



DEPARTMENT OF PUBLIC WORKS

STANDARD SPECIFICATIONS FOR INSTALLATION OF UTILITY CONSTRUCTION PROJECTS AND SUBDIVISION PAVEMENT DESIGN

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1. PURPOSE OF STANDARD SPECIFICATIONS

The following specifications and accompanying details are made available to private contractors and developers for the use on every utility or street project within the incorporated area of the Town of Greenwood. They are binding and shall be closely observed, any exceptions or alterations must be obtained in writing from the Town at least four (4) weeks prior to commencement of the project.

2. DEFINITIONS OF TERMS

- a. Whenever in these specifications, bond and other contract documents, the following terms or pronouns are used, the intent and meaning shall be interpreted as follows:

"Owner" or "Town of Greenwood"

Town of Greenwood, Sussex County, Greenwood, DE

"Engineer"

Consultant Engineer for Town of Greenwood or his duly authorized representative. Wherever the word Engineer is referred to in these specifications it can be substituted with the word "Owner" and he can at all times assume the responsibilities of the Engineer.

"Resident Project Representative"

An authorized representative of the Owner or Engineer assigned to make any and all necessary observations of the work performed and materials and/or equipment furnished by the Contractor.

"Developer"

Party(s), where applicable, ultimately responsible for the satisfactory completion of all improvements shown on the construction documents approved by the Town. The term "Developer" shall be applicable whenever such party(s) are the owner of record on which the proposed improvements are being made. Wherever "Contractor" is used throughout this document, "Developer" is assumed, where applicable.

"Contractor"

Party responsible for constructing the utility, acting directly or through his agents or employees.

"Subcontractor"

Any individual, firm or corporation who contracts with a contractor to perform part or all of the latter's contract.

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"Shop Drawings"

Drawings, diagrams, illustration schedules, performance charts, brochures and other data which are prepared by the Contractor or any subcontractor, manufacturer, supplier or distributor, and which illustrate some portion of the work.

"Drawings"

All drawings or reproduction of drawings pertaining to the work under the contract, which are furnished or approved by the Engineer.

"Specifications"

The definitions, descriptions, directions, provisions and requirements contained herein, and all written supplements thereto, made or to be made, pertaining to the contract, and the materials, equipment, and workmanship to be furnished under the contract.

"Contract" or "Contract Documents"

All things contained in the specifications, drawings, proposals, agreement and bond, and therein referred to, are to be considered as one instrument forming the contract. Also, any and all supplementary agreements which could reasonably be required to complete the construction contemplated.

"Approved," "As Required," and similar expressions

Meaning shall be construed as "as approved by the Engineer" and "as required by the Engineer."

"Provide"

A direction to the Contractor to furnish all materials, equipment and labor, and make payment for all of these necessary to complete the contract.

"Work"

Any and all things agreed to be furnished or done by or on the part of the Contractor, and which are required in the construction and completion of the project herein contemplated. Includes labor, material and equipment.

"Material" or "Materials"

Unless the context otherwise requires, these words or either of them, shall include equipment.

"Furnish"

A direction to the Contractor to supply and make payment for materials and equipment but not necessarily to install or pay workmen to install, or both of these items.

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"General Conditions"

Provisions that establish and pertain to the legal responsibilities between the parties involved in the work, namely Owner, Engineer and Contractor.

- b. Whenever, in the specifications and upon the drawings, the words DIRECTED, REQUIRED, PERMITTED, ORDERED, DESIGNATED, PRESCRIBED and words of like import are used, it shall be understood that the directions, requirements, permission, order, designation, or prescription of the Engineer or Owner is intended and similarly the words APPROVED, ACCEPTABLE, SATISFACTORY, and words of like import shall mean "approved by, or acceptable or satisfactory to the Engineer or Owner, unless otherwise expressly stated".

3. PRE-CONSTRUCTION AND PROGRESS MEETINGS

- a. The Developer/Contractor shall provide written verification that a pre-construction meeting was held with the Soil Conservation District, if the project required District approval, prior to beginning any construction.
- b. The Developer/Contractor shall contact the Town for the purpose of scheduling a pre-construction meeting prior to beginning construction. The Town will decide if the project warrants a pre-construction meeting and inform the Developer/Contractor accordingly. The Town will instruct the Developer/Contractor as to who should attend the meeting and the Developer/Contractor shall schedule the meeting. The Town shall record and distribute the minutes from the meeting.
- c. The Town shall, at the time of the pre-construction meeting, or at any time during construction, inform the Developer/Contractor of the Town's determination that a progress meeting will be necessary. The Town may also deem that progress meetings will be required on a regular basis. The Town shall schedule all progress meetings. The Town shall also record and distribute the minutes from the progress meetings.

4. PERMITS, FEES AND NOTICES

- a. The Contractor shall pay taxes, royalties and fees, and secure licenses and permits that are required during the time of the contract, by local, county, state and federal laws, ordinances, rules, codes and regulations for the legal performance of the contract.
- b. The Contractor shall perform the work in accordance with notices issued by public authorities having jurisdiction over the work, including, but not limited to, Delaware Department of Transportation, Delaware Department of Health, and the Soil Conservation District.

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- c. If the Contractor performs work, knowingly or ignorantly, contrary to requirements of local, county, state and federal laws, ordinances, rules, codes and regulations, he shall assume full responsibility and therefore, shall bear all costs of suits, actions and damages resulting from his illegal work performance.

5. INDEMNIFICATION OF THE OWNER

- a. The Contractor shall indemnify and hold harmless the Owner and the Engineer, and all who represent them, from and against claims, damages, losses and expenses arising out of the Contractor's performance of the work, provided such claim damage, loss and expense are attributable to:
 - (1) Bodily injury, sickness, disease or death, or injury to tangible property, including the loss of use resulting therefrom, and
 - (2) Negligence of the Contractor or his subcontractors and others directly related to the project, or both.

6. COOPERATION OF CONTRACTOR AND REPRESENTATIVE

The Contractor shall give the work his constant attention to facilitate the progress thereof and shall cooperate with the Engineer and Owner. The Contractor shall have at all times a competent and reliable English-speaking representative on the work, authorized to receive orders and act for him.

7. COOPERATION WITH OTHER CONTRACTORS

- a. The Contractor shall cooperate with, and so conduct his operations as not to interfere with, or injure the work of other contractors or workmen employed by the Owner. He shall promptly make good, at his own expense, any injury or damage which may be done by him or his employees or agents on the work.
- b. The Contractor shall suspend such part of the work herein specified, or shall carry on the same in such manner, as may be ordered by the Engineer.

8. AUTHORITY AND DUTIES OF RESIDENT PROJECT REPRESENTATIVE

Resident Project Representative (R.P.R.'s) employed by the Owner or Engineer shall be authorized to observe all work done and materials furnished. Such observation may extend to all or any part of the work and to the preparation or manufacture of the materials to be used. An R.P.R. may be stationed on the work to report to the Engineer as to the progress of the work and the manner in which it is being performed; also to report whenever it appears that the materials furnished and work performed by the Contractor fail to fulfill the requirements of these specifications. No inspection, nor any failure to inspect, at any time

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or place, however, shall relieve the Contractor from his obligation to perform all of the work strictly in accordance with the requirements of the specifications. The R.P.R. shall perform such other duties as are assigned to him. He shall not be authorized to revoke, alter, enlarge, relax or release any requirements of these specifications, nor to approve or accept any portion of work, nor to issue instructions contrary to the drawings and specifications. The R.P.R. shall in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the work by the latter.

9. DEFECTIVE MATERIALS AND WORK

All materials not conforming to the requirements of these specifications shall be considered as defective, and all such materials whether in place or not, shall be rejected and shall be removed immediately from the work unless otherwise permitted. No material which has been rejected, the defects of which have been corrected or removed, shall be used until approval has been given. All work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the Contractor at his own expense.

10. FAILURE TO REMOVE AND RENEW DEFECTIVE MATERIALS AND WORK

Should the Contractor fail or refuse to remove and renew defective materials used or work performed previously or to make any necessary repairs in an acceptable manner, and in accordance with the requirements of these specifications, within the time indicated in writing, the Engineer shall have the authority to cause the unacceptable or defective materials or work to be removed and renewed or such repairs to be made at the Contractor's expense.

11. LAWS TO BE OBSERVED

The Contractor shall observe and comply with federal, state, county, and local laws, ordinances, rules, regulations, decrees and orders that are in effect and applicable to the work during the time of construction; and he shall see that his subcontractors likewise meet this requirement. He shall indemnify, and hold harmless, the Owner and his representatives against claims and liability arising from Contractor and subcontractor violations of such laws, ordinances, rules, regulations, decrees, and orders, whether such violations be by the Contractor or any Subcontractor, or any of their agents and/or employees.

12. LINES, GRADES AND ELEVATIONS

- a. The Contractor shall be responsible for layout of the lines, grades, and elevations of the work and shall conform his work thereto.
- b. The Contractor shall furnish the Engineer, at least five (5) days prior to the start of construction, two (2) record copies of line and grade stakeout data as well as cut

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sheets for approval. The furnishing of such record data shall in no way release the Contractor from his responsibility for the completeness and accuracy of stakeout work necessary for construction.

- c. All survey and stakeout work shall be done by qualified personnel subject to the approval of the Engineer.
- d. All proposed manholes, catch basins, etc., shall be field located by the Contractor prior to the start of construction. Notice shall be given to the Engineer to observe the location and make any adjustments deemed necessary.

13. SANITARY PROVISIONS

The Contractor shall provide and maintain in a neat and sanitary condition such sanitary conveniences and accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the Department of Health or of other bodies or tribunals having jurisdiction thereof. He shall commit no public nuisance.

14. PUBLIC CONVENIENCE AND SAFETY

- a. The Contractor shall conduct the work in a manner that will minimize obstruction to traffic in the area. The safety and convenience of the general public and of the residents and occupants of property along and adjacent to the work shall be provided in an adequate and satisfactory manner. Footways and portions of highways and streams adjoining the work shall not be obstructed more than absolutely necessary. In no case shall any traveled thoroughfare be closed without permission of the Owner.
- b. Fire hydrants on or adjacent to the work shall be kept accessible to fire apparatus at all times, and no obstructions shall be placed within fifteen (15) feet of hydrant.
- c. Gutters and storm drain inlets shall be kept unobstructed at all times.

15. BARRICADES, DANGER, WARNING, AND DETOUR SIGNS

The Contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades, on which shall be placed acceptable warning signs. The Contractor shall detour traffic and shall furnish and maintain all detour signs required to direct traffic over the entire route of the detour. Costs for maintaining traffic shall be the responsibility of the Contractor.

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16. WORK AFFECTING DELAWARE D.O. T. JURISDICTION

- a. All materials and construction methods for work affecting Delaware Department of Transportation jurisdiction shall be done in complete accordance with permit and/or franchise stipulations or directives issued by same. All costs for such work shall be the responsibility of the Contractor.
- b. Maintenance of traffic shall be accomplished in full accordance with the Delaware DOT publication, "Traffic Controls for Street and Highway Construction and Maintenance Operations", latest edition. Work in DOT Right-of-Way shall not commence without an approved Maintenance of Traffic (MOT) plan.

17. PRESERVATION AND RESTORATION OF PROPERTY

- a. Contractor shall not enter private property without permission.
- b. The Contractor shall take necessary measures to preserve public and private property, including paving and lawns outside the required excavation lines, adjacent to the property. He shall not permit monuments to be moved until an authorized agent has referenced their locations, and until directed to move them. The Contractor shall pay all expenses for replacing property markers disturbed. Replacement shall be by a Surveyor licensed in the State.
- c. The Contractor shall be responsible for damages to property, whether caused by himself, his subcontractors, or as a result of negligent construction methods. Contractor shall provide restoration of damaged property to its original condition, or better, at no additional cost to the Owner. If Contractor fails to restore such property, the Owner may, upon 48-hours notice, have property restored at the Contractor's expense.

18. CONTRACTOR'S RESPONSIBILITY FOR WORK

Until the final acceptance of all the work shall be indicated in writing by the Engineer, the work shall be under the charge of and care of the Contractor. He shall take every precaution against destruction of, injury, or damage to the work, or to any part thereof from any other cause whatsoever. The Contractor shall rebuild, repair, restore, and make good, at his own expense, all destruction of, injuries, or damage to the work or any of the above causes before its final completion and acceptance shall be indicated in writing by the Engineer.

19. TEST OF SAMPLES OF MATERIALS

Tests of materials shall be made at the Contractor's expense, by a certified testing laboratory, in accordance with the officially approved methods as described or designated. The Owner

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reserves the right to conduct verification testing at his own expense. The Contractor shall cooperate with and assist the Owner in taking samples and packing them for shipment to a laboratory.

20. STORAGE OF MATERIALS

Materials shall be stored so as to insure the preservation of their quality and fitness for the work. When considered necessary, they shall be placed on wooden platforms or other hard clean surfaces, and not on the ground, and shall be placed under cover when directed. Stored materials shall be located so as to facilitate prompt inspection. Lawns, grass plots, or other private property shall not be used for storage purposes without written permission of the owner or lessee.

21. QUALITY OF MATERIALS AND WORKMANSHIP

- a. Materials and workmanship shall be of best possible quality and feasibility for the intended purpose, whether or not a brand name is specified. Materials shall be new and unused.
- b. Representative preliminary samples of materials may be requested by the Engineer for examination or testing, or both. Materials, for which samples are submitted to Engineer, shall not be ordered by Contractor until Engineer furnishes written approval of said samples. Materials may be further inspected by the Engineer during preparation and construction of the work; and materials found to be substandard will be rejected.
- c. Mechanical equipment which is designed as part of the improvements, to service the general needs of the site, shall be screened from view. Screening may be architectural or by means of landscaping. The long-term maintenance of the screening shall be the responsibility of the Developer or the homeowners association.

22. CLEAN UP

- a. The Contractor shall, at his own expense, keep the sites of his operations clean during construction and remove all rubbish as it accumulates.
- b. Upon failure of the Contractor to keep the sites of his operations clean to the satisfaction of the Owner, the Owner may, upon 24-hours notice to the Contractor, remove rubbish, as is deemed necessary, and charging the cost thereof to the Contractor.
- c. On or before the completion of the work, the Contractor shall, without charge therefore, tear down and remove all his buildings and temporary structures built by

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him, shall remove all rubbish of all kinds from any grounds which he has occupied, and shall leave the site of the work in a clean and neat condition.

23. TEMPORARY SUSPENSION OF WORK

The Engineer shall have the authority to suspend the work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the suitable execution of the work, or for such time as is necessarily due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent destruction, damage or deterioration of the work performed, provide suitable drainage by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The Contractor shall not suspend the work without authorization. Neither the failure of the Engineer to notify the Contractor to suspend the work on account of bad weather or other unfavorable conditions, nor permission by the Engineer to continue work during bad weather or other unfavorable conditions, shall be a cause for the acceptance of any work which does not comply in every respect with the contract and specifications.

24. PARTIAL AND FINAL COMPLETION

- a. The Town shall consider a project to be at partial completion when the following conditions have been satisfied.
 1. All water and sewer infrastructure has been installed and tested to the satisfaction of the Town. This shall include all sewer lateral and water meter pit frames and covers being set to the proper grade. In the case of a phased project, this shall include all of the above water and sewer infrastructure which has been installed and tested to the satisfaction of the Town that is essential for the satisfactory operation of the water and sewer infrastructure within the current phase.
 2. All stormwater pipe and associated structures have been installed to the satisfaction of the Town and the Conservation District. This shall include any stormwater pond(s) and swale(s). In the case of a phased project, this shall include all of the above which are necessary for the operation of the infrastructure within the current phase.
 3. The installation of all curbing (if required) and base coat of hot mix asphalt to the satisfaction of the Town. In the case of a phased project, this shall include all of the above within, and to the full extent of the current phase, as

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described on the approved construction documents.

4. The installation of all street signage within the current phase.
 5. The Town shall inspect each of the above items and generate a punch list. The Contractor shall contact the Town when all the items on the punch list have been addressed. The Town will then re-inspect the above items. After the reinspection, the Town will either re-issue a punch list or declare that all of the above items have been satisfactorily complete.
 6. The Owner shall submit a maintenance bond to the Town after the project, or the current phase of the project has been partially accepted by the Town. The bond shall be equivalent to 10% of the material and installation costs of all items included in number 1 through 4 above. The Owner shall substantiate the amount of the bonds by submitting an itemized breakdown, or invoices, provided by the Contractor. The term of the bond shall be one (1) year from the date of its acceptance by the Town.
 7. No certificate of occupancy shall be issued until a project, or the current phase of a project, has been partially accepted by the Town, and until a maintenance bond has been submitted.
- b. The Town shall consider a project to be at final completion when the project has previously been deemed partially complete and:
1. All top coat of hot mix asphalt has been installed to the satisfaction of the Town. In the case of a phased project, this shall include all of the top coat of hot mix asphalt within and to the full extent of the current phase (or phases) as shown on the approved construction documents.
- Note: No hot mix asphalt top coat shall be installed until 75% of the housing structures planned for the entire project have been completed.
2. All utilities proposed for the project have been installed and the entire site has been graded and stabilized to the satisfaction of the Town and the Conservation District. In the case of a phased project, this shall include all of the above within and to the full extent of the current phase (or phases).
 3. Submission and approval of the record ("as-built") drawings as described within Item 39 of these General Conditions. In the case of a phased project, the record drawings shall include all required items within the area being considered for final completion.

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4. The Town shall inspect the items above. The Town shall generate a punch list which shall detail deficiencies in any of the above items, including any deficiencies which may exist in items associated with partial acceptance, provided the maintenance bond submitted at the time has not expired. The Owner/Contractor shall contact the Town when all items on the punch list have been addressed. The Town will then re-inspect the above items. After the re-inspection the Town will either re-issue a punch list or deem that all of the above items have been satisfactorily completed.
5. The Owner shall submit a maintenance bond to the Town after the project, or current phase of the project has been fully accepted by the Town. The amount of the bond shall be 10% of the costs for the materials and installation of the top coat of asphalt. The Owner shall substantiate the amount of the bond by submitting an itemized cost breakdown, or invoices, provided by the Contractor. The term of the bond shall be one (1) year from the date of its acceptance by the Town.

25. TERMINATION OF MAINTENANCE PERIOD(S)

- a. It shall be the Contractor's responsibility to notify the Town prior to the termination of any one (1) year maintenance period.
- b. Upon being notified that any maintenance period is near the termination point, the Town shall perform an inspection of the items for which the bond may apply. The Town shall, if necessary, generate a punch list and provide a copy to the Contractor. When all items are acceptable to the Town, the maintenance bond, or its unused portion, shall be surrendered to the Contractor by the Town.

26. UNLIMITED LIABILITY OF CONTRACTOR

It is understood and agreed that any and all of the duties, liabilities and/or obligations imposed upon or assumed by the Contractor by or under these specifications, shall be taken and construed to be cumulative, and that the mention of any specific duty, liability or obligation imposed upon or assumed by the Contractor under these specifications shall not be taken or construed as a limitation or restriction upon any or all of the other duties, liabilities and/or obligations imposed upon or assumed by the Contractor.

27. WORK HOURS

Work is permitted between the hours of 7:00 a.m. and 7:00 p.m., Monday through Friday and between the hours of 8:00 a.m. and 4:00 p.m. on Saturdays. Written permission from the Town is required prior to performing work outside of these limits.

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28. LEGAL HOLIDAYS

- a. The Contractor will not be permitted to work on Sundays or days which are legal holidays in the state of Delaware, except in cases of emergency. An emergency is defined as "any occurrence or set of circumstances involving actual or imminent physical trauma or property damage demanding immediate attention," as taken from town code.
- b. In case he desires to work upon any Sunday or legal holidays, he shall notify the Owner in writing at least two (2) days in advance of such Sunday or holiday that he desires to work, stating the place where the said work will be conducted.

29. GUARANTEE

The Contractor hereby guarantees all of the work for a period of one (1) year after the date of partial and final acceptance thereof by the Owner as follows:

- a. Against all faulty materials and against all imperfect, careless, and unskilled workmanship.
- b. That the entire equipment and each and every part thereof shall operate (with proper care and attention) in a satisfactory and efficient manner, and in accordance with the requirements of the construction documents and the specifications contained herein.
- c. The Contractor agrees to replace, with proper workmanship and materials, and to reconstruct, correct, or repair, without cost to the Owner, work which is improper, imperfect, does not operate in a satisfactory manner, or fails to perform as specified, or all of these.
- d. The guarantee obligations assumed by the Contractor under these documents shall not be held or taken to be in any way impaired because of any specification errors, indication or approval by or on behalf of the Owner of articles, materials, means, combinations or things used in the construction, performance and completion of the work or any part thereof, or all of these.
- e. No use acceptance by the Owner of the work or any part thereof, nor any failure to use the same, nor any repairs, adjustments, replacements or corrections made by the Owner due to the Contractor's failure to comply with his obligations under the contract documents, shall impair in any way the guarantee obligations assumed by the Contractor under these documents.
- f. A maintenance bond shall be required by the Town. See Item 24, Partial and Final Completion.

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30. SHOP DRAWINGS

- a. The Contractor shall furnish shop drawings for any fabricated construction materials required for the work, unless otherwise directed by the Engineer. Furnish six (6) copies of each shop drawing for Engineer's approval. The Contractor shall not order materials until receiving shop drawing approval.
- b. Regardless of corrections made in or approval given to shop drawings by the Engineer, the Contractor will nevertheless be responsible for the accuracy of such drawings and for their conformity to the plans and specifications, unless he notifies the Engineer in writing of any deviation at the time he furnishes such drawings. Only drawings bearing the approval stamp of the Engineer shall be used for ordering materials or for construction.

31. SCHEDULE OF CONSTRUCTION

The Contractor shall complete the installation of utilities according to a schedule of construction as submitted by the Contractor and approved by the Owner. Submit three copies for approval.

32. TOWN ELECTRIC UTILITY INSTALLATION

- a. The Town Electric Department will install the electric utilities, except that all conduit for street crossings shall be installed by the Developer. The cost of the electric utility installation shall be paid by the Developer.
- b. The electric utilities shall not be installed until the following have been completed:
 1. Curbing and stone sub-base shall be installed in the roadways within the project, or within the current phase of the project.
 2. The site has been graded to within six (6) inches of final grade ten (10) feet beyond and including the right-of-way and in all other locations where electric utilities may be installed.
 3. All property corners and proposed locations of electric utility equipment shall be staked out by the Developer.

33. ISSUANCE OF BUILDING PERMIT(S)

No building permit shall be issued until the curbing, where applicable, and stone sub-base have been installed within the project, or within the current phase of the project.

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34. ISSUANCE OF CERTIFICATE(S) OF OCCUPANCY

No certificate(s) of occupancy (CO) shall be issued until the project or the current phase of a project has received acceptance of partial completion from the Town. See Item 24 of this section. The Town shall also perform an inspection of the site at the time of the request for a CO. The Developer/Contractor shall be required to repair any damage to curb, sidewalk, sewer lateral cleanouts, water meter pits, and the frames and covers of the latter. The specific site grading shall be required to be complete and free of any ponding areas. All utility pedestals, transformers, and frames and covers shall be set to the proper grade.

35. PAYMENT FOR RESIDENT PROJECT REPRESENTATIVE (RPR)

Fees for RPR inspection shall be paid by the Developer/Contractor. Contact the Town for details concerning RPR inspection fees prior to commencing construction.

36. LOCATION OF EXISTING UTILITIES

- a. The Contractor shall contact "Miss Utility" at (800) 282-8555 at least 48-hours prior to digging in the vicinity of existing underground utilities, to have utilities located and marked. It shall then be the Contractor's responsibility to verify these utilities, by test pits, a minimum of fifteen (15) days in advance of actual construction operations in the vicinity of the utilities.
- b. The failure to show on the contract documents any existing utilities shall not relieve the Contractor of his responsibilities of determining the location of these utilities, and any damage to the utilities or interruption of service shall be repaired by the Contractor according to the town or utility company specifications. The Owner shall be notified of any damage to any utilities.

37. WATER SUPPLY

The Contractor shall at his own cost provide such quantities of clean water as may be required for any and all purposes under the contract. He shall supply sufficient drinking water to all his employees.

38. RECORD ("AS-BUILT") DRAWINGS

The Contractor shall keep one copy of the contract documents at the site in good order, and provide mark-up to show all changes made during construction. These mark-up drawings shall be available to the Owner upon request. Upon completion of the project, the Contractor shall submit a complete set of record drawings. The record drawings must also be submitted as an electronic file. The electronic file shall be in AutoCAD format (version 2004 or older). The record drawings and file shall contain any information below that is applicable:

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- ☐ A written and graphic scale. Scale shall be sufficient to show detail.
- ☐ A prominent north arrow shall be drawn on every sheet.
- ☐ A description of the bearing reference system shall be stated on the cover sheet.
- ☐ All monuments, found or set shall be shown and described on the plan.
- ☐ All physical evidence along a boundary line, including fences, walls or buildings.
- ☐ Identify all public and private right-of-ways, including widths.
- ☐ Locate all permanent improvements including, but not limited to:
 - Water mains, valves, bends, fire hydrants, meter pits, pipe and valve sizes, capped stubs, and blow-off valves.
 - Sewer mains, manholes, cleanouts, air release valves, manhole invert elevations, manhole rim elevations, and pipe sizes (including laterals).
 - Storm sewer pipe and size, catch basins, manholes, invert elevations, and grate and/or manhole rim elevations.
- ☐ Location of all signage on the property.
- ☐ Location of all sidewalks and curb cuts.
- ☐ Location of all dumpster pads, including information on screening.
- ☐ Location of any satellite and/or tower equipment.
- ☐ Location of any electric transformers.
- ☐ Location of any meter boxes.
- ☐ Location of any secondary electric boxes.
- ☐ Location of any utility poles on site.
- ☐ Location of any underground equipment, including private irrigation service.
- ☐ Location of any free standing lighting.
- ☐ Location of any gas lines.
- ☐ Location and as-built survey of all storm water management ponds and structures, including swales and direction of flow.
- ☐ Location of turn-off valve for gas line.
- ☐ Location of bus shelter(s), including proposed advertising located on structure wall(s).
- ☐ Identify all utility and/or drainage easements provided to the Town.
- ☐ Identify the location of all landscaping in the area of Town utilities.
- ☐ Label all open space, including any recreation equipment.
- ☐ Location of any telephone utility improvements.
- ☐ Location of any cable utility improvements.

The record drawings shall be reviewed by the Town and the Contractor shall be informed as to whether they are acceptable within ten (10) working days.

