is left for the night or if pipe laying is suspended, all exposed ends of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plug shall be kept in the ends of the pipeline at all times when laying is not in actual progress.
- D. Cutting or Fitting Pipe: Whenever a pipe requires cutting to bring a pipe to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools that will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe. The method of cutting pipe shall be in accordance with manufacturer's recommendations. Such cuts shall be made by the contractor without extra compensation.
- E. Joining Concrete Pipe
- 1) Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter.
 - 2) All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry.
 - 3) Wipe the inside of the joint clean and smooth. Perform wiping by dragging a suitable swab or long handled brush through the pipe as installation progresses.
 - 4) Unless otherwise directed by the Town's Engineer, use the following methods of joining for *bell and spigot* and *tongue and groove* pipe:
 - a. Flexible watertight joints in concrete pipe.
 - i) Use butyl resin gaskets conforming to [paragraph 2.2.5 Preformed Plastic Gaskets](#). See also Town of Wake Forest Pre-Approved Material/Product List.
 - ii) Install gaskets and joint materials in accordance with the manufacturers' recommendations and as approved by the Engineer or his representative. The jointing material or factory-fabricated joints shall then be placed, fitted, and adjusted in such skillful manner as to obtain the degrees of water tightness required.
 - iii) Wet Areas: *In wet areas only or unless specified or directed otherwise by the Town's Engineer*, the bottom 2-inches of the pipe joint (as measured across the diameter of the pipe) shall be left unsealed to permit infiltration of groundwater. The pipe shall be bedded in #57 stone in such applications. Prior to or during placement of the pipe on the stone bedding, place an 18-inch wide strip of non-woven Geotextile separation fabric along the perimeter of the pipe joint to prevent migration of fines into the pipe. Attach fabric to pipe wall with tape or mastic to hold in place during backfill. Lap fabric ends a minimum of 12 inches and tape/seal.
 - iv) Protect from sun, blowing dust, and other deleterious agents at all times.

- v) Align the pipe with previously installed pipe, and pull the joint together. If, while making the joint, the gasket or jointing material becomes loose and can be seen through exterior joint recess when joint is pulled to within 1 inch of closure, remove pipe and remake the joint.
- vi) Inspect gaskets, and replace loose and improperly affixed gaskets and jointing materials.
- b. Doubling gasket material: Where a sealed joint is not achieved as required, the Contractor shall either pull the pipe out and double Ram-Nek or mortar and wipe the pipe joints inside (where possible) and outside. Mortared joints shall be wiped smooth and protected against drying by covering with wet burlap.
- c. At the Town's Engineer's discretion, he/she may request that all joints shall be left exposed for inspection purposes during the working day. At that time, a suitable ladder affording easy and safe access for such inspection shall be furnished.

3.5.2. JOINING PIPE OF DIFFERENT MATERIALS:

- A. Where new concrete pipe ties-in to an existing pipe of a different type of material, provide fittings or couplings made for the pipe material jointing, or provide a concrete collar as approved by the Town's Engineer.

3.5.3. SAMPLE JOINT TO BE MADE AND APPROVED:

- A. Before any joints are actually made in the trench, the Contractor shall demonstrate to the Town's Engineer, by making a sample joint, that the methods which he will employ conform to the specifications and will secure a watertight joint, and that the workmen whom he intends to use in this work are familiar with the requirements.

3.6 DRAINAGE STRUCTURES

3.6.1. GENERAL:

- A. Clay brick structures are not permitted.
- B. Junction boxes, catch basins, combination boxes, headwalls, etc. may be constructed of concrete brick or concrete block. Structures may be of either reinforced masonry or non-reinforced masonry depending upon either the standard shown on these specifications and/or the details shown on the plans/contract drawings by the engineer of record.
- C. Formed inverts:
 - 1) To reduce turbulence, all junction boxes, manholes etc. shall have formed inverts, regardless of pipe size or box type, formed to the spring-line of the pipe as shown on the plans or as directed by the Town's Engineer. The flow line of the box invert shall be of uniform grade from the invert of the influent line to the invert of the effluent line. Inverts shall be constructed of block, brick and mortar with a brushed finish. Invert forming is to be performed after the pipe penetrations have been made, the annular space around the pipe grouted and the pipe sawn flush with the interior face of the structure.

- D. All junction boxes, manholes, catch basins etc. shall have 2-inch diameter weep holes, approximately 7 inches off bottom, on each wall or as directed by the Engineer. Holes shall be constructed of 2-inch PVC pipe laid in mortar as the block is brought up. See also [paragraph 2.2.6 for Weep Hole Pipe](#) material and [paragraph 3.6.6 for Weep Hole Construction](#).
- E. No sand traps shall be constructed in the bottoms unless so directed by the Town's Engineer.
- F. **Manhole Junction Boxes:** Every non-grated junction box or manhole shall have a manhole access. No blind manholes or junction boxes are permitted.
- G. Frame and grate height may be adjusted with concrete or brick in accordance with Town of Wake Forest specifications. Use manhole frame and cover as indicated on the plans. Reinforce manhole opening in top as shown on standard details or as designed by NC Professional Engineer for required loading condition.
- H. **Design**
- 1) Boxes to be designed by NC Professional Engineers and approved by Town's Engineer for AASHTO HL93 loading condition.²
 - 2) **Steps:** For structures over 3'-6" in depth, provide steps. Steps are to be located on a non-pipe wall. Steps shall meet the applicable OSHA requirements. See also [Standard Detail 2.74](#).
- I. **Bedding:** See [paragraph 3.5.6.G Cushioning for Structures](#) of Specification Section 02210 *Trenching, Backfilling and Compaction of Utilities*.
- J. **Catch Basins And Inlets:**
- 1) **General:** All catch basins and inlets shall be standard NCDOT curb-opening inlet/grate type in accordance with NCDOT standard detail 840.03 with appropriate grate (see [Standard Detail 2.50](#)), unless otherwise specifically designated on the plans and approved by the Town's Engineer. The depth of a catch basin will normally be 4-feet. This depth may be increased or decreased by the Engineer as necessary to meet local conditions.
 - 2) All pipe lines entering a masonry catch basin shall be placed upon the concrete slab prior to beginning any brickwork. The brickwork shall be brought up snugly around such lines and a tight connection made to prevent any washouts and cavities at the basin.
 - 3) Catch basins shall be constructed on line and grade as given by the designer and in the locations as specified. Castings shall be set true to line and grade.

3.6.2. UNREINFORCED MASONRY STRUCTURES:

- A. In non-reinforced masonry construction, the unit used shall conform to the requirements of [paragraph 2.3.3 concrete building block](#).

² HL93 design truck wheel load is same as HS20-44 wheel load without lane loading (which does not apply to below ground structures as confirmed by ASTM C1577 and permitted by AASHTO).

- B. The walls shall be constructed of concrete building brick in the manner as shown on the plans, corbelling in as necessary to meet the standard casting specified. Masonry construction shall conform to section 834, *block masonry construction – general and* section 840, *minor drainage structures* of the NCDOT *Standard Specifications for Roads and Structures*, latest edition. All concrete brick shall be soaked in water to refusal before being used. Upon use, the excess adhering surface water shall be wiped off.
 - C. Masonry boxes may be used with the Town of Wake Forest [Standard Details 2.50, 2.51, 2.54, 2.55, and 2.56](#). See also [Table 2700.1](#) for a list of other approved NCDOT standards with concrete brick boxes.
 - D. Maximum depth: See [Standard Detail 2.57, Drainage Structure Notes](#). Structures to be designed by NC Professional Engineer and approved by Town’s Engineer. See [paragraph 3.5.1.H.1 Design](#).
 - E. Maximum wall span: Minimum wall thickness: minimum wall thickness of all boxes and manholes shall be 8 inches solid **concrete** brick masonry or 8 inches concrete block with concrete filled cells for all boxes or manholes 12 feet or less in depth. The maximum horizontal wall span of an unreinforced 8-inch thick masonry wall shall not exceed 5 feet for boxes 8 feet or less in depth without special engineering. See [Standard Detail 2.57 Drainage Structure Notes](#) for other requirements.
 - F. The bottom for the masonry structures shall be no less than 6 inches thick unless shown otherwise on the plans and approved by the Town’s Engineer.
 - F. Mortar in masonry structures is to be ASTM C270, Type S or M.
 - G. **Pipe Penetrations:** Inside of boxes shall allow for 6 inches of clearance on both sides of pipe. The dimension shown on the structures in the standard details are minimum box dimensions. For boxes with greater dimensions add a reinforced concrete top slab or lengthen the box by adding additional grates and frames).
- 3.6.3. PRECAST REINFORCED CONCRETE STORM DRAINAGE BOX STRUCTURES (Flush Wall, Waffle And Knockout Panel Type):**
- A. Precast reinforced concrete catch basins and inlets: Precast catch basins and inlets shall conform to the requirements of [paragraph 2.2.1 Precast Underground Concrete Utility Structures](#).
 - B. Design requirements: See [paragraph 2.2.1, precast underground concrete utility structures](#)
 - C. **Maximum Depth** (manhole junction boxes and catch basins): Limit maximum depth to top of bottom slab for waffle wall structure to 10’-0” ; limit solid wall structure to 15’-0” unless approved otherwise by the Town’s Engineer.
 - D. **Grade adjustment:** Precast storm drainage boxes with knockout panels shall be set to the prescribed grade designated on the construction drawings. Precast boxes shall be placed on a stone bed of a minimum of 6 inches of #57 stone. Boxes shall be adjusted to final grade by the addition of either precast reinforced concrete grade rings or solid clay brick or concrete masonry with type M mortar. Boxes may not be saw cut to lower the grade unless first approved by the Town’s Engineer and then by no more than 2 inches. Due to the potential for grade variation in setting the structures, and to