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1.01 GENERAL

- A. The Contractor shall perform all excavation, backfilling, grubbing and grading required for construction and installation of pipelines, structures and appurtenances. Excavation shall include removal of pavement, concrete, rock, earth and debris, regardless of character. Trenches and excavations shall be sheeted, shored and braced by the Contractor, as necessary to allow construction and provide safe working conditions. Additionally, the Contractor shall be responsible for maintaining a dry excavation by dewatering. He shall also locate, support and protect existing utilities and structures encountered in the work, provide traffic control, dispose of surplus and unsuitable excavated materials and restore backfilled areas to original condition or as required by the respective contract drawings and specifications. All backfilled and restored areas shall be maintained by the Contractor, in a proper condition, for the duration of the project.
- B. The Contractor is responsible for direct or indirect damage to existing structures, pipelines, conduits, poles, wires of every description in the vicinity of his work whether above or below ground, or that may be encountered in trench or structure excavation. This responsibility shall include the cost of protection by sheeting, bracing, hand excavation, when warranted, and the expense to repair or replace any existing facility damaged directly or indirectly by construction activities, whether such facility is or is not shown on the drawings.
- C. The Contractor shall verify the location size and elevations of all existing utilities at the various points of connection and/or crossings prior to starting any work. Any discrepancies in locations or inverts shall be brought to the attention of the Engineer or the Owner in order that the designs may be adjusted accordingly. Damages suffered or additional costs incurred by the Contractor, as a result of his failure to conform to the requirements of this paragraph, shall be the sole responsibility of the Contractor. Connections to existing utilities shall be made by the Contractor at such a time and in such a manner as the Engineer or Owner may direct.
- D. Excavation and backfill, within an area where a state agency has jurisdiction, shall be done in accordance with requirements and provisions of the permits issued by the agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these specifications.

1.02 PIPELINE TRENCH EXCAVATION

- A. The Contractor shall excavate, maintain and backfill all excavation necessary for completing the work under the contract. Unless otherwise specified or approved,

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excavation shall be open cut.

- B. Trenches shall be excavated to the necessary width and depth, as shown on the drawings and as required for the safe installation of the utility, etc.
- C. The sides of the trenches shall be practically plumb and shall not be sloped unless approved in writing by the Engineer. Trench sides shall be supported or sheeted as required to protect pavement surfaces, curbing, utilities, etc., and required for safety. Safety regulations shall be as required by State safety codes and OSHA.
- D. In paved areas, the Contractor shall remove the paving only as necessary for the excavation of the trench or as detailed. Pavement edges at the trench shall be saw cut neat and straight prior to the start of any excavation. Should the pavement damage result from cave-ins, settlement, etc., he shall replace such paving at his own expense.
- E. The excavation of all trenches shall be fully completed at least twenty (20) feet in advance of pipe laying, unless otherwise authorized or directed. The Engineer or Owner may require the backfilling of open trench, over completed pipelines, or ahead of the pipe laying operation, if in his judgement, such action is necessary.
- F. Should work be stopped for any reason and any excavation is left open for an unreasonable length of time, the Contractor shall refill the excavation at his own expense if so directed, and shall not reopen the excavation until he is ready to complete the facility. Should the Contractor refuse or fail to refill any excavation completely within eight (8) hours after a proper notice, the Owner shall be authorized to do the work and expenses resulting shall be paid by the Contractor.
- G. The Contractor shall complete excavation as nearly as practicable to the lines of the utility to be installed as detailed. All cavities in the bottom of the trench shall be filled to the required level with compacted crushed stone or gravel.
- H. Excavated materials shall be graded, hauled, stored and protected as such material found suitable will be required for backfilling, repaving or other purposes. Material classified as unsuitable shall be disposed of by the Contractor.
- I. Excavated materials shall not be placed on private property, unless written permission is obtained from the property Owner.
- J. The Contractor shall be responsible for any damage to curb, gutter, sidewalk, traffic control devices, pavement material. Any damage resulting directly or indirectly shall be replaced in kind by the Contractor. The reuse of disturbed curb, gutter or sidewalk

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is prohibited. New sections shall be installed to the nearest undisturbed control joint.

1.03 PIPELINE TRENCH BACKFILL

- A. Materials excavated from the trench shall be used for trench backfill, provided that, in the opinion of the Engineer or Owner, the excavated material is suitable for this purpose. Backfill material shall be free from large lumps and stones having any dimension greater than two (2)-inches.
- B. Suitable material, as approved by the Engineer, shall be carefully deposited in the trench by methods which will not damage or disturb the pipe or structure. Backfill material shall be placed in eight (8)-inch loose layers. Care shall be taken in the use of mechanical tampers not to injure or move the pipe or to cause the pipe to be supported unevenly.
- C. All backfill material shall be compacted to 95% of maximum density between minus two (2) to plus two (2) percent of optimum moisture content as determined by the Modified Proctor Test, ASTM D1557. Materials containing an excess of moisture shall be permitted to dry until the moisture content is within the specified range. Materials too dry shall be wetted uniformly until the moisture content is in the specified range.
- D. No compacting shall be done when the material is too wet to be compacted properly. At such times the work shall be suspended until the backfill materials have dried out sufficiently to, permit proper compaction or such other precautions shall be taken as may be necessary to obtain proper compaction. The Contractor is responsible for hauling, storing and drying of excavated material to be used in backfill operations.
- E. The Engineer may request compaction tests of the backfilled trenches at any time during construction or upon completion of the backfill operations. Such testing shall be arranged by the Contractor and performed by an independent testing agency approved by the Engineer. The Contractor shall pay the testing laboratory for all tests performed inclusive of sample collection, preparation and transportation. If the results of any tests show that backfills do not meet the specified compaction, the Contractor shall, at his own expense, correct the condition as directed by the Engineer.
- F. The Contractor shall, at his own expense, maintain all refilled excavations in proper condition. Trench surfaces shall be reshaped when necessary. If the Contractor fails to make repairs within forty-eight (48) hours after receipt of written notice from the Owner, the Owner may refill said depression wherever necessary and the cost of so doing will be paid by the Contractor. The Contractor shall be responsible for any

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injury or damage that may result from lack of maintenance of any refilled excavation at any time prior to final acceptance.

- G. All unauthorized excavations made by the Contractor shall be immediately backfilled in accordance with the requirements of the specifications for trench backfill, at the Contractor's expense.
- H. After completion of backfilling, all material not used, shall be disposed of, and all places on the line of the work shall be left clean and in good condition. This cleaning up shall be done by the Contractor. If he fails to do this work within a reasonable time after receipt of notice, it will be performed by the Owner, and the cost will be assessed to the Contractor.
- I. No backfill shall be placed against new concrete or masonry structures until properly cured. In the case of concrete, test reports must indicate that a 2500 psi compressive strength exists.
- J. The Contractor shall exercise caution in backfill and compaction to prevent damage to structures.

1.04 EXCAVATION BELOW SUBGRADE AND GRAVEL REFILL

Materials below the excavation limit for pipelines and structures (below subgrade) , which in the judgement of the Engineer or Owner should be removed, shall be removed as directed. All spaces created by the removal of unsuitable material below subgrade, shall be refilled and compacted with crushed stone or gravel.

1.05 DEWATERING

- A. All excavations below the subgrade of the work, must be kept free of water while work is in progress. This may be accomplished by ordinary pumping methods or by well points, whichever will produce the required results. Upon removal of dewatering equipment, the Contractor shall backfill all holes and restore disturbed areas to their original condition.
- B. Dewatering for the structures and pipelines shall commence when groundwater is first encountered and shall be continued until such time as backfill has been completed. No concrete footings shall be laid in water nor shall water be allowed to rise over them until the concrete or mortar has set at least eight (8) hours. Groundwater shall not be allowed to rise around the pipe until the trench is backfilled.

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- C. The Contractor shall dispose of the water from the work in a suitable manner without damage to adjacent property. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be disposed of in such a manner as not to be a menace to the public health.
- D. The Contractor shall remove any siltation deposits in storm sewer systems, resulting from his dewatering or construction operations. He shall also be responsible for conveyance of dewatering flows and for erosion and sediment control.

1.06 SHEETING, SHORING AND BRACING

- A. The Contractor shall furnish and install all sheeting, shoring and bracing necessary to insure safe working conditions and to prevent damage to public and private property and structures. If, in the opinion of the Engineer, the sheeting, shoring, or bracing is not of proper quality or is not properly placed to insure safe working conditions and to prevent property damage, the Contractor shall remedy such inadequacy at his own expense as may be directed by the Engineer. Sheeting, shoring, and bracing shall be removed as backfilling progresses, except at such locations as the Engineer may direct or approve it to be left in place.
- B. The Contractor shall cut off any sheeting left in place, at least eighteen (18)-inches below finished grade, and shall remove the material cut off without compensation.
- C. Where necessary for the protection of any structure of property, sheeting shall be driven to such depth below the bottom of the trench as may be required to protect all existing and/or proposed work.
- D. A trench box is an acceptable alternative to sheeting, shoring or bracing, providing, such boxes conform to safety codes in effect for the project.

1.07 SELECT BACKFILL

- A. Should the Contractor encounter unsuitable material during excavation, he shall remove and dispose of such material.
- B. Should sufficient suitable material from excavations of the project not be available for backfill, the Contractor shall furnish Select Backfill upon approval of the Engineer. Special backfill shall conform to Delaware Department of Transportation Type "c" borrow.
- C. The Contractor shall furnish certification that his borrow is from a Delaware DOT approved source.

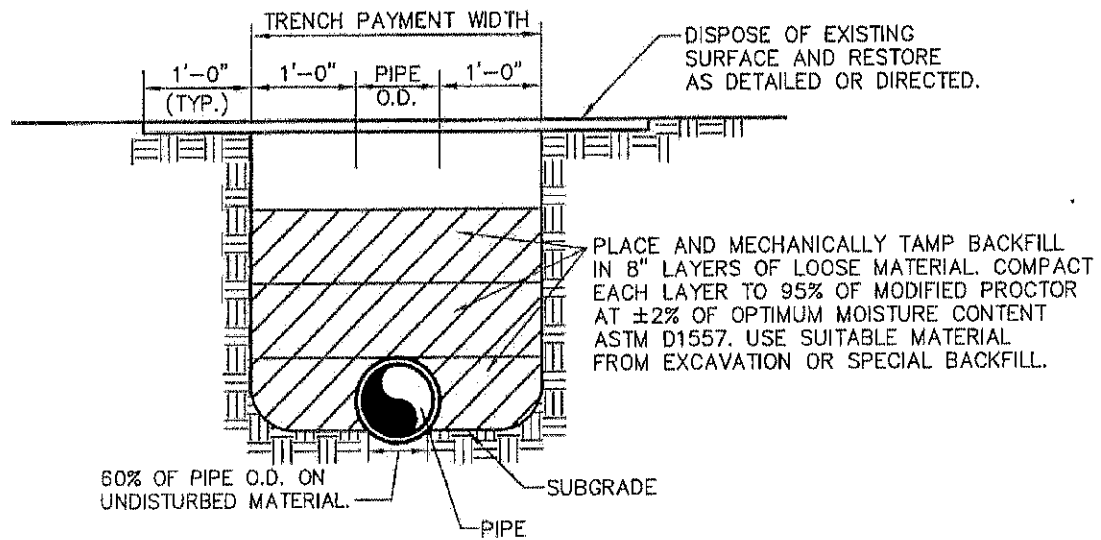
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1.08 TEMPORARY REPAVING

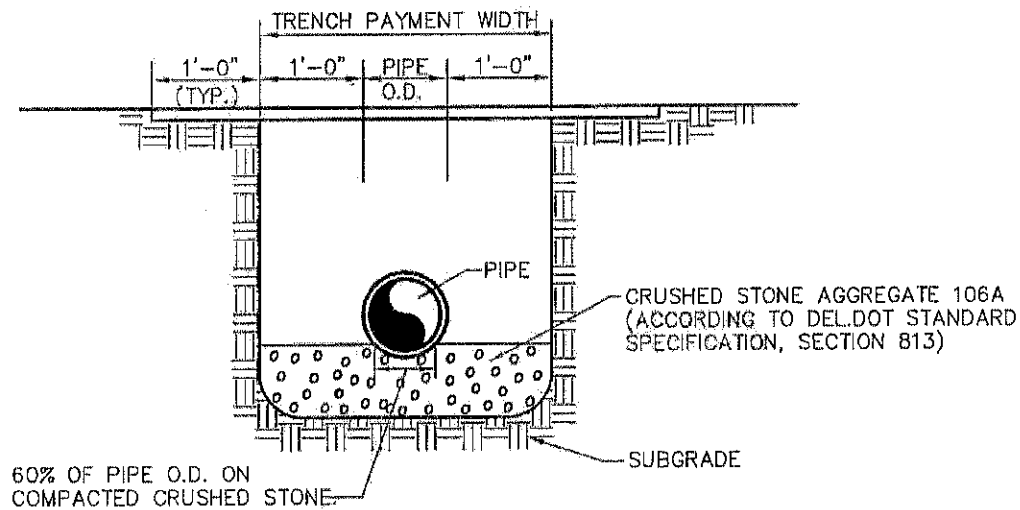
- A. The Contractor shall furnish, place and compact two (2)-inches of cold patch as temporary pavement surface over all backfill areas created for pipeline and structure installation located in roadways or driveways. This surface shall be maintained by the Contractor until permanent surface restoration has been performed.
- B. Should the Contractor remove existing pavement beyond the width specified or detailed on the plans, or should pavement be disturbed from settlement, slides or other construction activities, he shall saw cut back the pavement and provide temporary paving in these areas.
- C. On state highways and all other areas over which the Delaware Department of Transportation exercises jurisdiction, all pavement restoration shall be done in accordance with the permit requirements of the Division of Highways.

END OF SECTION

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TRENCH BACKFILL



CRUSHED STONE BEDDING

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		TRENCH BACKFILL & PIPE BEDDING DETAIL NO SCALE
SECTION - 1		DRAWING: D1-1'

2.01 GENERAL

The Contractor shall furnish and install all water mains, valves, hydrants, fittings, corporation stops, house service piping and appurtenances as specified herein and as defined on the drawings or as directed by the Engineer. Provide all necessary adaptors for connection to existing mains. The Contractor is given the option of using ductile iron or PVC pipe. PVC pipe shall not be permitted for hydrant leads or inside of railroad steel crossing sleeves.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51, latest edition, and shall be thickness Class 50 in streets and inside highway sleeves and Class 56 under railroads unless otherwise noted. The Contractor shall have the option of furnishing mechanical or push-on joints conforming to latest edition of ANSI/AWWA C111/A21.11.
- B. Pipe and fittings shall have an external standard asphaltic coating approximately one (1) mil thick.
- C. Pipe and fittings shall have an internal cement lining in accordance with latest revision of ANSI/AWWA C104/A21.4. No bituminous coating shall be used on the inside of pipe and fittings unless prior written approval is obtained from the Delaware Division of Public Health.
- D. All fittings and specials shall be gray-iron or ductile-iron with mechanical joint having a 250 psi pressure rating for gray-iron and 350 psi in the case of the ductile-iron. They shall be marked and manufactured in conformance with ANSI/AWWA C110/A21.10, latest edition. Compact ductile iron fittings will be an acceptable alternate. They shall be mechanical joint with a 350 psi pressure rating conforming to ANSI/AWWA C153/A21.53 and C111/A21.11.

2.03 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE AND FITTINGS

- A. Polyvinyl chloride pipe shall meet the requirements of AWWA C-900. It shall be manufactured in standard length not exceeding twenty (20) feet and have an outside diameter equal to cast iron pipe. PVC pipe shall have standard dimension ratio (DR) of 18.0 or less. The pipe shall be rated for a working pressure of at least 150 psi.
- B. Polyvinyl chloride (PVC) pipe shall be manufactured with an elastometric-gasket joint conforming to ASTM D 3139. Pipe ends shall be beveled.
- C. Fittings for PVC water main shall be cast iron or ductile iron as specified in 2.02.

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- D. The Contractor shall provide all necessary adaptors for connecting PVC pipe to cast iron fittings and valves or other pipe lines. Adaptors shall be as recommended by the pipe manufacturer.
- E. Polyvinyl chloride pipe shall be delivered and stockpiled in unit pallets. Store pipe on flat surface. No stacking of pallets of random lengths above five (5) feet in height will be allowed. If pipe is stockpiled for more than thirty (30) days prior to installation in the trench, it must be suitably covered with reflective materials to protect the pipe from ultraviolet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.
- F. Bowed sections of pipe will not be acceptable and will not be allowed to be installed on this project.

2.04 POLYETHYLENE (PE) PIPE AND FITTINGS (FOR DIRECTIONAL BORES)

- A. PE pipe shall be SDR11 plain end for fusion welding conforming to ASTM F 714 and ASTM D 3035. Minimum pressure rating shall be 160 psi.
- B. Molded fittings will conform to ASTM F 714. End sections of PE piping in directional bore shall have an AWWA C-207 Class D flanged end butt. Fusion welded to PE main. Flange shall be drilled to standard 125 pound tensile.
- C. Terminal end of PE pipe shall be connected to continuing ductile iron or PVC pipe with a flanged expansion joint. The flanged expansion joint shall be a "FlexTend" flexible expansion joint as manufactured by EBAA, or approved equal.

2.05 BORING AND JACKING OF WATER MAINS

- A. Where possible, an approach trench shall be excavated far enough to provide a jacking face of at least three (3) feet from a pavement surface. This open face shall be shored securely to prevent slipping or raveling of the face.
- B. Boring pits shall be large enough to contain all necessary equipment and tools. Adequate provisions shall be made for the removal of excavated material.
- C. A substantial backstop of heavy timber or steel beams shall be provided to take the thrust of the jack or boring equipment.
- D. As material is excavated or bored ahead of the pipe, the pipe shall be jacked in to follow this excavation. The distance dug ahead of the pipe shall not exceed six (6) inches.

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- E. The installation of casing pipe and the boring or excavation shall be done simultaneously.
- F. Voids between the sleeve and excavation shall be filled by pressure grouting.
- G. Cement grout shall be used to seal the pipe ends between the carrier pipe and sleeve.
- H. A one (1) inch PVC pipe shall be installed in the downgrade seal to permit drainage.
- I. Steel pipe sleeve shall be furnished in random lengths of the diameter shown on the plans and noted in the proposal and shall conform to the requirements of AWWA C-200; Grade B pipe shall be used. The pipe, including field connections, shall be coated with bitumastic compound, inside and outside. Pipe thickness for 18-inch diameter sleeve shall be 0.313 inches. 12-inch diameter sleeves shall be 0.250 inches thick. All joints for casing pipe shall be made by continuous weld completely around the perimeter of the pipe in accordance with AWWA C-206.
- J. Carrier pipe shall be Class 50 ductile iron or polyvinyl choride AWWA C-900 at each location as required by the plans, except at railroad crossing, use Class 56 ductile iron pipe.

2.06 DIRECTIONAL BORE

- A. The system must be remotely steerable and permit electronic monitoring of tunnel depth and location. The system must be able to control the depth and direction of the pipe and must be accurate to a window of +/- 2 inches.
- B. The system must be capable of turning 90 degrees in a 35 foot radius.
- C. The system shall utilize a fluid-cutting process, using a liquid clay such as bentonite. This clay must be total inert and contain no risk to the environment.
- D. Liquid clay shall remain in the tunnel to increase stability of the tunnel and provide a lubricant to reduce frictional drag when the pipe is installed.
- E. Spoils shall be recovered by use of a vacuum system mounted on a vehicle for removal of spoils to an approved spoils site. Spoils shall not be discharged into sewers or storm drains.
- F. The equipment must be capable of completing the boring in a single bore.
- G. Equipment must be fitted with a permanent alarm system capable of detecting an electrical current. The system will have an audible alarm to warn the operator when

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the drill head nears electrified cables.

2.07 GATE VALVES AND BOXES

- A. Gate valves shall be resilient seat type, in accordance with AWWA C509. Valve bodies and bonnets shall be cast iron epoxy coated on the inside per AWWA C550.
- B. Stem and wedge nuts shall be bronze. Stems shall be sealed by at least two (2) O-rings. Seals shall be replaceable with the valve fully open and while subject to the rated pressure.
- C. Wedge shall be constructed of ductile iron, fully encapsulated in synthetic rubber, except for guide and wedge nut areas or it shall have a replaceable, internally reinforced, contoured molded rubber disc seat ring attached to the face of the wedge with self-locking, stainless steel screws. Wedge rubber shall be molded in place and bonded to the ductile iron portion. Wedge shall seat against accurately formed seating surfaces in the valve body.
- D. Waterway shall be smooth and shall have no depressions or cavities in seat area where foreign material can lodge and prevent closure or seating.
- E. Gate valves shall be manufactured by Waterous Company or Mueller.
- F. Provide each gate with a 5 1/4-inch diameter Buffalo screw type valve box with "Water" cast in the lids. All boxes for 4, 6, and 8-inch valves shall be equipped with #6 round base. 10-inch valves shall be used with #8 valve box base. Valve boxes shall be adjustable between 2'-4" and 3'-4" except when deeper settings are required. Lids shall be extra deep and have two holes for removal of lid. Valve boxes shall be as manufactured by Mueller, or approved equal.
- G. Provide socket valve operating wrenches.

2.08 TAPPING SLEEVE AND VALVE

- A. Tapping sleeve shall be of all stainless steel construction including sleeve, bolts and nuts. Sleeves shall wrap 360° around the pipe with gridded full circumference gasket. Units shall be FAST Model by Ford Meter Box Company.
- B. Tapping valves shall be cast iron, Clow Number F6114.
- C. Install tapping sleeve and valve per manufacturer's recommendations.

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2.09 FIRE HYDRANTS

- A. Fire hydrants shall be per Town of Greenwood Standards. Hydrants shall be compression type with a 5 1/4- inch main valve opening, two 2 1/2-inch hose nozzles, one 4 1/2-inch pumper nozzle, and a 6-inch mechanical joint hub base. Hydrant seats shall be provided with bronze to bronze threaded connections.
- B. All nozzle and steamer threads shall conform to National Standard. Hydrants shall be of proper length for a 4-foot trench depth or as required by field conditions and be Mueller Model A-442 Modern Centurian, Kennedy K-81D Guardian, or equal. They shall meet requirements of AWWA Standard C-502.
- C. A sworn certificate of inspection and testing shall be furnished by the manufacturer. Install hydrants with restraint system as detailed on the drawings, or with a hydrant tee.
- D. All hydrants to be furnished with non-kinking chains on the 2 1/2- inch nozzles.
- E. Hydrants shall open by turning the operating nut counter-clockwise.
- F. Fire hydrants to receive one (1) coat of primer and two (2) coats of chrome yellow paint in accordance with Federal Standard 595A. The final coat shall be field applied after the hydrant has been installed. The color of the hydrant tops to be determined by pressure test. Coordinate with the Town of Greenwood.
- G. Provide hydrant operating wrenches and repair kits.

2.10 LAYING WATER MAINS, FITTINGS AND APPURTENANCES

- A. Water main pipe, fittings, and valves shall be installed per manufacturer's printed instructions. Care shall be taken to insure that no joints are made with unevenness or rough edges. Pipeline deflection must be kept below the manufacturer's limitations.
- B. All pipes shall be bedded on a solid foundation prior to backfilling. Defects due to settlement shall be corrected by the Contractor at his own expense. Bell holes shall be dug sufficiently large to receive same.
- C. Pipe and fittings shall be kept clean until final acceptance of the work. All open pipe ends shall be provided with plugs to keep dirt, water and other materials from entering. This plug shall be kept in place when actual pipe laying is not in progress.

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- D. Excavation and backfill for water mains and appurtenances shall be per Section 1 of these specifications.
- E. PVC pipe shall be beveled before making pipe joint.
- F. Install no pipe on frozen or frost penetrated subgrade. When directed, the Contractor shall install pipe on artificial foundations. Such foundation may consist of gravel or concrete and shall be to the dimensions and in the manner directed by the Engineer.
- G. Pipeline detectable tape shall be installed continuously along all PVC water mains. The tape shall be installed directly above the water main and twelve (12) inches from the ground surface. The tape shall be Lineguard Type II Detectable Tape as manufactured by Lineguard, Inc., of Wheaton, Illinois, or equal. The tape shall be a minimum of two (2) inches wide, blue in color, imprinted with the words "CAUTION--WATER LINE BELOW," and be capable of being detected with inductive methods.
- H. All concrete required to construct buttresses behind plugs, tees, bends and other fittings and anchorages beneath vertical bends shall be placed as directed and/or as shown on the details.

2.11 INSTALLING FITTINGS, HYDRANTS, GATE VALVES AND VALVE BOXES

- A. Fittings, hydrants, gate valves and valve boxes shall be placed along the water mains at the locations indicated on the drawings or where otherwise designated by the Engineer.
- B. A valve box shall be carefully placed over the bonnet of each gate valve with the top at the finished surface of the street, sidewalk or at such other elevation as the Engineer shall direct. It shall be set exactly plumb. In tamping the backfill around the box, special care shall be taken to keep the box plumb and to have it firmly supported on two, 4-inch thick solid concrete blocks so as to avoid settlement. Any box which is found out of plumb, or which is not firmly supported, shall be excavated and reset in a satisfactory manner, at the Contractor's expense. Place gravel in and around valve box bases to provide for drainage.
- C. Ductile iron pipe with cast iron or ductile iron fittings shall be used exclusively throughout the hydrant assembly. The use of polyvinyl chloride pipe will not be permitted in construction of any portion of the hydrant leads.

2.12 DISINFECTION OF WATER MAINS

- A. Upon completion of water main construction, disinfect main and appurtenances.

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Disinfection shall be done in accordance with ANSI/AWWA C-601, latest edition. Contractor shall submit a plan of disinfection for approval by the Engineer.

- B. After the applicable retention period, the heavily chlorinated water shall be flushed from the main. This water shall be discharged to the sanitary sewer system. Only after water leaving the main is no higher in chlorine concentration than normal drinking water, will a discharge to storm drains be allowed. Convey flushed water to discharge point in a closed system.
- C. Affidavits of compliance, certifying the water sampled from the water mains to be free of coliform bacteria, shall be submitted to the Engineer. The Contractor is responsible for requesting tests from the Delaware Department of Public Health. He shall provide written documentation when a section of mains can be placed in service.
- D. The Contractor shall place in each length of pipe, hydrants, hydrant branches, and other appurtenances, a sufficient amount of HTH tablets to insure adequate disinfection treatment of the main after its completion. Tablets shall be fastened to the inside top of every length of pipe as laid, using gasket cement known as "Permatex No. 2".
- E. The Contractor will be held entirely responsible for securing a minimum residual chlorine content of 5 p.p.m. at the extremities of the mains after twenty-four (24) hours or more contact with the full water pressure on the main.
- F. Water for filling the mains shall be introduced at a velocity of less than one (1) foot per second in order to permit the HTH or Perchloron to completely dissolve and have a reasonable uniform distribution throughout the mains. It is the intent of this Specification to require a sufficient amount of chemical to be equivalent to a dosage of 50 p.p.m. of chlorine.
- G. After the chlorine has been in contact with the mains or storage units for twenty-four (24) hours or longer, samples collected from the extremities of the mains shall indicate a residual chlorine content of 5 p.p.m. or more.
- H. If less than 5 p.p.m. residual chlorine is indicated, the system shall be drained and the disinfection treatment repeated.
- I. If samples collected at the extremities indicate a residual chlorine of 5 p.p.m. or more, the system shall be flushed until there is only a normal chlorine residual (1.0 p.p.m. or less) present, as determined by the DPD Method Test. Samples of water shall be collected from various points along the lines, by the State Board of Health for bacteriological analysis. If satisfactory bacteriological results are obtained, the

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lines may then be allowed to be placed in service. A copy of all test results shall be submitted to the Engineer.

2.13 WATER MAIN TESTING

- A. The Contractor shall furnish all equipment, labor and materials, including water, pumps, compressors, stopwatch, gauges, and meters as approved by the Engineer for testing. The Engineer shall determine the amount of main to be tested at anyone time and reserves the right to separate the installation into several test sections. All tests must be witnessed by the Engineer or Owner.

B. Pressure Test

After the pipe has been laid, all newly laid pipe or any valved section thereof, shall be subjected to a hydrostatic pressure of 100 psi.

- 1) Test Pressure shall:
 - a. Be of at least two hour duration.
 - b. Not vary by more than \pm five psi.
- 2) Pressurization:
Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of the lowest point of the line or section under the test and corrected to the elevation of the test gauge shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Owner.
- 3) Air Removal:
Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points, so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, all corporation cocks shall be removed and plugged, or left in place at the discretion of the Owner.
- 4) Examination:
All exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test shall be repaired or replaced with same material and the test shall be repeated until it is satisfactory to the Owner.

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C. Leakage Test

A leakage test shall be conducted concurrently with the pressure test.

1) Leakage Defined:

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or at any valved section thereof, to maintain pressure within five psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

2) Allowable Leakage:

No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{ND \text{ square root of } P}{7400}$$

in which L is the allowable leakage, in gallons per hour; N is the number of joints in the length of pipe line tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test in pounds per square inch gage.

Allowable leakage at various pressure is shown in Table I (appearing after this Subsection).

3) When hydrants are in the test section, the test shall be made against the closed hydrant.

D. Should the tests show the main to be defective, the Contractor shall remedy such defects and retest the main as specified above. This procedure shall be repeated until the test requirements are met.

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TABLE I

Allowable Leakage per 1000 feet of Pipeline* - gph						
Avg. Test Pressure psi	Nominal Pipe Diameter - Inch					
	2	3	4	6	8	10
150	0.19	0.28	0.37	0.55	0.74	0.92
125	0.17	0.25	0.34	0.50	0.67	0.84
100	0.15	0.23	0.30	0.45	0.60	0.75

**For pipe with 18-ft nominal lengths. To obtain the recommended allowable leakage for pipe with 20-ft nominal lengths, multiply the leakage calculated from the table by 0.9. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.*

2.14 SERVICE PIPE AND APPURTENANCES

A. GENERAL

- 1) For all new residential or commercial developments currently not served by the Town of Greenwood, the Contractor is responsible for furnishing and installing all corporation stops, house service pipe, or prefabricated meter setters, covers, valves and appurtenances as indicated on the drawings, and specified herein. Meter setters and lids shall accommodate radio-read.

The Contractor will provide a main tap complete with corp stop for all new residential or commercial developments in areas already served by the Town of Greenwood. The service will be stubbed out to the R.O.W. line from where it becomes the property owner's responsibility.

The meter setters installed by the Contractor shall accommodate the following meters for installation by Owner.

- a. Single family residential hook-ups Hersey 5/8" x 3/4" Model 430.
- b. Multi family, apartment, light commercial hook-up Hersey 1" meter Model 452.
- c. Commercial hook-up 2" Hersey meter Model MVR.

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- 2) The Contractor shall provide all tools, equipment and accessories required for tapping ductile iron and polyvinyl chloride water mains and installing water services. All underground service lines, valves and fittings shall conform to ANSI/AWWA C800-84.
- 3) Detectable tape, approved by the Engineer, shall be placed directly over all water services during backfilling operation, so magnetic detection of service lines may be utilized in the future, by Owner.

B. HOUSE SERVICE

- 1) Standard Water service lines shall be polyethylene, 1-inch diameter, SDR-9 copper tube size unless otherwise shown on the plans. Service lines shall conform to AWWA C901 and ASTM D-2737.
- 2) For tapping ductile iron pipe and PVC pipe use Ford, series FRS202 stainless steel tapping sleeve with one (1)-inch CC thread. Use Teflon tape for threaded service connections. Do not torque saddles or sleeves, without water pressure, in main.
- 3) Corporation stops shall be one (1)-inch, Mueller Model B-25008. Install stainless steel liners at connection to service lines. Liners shall be Mueller Part No. 504385. The Contractor shall furnish and install liners wherever a compression connection is used on plastic service lines.
- 4) Cutting tools shall be of the hollow, shell bit type for removal of pipe plug. For tapping PVC mains, use only Mueller Plastic Cutting Tool. On closely spaced taps for townhouse developments, place corporation stops as recommended by pipe manufacturer. Furnish saddles with standard AWWA corporation stop inlet thread. Saddles shall be Ford stainless steel double strapped type FRS202 or approved equal.
- 5) Prefabricated 18" x 30" PVC meter box assemblies shall be Model PSBH-288-18-36 as manufactured by Ford Meter support shall be by a lateral PVC brace. Check valve shall be Ford HA 31-323 or approved equal. System shall also include an angle ball valve with lock wings. Valve shall be Ford BA13-232W or approved equal. Couplings for connection shall be 3/4" F.I.P. x 1" P/J C.T.S. Ford C-14-34 with stainless inserts or approved equal.
- 6) Cover frames shall be installed in non-traffic areas only. Lids shall be polyids as manufactured by Mid-States Plastics, Inc., model MSIL1, to facilitate electronic reading. Lids shall have the word "Water Meter" cast into the cover and include lifter worm locks. Supply meter box lid wrenches.

DATE: December 2005	WATER MAINS AND APPURTENANCES	
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Contractor shall verify fit and compatibility of assembly components prior to ordering. All assemblies shall be suitable for 5/8" x 3/4" Hersey radio-read meters as furnished, and installed by the Town of Greenwood. Cover frames shall be Ford Model A32.

- 7) Meter pits shall be installed on the front property line, as close as possible to the center of the lot in new construction. A minimum separation distance of ten (10) feet shall be maintained between meter pits and sewer cleanouts, and also water service lines and sewer laterals.

C. COMMERCIAL SERVICE

- 1) All service lines larger than one (1)-inch diameter shall be two (2)-inch Schedule 80 PVC threaded service pipe or two (2)-inch diameter, SDR-9 copper tube size polyethylene tubing.
- 2) For tapping ductile iron and PVC pipe use Ford, series FRS202 stainless steel tapping sleeve with two (2)-inch CC thread. Use Teflon tape for threaded service connections. Do not torque saddles or sleeves, without water pressure, in main.
- 3) Use Mueller two (2)-inch CC thread corporation stop, model B25008.

D. GANG METER PITS (Up to Five (5) Meters)

- 1) All service lines connecting gang meter pits to water mains shall be two (2)-inch schedule 80 PVC threaded service pipe or two (2)-inch diameter, SDR-9 copper tube size polyethylene tubing. The manifold in the pit shall be schedule 80 PVC pipe. The service pipes downstream of the pit shall be P.E. SDR-9, one (1)-inch diameter.
- 2) The gang meter shall be installed in a precast concrete meter pit by Penn-Cast Products, Inc. Model #440 as shown on plan, top section only. The service pipe or tubing has to be installed in a sleeve.
- 3) For tapping ductile iron pipe and PVC pipe use Ford, series FRS202 stainless steel tapping sleeve with two (2)-inch CC thread. Use Teflon tape for threaded service connections. Do not torque saddles or sleeves, without water pressure, in main.
- 4) Corporation stop shall be Mueller two (2)-inch model B-25008 with CC thread, or approved equal.

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- 5) The setting shall be as detailed on the plans. For each meter in the pit use Ford yoke 502P, Ford straight yoke ball valve B91-324, Ford straight yoke check valve HS91-323 and a Ford expansion connection EC-23-W couplings for connecting to service tubing shall be 3/4" M.I.P. x 1" P/J C.T.S., Ford C-84-34.
- 6) Cover shall be Ford MC-36 with twenty (20)-inch lid and thirty-six (36) inch inside diameter.
- 7) Drill 2" hole on house side of pit, 6" below underside of top slab, centered in the wall to accommodate wiring to building for electronic meter readings.
- 8) For gang pits of more than five (5) meters see special Town detail sheet.

E. LAYING SERVICE PIPE AND APPURTENANCES

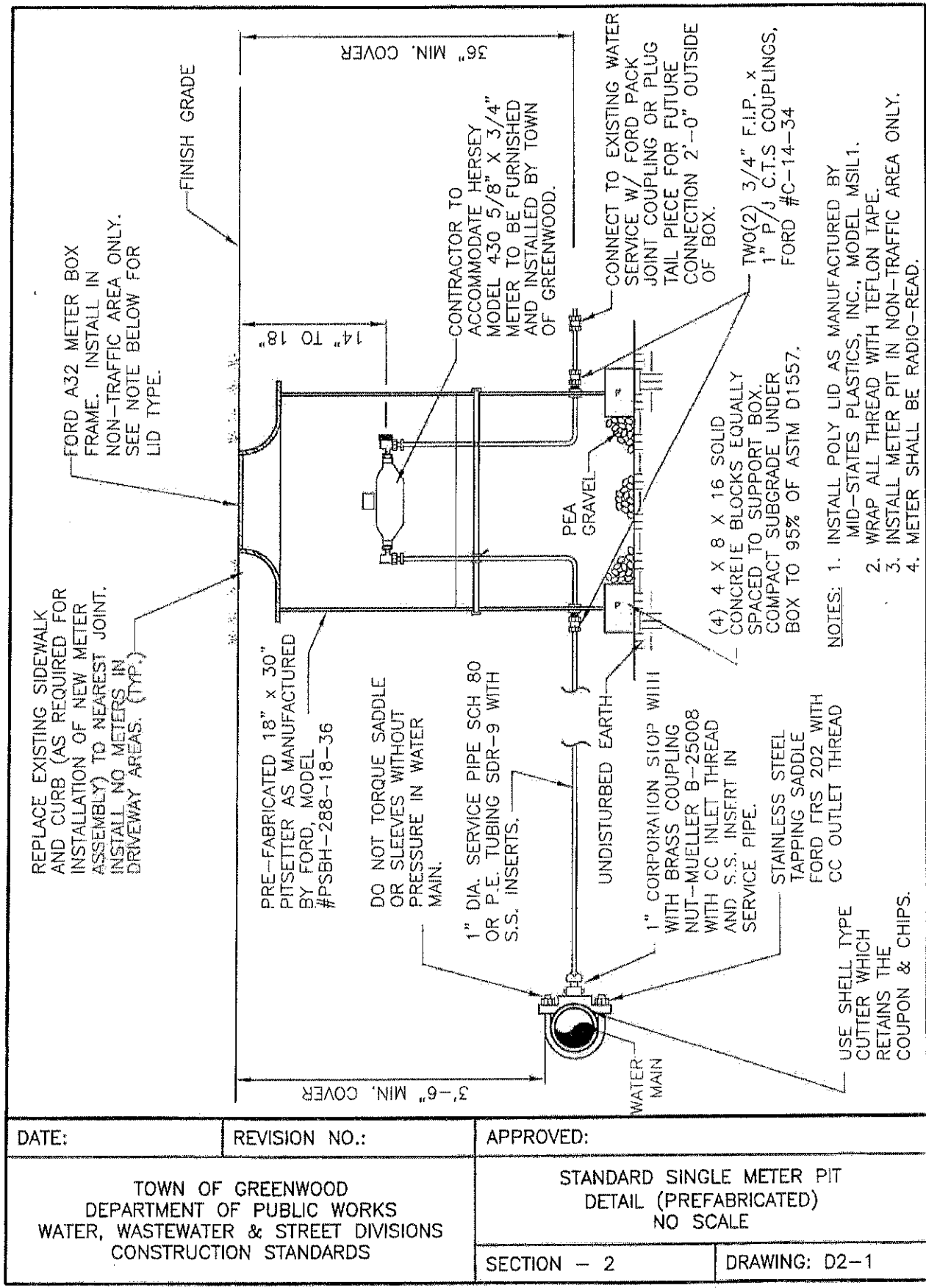
- 1) All service pipe shall be carefully inspected for damaged areas. All damaged pipe shall be cut out and recoupled. Pipe installed during hot weather shall be allowed to contract to normal length before backfilling. Pipes and fittings shall be bedded on a solid foundation.
- 2) Fittings and valves shall be kept clean, handled carefully and installed according to the manufacturer's recommendations.
- 3) All new service lines shall be installed as directed by the Engineer.
- 4) Service lines in streets shall be installed by open cutting or with an underground piercing tool such as an ACCU-punch or equal. Maximum diameter of piercing tool to be 2 1/2-inches. Based on bids received, the Owner may adjust the quantity of the various types of service installation or eliminate the use of the piercing tool as is in his best interest.
- 5) Installation of services by piercing tool shall be performed with all necessary devices to assure alignment accuracy. Such devices shall include a magnetic level, launcher, and aiming frame. The Contractor shall demonstrate installation procedures to the Engineer and the DOT for approval prior to use.
- 6) Service connections and meter boxes shall be installed immediately after the construction of the adjacent main. Postponement after the construction of service lines will not be allowed.
- 7) Requirements for sterilization and pressure testing of service connections shall be the same as specified for mains in this specification.

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- 8) The Contractor is responsible for locating existing services, cutting and reconnect ion with all necessary adaptors or sleeves, within the unit price bid for service lines. The Contractor shall obtain and pay for then services of a licensed plumber if required by code.

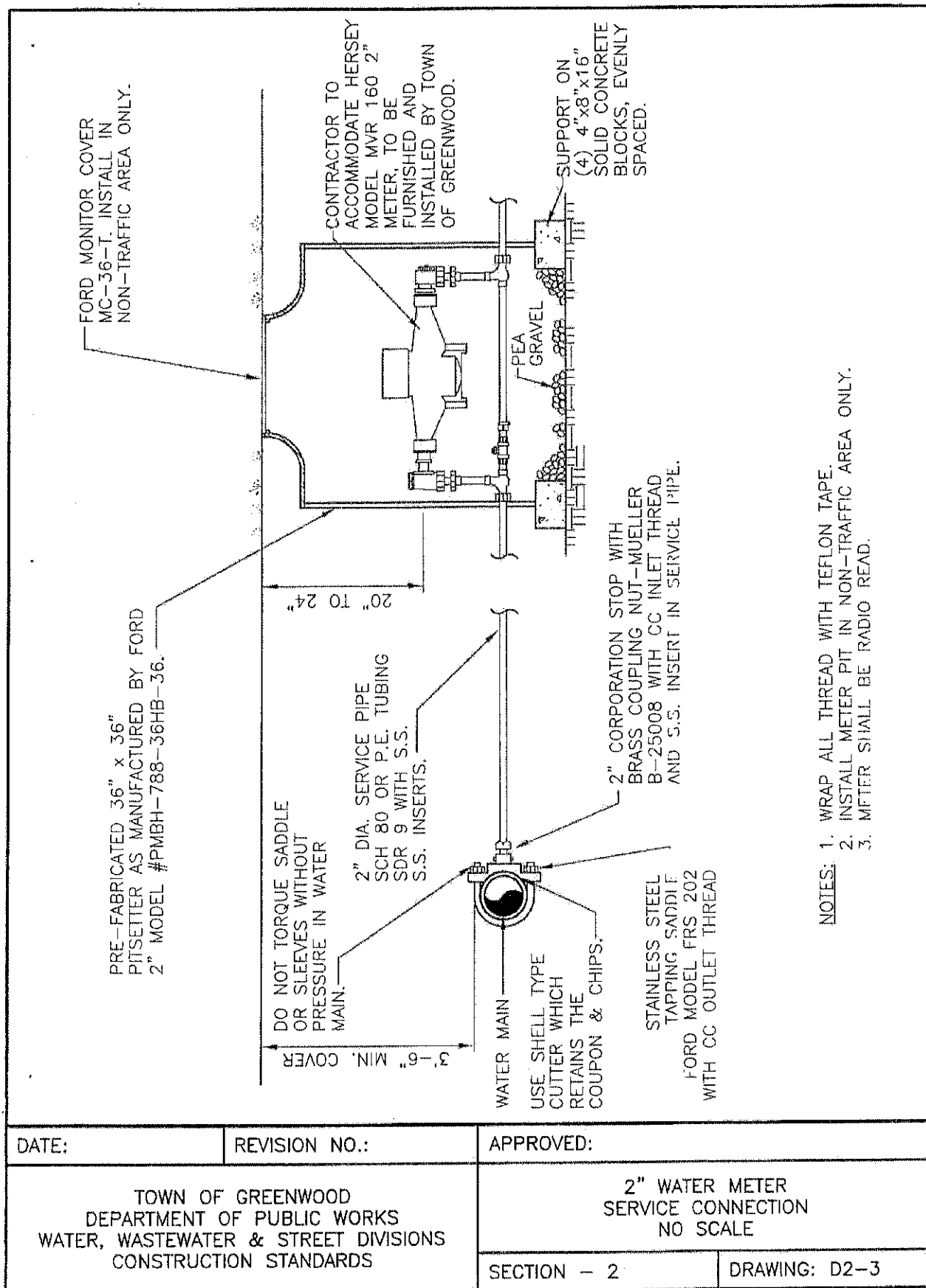
END OF SECTION

DATE: December 2005	WATER MAINS AND APPURTENANCES	
REVISION:	SECTION 2	PAGE : 2-14



- NOTES:
1. INSTALL POLY LID AS MANUFACTURED BY MID-STATES PLASTICS, INC., MODEL MSIL1.
 2. WRAP ALL THREAD WITH TEFLON TAPE.
 3. INSTALL METER PIT IN NON-TRAFFIC AREA ONLY.
 4. METER SHALL BE RADIO-READ.

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		STANDARD SINGLE METER PIT DETAIL (PREFABRICATED) NO SCALE
SECTION - 2		DRAWING: D2-1



DATE:

REVISION NO.:

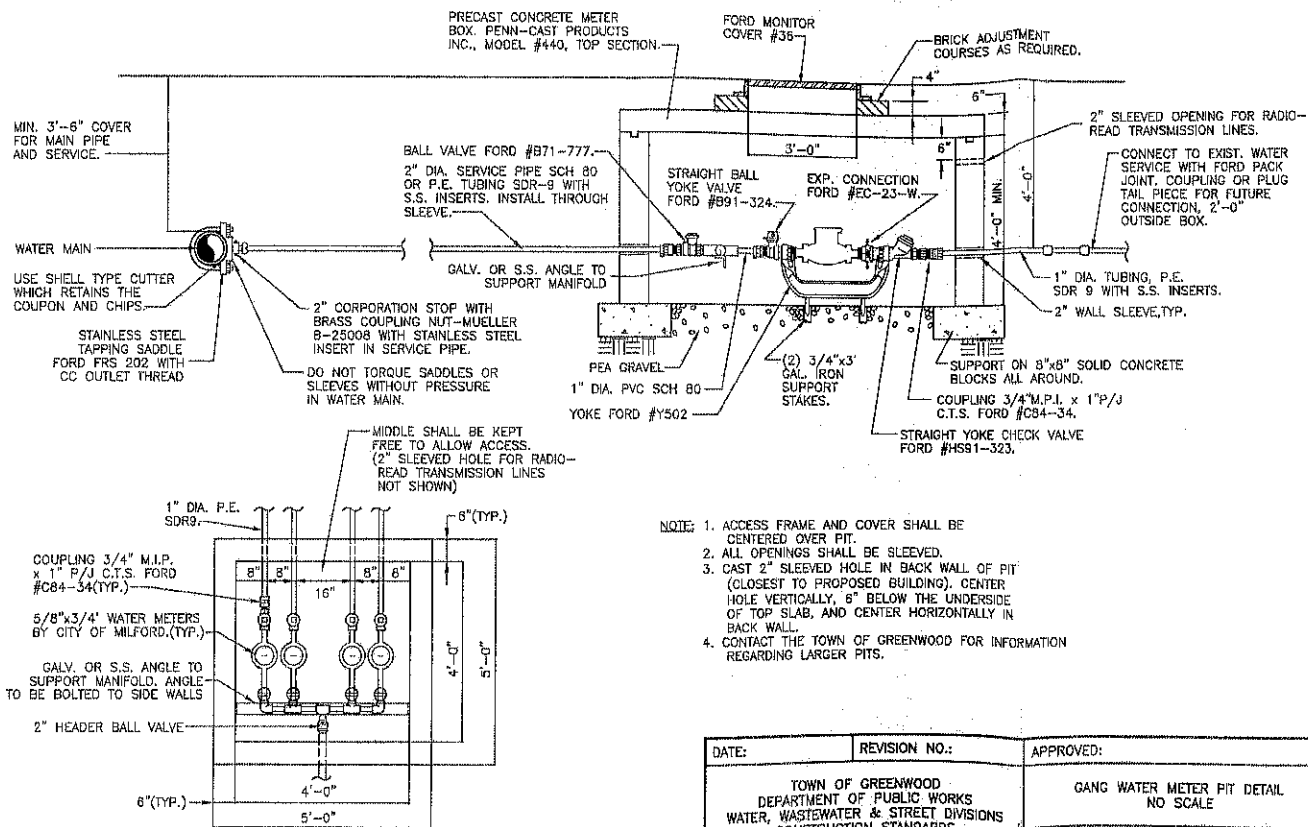
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

2" WATER METER
SERVICE CONNECTION
NO SCALE

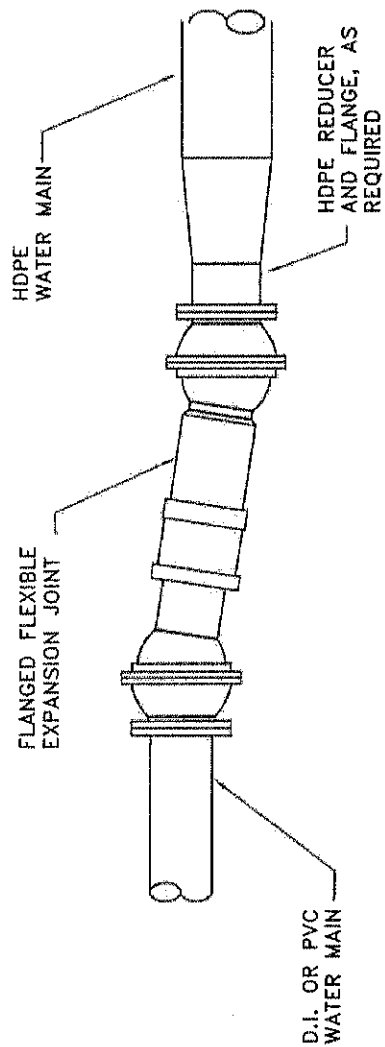
SECTION - 2

DRAWING: D2-3



- NOTE: 1. ACCESS FRAME AND COVER SHALL BE CENTERED OVER PIT.
 2. ALL OPENINGS SHALL BE SLEEVED.
 3. CAST 2" SLEEVED HOLE IN BACK WALL OF PIT (CLOSEST TO PROPOSED BUILDING). CENTER HOLE VERTICALLY, 6" BELOW THE UNDERSIDE OF TOP SLAB, AND CENTER HORIZONTALLY IN BACK WALL.
 4. CONTACT THE TOWN OF GREENWOOD FOR INFORMATION REGARDING LARGER PITS.