avoid cutting the boxes, it is recommended that boxes be ordered slightly short of the depth required to permit final grade adjustment by adding risers. However, the total depth of riser ring or masonry adjustment shall not exceed 8 inches.

E. See also [Table 2700.1](#) for a list of approved NCDOT standards for other masonry and precast boxes.

F. **Pipe Penetration(s) Into Precast Boxes:**

- 1) Cut or form openings for pipe to provide required size and location. Remove knockout panels by saw cutting. Cut to pipe OD plus 2 inches.
- 2) Orient waffle wall structures so that pipes enter through the knockout/waffle panels only.
- 3) Preformed pipe penetrations may enter through the corners of solid wall precast boxes if a minimum of 6" of wall is provided above the hole.
- 4) Patching: The pipe shall be placed in the hole and the annular opening grouted the full 360 degrees of the pipe diameter with concrete. The grouted pipe penetration shall be inspected prior to backfilling. Once the concrete collar has set (4 days minimum), pipe(s) protruding into the box shall be cut flush with the inside face of the box and the annular edge grouted to form a smooth entrance.

3.6.4. ACCEPTABLE NCDOT STANDARD BOXES

A. The following NCDOT standards are approved for use in the Town of Wake Forest:

| Table 2700.1 | |
|--------------|---|
| Detail | Sheet Title |
| 840.01 | Brick Catch Basin – 12" thru 54" |
| 840.02 | Concrete Catch Basin – 12" thru 54" |
| 840.05 | Brick Open Throat Catch Basin – 12" thru 48" Pipe |
| 840.14 | Concrete Drop Inlet – 12" thru 30" Pipe |
| 840.15 | Brick Drop Inlet – 12" thru 30" Pipe |
| 840.17 | Concrete Grated Drop Inlet Type 'A' – 12" thru 72" Pipe |
| 840.18 | Concrete Grated Drop Inlet Type 'B' – 12" thru 36" Pipe |
| 840.19 | Concrete Grated Drop Inlet Type 'D' – 12" thru 36" Pipe |
| 840.26 | Brick Grated Drop Inlet Type 'A' – 12" thru 72" Pipe |
| 840.27 | Brick Grated Drop Inlet Type 'B' – 12" thru 36" Pipe |
| 840.28 | Brick Grated Drop Inlet Type 'D' – 12" thru 36" Pipe |
| 840.31 | Concrete Junction Box – 12" thru 66" Pipe |
| 840.32 | Brick Junction Box – 12" thru 66" Pipe |
| 840.45 | Precast Drainage Structure (1 of 2) |
| 840.46 | Precast Drainage Structure (2 of 2) |

3.6.5. MANHOLE CONSTRUCTION FOR PRECAST STANDARD MANHOLES AND DROP INLET BASES

- A. **Precast Reinforced Concrete Manholes:** Manholes of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C478. The wall shall be a minimum of 5 inches thick and have a 6-inch minimum base. The standard joint shall be sealed with plastic cement putty meeting Federal Specification SS-C-153. Either an “O” ring or “ram neck” joint seal may be used. The “O” ring joint shall conform to the requirements of ASTM C443. The gasketed joint shall conform to ASTM C990 (AASHTO M199).