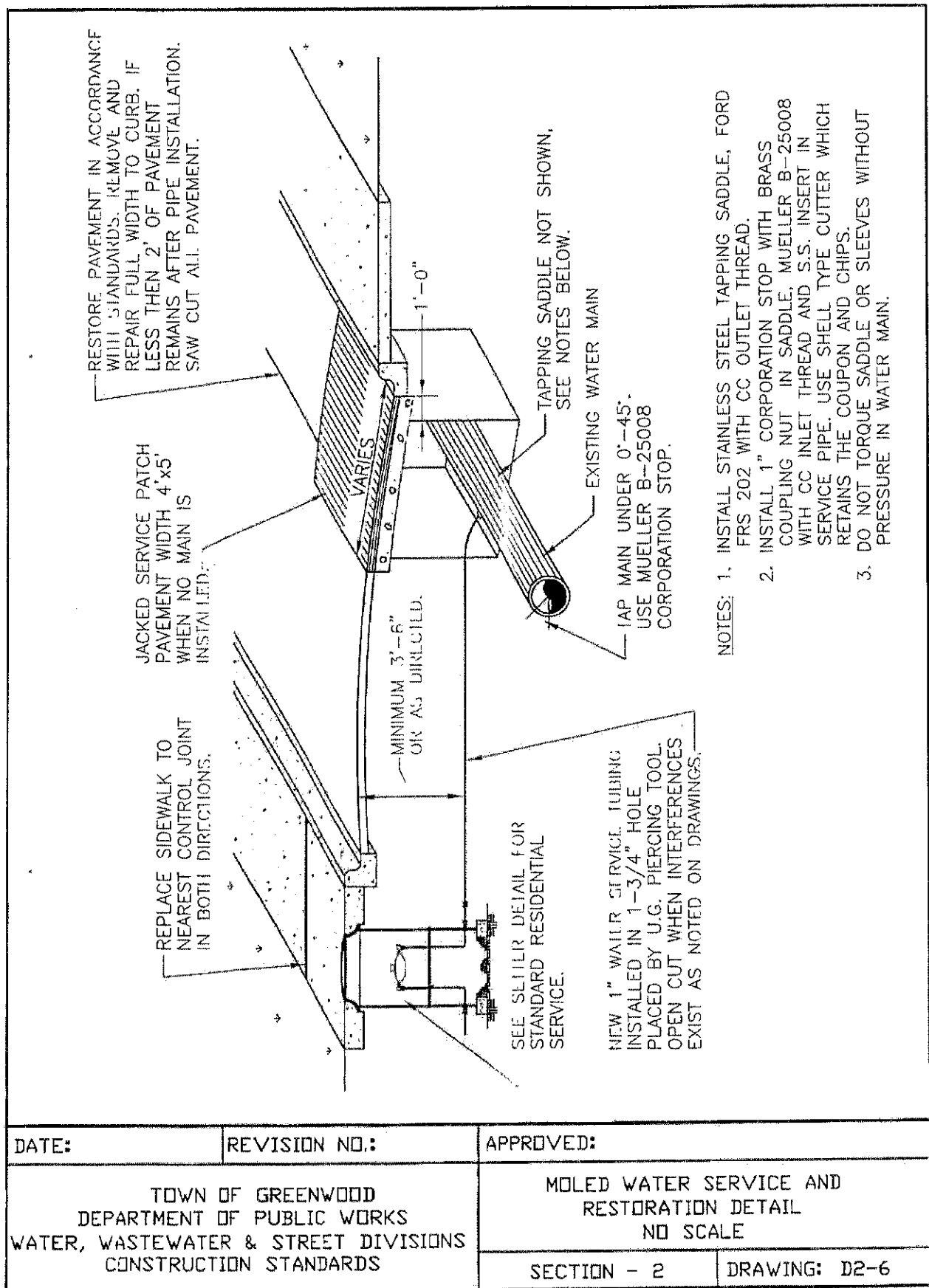
DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		
SECTION - 2		DRAWING: D2-4



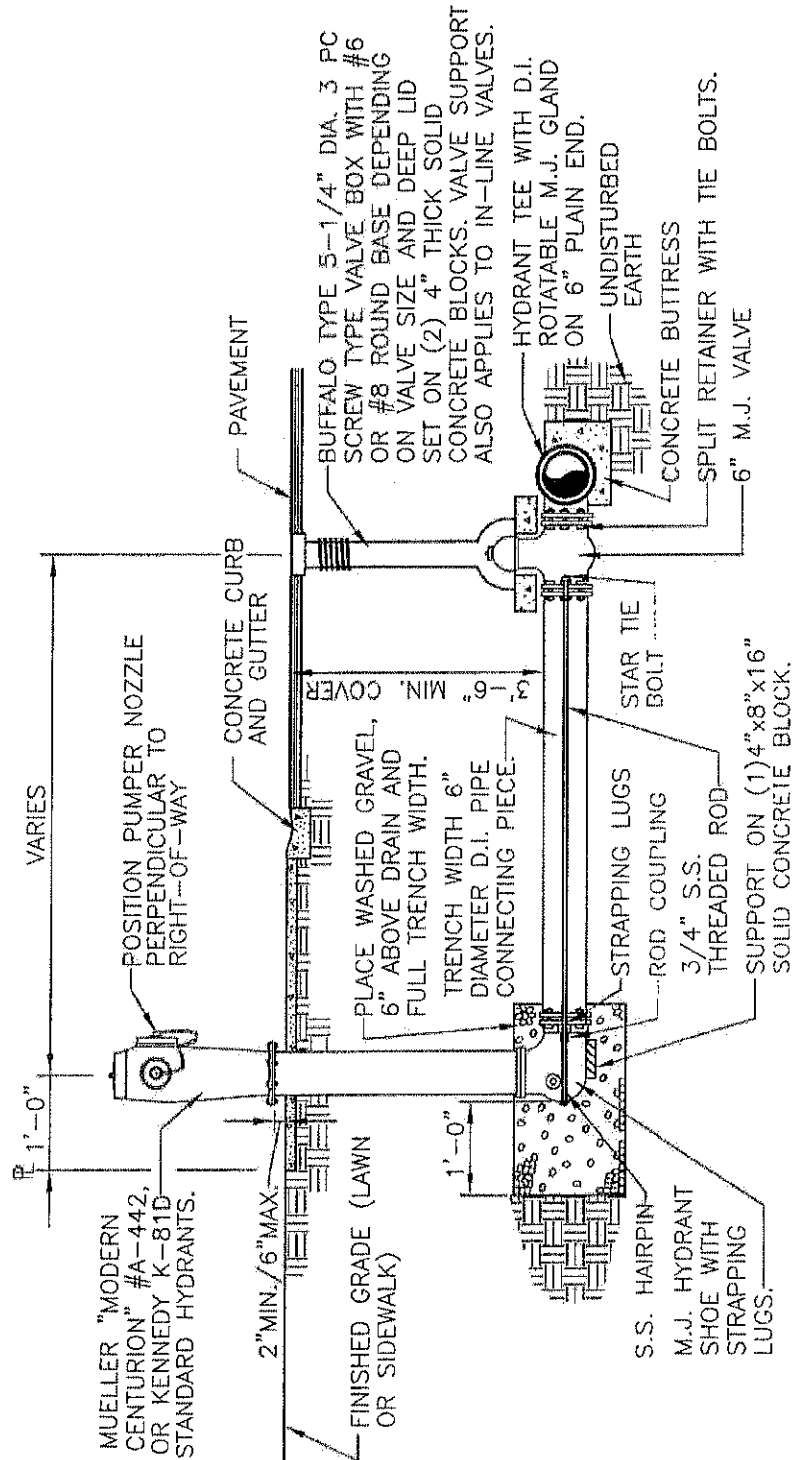
NOTE: EXPANSION JOINT SHALL BE "FLEXTEND" AS MANUFACTURED BY EBAA, OR APPROVED EQUAL.

DIRECTIONAL BORE TERMINAL END EXPANSION JOINT

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		DIRECTIONAL BORE TERMINAL AND EXPANSION JOINT NO SCALE
		SECTION - 2 DRAWING: D2-5

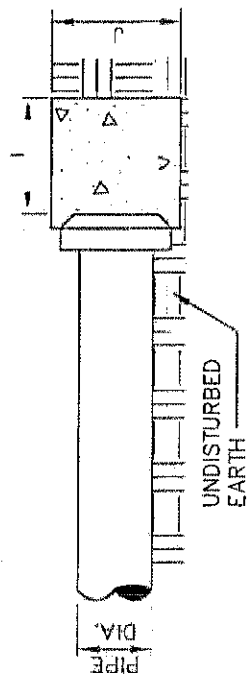


DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		MOLED WATER SERVICE AND RESTORATION DETAIL NO SCALE
SECTION - 2		DRAWING: D2-6

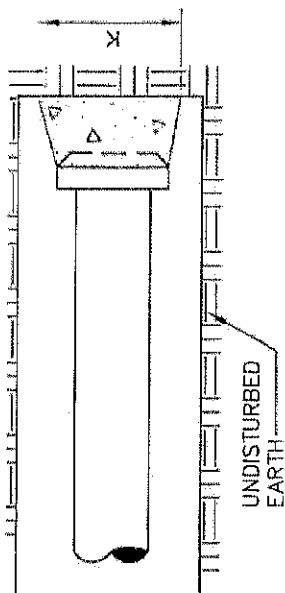


NOTE: RETAINER GLANDS MAY BE USED IN PLACE OF STRAPPING ROD. GLANDS SHALL BE EBAA SERIES 2000SV.

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		FIRE HYDRANT DETAIL NO SCALE
SECTION - 2		DRAWING: D2-7



PROFILE



PLAN

DIMENSION SCHEDULE					
PIPE DIA.	6"	8"	10"	12"	16"
I	6"	8"	8"	10"	1'-0"
J	1'-0"	1'-4"	1'-8"	2'-0"	2'-8"
K	1'-5"	1'-11"	2'-5"	2'-10"	3'-9"

DATE:

REVISION NO.:

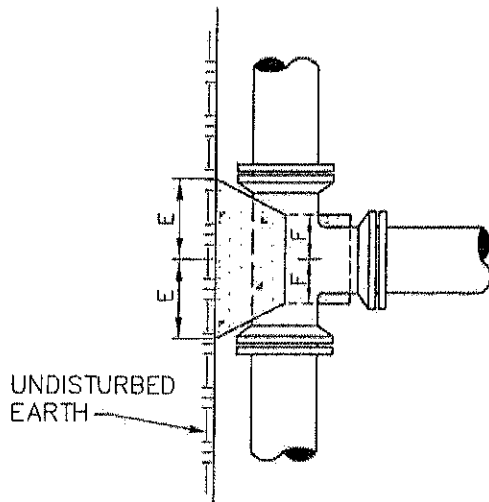
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

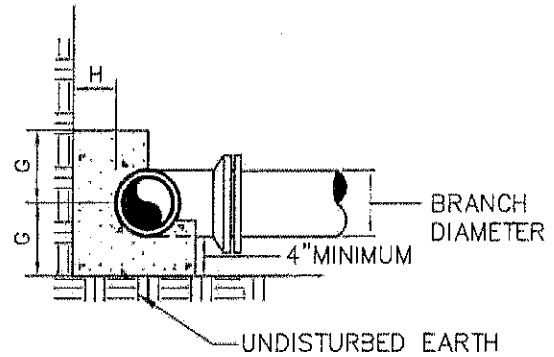
PLUG DETAIL
NO SCALE

SECTION - 2

DRAWING: D2-8



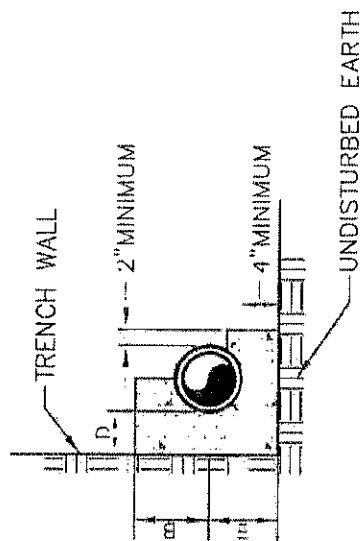
PLAN



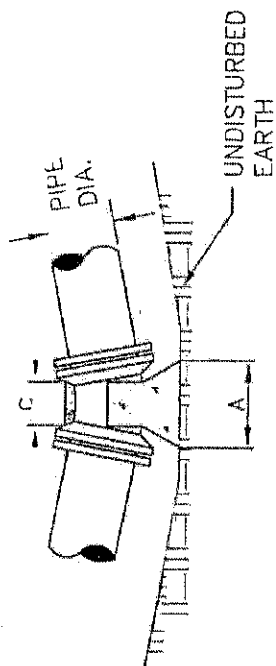
PROFILE

DIMENSION SCHEDULE					
BRANCH DIA.	6"	8"	10"	12"	16"
E	8"	10"	1'-0"	1'-3"	1'-8"
F	6"	8"	8"	8"	10"
G	7"	9"	1'-0"	1'-2"	1'-6"
H	8"	9"	10"	1'-0"	1'-2"

DATE:	REVISION NO.:	APPROVED:	
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		TEE AND WYE DETAIL NO SCALE	
		SECTION - 2	DRAWING: D2-9



PROFILE



PLAN

DIMENSION SCHEDULE														
BEND		11 1/4°					22 1/2°							
PIPE DIA.	6"	8"	10"	12"	16"	6"	8"	10"	12"	16"				
A	6"	6"	10"	1'-0"	1'-4"	9"	1'-0"	1'-6"	1'-9"	2'-3"				
B	7"	8"	9"	10"	1'-0"	7"	8"	9"	10"	1'-0"				
C	4"	6"	6"	10"	1'-0"	4"	6"	8"	10"	1'-0"				
D	7"	7"	8"	8"	9"	8"	9"	10"	11"	1'-2"				
BEND		45°					90°							
PIPE DIA.	6"	8"	10"	12"	16"	6"	8"	10"	12"	16"				
A	1'-3"	1'-8"	2'-1"	2'-6"	3'-4"	2'-0"	2'-6"	3'-0"	3'-6"	5'-0"				
B	7"	8"	9"	1'-1"	1'-3"	6"	9"	1'-0"	1'-3"	1'-6"				
C	4"	6"	8"	10"	1'-0"	4"	6"	8"	10"	1'-0"				
D	8"	9"	10"	11"	1'-2"	1'-5"	1'-7"	1'-8"	1'-9"	1'-10"				

DATE:

REVISION NO.:

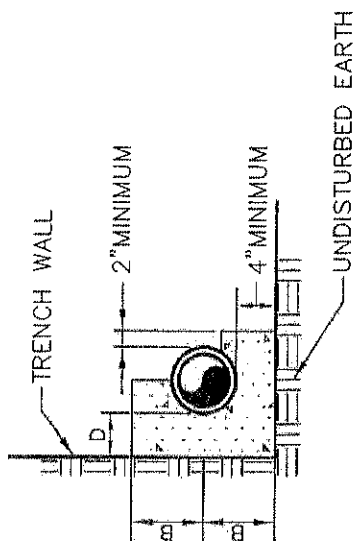
APPROVED:

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DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

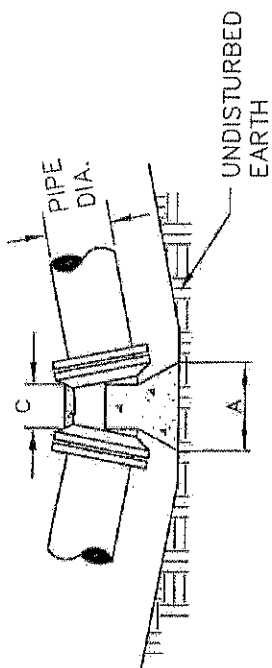
HORIZONTAL BEND DETAIL
NO SCALE

SECTION - 2

DRAWING: D2-10



PROFILE



PLAN

DIMENSION SCHEDULE												
BEND	11 1/4°						22 1/2°					
PIPE DIA.	6"	8"	10"	12"	16"	16"	6"	8"	10"	12"	16"	16"
A	6"	6"	10"	1'-0"	1'-4"	1'-4"	9"	1'-0"	1'-6"	1'-9"	2'-3"	2'-3"
B	7"	8"	9"	10"	1'-0"	1'-0"	7"	8"	9"	10"	1'-0"	1'-0"
C	4"	6"	6"	10"	1'-0"	1'-0"	4"	6"	8"	10"	1'-0"	1'-0"
D	7"	7"	8"	8"	9"	9"	8"	9"	10"	11"	1'-2"	1'-2"
BEND	45°						90°					
PIPE DIA.	6"	8"	10"	12"	16"	16"	6"	8"	10"	12"	16"	16"
A	1'-3"	1'-8"	2'-1"	2'-6"	3'-4"	3'-4"	2'-0"	2'-6"	3'-0"	3'-6"	5'-0"	5'-0"
B	7"	8"	9"	1'-1"	1'-3"	1'-3"	6"	9"	1'-0"	1'-3"	1'-6"	1'-6"
C	4"	6"	8"	10"	1'-0"	1'-0"	4"	6"	8"	10"	1'-0"	1'-0"
D	8"	9"	10"	11"	1'-2"	1'-2"	1'-5"	1'-7"	1'-8"	1'-9"	1'-10"	1'-10"

DATE:

REVISION NO.:

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DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

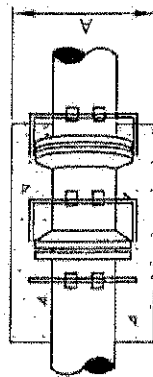
HORIZONTAL BEND DETAIL
NO SCALE

SECTION - 2

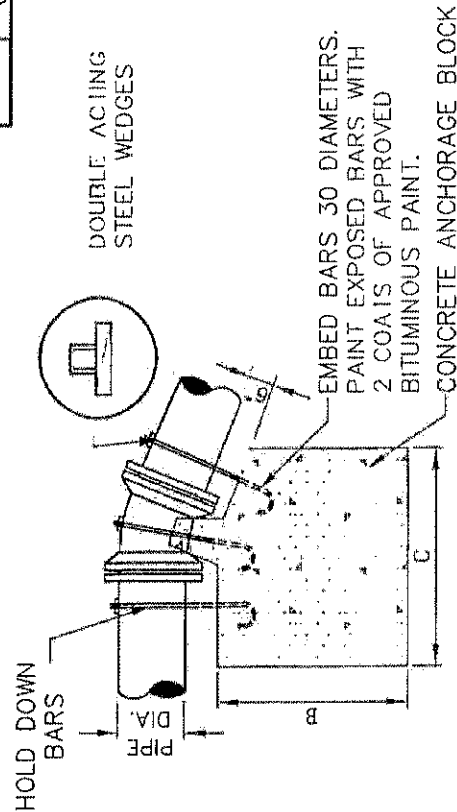
DRAWING: D2-10

DIMENSION SCHEDULE					
BEND		PIPE DIAMETER			
		6"	8"	10"	16"
11 1/4"	A	1'-6"	1'-6"	2'-5"	3'-0"
	B	1'-3"	1'-9"	1'-9"	2'-0"
	C	2'-0"	2'-6"	2'-9"	3'-0"
22 1/2"	A	2'-0"	3'-4"	3'-8"	4'-4"
	B	1'-9"	2'-3"	2'-6"	2'-6"
	C	2'-6"	2'-8"	3'-10"	4'-0"
45°	A	2'-6"	3'-0"	4'-0"	4'-6"
	B	2'-6"	2'-9"	3'-0"	3'-6"
	C	3'-0"	4'-0"	4'-6"	4'-9"

BAR SCHEDULE			
SIZE	REINFORCING BARS		
	11 1/4"	22 1/2"	45°
6"	3 #6	3 #6	3 #6
8"	3 #6	3 #6	3 #6
10"	3 #6	3 #6	3 #6
12"	3 #6	3 #6	3 #6
16"	3 #6	3 #6	3 #6

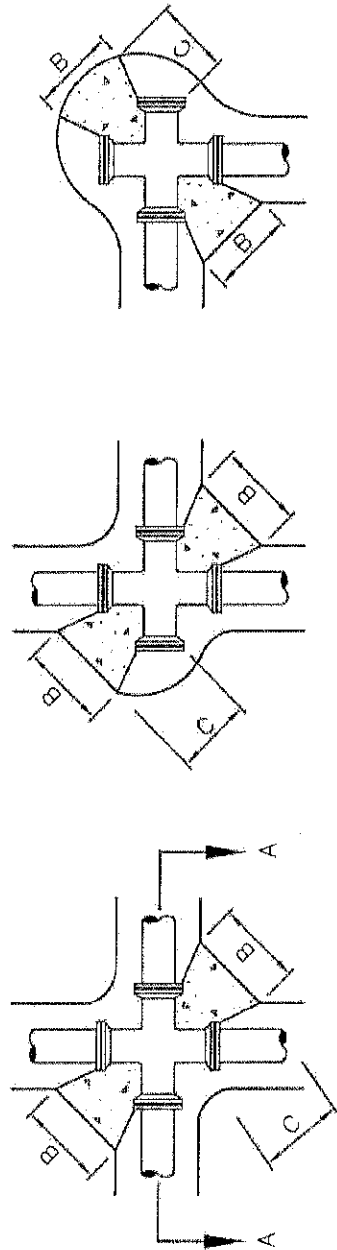


PLAN

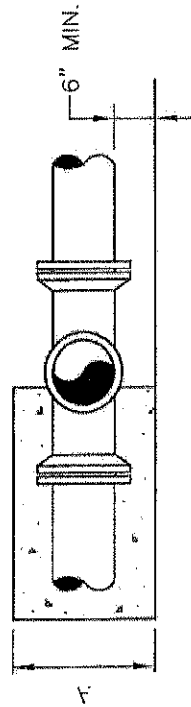


PROFILE

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		VERTICAL DOWNWARD BEND DETAIL NO SCALE
SECTION - 2		DRAWING: D2-11



PLAN VIEW



SECTION A

DIMENSION SCHEDULE				
LARGEST BRANCH DIA.	6"	8"	10"	
A	1'-9"	2'-6"	3'-0"	
B	1'-2"	1'-4"	2'-0"	
C	2'-6"	MIN. OR TO UNDISTURBED SOIL		

DATE:

REVISION NO.:

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TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

CROSS DETAIL
NO SCALE

SECTION - 2

DRAWING: D2-12

INSTALL PREFAB MANHOLE
STEPS AND PLACE BETWEEN
BLOCK COURSES.

4'-0" x 4'-0" HATCH
BILCO MODEL JD-2AL.

(3) #4 E.W.
AROUND
HATCH.

#4 @ 12"
O.C., E.W.

LOCATION
OF VALVES.

GATE VALVE, SIZE
AS REQUIRED (TYP.)

8" CMU
#4 DOWELS @
2'-0" O.C. FILL
CORES WITH
CONCRETE.

4'-0" MIN.

(3) #4

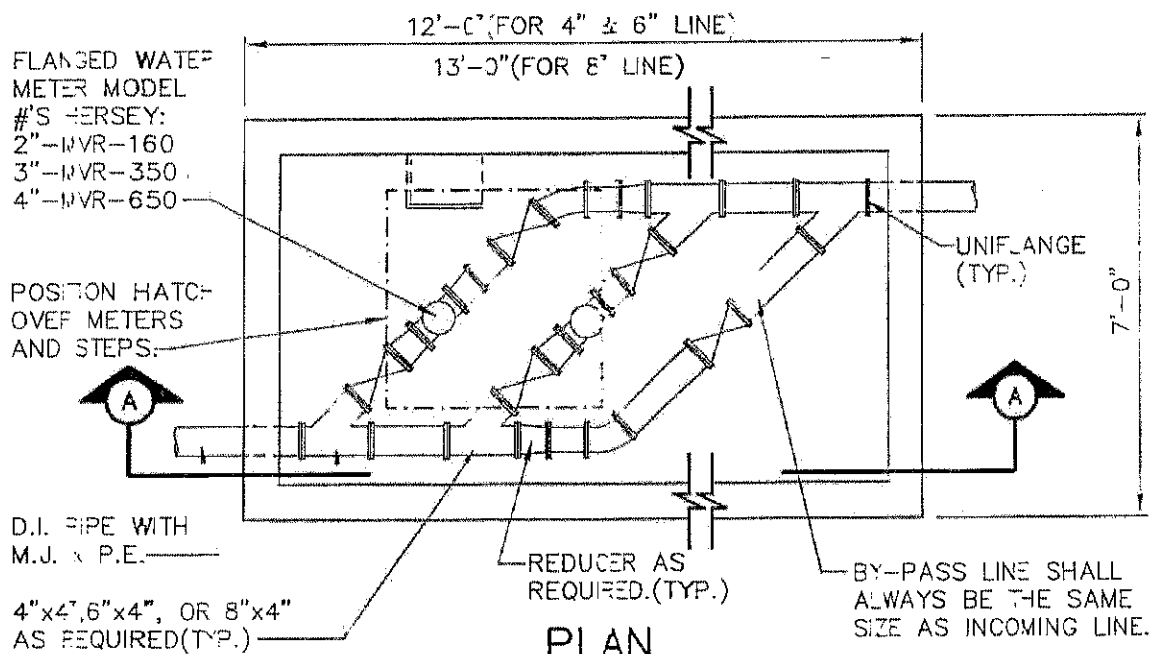
18"

SUPPORT PIPE AND
VALVES ON 6" PEA
GRAVEL.

NOTES:

1. EQUIPMENT SUPPLIED AND
INSTALLED BY DEVELOPER
MAINTAINED BY TOWN OF
GREENWOOD.
2. NOT TO BE INSTALLED IN
TRAFFIC AREAS.

SECTION "A"



PLAN

DATE:

REVISION NO.:

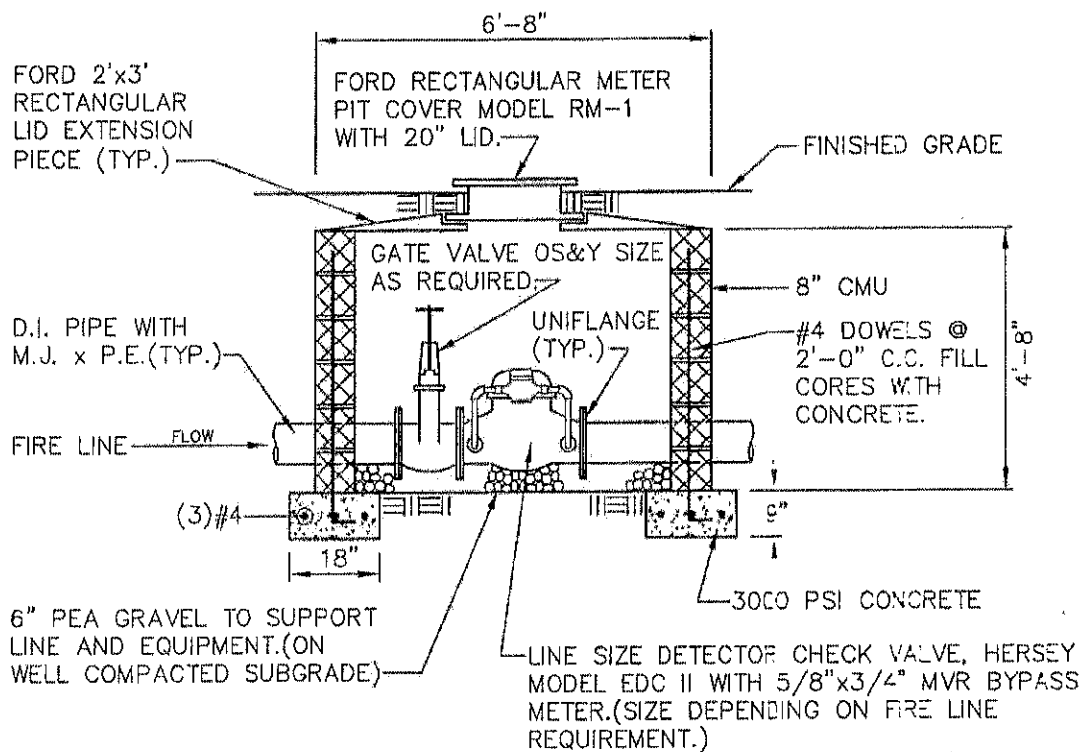
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

INDUSTRIAL/COMMERCIAL METER DETAIL
NO SCALE

SECTION - 2

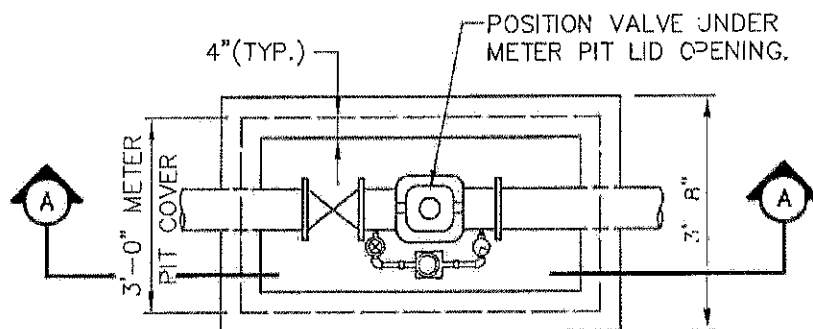
DRAWING: D2-13



SECTION "A"

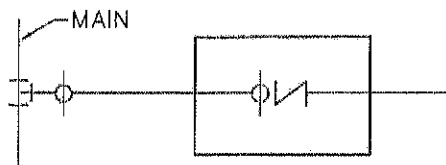
NOTES:

1. EQUIPMENT SUPPLIED AND INSTALLED BY DEVELOPER, MAINTAINED BY TOWN OF GREENWOOD.
2. NOT TO BE INSTALLED IN TRAFFIC AREAS.

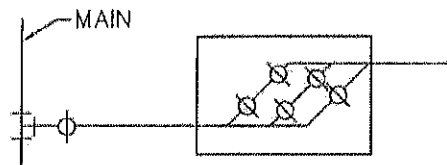


PLAN

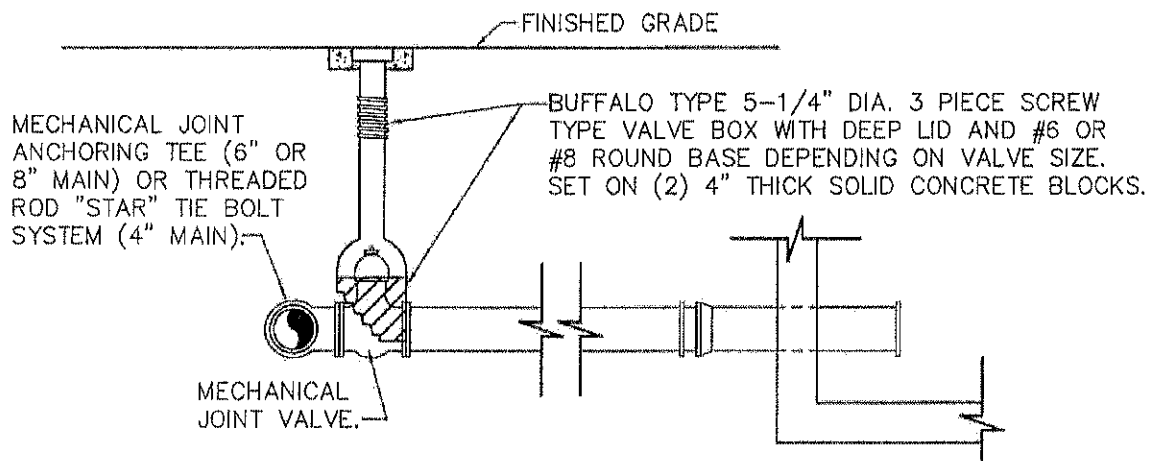
DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		FIRE LINE BACKFLOW PREVENTER DETAIL NO SCALE
SECTION - 2		DRAWING: D2-14



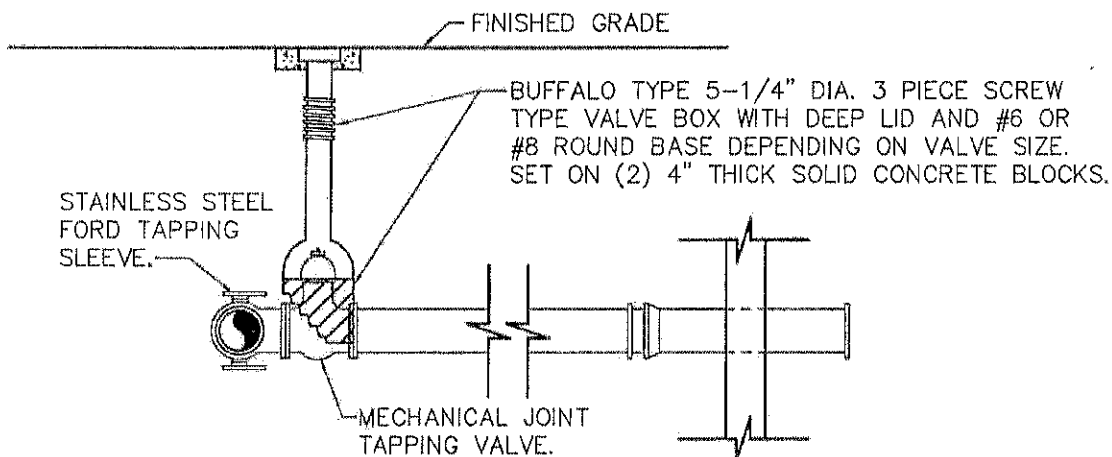
FIRE LINE BACK FLOW
PREVENTER HOOK-UP



INDUSTRIAL/COMMERCIAL
METER HOOK-UP



NEW MAIN INSTALLATION



EXISTING MAIN INSTALLATION

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TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		INDUSTRIAL/COMMERCIAL INSTALLATION DETAIL NO SCALE
		SECTION - 2 DRAWING: D2-15

3.01 GENERAL

- A. The Contractor shall furnish all material and shall construct the pipe lines and all required appurtenances at the locations and to the lines, slopes and elevations shown on the drawings or designated by the Engineer.
- B. All sewer pipe shall be polyvinyl chloride (PVC) pipe.
- C. The Contractor shall submit certifications to the Engineer that all pipe, fittings and joints are as specified herein.

3.02 POLYVINYL CHLORIDE SEWER PIPE AND FITTINGS

- A. Polyvinyl chloride (PVC) pipe, used for sewer construction, shall equal or exceed the requirements of ASTM-D-3034 and shall have a minimum standard dimension (SDR) ratio of 35 and the minimum pipe stiffness, as tested in accordance with ASTM-D-2412, shall be 45 when measured under 5% deflection at 73° Fahrenheit. Pipe shall be manufactured with integral wall bell and spigot joints in standard lengths not exceeding 20.0 feet.
- B. All polyvinyl chloride (PVC) pipe and fittings shall utilize an elastomeric o-ring gasketed joint, assembled in accordance with the manufacturer's recommendations.
- C. Polyvinyl chloride wye branches, pipe stoppers and other fittings shall be manufactured in accordance with the same specifications and shall have the same thickness, depth of socket, and annular space as the pipe. Tee fittings will not be permitted for use. Wye branches shall be complete pipe sections. Saddles will not be permitted for use.
- D. Polyvinyl chloride pipe shall be delivered and stockpiled in unit pallets. Stacking of pallets above five (5) feet in height will not be allowed. If pipe is stockpiled for more than thirty (30) days prior to installation in the trench, it must be suitably covered with reflective material to protect the pipe from ultraviolet rays emanating from sunlight. Do not use plastic sheets. Allow for air circulation under covering.
- E. Bowed sections of pipe will be unacceptable and installation of pipe which has bowed, whether or not the bow has been corrected, will not be allowed.

3.03 POLYVINYL CHLORIDE FORCE MAIN PIPE AND FITTINGS

- A. Pipe shall be manufactured to meet the requirements of ASTM-D-1785 Polyvinyl Chloride (PVC) pressure pipe Schedule 80. Pipe shall be manufactured in lengths not exceeding twenty (20) feet. Pipe shall be integral bell by plain end design.

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B. Pipe Joints

All pipes to be connected by solvent welding shall be installed by experienced pipe layers, to the satisfaction of the Engineer. Jointing shall be done in the manner recommended by the manufacturers. The PVC-compound shall meet ASTM-D-1784 requirements.

C. Pour concrete thrust blocks according to the details on all horizontal or vertical pipe bends.

D. The force mains shall be filled with water supplied by the Contractor, as directed by the Engineer, and the pressure raised to obtain a minimum test pressure of 75 psi, or two (2) times the operating pressure, whichever is greater, measured at the highest point of the section of pipeline under test. Particular care shall be taken to eliminate all air from the pipeline. The force mains shall be subject to a leakage test at the specified test pressure, measured at the highest point of the section of pipeline under test. This test shall be a minimum of four (4) hours duration during which time the leakage shall not exceed 25 gallons per inch of diameter per mile in 24-hours, and this is not to include any visible leaks. All visible leaks shall be repaired by the Contractor at no expense to the Owner. The Contractor shall make any and all repairs at his expense that may be necessary until the leakage test requirements have been met.

3.04 POLYETHYLENE (PE) PIPE AND FITTINGS (FOR DIRECTIONAL FORCE MAIN BORES)

A. PE pipe shall be SDR11 plain end for fusion welding conforming to ASTM F 714 and ASTM D 3035. Minimum pressure rating shall be 160 psi.

B. Molded fittings will conform to ASTM F 714. End sections of PE piping in directional bore shall have an AWWA C-207 Class D flanged end butt. Fusion welded to PE main. Flange shall be drilled to standard 125 pound tensile.

C. Terminal end of PE pipe shall be connected to continuing ductile iron, PVC or PE pipe with a flanged expansion joint. The flanged expansion joint shall be a "FlexTend" flexible expansion joint as manufactured by EBAA, or approved equal.

3.05 PIPE INSTALLATION

A. Pipe and fittings shall be carefully handled and lowered into the trench. Special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipe.

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- B. Before pipe is placed, the bottom of the trench shall be carefully shaped to fit the lower part of the pipe exterior with reasonable closeness for width of at least 60% of the pipe width. Bell holes shall be dug sufficiently large to insure the making of proper joints and so that after placement, only the barrel of the pipe receives bearing pressure from the trench bottom. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Any defects due to settlement shall be made good by the Contractor.

- C. Minimum Pipe Slopes:

Assuming an "n-value" of 0.010 for PVC, the table below provides the minimum allowed pipe slopes.

Sewer Size	Minimum Slope in Feet/100 Feet
8 inch	0.28
10 inch	0.22
12 inch	0.17
15 inch	0.12
18 inch	0.10
21 inch	0.08
24 inch	0.06

- D. Proper and suitable tools and appliances, for the safe and convenient handling and laying of pipe, shall be used.
- E. Whenever a pipe requires cutting to fit into the line or to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end.
- F. The pipes shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. The open ends of all pipelines shall be provided with a stopper carefully fitted so as keep dirt and other substances from entering. This stopper shall be kept in the end of the pipeline at all times when laying is not in actual progress.

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- G. All concrete required to support and reinforce wye branches, bends and other fittings shall be placed as directed, and the cost thereof shall be included and covered within the price bid.
- H. Backfill materials shall be hand placed and mechanically tamped in six (6)-inch layers, placed uniformly on both sides of the pipe, to a point at least one (1) foot above the pipe crown. Each layer shall be thoroughly compacted for the full trench width and under, around and over the pipe.
- I. Pipeline detectable tape shall be installed continuously along all sewer mains. The tape shall be installed directly above the pipe and twelve (12)-inches from the ground surface. The tape shall be Lineguard Type II Detectable tape as manufactured by Lineguard, Inc., of Wheaton, Illinois or equal. The tape shall be a minimum of two (2)-inches wide, imprinted with the words "CAUTION--SEWER LINE BELOW" and be capable of being detected with inductive methods.
- J. The pipe used for stream crossing shall be ductile iron encased in concrete within the limits of the stream and to a point ten feet (10') from each bank. All pipe located within ten feet of a stream shall be ductile iron. Wherever possible, the line shall be located three feet (3') or more below the stream bed at stream crossing. (See Detail 3).
- K. For refill of the remaining trench depth, refer to "Excavation and Backfill" Section of these specifications.

3.06 LAYING PIPE IN FREEZING WEATHER

No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when the Engineer shall deem that there is danger of the formation of ice or the penetration of frost at the bottom of the excavation, unless all required precautions as to the minimum length of open trench and promptness of backfilling are observed.

3.07 ARTIFICIAL FOUNDATION

Whenever directed, the Contractor shall lay pipe upon an artificial foundation which he shall construct. Such foundation may consist of gravel or of concrete; all to be of the form and dimensions and place according to the details or in the manner required by the Engineer.

3.08 TESTING

- A. Gravity sewer to be tested in accordance with the following:

- 1) Contractor shall furnish all labor, tools, materials, and equipment, including

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water, pumps, compressors, stopwatch, gauges, and meters, subject to the approval of the Engineer for testing in accordance with these specifications.

- 2) The Engineer shall be notified in advance of all tests, and all tests shall be conducted to his entire satisfaction.
- 3) The Gravity sewer shall be mirror, mandrel, and air tested as follows:

a. MIRROR TEST:

Upon completion of pipe laying and backfilling to a point at least two (2) feet above the crown of the pipe, the Engineer will conduct a mirror test to check for defects, excess deflection, leakage, and for horizontal or vertical misalignment. Mirror testing shall consist of reflecting sunlight or artificial light via mirrors through the completed section of pipeline, which, in order to be accepted, shall be true and straight in horizontal and vertical alignment to allow for the full passage of the reflected light.

b. MANDREL TEST:

Sanitary sewer pipe shall be deflection tested not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling an approved solid pointed mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the inside diameter of the pipe. The mandrel shall be a rigid, non-adjustable mandrel having an effective length of not less than its nominal diameter.

Testing shall be conducted on a manhole to manhole basis and shall be done after the line has been completely cleaned and flushed. Any portion of the sewer which fails to pass the test shall be excavated, repaired or realigned and retested with both air and deflection tests.

c. LEAK TESTING USING AIR:

- 1) Sewers shall be tested in sections of not more than 400 foot lengths unless otherwise approved by the Engineer. Each section shall be tested immediately upon completion thereof. Each section shall meet the air pressure drop limitations specified herein.

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- 2) All material and labor required for leakage tests shall be furnished by the Contractor.
- 3) Sewers shall be tested using the low-pressure air method in accordance with the requirements of ASTM C-828 and the Uni-Bell Plastic Pipe Association recommendations, based upon the Ramseier test time criteria. Procedural and equipment details shall be submitted to the Engineer prior to acceptance of its use for testing.
- 4) If the test time for the designated size and length elapses before the test pressure drops 0.5 psig, the section undergoing the test shall have passed.
- 5) If the pressure drops 0.5 psig before the appropriate test time has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test. Contractor shall determine, at his own expense, the source or sources of leakage and he shall repair or replace all defective materials and/or workmanship to the satisfaction of the Engineer. The completed pipe installation shall then be retested and required to meet the requirements of this test.

3.09 BORING AND JACKING OF SANITARY SEWER

- A. Where possible, an approach trench shall be excavated far enough to provide a jacking face of at least three (3) feet from a pavement surface. This open face shall be shored securely to prevent slipping or raveling of the face.
- B. Boring pits shall be large enough to contain all necessary equipment and tools. Adequate provision shall be made for the removal of excavated material.
- C. A substantial backstop of heavy timber or steel beams shall be provided to take the thrust of the jack or boring equipment.
- D. As material is excavated or bored ahead of the pipe, the pipe shall be jacked in to follow this excavation. The distance dug ahead of the pipe shall not exceed six (6)-inches.
- E. The installation of casing pipe and the boring or excavation shall be done simultaneously.
- F. Voids between the sleeve and excavation shall be filled by pressure grouting.

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- G. Cement grout shall be used to seal the pipe ends between the carrier pipe and sleeve.
- H. A one (1)-inch PVC pipe shall be installed in the downgrade seal to permit drainage.
- I. Steel pipe sleeve shall be furnished in random lengths of the diameter shown on the plans and noted in the proposal and shall conform to the requirements of AWWA C-200; Grade B pipe shall be used. The pipe, including field connections, shall be coated with bitumastic compound, inside and outside. Pipe wall thickness for sleeves shall be standard thickness. All joints for casing pipe shall be made by continuous weld completely around the perimeter of the pipe in accordance with AWWA C-206.
- J. Carrier pipe shall be as required by the plans.
- K. Use runners or cradles to support the pipe in the casing. A minimum of three (3) supports is needed per joint of pipe providing a maximum span of 6 1/4-feet for PVC pipe lengths of 12.5 feet or less. The maximum span between supports for pipe lengths of 19 to 20 feet must not exceed 7.5 feet.

3.10 DIRECTIONAL BORE (FORCE MAIN ONLY)

- A. The system must be remotely steerable and permit electronic monitoring of tunnel depth and location. The system must be able to control the depth and direction of the pipe and must be accurate to a window of +/- 2 inches.
- B. The system must be capable of turning 90 degrees in a 35 foot radius.
- C. The system shall utilize a fluid-cutting process, using a liquid clay such as bentonite. This clay must be total inert and contain no risk to the environment.
- D. Liquid clay shall remain in the tunnel to increase stability of the tunnel and provide a lubricant to reduce frictional drag when the pipe is installed.
- E. Spoils shall be recovered by use of a vacuum system mounted on a vehicle for removal of spoils to an approved spoils site. Spoils shall not be discharged into sewers or storm drains.
- F. The equipment must be capable of completing the boring in a single bore.
- G. Equipment must be fitted with a permanent alarm system capable of detecting an electrical current. The system will have an audible alarm to warn the operator when the drill head nears electrified cables.

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3.11 SEWER MANHOLES

A. GENERAL

- 1) The Contractor shall have the option of constructing shallow (4' or less) manholes of precast reinforced concrete or "SS" sewer brick as indicated on the drawings. Manholes deeper than four (4) feet will be precast reinforced concrete.
- 2) Manholes shall be built at such points on the pipelines, and of such form and dimensions as are shown on the drawings or as may be directed. Manholes shall be built as pipe laying progresses, and the Engineer may stop work entirely on the pipe laying, if manhole construction is delayed to such an extent as to be hazardous to construction or the public.
- 3) Manholes shall be spaced no more than 400 feet apart and at all bends in gravity sewer mains.

B. PRECAST REINFORCED CONCRETE MANHOLES

- 1) Precast reinforced concrete risers, eccentric cones and bases shall be in conformance with ASTM Designation C 478. Joints between riser sections shall be fitted with an "O" ring rubber gasket, meeting the requirements of ASTM Designation C 443. Installation of risers shall be in accordance with manufacturer's recommendations under the supervision of the Engineer.
- 2) Precast reinforced concrete base and riser sections shall be as manufactured by Atlantic Concrete Products Company, Virginia Precast Corporation, or equal.
- 3) Interior and exterior joint spaces of all manhole risers shall be filled prior to application of the exterior waterproofing. The interior joint shall be mortared. The exterior joint may be mortared or filled with a joint filler compound. Said compound shall be Pioneer 301 as manufactured by Daubert Chemical Company, Oakbrook, Illinois, or equal.
- 4) Lifting holes in the walls of precast reinforced concrete risers will be allowed but shall be plugged with rubber stoppers and grouted flush with face or manhole wall after installation of manhole riser sections. Not more than two (2) holes shall be cast in the walls of each riser section for the purpose of handling.
- 5) The exterior surface of all precast manholes shall receive a minimum two (2)

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coat application of a 68% solids coal tar type protective coating. The total average dry film thickness shall measure 24 mils with no single measurement to be less than 20 mils. Surface shall be prepared in accordance with the manufacturer's instructions and coatings applied in the field in a manner acceptable to the Engineer. The coating material shall be Bitumastic Super Service Black manufactured by Koppers Company, Inc., Pittsburgh, Pennsylvania, Tar Jet Super Black XX-32-B-22 manufactured by Pennsbury Coatings Corp., New Britain, Pennsylvania, or equal.

- 6) All pipe-to-manhole connections in the precast manhole shall be made by means of an integrally cast flexible connector which shall be Lockjoint flexible manhole sleeve as manufactured by Interpace Corp., Parsippany, New Jersey, or A-Lok flexible manhole gasket as manufactured by A-Lok Corp., Trenton, New Jersey, or equal.

C. FLOW CHANNELS

- 1) Manhole flow channels and benches shall be constructed of "SS" sewer brick with care taken to secure smooth and even surfaces with full special mortar joints. Channel sections shall be built up to true line and radius, and curved sections shall provide a uniform transition in the flow direction.
- 2) Materials and construction of flow channels shall be in accordance with appropriate sections for materials so used, as hereinafter specified.
- 3) Precast concrete flow channels shall not be allowed.

D. CONCRETE

All concrete for manhole base slabs and cradles, encasements, blocking, etc. shall have a minimum compressive strength of 3,000 psi at twenty-eight (28) days.

E. BRICK

All brick shall conform to the "Standard Specifications for Sewer Brick," ASTM Designation C 32, Grade SS, except that the maximum absorption for the average of five (5) bricks shall not exceed 10%; and the individual brick maximum shall not exceed 14%.

F. MORTAR

- 1) Cement shall be in accordance with "Standard Specifications for Portland Cement", ASTM Designation C 150 for Type II.

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- 2) Sand shall be composed of sharp, angular, silicious grains, coarse, or graded from fine to coarse, with the coarsest grains predominating, and sensibly free from clay, loam, dirt, mica, organic matter, or other impurities. Sand containing more than 5% by weight of foreign material shall not be used. This limit may be changed for special classes of work, if hereinafter specified. Sand exhibiting more than an acceptable amount of fine matter or impurities may be required to be washed after delivery on the work or shall be rejected altogether. Sand for mortar shall be screened to reject all particles of a greater diameter than 1/4-inch and shall not contain more than 5% by weight of a very fine material.
- 3) Unless hereinafter specified otherwise, all mortar shall be composed of cement and sand of the character above specified. The proportion of volume shall be one (1) part of cement to two (2) of sand. One volume of cement shall be 94 pounds net. One volume of sand shall be 0.9 cubic feet, the sand not being packed more closely than by throwing it into a box in the usual way. Mortar shall be fresh mixed in small batches for the work in hand. Tight boxes or platforms made for the purposes shall be used. The sand and cement shall be thoroughly mixed dry, in the proper proportions, until uniform color has been produced, whereupon a moderate dose of water shall be added, so as to produce a stiff paste of the proper consistency.
- 4) Sand obtained from the excavation shall not be used.

G. LAYING BRICK

- 1) All brickwork shall be laid by competent professionals.
- 2) All brick shall be laid in a full bed of mortar with all vertical and horizontal joints filled solid with mortar.
- 3) Joints shall not be less than 3/8-inch or more than 1/2-inch wide except as otherwise specified.
- 4) No brickwork shall be laid when the temperature is below 40° or when the indications are for lower temperatures within twenty-four (24) hours. The Contractor shall take such measures as may be approved to prevent brickwork from being exposed to freezing temperatures for a period of not less than five (5) days after laying.
- 5) Special care shall be taken in laying brick in inverts of manholes to insure a uniform flow of water through the sections. In such locations, joints shall not exceed 1/16-inch in thickness and each brick shall be laid in full mortar bed

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with joints on bottom side and end made in one operation. No grouting or working in of mortar after laying the brick, will be permitted.

H. MANHOLE STEPS

- 1) Manhole steps shall be made of 3/8-inch diameter (No.3) steel reinforcing bars, ASTM Designation A 615, Grade 60, encased in polypropylene plastic. Manhole steps shall have notched tread ridge with retainer lug on each side.
- 2) Manhole steps shall be cast in place during manufacture of precast reinforced concrete manholes or placed in brick manholes during construction. Embedment length shall be suitable for minimum five (5)-inch thick, precast reinforced concrete riser walls.
- 3) Manhole steps shall be OSHA approved and as manufactured by; M.A. Industries, Inc., Peachtree City, Georgia; ICM, Inc., Jacksonville, Arkansas, or equal.
- 4) Manhole steps shall be spaced twelve (12)-inches apart. The maximum spacing from top of manhole to the first step shall not exceed sixteen (16)-inches.

I. MANHOLE FRAMES AND COVERS

- 1) Frames and covers for manholes shall be set by the Contractor as the work progresses. The frame shall be well bedded in mortar.
- 2) Frames and covers shall be Neenah Model R-1642 heavy duty, solid lid, with one (1) pick hole. Material for frames and covers shall be in accordance with standard specifications for gray iron castings ASTM A-48 for Class 35.
- 3) The maximum allowable vertical adjustment of manhole cover frames shall be 12 inches. Adjustments shall be made with brick and mortar or precast adjustment rings.
- 4) Manhole stubs shall be extended four (4) feet outside of the manhole wall, unless otherwise detailed. The stub end shall be plugged.

J. TESTS

If inspection reveals any visible leakage or seepage in any manhole, the Contractor will be required to accomplish such remedial measures as may be directed by the Engineer. Caulking or patching of interior manhole surfaces will not be acceptance.

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3.12 SEWER HOUSE CONNECTIONS

A. GENERAL

- 1) In all house connections, each property shall be separately and independently connected with the sanitary sewer, and for the purpose of this regulation, each side of a so-called double house shall be considered as a separate property and each side must have a separate house connection located entirely within its boundaries.
- 2) The Town must be given ample notice (48 hours) in order to examine the work before ordering the backfilling to begin.
- 3) Any part of the work which may have to be covered without previously obtaining the consent of the Town, shall be uncovered for examination if so ordered by Town.
- 4) The backfilling around a house connection shall be so executed as not to injure the joints of the pipes.
- 5) All sewer laterals for house connections shall connect directly to the gravity main using a Y-branch connection. No laterals shall be allowed to connect to a manhole.

B. HOUSE CONNECTION CONSTRUCTION

- 1) Cleanouts
 - a. At least one cleanout must be provided on every house connection.
 - b. Location(s) of cleanout(s) shall be governed by the following consideration:
 - Maximum pipe run between cleanout(s) shall be seventy-five feet (75').
 - A cleanout brought to grade shall be placed immediately upstream from deviation from straight horizontal alignment of more than 22 ½ degrees (1/16 bend).
 - Only one 22 ½ degree bend will be permitted per one hundred feet (100') without a cleanout.

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- c. A sanitary lateral cleanout shall be placed on the lateral within five feet (5') of the building to be serviced.
- d. A cleanout brought to grade shall be placed immediately upstream from each deviation from straight grade.
- e. The cleanout cover shall be installed to match finished grade and shall be supported with compacted earth or a cement base as needed to maintain cover at finished grade.
- f. Cleanouts shall be connected to the house line with "wye" fittings with the cleanout leg pointing upstream.
- g. All cleanouts shall be plugged to prevent infiltration of ground or surface water.

C. PIPE SIZE

- 1) No gravity type house connection shall be less than six inches (6") internal diameter from main to property line, four inches (4") to house.
- 2) Each house connection shall be laid on an even grade and straight line, where feasible.
- 3) The grade of a house connection wherever possible shall not be less than two percent (2%) nor greater than ten percent (10%); but in every case shall be subject to the judgement of the Town.

D. GREASE TRAP

- 1) A properly designed ventilated grease trap shall be interposed between the house connection and the kitchen and pantry sinks of every hotel, eating house, restaurant, cooking establishment or gasoline service station.
- 2) No trade wastes, such as those from factories, laundries, dairies, etc., shall be discharged into the sanitary sewer except by special permission from the Town of Greenwood.
- 3) Grease trap design and installation shall be as per current Kent County, Delaware Standards.

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E. INSPECTION

- 1) Sewer inspection is available from 8:00 A.M. to 4:00 P.M., Monday through Friday except for holidays.
- 2) Requests for sewer inspection shall be made at least 48 hours in advance by calling 349-4534.