Concrete used in the construction of the manholes shall have a minimum 28 day strength of 4000 psi air entrained (with 4 to 6 percent air) conforming to ASTM C-33 and ASTM C-94. Manhole units shall consist of standard modular precast riser sections, modular riser sections and a monolithic base (except doghouse bases are to be used when placing manholes over existing mains). Manhole steps shall be integrally cast in to the walls of the manhole sections. Where conditions do not favorably accommodate the use of an eccentric cone, eccentric precast reinforced concrete flat tops are to be used. Manholes over 12 feet in depth, as measured from top of casting to effluent invert, shall have extended bases with appropriate reinforcing. Manholes steps shall be located perpendicular to the flow.

- B. **Standard Manhole Junction Boxes:** Manholes shall be constructed in accordance with the Town of Wake Forest [Standard Details 2.60](#) and [2.61](#) with the following exceptions:
- 1) Flexible boots and precast concrete inverts will not be required.
 - 2) Joints will be as specified in [paragraph 2.2.3](#) of this specification.
 - 3) The pipe opening in precast units shall be at least 4 inches but not more than 8 inches larger than the outside diameter of the pipe. Pipe openings shall be formed, drilled, or neatly cut as approved by the Engineer.
 - 4) The Contractor shall pack the annular opening between the pipe culvert and the precast structure with grout. Such materials shall be thoroughly bonded to both the pipe and structure.
 - 5) Do not plug weep holes. Place a non-woven Geotextile fabric over weep holes.
 - 6) Pour concrete inverts in all structures. Concrete shall be in compliance with products section for miscellaneous concrete of these specifications. Shape manhole channel with a smooth semicircular bottom matching inside diameter of the connecting pipe/pipes. Change directions of flow with a smooth curve of as large a radius as the manhole size will permit. Change size and grade of channels gradually and evenly. Shape the shelf to provide a slope between 1 and 2 inches per foot towards the invert. See [Standard Details 2.60](#) and [2.61](#).
 - 7) Manholes shall be installed plumb.
 - 8) Manholes shall be no less than 4 feet in diameter. Larger diameter manholes needed to accommodate larger pipe shall be sized based on an angle of entry sufficient to accommodate adjacent pipe, with sufficient annular clearance to permit pipe entry into manhole, while also providing a vertical undisturbed column of reinforced concrete between adjacent pipes of at least 8 inches in thickness for manholes up to 12 feet in depth.

- 9) NCDOT Standard Detail 840.53 may only be used if approved by the Town's Engineer prior to its proposed use.
- 10) Manholes shall be fabricated in such a way as to minimize the potential of the pipe landing in a riser joint.
- C. **Replacement/Rehabilitation of Existing Manholes:** where the new grade of the storm drain is such that, in the judgment of the Town's Engineer, a new manhole is necessary, the old manhole must be completely removed and a new precast manhole set in its place. Where the old manhole is of satisfactory quality, the contractor will make connection thereto as directed by the Town's Engineer at no additional cost even if it is necessary to modify the manhole to meet the new grade. Such extras are considered incidental to the manhole connection cost.
- D. **Adjustments:** The Contractor shall exercise care in the ordering of structures so that the use of brick for leveling and adjustments can be minimized. Where adjustment of a manhole is required, unless otherwise directed by the Town's Engineer, grade rings shall be used. The depth of grade rings shall not exceed 12 inches before removal of the cone or flat top is necessary for adjustment.

On all storm manholes, a mastic joint material shall be placed between the iron frame and the cone or grade ring.

When applicable, during the installation of manholes, if frame and cover is near or within wheel path in roadway, turn cone to place the frame out of wheel path.

3.6.6. WEEP HOLE CONSTRUCTION / POROUS BACKFILL

Placement of drainpipes for weep holes and porous backfill material shall conform to the Town of Wake Forest applicable standard details and the requirements of the NCDOT *Standard Specifications for Roads and Structures*, Section 420-11, *Drains in Walls and Culverts*. Construct in accordance with Sections 414-7 and 414-8 of the NCDOT Standard Specifications. See [par graph 2.2.6](#) for PVC pipe spec.

3.6.7. CATCH BASIN-MANHOLE COMBINATION:

In some locations, as shown on the plans, it will be necessary to construct a combination catch basin-manhole. The specifications as given above for manholes and catch basins shall be adhered to as applicable. This structure will have a standard round manhole shape at the bottom with a standard manhole bottom, but will be furred in at the top to meet a standard catch basin casting.

3.7 CONSTRUCTION OF MISCELLANEOUS APPURTENANCES

End walls and other miscellaneous storm drainage items shall be constructed in accordance with the latest edition of the NCDOT *Standard Specifications For Roads and Structures* and the applicable NCDOT standard details.