F. PIPE CLASSIFICATION AND PIPE REQUIREMENTS

The pipe used for either house connections or sewer extensions must meet the requirements of most recent ASTM specifications and good engineering practice.

G. HOUSE CONNECTIONS

Polyvinyl Chloride - PVC Schedule 40 with cemented coupling joints, rubber compression joints or SDR-35 pipe shall be used for sewer house connections.

H. STREAM CROSSING

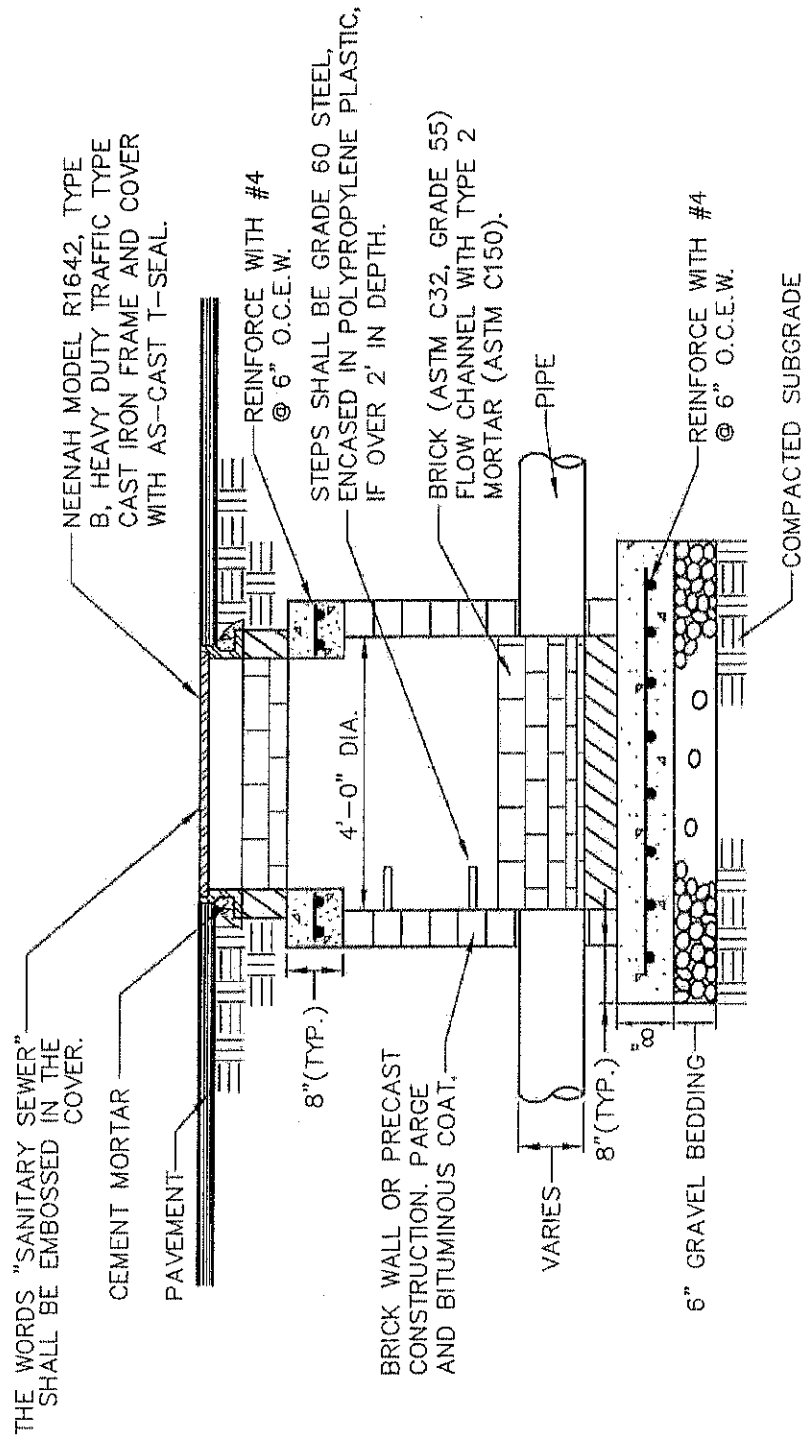
The pipe used for stream crossing shall be ductile iron encased in concrete within the limits of the stream and to a point ten feet (10') from each bank. All pipe located within ten feet of a stream shall be ductile iron. Wherever possible, the line shall be located three feet (3') below the stream bed at stream crossing.

I. RESIDENTIAL SEWER CONNECTIONS

Taps and sewer laterals shall be situated to maintain a minimum of ten feet (10') of separation from any water service or water supply.

END OF SECTION

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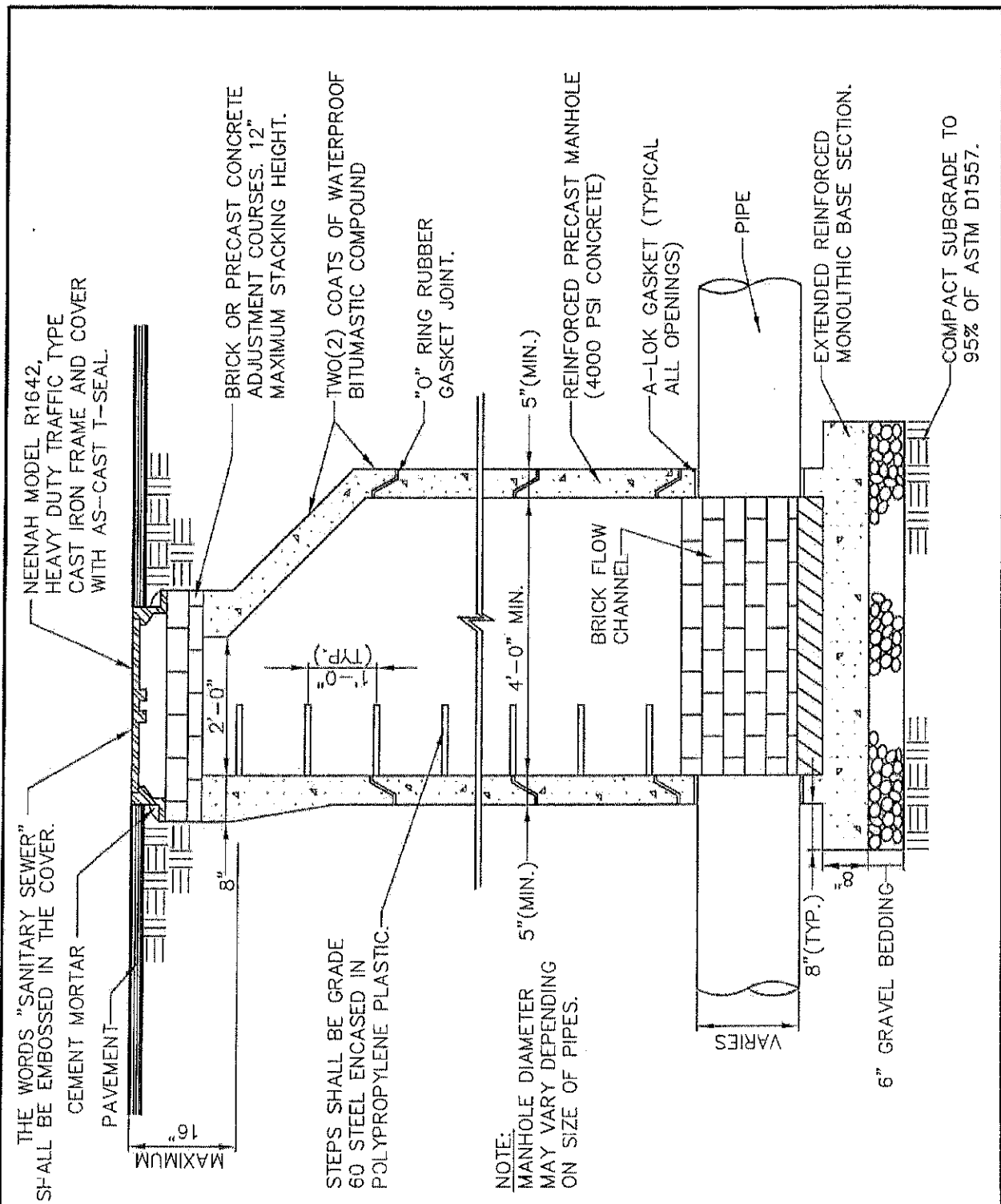
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

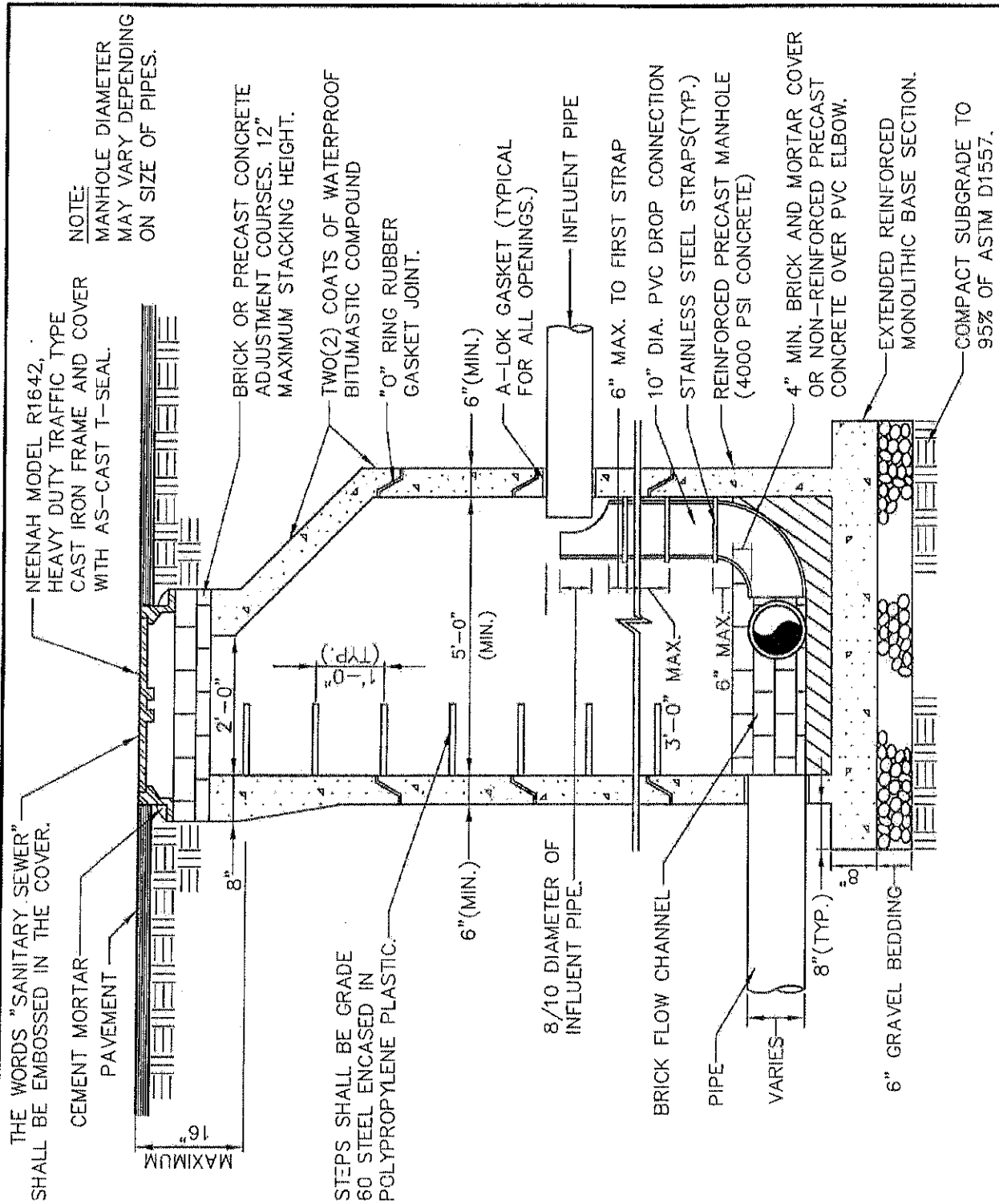
SHALLOW MANHOLE DETAIL
NO SCALE

SECTION - 3

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TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		PRECAST CONCRETE MANHOLE DETAIL NO SCALE
SECTION - 3		DRAWING: D3-2



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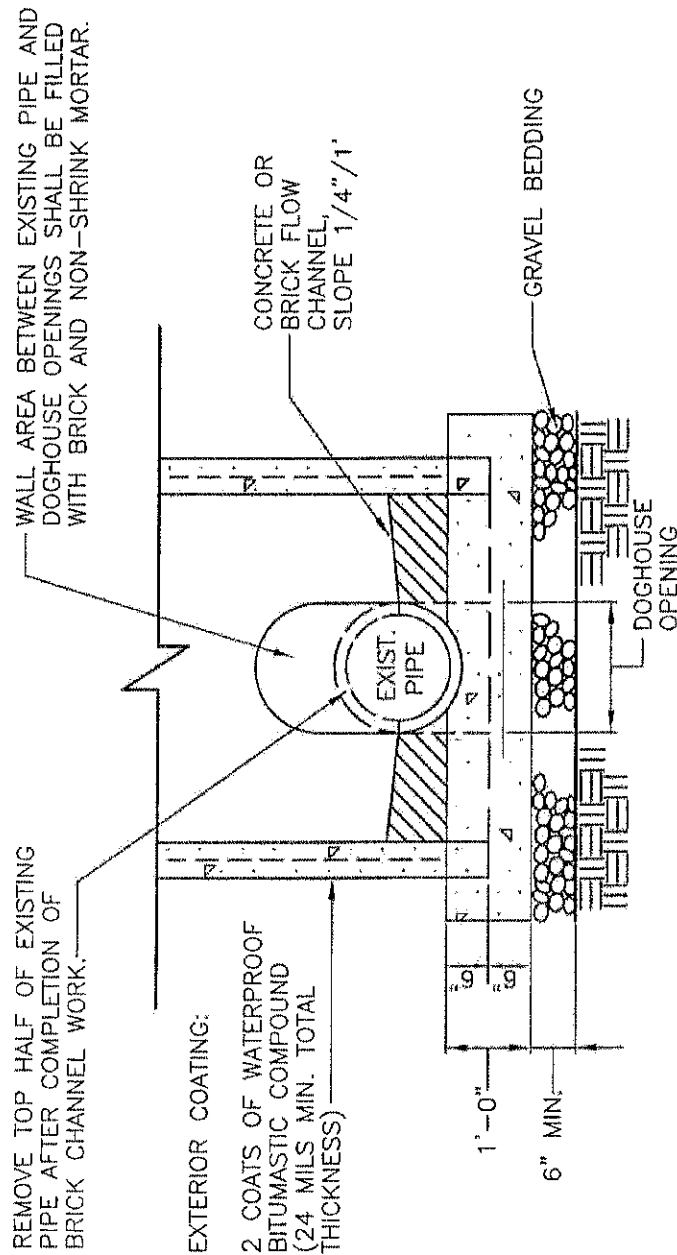
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
WATER, WASTEWATER & STREET DIVISIONS
CONSTRUCTION STANDARDS

INSIDE DROP MANHOLE DETAIL
NO SCALE

SECTION - 3

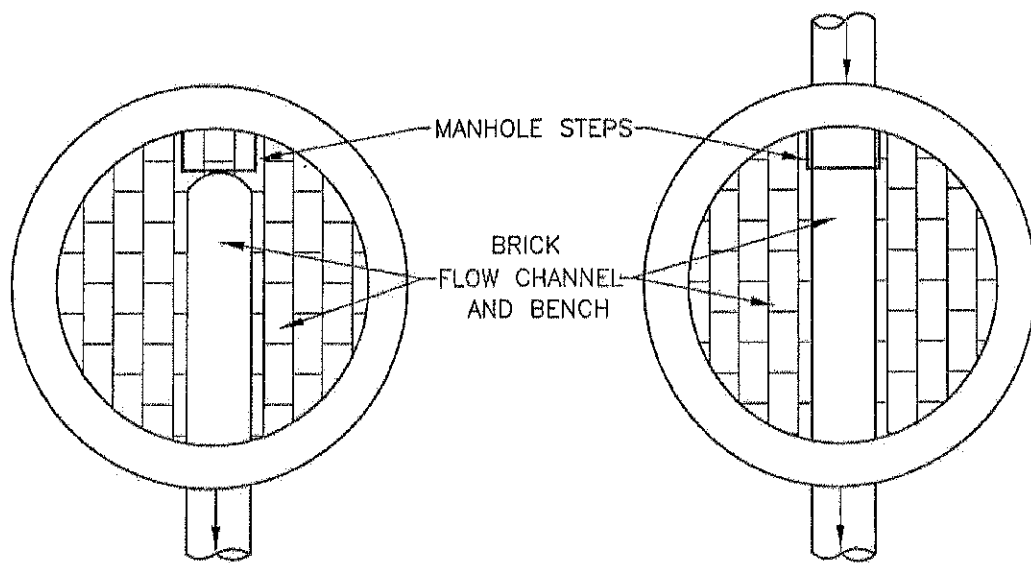
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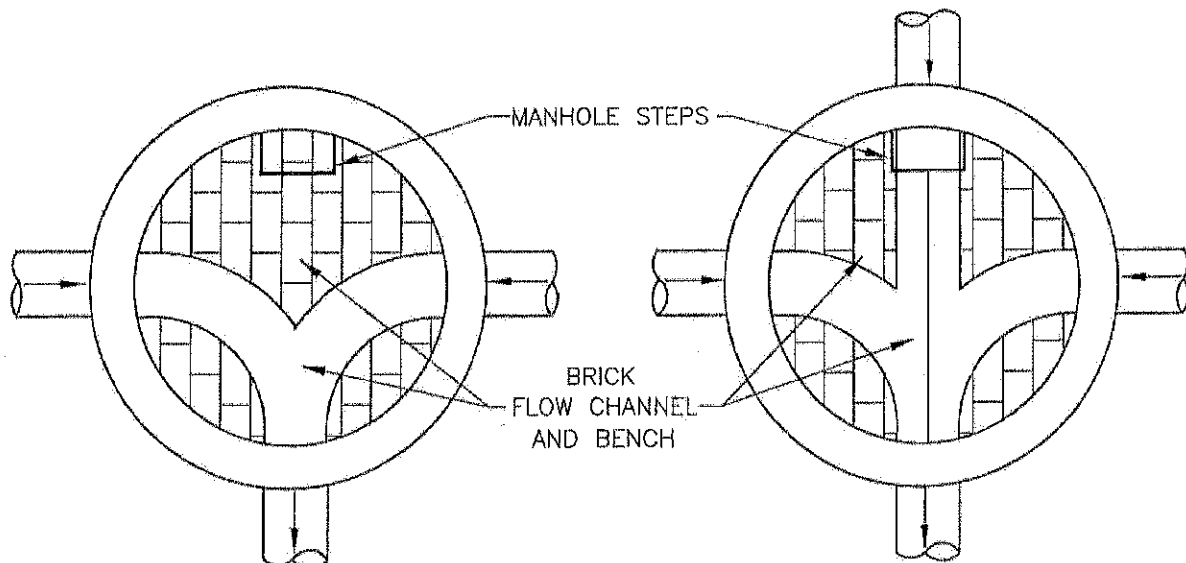
1. CONCRETE COMPRESSIVE STRENGTH SHALL BE 4,000 P.S.I.
2. MANHOLE SHALL CONFORM TO ASTM-C478, LATEST REVISION.
3. ALL PORTIONS OF MANHOLE SHALL BE CONSTRUCTED AS DETAILED FOR PRECAST CONCRETE MANHOLE.

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TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		DOGHOUSE MANHOLE DETAIL NO SCALE
SECTION - 3		DRAWING: D3-5



TERMINAL

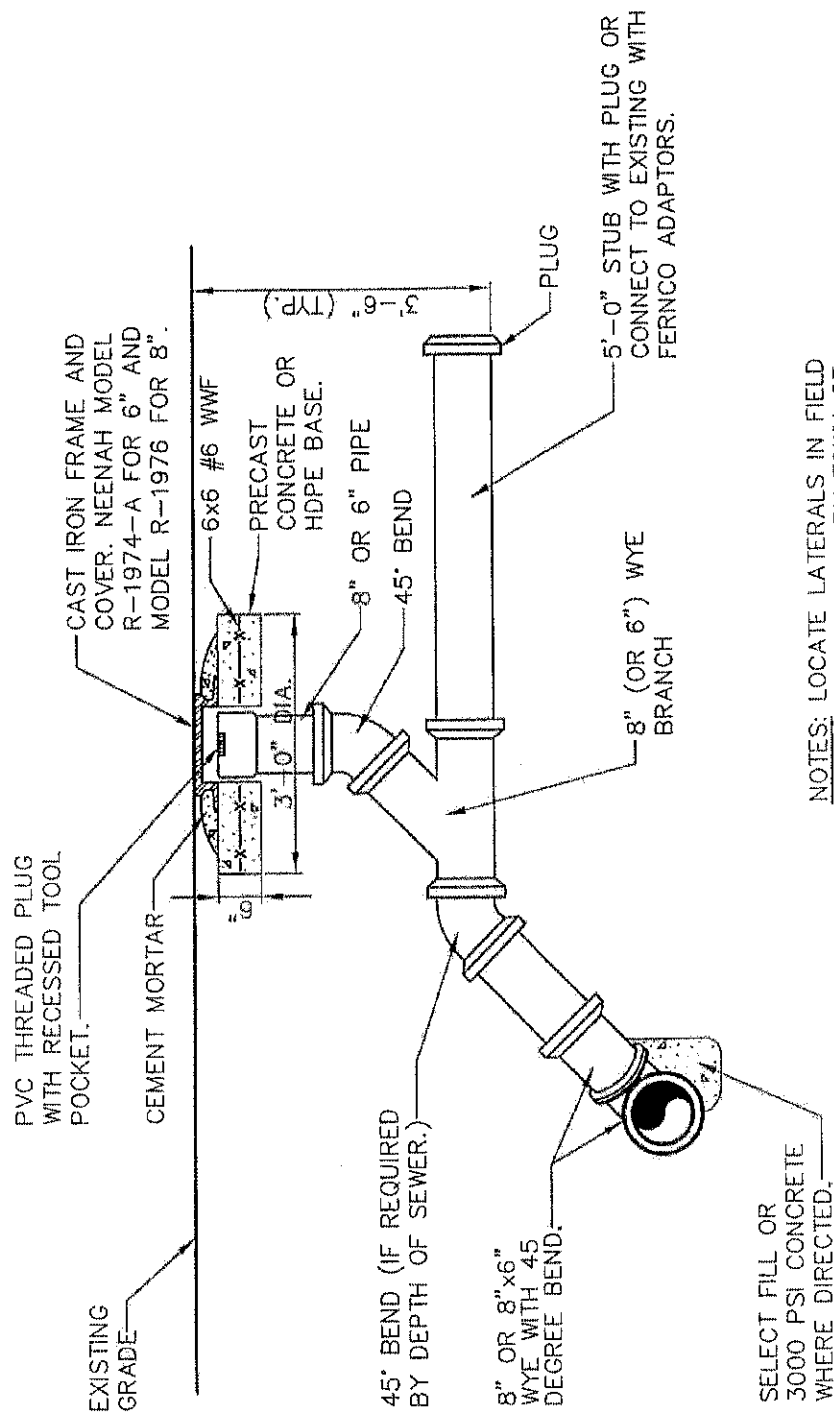
1-WAY



2-WAY

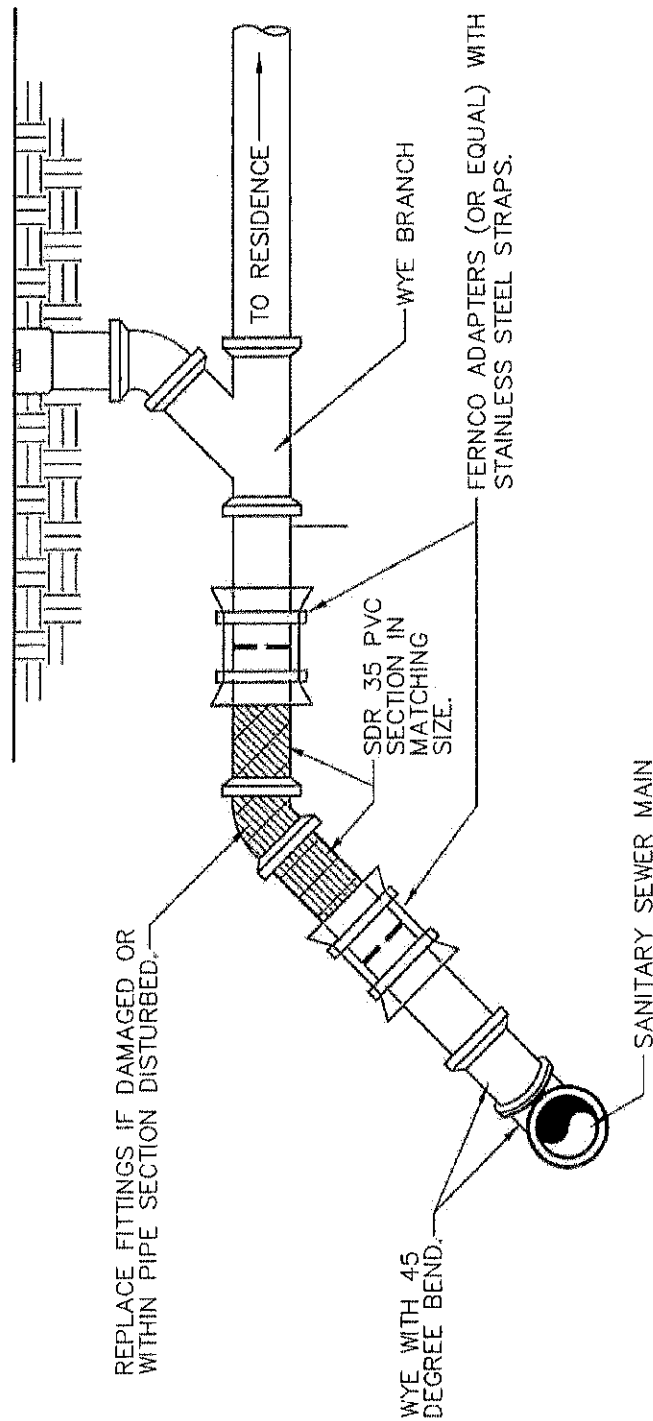
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		SECTION - 3 DRAWING: D3-6



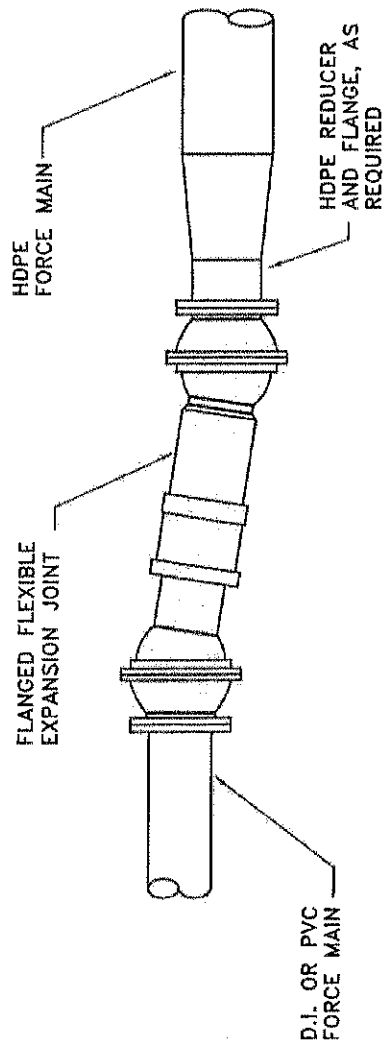
NOTES: LOCATE LATERALS IN FIELD
AS DIRECTED BY TOWN OF
GREENWOOD.

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		BUILDING LATERAL CLEANDUT DETAIL NO SCALE
		SECTION - 3 DRAWING: D3-7



- NOTES:
1. LOCATE LATERALS IN FIELD AS DIRECTED BY TOWN OF GREENWOOD.
 2. CAST IRON FRAME AND COVER, AND CONCRETE OR HDPE BASE NOT SHOWN, BUT REQUIRED. SEE DETAIL D3-7.

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		SEWER LATERAL RESTORATION DETAIL NO SCALE
		SECTION - 3 DRAWING: D3-8



NOTE: EXPANSION JOINT SHALL BE "FLEXTEND" AS MANUFACTURED BY EBAA, OR APPROVED EQUAL.

DIRECTIONAL BORE TERMINAL END EXPANSION JOINT

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS WATER, WASTEWATER & STREET DIVISIONS CONSTRUCTION STANDARDS		DIRECTIONAL BORE TERMINAL END EXPANSION JOINT NO SCALE
		SECTION - 3 DRAWING: D3-9

4.01 GENERAL

- A. This section covers storm sewer pipe, precast manholes, and precast catch basins.
- B. The Contractor shall furnish and install all storm drains and appurtenances as specified herein and as defined on the drawings or as directed by the Engineer.
- C. The Contractor shall submit certifications to the Engineer that all pipes, fittings and joints are as specified herein.

4.02 REINFORCED CONCRETE PIPE

- A. Pipe manufactured shall meet the applicable strength requirements contained in ASTM Designation: C-76, Reinforced Concrete Culvert, Storm Drain and Sewer Pipe, minimum circumferential reinforcement shall be as prescribed for Class III. Class IV shall be required when cover is less than 12 inches.
- B. In addition to the applicable ASTM Requirements for steel reinforcing, the joints shall be provided with circumferential reinforcement equipment at least to the area of a single line in the barrel of the pipe to insure against possible overstresses or damage to the pipe during jointing operations. The circumferential reinforcing members in the tongue and groove ends shall be spaced not greater than two (2)-inch on center.
- C. Pipe shall be manufactured without lifting holes and shall be handled at all times by means of slings or other methods approved prior to start of construction.
- D. All pipe joints shall be water tight.

4.03 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

- A. HDPE pipe shall be smooth interior, AASHTO designation M252 and M294, with a maximum diameter of 48 inches.
- B. Pipe joints and fittings shall conform to AASHTO M252 and M294.
- C. HDPE pipe shall be manufactured by Advanced Drainage Systems, Inc., (ADS -N12), Hancor, Inc., (Hi-Q), or approved equal and shall be installed per manufacturer's guidelines.
- D. All pipe joints shall be watertight.

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4.04 PIPE AND FITTINGS

- A. Pipe laying shall not begin until all stakeout and cut sheets have been approved by the Engineer.
- B. The Contractor shall utilize proper and suitable tools and equipment for the safe handling and laying of the pipe and fittings in accordance with the manufacturer's standards. Pipe and fittings shall be carefully handled and lowered into the trench.
- C. Should the pipe require cutting to fit in the line or to bring it to the required location, the work shall be done without extra compensation, in a satisfactory manner so as to leave a smooth end, perpendicular to the axis of the pipe.
- D. Before making joints, each pipe shall be 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. No pipe shall be laid in wet trench conditions that preclude proper bedding or on a frozen trench or when weather conditions are unsuitable for proper installation.
- E. In laying pipe, special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipeline.
- F. No wedging or blocking will be permitted in laying any pipe; unless by written order from the Engineer.
- G. Pipe and appurtenances shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed work. The open end shall be kept closed with a plug until the next length is laid. At the close of work each day, the end of the pipeline shall be tightly closed with an expansion stopper so that no dirt or other foreign substances may enter the line, and this stopper shall be kept in place until pipe laying is again resumed.
- H. Manholes shall be installed as pipe laying progresses.

4.05 PRECAST CONCRETE MANHOLES AND INLETS

- A. The Contractor shall construct structures of precast reinforced concrete risers and base sections. All catch basins and junction boxes shall be constructed as per most recent State of Delaware Department of Transportation (DelDOT) Standard Construction Details. Storm sewer manholes shall be constructed as per Town of Greenwood manhole details.

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- B. Structures shall be built at such points on the pipelines and of such form and dimensions, as are shown on the drawings or as may be directed. Structures shall be installed as pipe laying progresses and the Owner may stop work entirely on laying pipe if manhole and inlet construction is delayed to such an extent as to be hazardous to construction or the public.
- C. Precast reinforced concrete base riser sections shall be as manufactured by Atlantic Concrete Company, Virginia Precast Corporation, or equal.
- D. Interior and exterior joint spaces of all structure risers shall be filled prior to application of the exterior waterproofing. The interior and exterior joint shall be mortared.
- E. Lifting holes in the walls of precast reinforced concrete risers will be allowed, but shall be plugged with rubber stoppers and grouted flush with face of manhole and inlet wall after installation of manhole and inlets riser sections. Not more than two (2) holes shall be cast in the walls of each riser section for the purpose of handling.
- F. The exterior surface of all precast manholes and inlets shall receive a minimum two (2) coat application of 68% solid coal tar type protective coating. The total average dry film thickness shall measure 24 mils with no single measurement to be less than 20 mils. Surfaces shall be prepared in accordance with the manufacturer's instructions and coatings applied in the field in an acceptable manner.
- G. Inlet flow channels and benches shall be constructed of brick with care taken to secure smooth and even surfaces. Channel sections shall be built up to true line and radius, and curved sections shall provide a uniform transition in the flow direction. Materials and construction of flow channels shall be in accordance with appropriate sections for materials so used, as hereinbefore specified.

4.06 CASTINGS

- A. Frames and covers or grates for structures shall be set by the Contractor as the work progresses.
- B. Material and sizes and types of frames and covers shall be as per current DelDOT Standard Construction Details and of the sizes and types specified on the plans.
- C. All catch basin grates shall be DelDOT Type 3.

DATE: December 2005	STORM DRAIN AND APPURTENANCES	
REVISION:	SECTION 4	PAGE : 4-3

4. 07 BRICK AND MORTAR FOR INLET FLOW CHANNELS

- A. All brick shall conform to the "Standard Specifications for Sewer Brick", ASTM C-32, Grade SS.
- B. Mortar shall be in accordance with the "Standard Specifications for Portland Cement," ASTM C-150 for Type II.

4. 08 MANHOLE AND INLET STEPS

- A. Steps in structures shall be made of (3/8) three-eighths inch diameter (No.3) steel bars, ASTM Designation A-615, Grade 60, encased in polypropylene plastic. Manhole steps shall have tread ridge with retainer lug on each side.
- B. Steps in structures shall be cast in place during manufacture of precast reinforced concrete risers and eccentric top sections, or embedded during construction of brick manholes. Embedment length shall be suitable for minimum five (5)-inch thick, precast reinforced concrete riser walls.
- C. Steps in structures shall be OSHA approved and as manufactured by; M.A. Industries, Inc., Peachtree City, Georgia; ICM, Inc., Jacksonville, Arkansas, or equal.
- D. Steps in structures shall be spaced twelve (12)-inches apart. The maximum spacing from top of manhole to the first step shall not exceed sixteen (16)-inches.

END OF SECTION

DATE: December 2005	STORM DRAIN AND APPURTENANCES	
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5.01 GENERAL

- A. Contractor shall provide all labor, materials and appurtenances for construction of concrete sidewalk, curb and gutter where indicated on the drawings and as specified.
- B. The Contractor shall furnish and install PVC pipe sleeves in sidewalk areas designated by the Owner for street signs.

5.02 METHODS AND MATERIALS

- A. All materials and construction methods shall be in accordance with the most recent DeIDOT Specifications for Road and Bridge Construction. All curb and gutter shall be as per most recent DeIDOT Standard Construction Details.
- B. All concrete shall be according to DeIDOT Specifications for Road and Bridge Construction, Section 812, Class B. Minimum ultimate compressive strength of concrete shall be 3,000 pounds per square inch at the end of twenty-eight (28) days. Submit mix design for approval. All concrete shall be air entrained.
- C. Curbs shall be depressed at all existing driveway locations in accordance with DeIDOT Standard Construction Details, including proper preparation of subgrade and proper placing and spacing of joints and joint materials.
- D. The Contractor shall permanently repair or relay all curbs, sidewalks and driveways that have been removed, broken, or otherwise injured in executing any of the work under the contract or injured by settlement of any backfilled excavation at any time prior to termination of the contract and guarantee period. The minimum allowable length for replacement of damaged curb shall be ten (10) feet.
- E. New curb and sidewalk or replacement of areas damaged during construction shall be installed in accordance with the most recent DeIDOT Specifications for Road and Bridge Construction. Install wheelchair curb ramps at all street corners constructed as per current DeIDOT Standard Construction Details.

5.03 SUBBASE

Subbase for concrete sidewalk and integral curb and gutter shall be clean, well graded, select material. Select material shall be well-graded sand or bank-run sand-gravel. Compact to at least 95% of maximum density at minus two (2) to plus two (2) percent of optimum moisture content as determined by the Modified Proctor Test ASTM D1557.

DATE: December 2005	CONCRETE SIDEWALKS, CURB & GUTTER, AND DRIVEWAYS	
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5.04 RECONSTRUCTION OF PRIVATE DRIVEWAYS

Saw cut existing driveways if sections are acceptable for reuse. Prior to replacement of driveways, the Contractor, Engineer and Owner shall review field conditions. The Owner will designate the extent of additional removal and replacement which shall not entitle the Contractor to additional compensation above the unit price bids. Upon completion of utility construction, the Contractor shall reconstruct private driveways in kind, except as follows:

A. Concrete Driveways

- 1) Concrete driveways shall be replaced and reconstructed upon a properly prepared, graded and compacted subgrade and in compliance with the most recent DelDOT Specifications for Road and Bridge Construction.
- 2) Driveways shall be constructed to a minimum thickness of six (6)-inches and shall be reinforced with six (6)-inch by six (6)-inch w1.4 x w1.4 wire mesh.
- 3) Restoration shall provide for a smooth transition from back of sidewalk or driveway construction to undisturbed areas and shall be free of all localized depressions or abrupt changes in grade that may trap or otherwise misdirect surface drainage or represent possible damage to vehicular travel.

B. Bituminous Concrete Driveways

- 1) Bituminous driveways and parking areas disturbed through the Contractor's construction operations shall be restored by a minimum of two (2)-inches of hot-mix bituminous concrete pavement placed in a single lift onto a base course consisting of four (4)-inches of properly prepared and compacted crushed stone or quarry waste. Commercial and residential entrances on state maintained streets shall be in accordance with the plan details. Match existing thickness where condition exceeds minimum restoration.
- 2) The hot-mix bituminous concrete surface shall conform to the most recent DelDOT Specifications for Road and Bridge Construction for Type C and shall be constructed in accordance with the applicable Articles of Section 401 "Hot-Mix, Hot Laid Bituminous Concrete Pavement".
- 3) The subgrade shall be properly prepared, graded and compacted in accordance with Section 2 of the specifications noted above.

5.05 SIDEWALK CONSTRUCTION

- A. Concrete sidewalks shall be replaced as required, or as directed, in accordance with

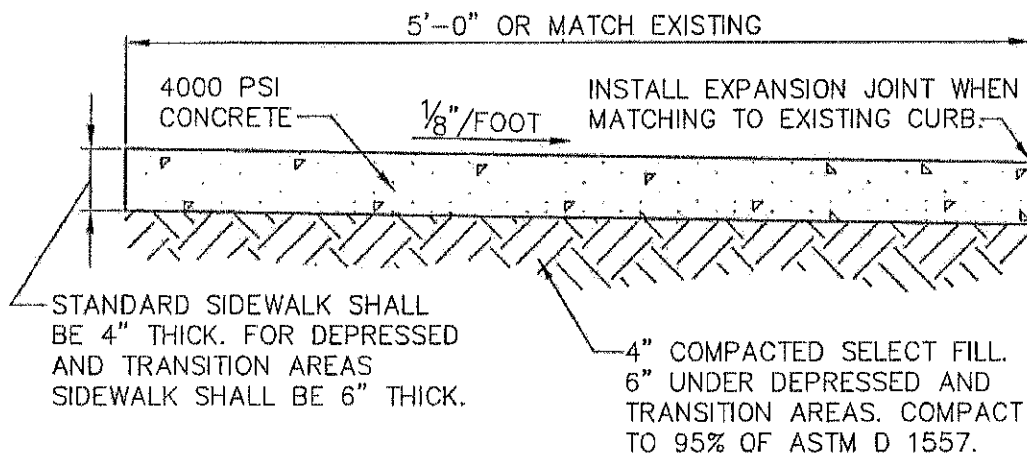
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REVISION:	SECTION 5	PAGE : 5-2

Section 705 of the most recent DelDOT Specifications for Road and Bridge Construction. Handicap ramps shall be installed in all areas defined herein.

- B. Sidewalks in areas not subject to vehicular loading shall have a minimum thickness of four (4)-inches placed upon a properly prepared, graded and compacted subgrade.
- C. Sidewalks in vehicular loading areas shall be a minimum thickness of six (6)-inches reinforced with six (6)-inch by six (6)-inch, w1.4 x w1.4 wire mesh. Subgrade shall be prepared as stated for non-load areas.
- D. Replacement of partial sections of concrete sidewalk, where so directed, shall be extended to the nearest existing joint in each direction.
- E. Sidewalks shall be replaced to a width equal to that existing prior to start of construction and such width shall be maintained throughout the entire length of the block. In no instance shall the constructed width be less than four (4) feet. The width for installation for new sidewalk shall be five feet.
- F. A broom finish shall be applied perpendicular to the direction of traffic.

END OF SECTION

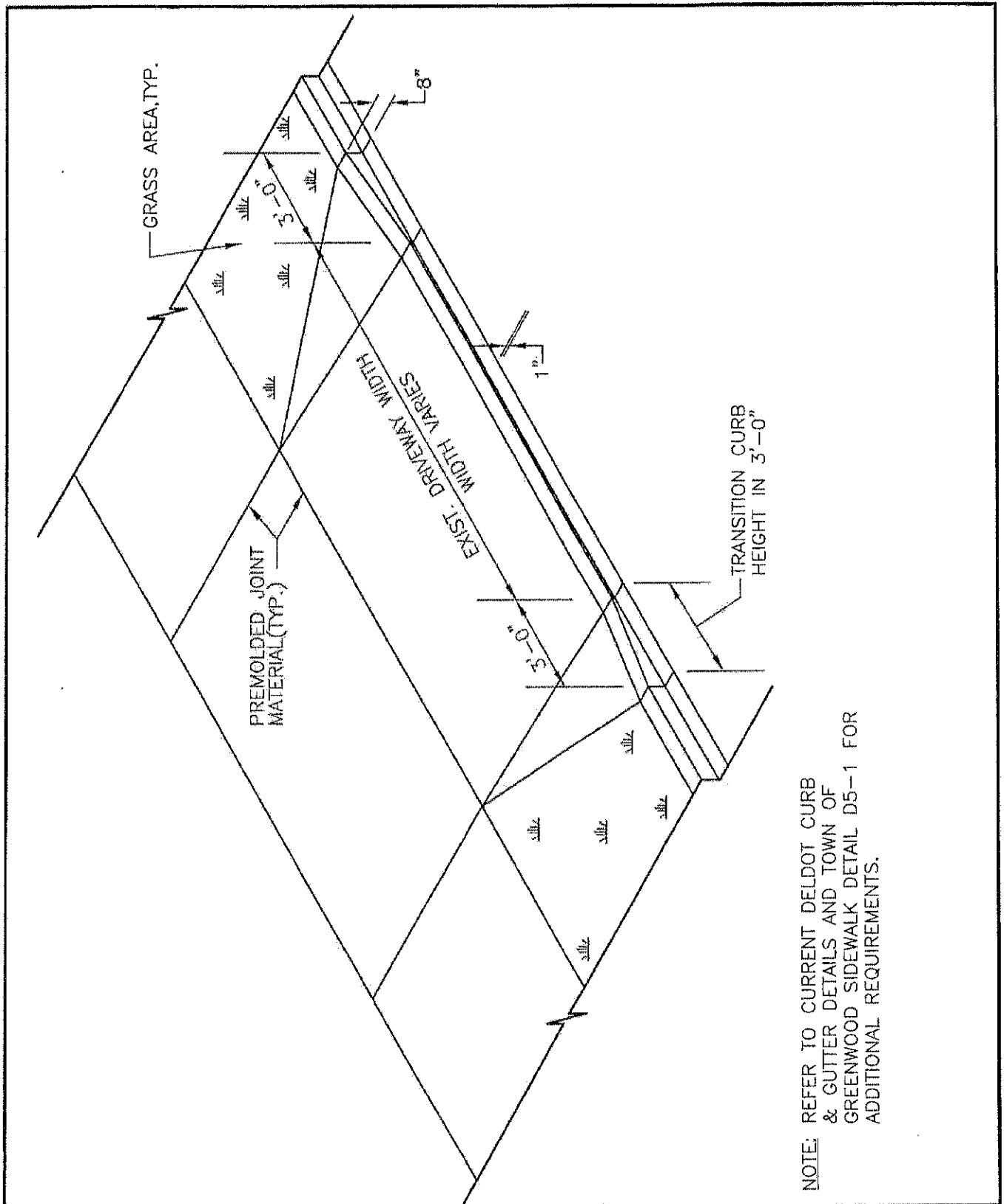
DATE: December 2005	CONCRETE SIDEWALKS, CURB & GUTTER, AND DRIVEWAYS	
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NOTE: PLACE EXPANSION JOINTS 20' ON CENTER AND CONTROL JOINTS 5' ON CENTER OR MATCH EXISTING PATTERN.

CONCRETE SIDEWALK DETAIL
NO SCALE

DATE:	REVISION NO.:	APPROVED:	
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		SIDEWALK DETAIL NO SCALE	
		SECTION - 5	DRAWING: D5-1



DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		DRIVEWAY CURB CUT DETAIL NO SCALE
SECTION - 5		DRAWING: D5-2

6.01 GENERAL

- A. The Contractor shall restore all surfaces damaged by his operations to the widths and extent detailed or noted on the plans or specified herein.
- B. Surface restoration in streets and roads maintained by the State Department of Highways shall be accomplished in accordance with applicable utility construction permits.
- C. Various conditions and types of surface restoration are shown on the details. Materials and construction methods to be in accordance with the following specification and the most recent DelDOT Specifications for Road and Bridge Construction.
- D. Existing pavement to be trimmed to secure a straight clean edge for repaving. Saw cut pavement as shown on the drawings and as directed to obtain a clean pavement edge.
- E. No staggered or irregular longitudinal trench repair widths shall be allowed in each block of work. Repairs shall be of a uniform width and in a straight line.
- F. Minimum pavement restoration width is four (4) feet, including edge of roads. Actual width shall be as detailed or noted on the plans. Payment is limited to these widths. Should the Contractor damage or disturb larger areas, he shall replace the additional area at his cost.
- G. Surface course and concrete sections shall be lifted out , not broken out.
- H. Undermined areas shall be grout filled or cut back.
- I. A temporary two (2)-inch layer of cold patch shall be placed on all utility trenches at the end of every workday.
- J. Metal plating may be used at the end point of the utility laying operation and must be used to protect the integrity of concrete patches.
- K. All adjustments to existing utilities shall be made prior to overlay operations and have to be repeated if there is any damage due to rolling and compacting operations.
- L. Manhole or catch basin adjustments can be made with pre-cast manhole adjustment rings, brick courses or mortar layers. Valve boxes shall be adjusted to the proper elevation using the screw adjustment.

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- M. Pavement adjacent to all trenches shall be cut back by one (1) foot on each side.
- N. Skewed patches will not be permitted. All patches shall be boxed square.
- O. Paving operations can be performed with the minimum temperatures, material types, and thicknesses as specified in Section 410 of the most recent DelDOT Specifications for Road and Bridge Construction.
- P. Catch basins, inlets, curbs and all other appurtenances shall be adequately covered and protected prior to application of bituminous materials. No earth or bituminous materials shall be allowed to enter any storm drainage system and suitable containment provisions shall be employed to prevent surface runoff of bituminous materials.
- Q. The final surface, except on overlays, shall match grades existing prior to construction and shall be such that a smooth transition free of abrupt changes in grade is made with adjacent pavements and/or sidewalks. No depressions or other misalignment shall obstruct, trap or otherwise misdirect the flow of surface water drainage.

6.02 MAINTENANCE OF REFILLED EXCAVATIONS

- A. The Contractor shall maintain, at his own expense, all refilled excavations and surfacing in proper condition as specified herein. All depressions appearing in the refilled excavation, stabilized base and temporary paving shall be properly refilled. If the Contractor fails to make repairs within forty-eight (48) hours after receipt of written notice from the Engineer, the Owner may refill said depressions and the cost thereof shall be billed to the Contractor. In case of emergency, the Owner may refill any depression or protect with barricades without giving previous notice to the Contractor, and the cost of so doing shall be billed to the Contractor.
- B. The Contractor shall be responsible for any injury or damage that may result from lack of maintenance of any refilled excavation at any time.

6.03 BASE COURSES

- A. Crusher Run

Crusher run base course shall be spread on prepared and compacted refilled excavations to the compacted depth shown on the drawing details.

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Materials and methods of construction shall meet the provisions of Section 302 of the referenced DelDOT specifications.

B. Bituminous Concrete Base Course (Deeplift)

Bituminous concrete base course shall be spread on prepared and compacted refilled excavations to the compacted depth shown on the drawing details.

Materials and methods of construction shall meet the provisions of Section 401 of the referenced DelDOT specifications.

6.04 BITUMINOUS SURFACE TREATMENT

- A. Bituminous surface treatment shall consist of a number of courses of bituminous material and aggregate as shown on the drawings.
- B. Materials and methods of construction shall meet the provisions of Section 404 of the referenced DelDOT specifications.

6.05 BITUMINOUS CONCRETE PAVEMENT

- A. Hot-mix, hot laid bituminous concrete shall consist of placing bituminous concrete base and/or wearing courses on a prepared base to the minimum compacted thickness shown on the drawings.
- B. Hot-mix, hot laid bituminous concrete shall meet the provisions of Section 401 of the referenced DelDOT specifications. All thicknesses detailed shall be compacted thicknesses.

6.06 CONCRETE PAVEMENT

- A. Concrete used in the restoration of streets and roads shall be placed to the minimum thickness shown on the drawings. Concrete may be a base course with a bituminous concrete overlay or a finished surface course as shown on the drawings.
- B. Concrete pavement shall meet the provisions of Section 500 -Rigid Pavement, of the referenced DelDOT specifications.
- C. Concrete sidewalk, curb, gutter and driveway restoration shall meet the provisions of Sections 701 and 705 of the referenced DelDOT specifications.

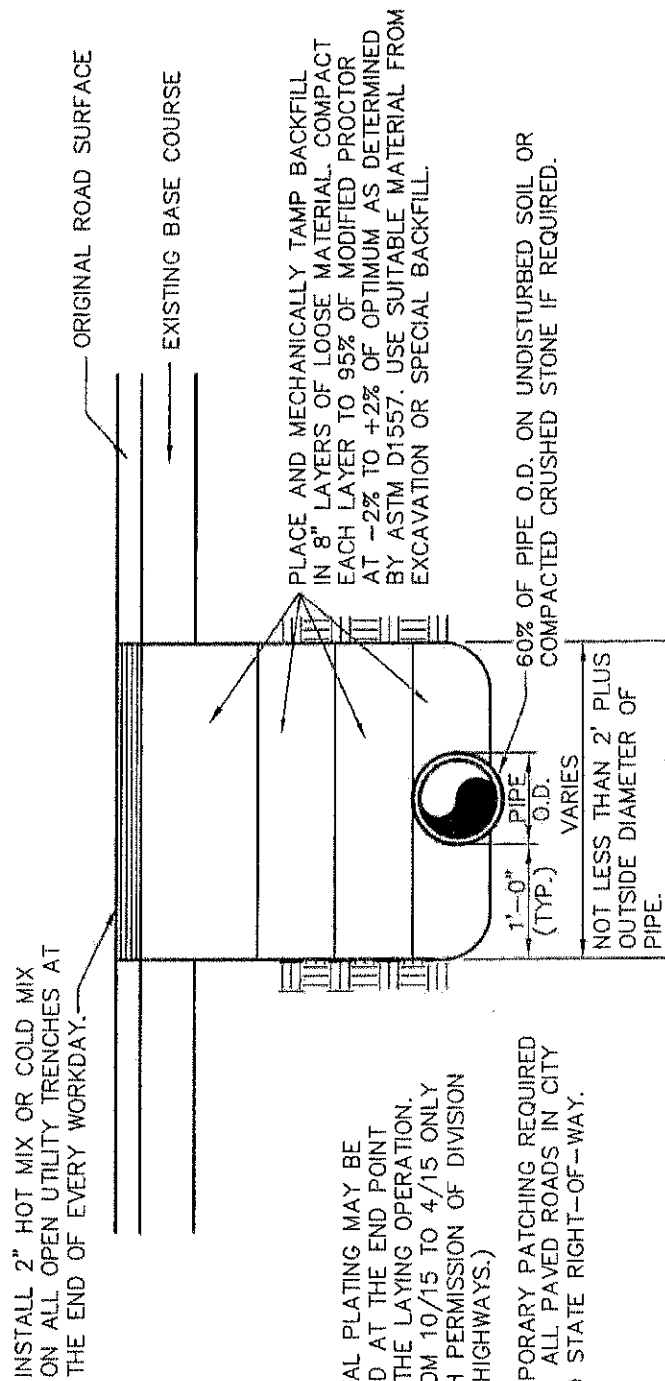
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6.07 TOPSOIL AND SEEDING

- A. Topsoil shall be placed in areas where grass has been disturbed by the Contractor's operations. Depth of topsoil shall be four (4)-inches minimum. Topsoil salvaged and stockpiled during trench and structure excavation may be used for this purpose. When topsoiling, all materials and methods of construction shall meet the provisions of Sections 732 and 733 of the referenced DelDOT specifications.
- B. Seeding shall consist of furnishing and placing seed and soil supplements on topsoiled areas and at any other locations as directed by the Engineer. When seeding, all materials and methods of construction shall meet the provisions of Section 734 of the referenced DelDOT specifications.
- C. Fertilizer shall be a recognized commercial fertilizer containing a minimum 5% nitrogen, 10% available phosphoric acid and 10% soluble potash by weight. It shall be applied in sufficient amounts to provide sixty (60) pounds of nitrogen per acre.
- D. Fertilizing and seeding application rates shall be in conformance with Section 734 "Seeding" of the referenced DelDOT specifications as specified for "Standard Roadside Mix". Seed shall be applied at a rate of four (4) to five (5) pounds per 1000 square feet.
- E. No mulch shall be required unless the area to be seeded rests upon a slope greater than 3 to 1. Mulch for these areas shall consist of straw mulch as specified in Section 735 "Mulching" of the referenced DelDOT specifications.