3.8 SUBDRAINS

- A. Where considered necessary by the Town's Engineer or otherwise recommended by a Geotechnical Engineer, due to a seasonal high ground water condition which would

pose a threat to the structural integrity of the street pavement section, a 6-inch diameter helical steel sub-drains shall be installed. The subdrain shall be at grades shown or as directed and stone shall completely encircle the sub-drain pipe for a minimum distance of one diameter from the pipe in all directions. Installation of subsurface drainage systems shall conform to the requirements of section 815 – *Subsurface Drainage* of the NCDOT *Standard Specifications for Roadways and Structures*, latest revision using non-woven needle-punched fabric. The stone shall be wrapped in fabric.

The stone shall be of uniform size and shall be enclosed in the filter media cloth. The pipe, stone and filter media shall be as specified in the materials section of these specifications.

Subdrain pipe grade shall generally follow the top of curb or edge of pavement grade except that the minimum slope shall be 0.5% for 6-inch helical steel pipe subdrain. Subdrains shall tie into catch basins or storm manholes. No bends will be allowed.

3.9 ABANDONING STORM DRAINAGE LINES & MANHOLES

- A. **Storm Lines:** Unless directed otherwise by the Town's Engineer, when an existing storm drainage line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout pumped into the line until line is completely filled.

3.10 EXCAVATION OF DRAINAGE CHANNELS

- A. Open storm drainage channels and ditches shall be graded and shaped in accordance with the elevations, slopes, widths, and lengths indicated on the plans except that the side slopes shall be 3:1 or flatter. The outfall elevation of the new channels and ditches shall be graded to match the flow elevations of all existing or natural channels, unless indicated or specified otherwise.
- B. The drainage channels shaped with fill materials shall be compacted within the limits and in accordance with the related backfill work specified elsewhere.
- C. The drainage channels shall be prepared, seeded, and mulched in accordance with the related work specified elsewhere. Where indicated on the drawings, specified, or otherwise directed by the Town's Engineer, erosion control measures, such as temporary liners, rip rap, concrete liners, etc., shall be provided.

3.11 PLACEMENT OF RIP RAP AND RIP RAP BEDDING AT PIPE OUTLET PROTECTION

- A. Placement of rip rap and fabric shall conform to section 876 – *rip rap* of the NCDOT *Standard Specifications For Roadways And Structures*, latest revision.

3.12 PAVEMENT REPLACEMENT

Where it is necessary to install pipe or structures under existing pavement, the Contractor will be required to replace all pavement, curb, sidewalk, or any structures damaged at his expense unless a line item is given for replacement of pavement. Payment, if allowed for by the unit price, shall be by the square yard. Pavement repair shall be in accordance with [Standard Detail 2.06](#).

3.13 INSPECTION

- A. At any time during construction up to and including completion of entire pipe installation, the Town's Engineer may inspect the work in part or as a whole in order to satisfy himself/herself that every portion of the project has been faithfully carried out in accordance with the plans, specifications, and standard details, as applicable.
- B. If, in the opinion of the Town's Engineer, a defect exists in the pipeline or its appurtenances, in some place not accessible except by uncovering, the Town's Engineer may order the line to be uncovered. If it is found that after the pipe has been uncovered at the order of the Town's Engineer, no defect exists or that the defects were not the fault of the contractor, then the expense so incurred by the contractor shall be borne by the town.
- C. Flush all sand, dirt, and debris from the lines prior to acceptance. Video taping of lines is to be performed in the presence of a town representative
- D. Inspect the system for conformance with line and grades shown on the plans and provide record drawing measurements on record drawings.
- E. **Visual inspection:** all lines and manholes shall be visually inspected by the town of wake forest from every manhole by use of mirrors. At the direction of the Town's Engineer, areas of questionable construction may be inspected by the town using television cameras (which are to be provided by developer and/or contractor). The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines, which do not exhibit a true and correct line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the barrel left clean for its entire length.
- F. **Laying tolerance: place pipe to the grades and alignment shown on the plans**
 - 1) **Horizontal Laying Tolerance:** 1:500 horizontal (straight runs), unless otherwise directed by the Town's Engineer.
 - 2) **Vertical Laying Tolerance:** Unless otherwise directed by the Town's Engineer, the maximum permitted negative grade variation in post-construction pipe grade shall be -10% of the design grade. The computation of the post-construction pipe grade shall be based on a post-construction field survey. The grade shall be computed by taking the actual difference between the invert in and invert out of the pipe run divided by the actual pipe length. Pipe runs laid at less than the approved design grade must be removed and re-laid.

Example:

Design Grade: 0.005 ft/ft or 0.5%

Field Check of Grade:

| | |
|-----------------------------------|--------------|
| <i>Surveyed Invert in =</i> | <i>96.50</i> |
| <i>less Surveyed Invert out =</i> | <i>96.04</i> |
| <i>Difference =</i> | <i>0.46</i> |

Actual Pipe Run Length = 100 (not measured C-C of Boxes!)

$$\text{Slope} = \frac{0.46}{100} = .0046 \text{ or } 0.46\%$$

Variation Check:

| | |
|---------------------|-------|
| <i>Design Grade</i> | 0.50% |
| <i>Actual Grade</i> | 0.46% |
| <i>Difference:</i> | 0.04% |

Allowable deviation is 10% of Design Grade = 0.10 x 0.50% = 0.05%

Allowable deviation of 0.05% > 0.04% allowable deviation... VARIATION OK!

3.14 MAINTENANCE

The developer shall maintain all pipe installations in such a condition that they will function continuously from the time the pipe is installed until the development/project is accepted for maintenance by the Town. Furthermore, soil erosion and sedimentation control measures shall be installed wherever necessary, including at curb inlets for example, and maintained for the duration of the development until the project is fully stabilized. Once permanent groundcover has been established, temporary erosion control measures shall be removed and the disturbed areas landscaped and seeded.

3.15 MEASUREMENT & PAYMENT

3.15.1. MEASUREMENT

- A. **Pipe:** measurement of pipe shall be from the exact beginning of the pipe to end of pipe. Measurement is not to include that distance through manholes or junction boxes. Lateral lines for catch basins and other connections will be measured and paid for in the same manner. All mains and laterals shall be measured alike except that under no circumstances shall measurement be made through any one manhole for more than one line.
- B. **Manholes:** measurement of manholes shall be either by depth of the manhole or per unit as identified in the proposal.
 - 1) **Unit method:** When the unit method is used, manholes shall be considered a unit inclusive of casting, bolting frames, stone bedding, connection, mortar, steps, gaskets, setting, finishing, bolting, invert forming, breaking/cutting of protruding pipe edges and finishing edges. The unit method shall also be used for manholes where wide departure is made from a standard. No extra payment shall be made for warping to meet local conditions.
- C. **Catch Basins:** Catch basins shall be paid for by unit price as bid in the proposal, said unit price to include all costs of the basin including precast units, brick work, frames, stone bedding, connection, mortar, steps, gaskets, setting, finishing, bolting frames, invert forming, breaking/cutting of protruding pipe edges and finishing edges. No extra payment shall be made for warping to meet local conditions.
- D. **End/Headwalls, Special Structures:** These shall be paid by lump sum for the structure as designated in the contract drawings and called for in the itemized proposal.

- E. **Pavement Repair:** By the square yard. The pavement section shall be as detailed on the plans, which may be either full depth asphalt or a combination of asphalt and ABC. The cost of pavement repair shall include saw cutting existing asphalt, removal, cut maintenance, compaction of subgrade, tack coat, paving and 12 month warranty. See [Standard Detail 2.06](#).
- F. **Bedding Stone:** Bedding stone shall be #5, #57, #67 or #467 clean stone. Payment for bedding stone shall be made by the ton. Measurement for bedding stone shall be computed by a maximum width of the trench of the pipe OD plus 12-inches on each side of the pipe times the depth of bedding stone, which corresponds to the bedding class used. Stone tickets will be required to verify payment.
- G. **Foundation Stone:** Surge pile stone, #5, #57 or other stone as directed by the Town's Engineer, by the ton. Stone depth for building a foundation under pipe shall be based on the actual stone needed to improve the foundation but no more than 1/3 the pipe diameter being laid unless approved otherwise by the Town's Engineer. Stone tickets will be required to verify payment estimates.
- H. **Trench Borrow:** Trench borrow will be paid by the cubic yard for material placed in trenches.
- I. **Rock:** Rock shall be paid by the cubic yard for rock removed by blasting. No pay for rock removed by ripping.
- J. **Subdrain:** Payment will be made by the linear foot of line laid. The cost shall include pipe, fittings, stone, fabric, trenching, backfill, compaction, equipment , labor and basin tie-in.

3.15.2. PAYMENT:

- A. Payment for storm drainage items shall be by the unit according to the bid price in the proposal.

END OF SECTION 02700

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