END OF SECTION

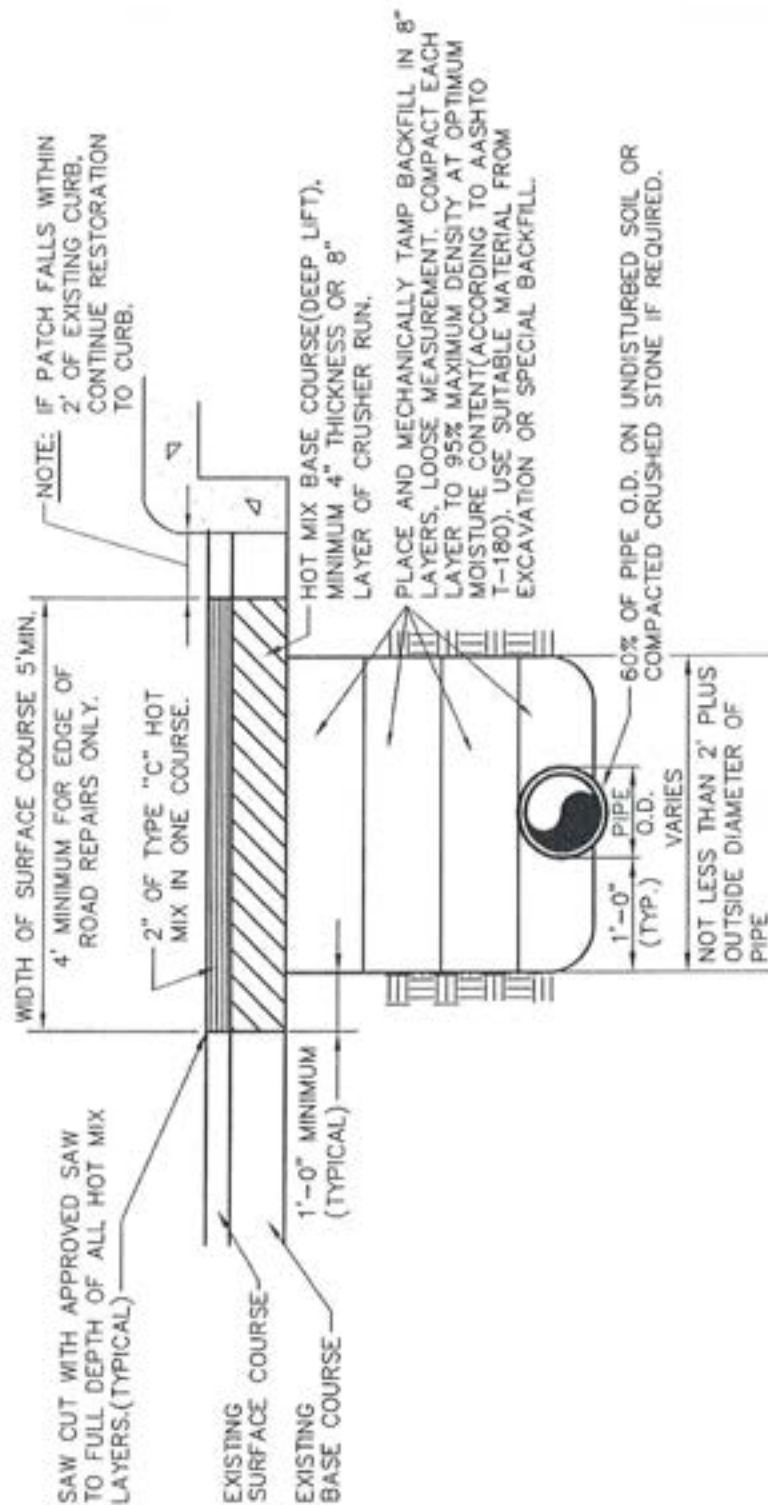
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NOTES:

1. METAL PLATING MAY BE USED AT THE END POINT OF THE LAYING OPERATION. (FROM 10/15 TO 4/15 ONLY WITH PERMISSION OF DIVISION OF HIGHWAYS.)
2. TEMPORARY PATCHING REQUIRED FOR ALL PAVED ROADS IN CITY AND STATE RIGHT-OF-WAY.

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		TEMPORARY CROSS ROAD AND LONGITUDINAL PATCH DETAIL NO SCALE
		SECTION - 6 DRAWING: D6-1



PERMANENT CROSS ROAD AND LONGITUDINAL PATCH (HOT-MIX OVER CRUSHER RUN OR DEEP LIFT TYPE BASE COURSE.)

DATE:

REVISION NO.:

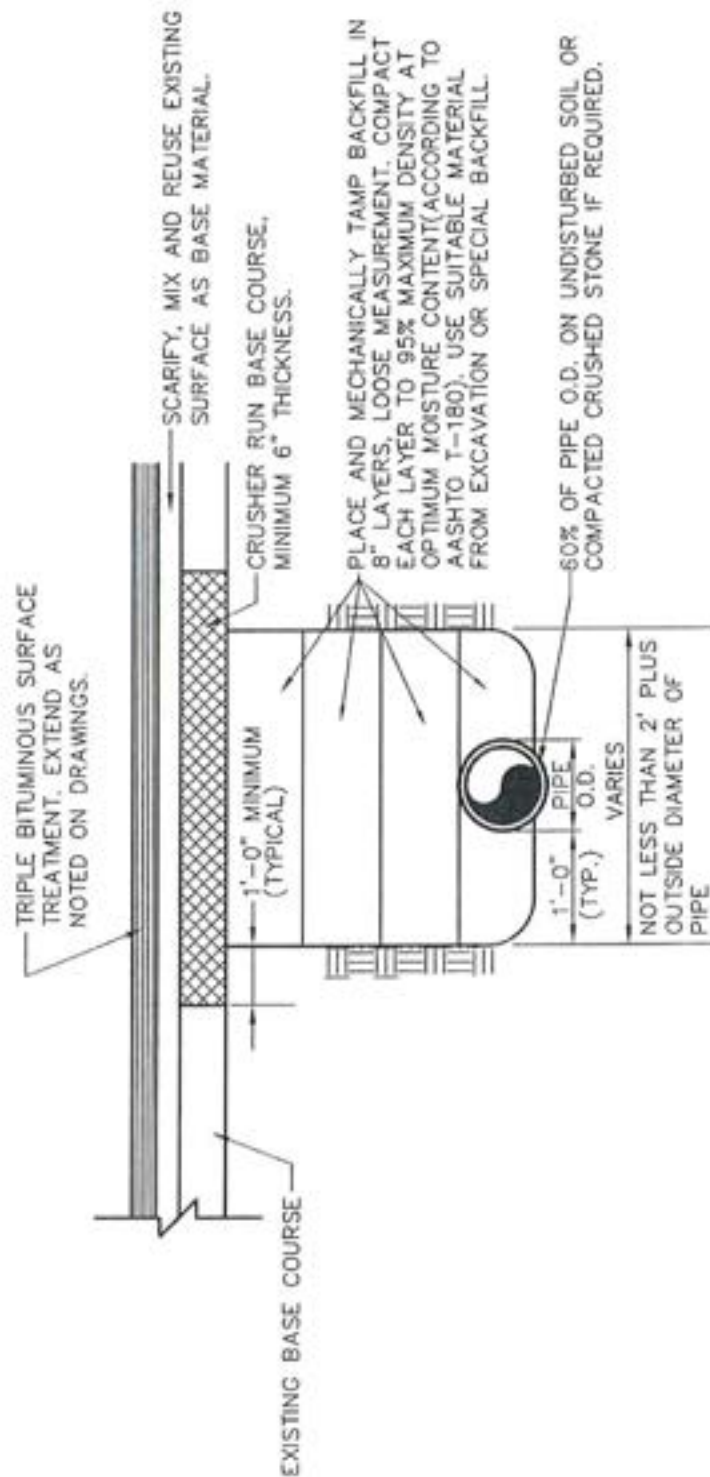
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
STREET DIVISION
CONSTRUCTION STANDARDS

PAVEMENT RESTORATION DETAIL #1
FOR CITY STREETS
NO SCALE

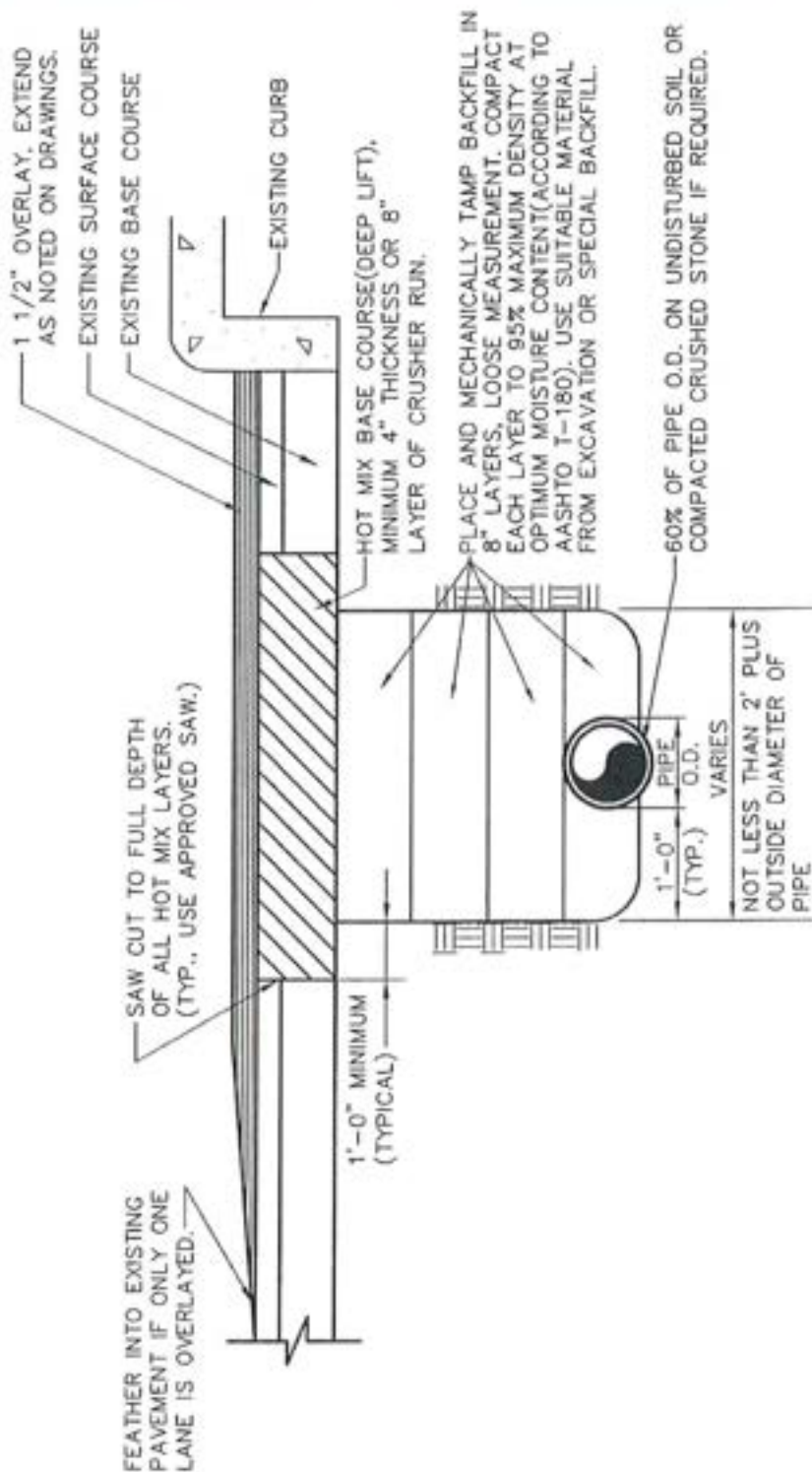
SECTION - 6

DRAWING: D6-2



PERMANENT CROSS ROAD AND LONGITUDINAL PATCH (BITUMINOUS SURFACE TREATMENT OVER CRUSHER RUN BASE COURSE)

DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		PAVEMENT RESTORATION DETAIL #2 FOR CITY STREETS NO SCALE
		SECTION - 6 DRAWING: D6-3



OVERLAY DETAIL

(HOT-MIX OVER CRUSHER RUN OR DEEP LIFT TYPE BASE COURSE.)

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TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		PAVEMENT RESTORATION DETAIL #3 FOR CITY STREETS NO SCALE
SECTION - 6		DRAWING: D6-4

7.01 SOILS INVESTIGATION

- A. The Owner or Developer shall employ the services of a Geotechnical Engineering firm to perform a subsurface investigation for the purpose of obtaining information needed to design the proper pavement section.
- B. The Geotechnical Engineering firm used, must have on staff, an engineer registered in the State of Delaware who is qualified and experienced in the field of Geotechnical Engineering and who is actually engaged in the practice of soils mechanics and foundation engineering.
- C. Borings shall be made for all proposed streets within the project area. The following guidelines and methods will be followed when performing the field work:
- 1) Borings shall be accomplished by using hollow stem augers and/or other equipment necessary to obtain soil samples of each stratum encountered.
 - 2) Boring locations shall be placed along the centerline of the street no more than 300 feet apart, with a minimum of two (2) borings per street.
 - 3) Borings shall be performed to a depth of three (3) feet below the subgrade of the proposed pavement system.
 - 4) Soil shall be sampled by stratum. At each soil composition change, a sample, sufficient in size to perform the required laboratory testing, shall be obtained.
 - 5) When water is encountered, borings should be left open until water level stabilizes, and then depth to water should be recorded.
 - 6) A log of each boring should be performed by the geotechnical field personnel. The following information should be recorded on the boring log:
 - a. Name of street
 - b. Location of boring - Station and offset
 - c. Surface elevation
 - d. Date boring was performed
 - e. Depth, vertical arrangement, and thickness of each stratum
 - f. Sample number
 - g. Visual soil classification of each stratum
 - h. Depth to water (if encountered)

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- D. The following laboratory tests shall be performed on the material sampled from each stratum encountered in the individual borings:
- 1) Practice for dry preparation of soil samples for particle size analysis and determination of soil constants (ASTM Designation D421).
 - 2) Method of particle-size analysis of soils (ASTM Designation D422).
 - 3) Amount of material in soils finer than the number 200 sieve (ASTM Designation D1140).
 - 4) Method for laboratory determination of water content of soils (ASTM Designation D2216).
 - 5) Classification of soils for engineering purposes (ASTM Designation D2487).
 - 6) Test method for liquid limit, plastic limit and plasticity index of soils (ASTM Designation D4318).
- E. Methods which deviate from any of the above procedures must be submitted to the Town of Greenwood for approval.
- F. Results of the soil investigation submitted to the Town of Greenwood should contain the following information:
- 1) A plan view of the proposed streets showing boring locations.
 - 2) Logs containing the required data for all borings made.
 - 3) Tests results of all laboratory tests performed.
 - 4) A profile view of each street with borings plotted to scale showing the ASTM classification of soils encountered.
- G. The Town of Greenwood reserves the right to check soil survey borings and inspect testing laboratories as part of their review of the investigation work.

7.02 SUBDIVISION PAVEMENT DESIGN

- A. Subdivision streets shall be designed based on the following standards and practices.
- B. The applicable details show typical sections for residential streets, based on the following definitions:

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- 1) Minor Street - A street which will serve less than 50 dwelling units.
 - 2) Minor Collector Street - A street serving between 50 and 300 dwelling units.
 - 3) Major Collector Street - A street serving over 300 dwelling units.
- C. The design of pavement sections for subdivision streets shall be based on the type of soils as determined by the soils investigation, the anticipated number of units utilizing the streets, and the utilization of streets by construction traffic.
- D. The required structural numbers are shown in the attached tabulations.
- E. For streets serving over 50 units, a minimum of three (3)-inches of hot-mix surface and base course and six (6)-inches of compacted graded aggregate shall be used.
- F. The final wearing course of hot-mix on collector streets shall not be placed until 75% of the houses are completed or within one (1) year of placement of the base course of hot-mix, whichever occurs first.
- G. Prior to placing the pavement section, the subgrade shall be prepared and test rolled as detailed in the most recent DelDOT Specifications for Road and Bridge Construction. If the test rolling shows the subgrade to be unstable, the Contractor shall scarify, disc, aerate or add moisture and recompact the subgrade to the extent that when retested it will be stable. If, in the opinion of the Engineer, there are areas to be removed or undercut, they may be ordered, excavated and replaced with approved material.
- H. The total minimum required structural number based on the number of units using the street are as follows:

REQUIRED STRUCTURAL NUMBER

No. of Units	Good Soil	Poor Soil
1 - 50	1.70	2.70
51 - 100	2.00	2.90
101 - 200	2.50	3.30
201 - 300	2.90	3.70
Over 300	3.30	4.10

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See most recent DelDOT Rules and Regulations for Subdivision Streets for specific material thicknesses.

Note: Good soils - all soils within the A-1, A-2, and A-3 AASHTO soil classifications.

Poor soils - all soils within the A-4, A-5, A-6 and A-7 AASHTO soil classifications.

- I. The pavement section of streets built to serve a future area of development shall be increased in strength to serve both the present and future traffic loads. If such a street must also serve construction traffic of future development, the pavement section shall again be increased in strength as follows:

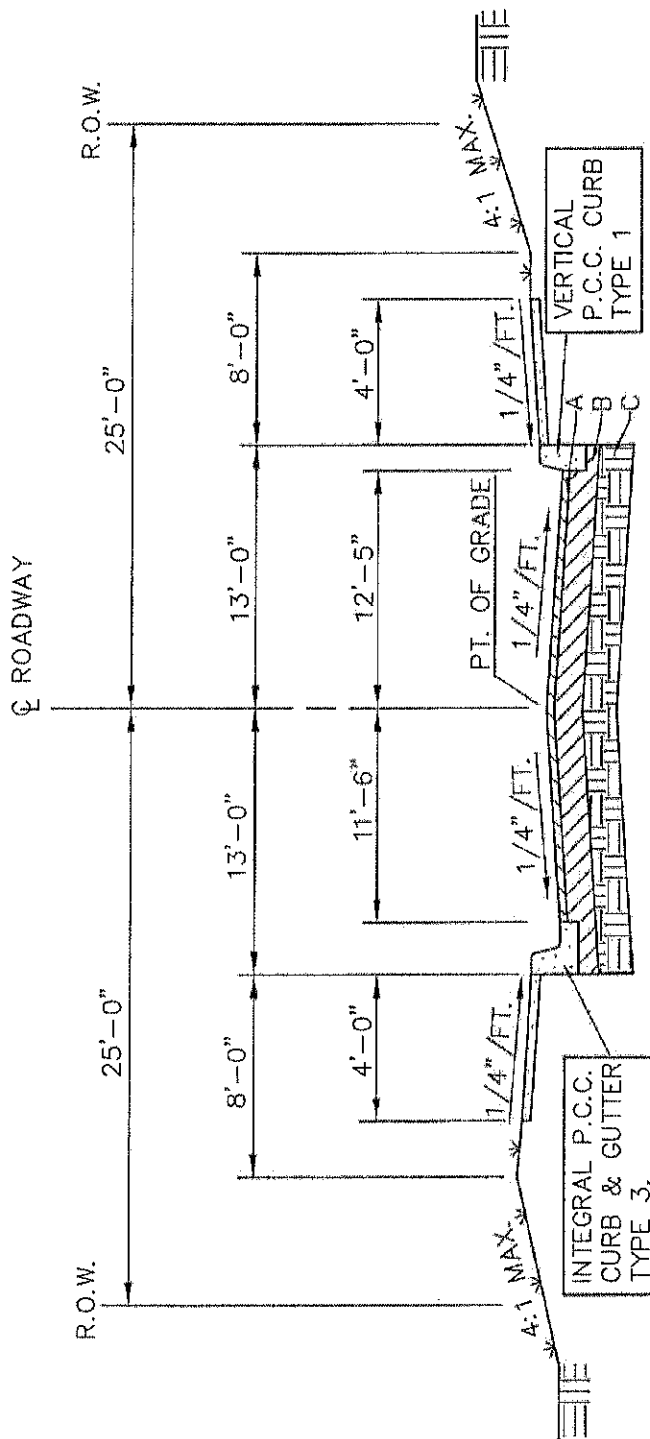
No. of Units Proposed for Future Development Area	Increase in Structural Number
1 - 100	0.48
100 - 300	0.80

- J. Following is the list of structural numbers used to obtain a pavement section thickness which will meet or exceed the minimum required structural number shown above:

Use	Material	Structural Number for Inch Thickness
Surface Course	Type C Hot-Mix	0.40
Base Course	Type A Hot-Mix	0.35
	Type B Hot-Mix	0.40
	Bituminous Concrete (Deep Lift)	0.32
Sub-base Course	Select Borrow	0.08
	Quarry Waste	0.11
	Crusher Run	0.14
	Pre-Mixed (CR-1)	0.20
	Soil Cement (6% Cement \pm 1%)	0.20

END OF SECTION

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PAVEMENT WIDTH SHALL BE 11'-0" WHEN USING
INTEGRAL P.C.C. CURB & GUTTER TYPE 2.

NOTES:

1. ALL CURBING SHALL BE AS PER
CURRENT DELDOT STANDARDS.

2. ↳ ↳ ↳ 6" TOPSOIL, SEED AND MULCH.

3. REFER TO SECTION 5 FOR SIDEWALK
SPECIFICATIONS.

4. REFER TO SECTION 7 OF THE
SPECIFICATIONS FOR DESIGN
INFORMATION.

A - COMPACTED HOT MIX ASPHALT
SURFACE AND BASE COURSE
PER DIVISION OF HIGHWAYS
STANDARD SPECIFICATIONS.

B - SUB BASE COURSE MATERIAL
COMPACTED TO 95% OF ASTM
D1557 MODIFIED PROCTOR
METHOD.

C - SUBGRADE MATERIAL COMPACTED
TO 95% OF ASTM D1557 MODIFIED
PROCTOR METHOD.

DATE:

REVISION NO.:

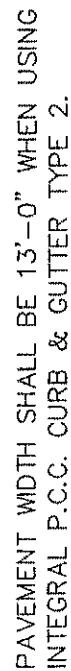
APPROVED:

TOWN OF GREENWOOD
DEPARTMENT OF PUBLIC WORKS
STREET DIVISION
CONSTRUCTION STANDARDS

TYPICAL SECTION DETAIL
MINOR STREET
NO SCALE

SECTION - 7

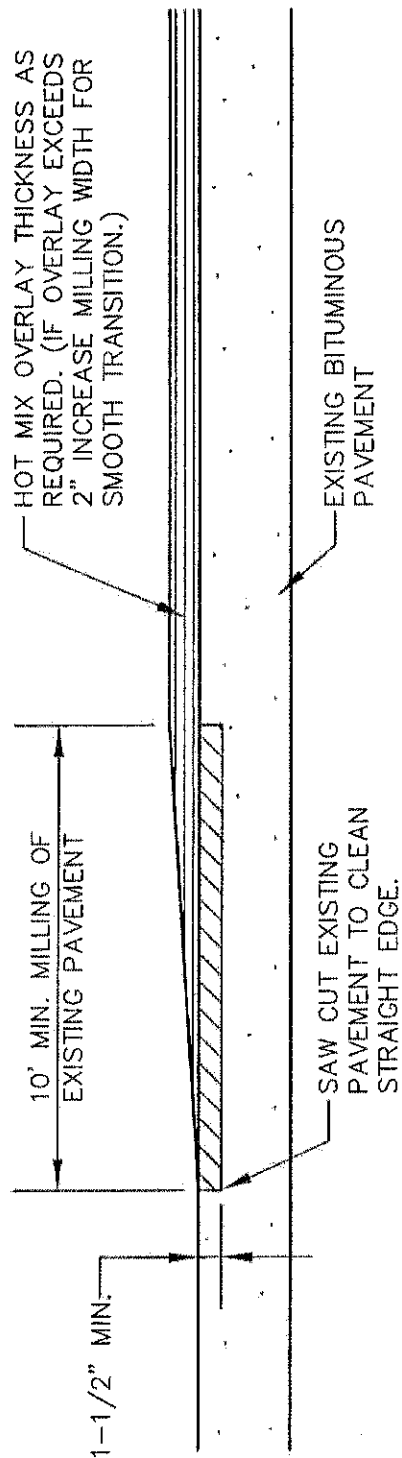
DRAWING: D7-1



4. REFER TO SECTION 7 OF THE SPECIFICATIONS FOR DESIGN INFORMATION.

C - SUBGRADE MATERIAL COMPACTED TO 95% OF ASTM D1557 MODIFIED PROCTOR METHOD.

DRAWING: D7-2



DATE:	REVISION NO.:	APPROVED:
TOWN OF GREENWOOD DEPARTMENT OF PUBLIC WORKS STREET DIVISION CONSTRUCTION STANDARDS		HEELING-IN DETAIL NO SCALE
SECTION - 7		DRAWING: D7-3

8.01 CAST-IN-PLACE CONCRETE

A. APPLICABILITY

This section shall not apply to zoning categories R-1, R-2, R-3 and OB-1.

8.02 SUBMITTALS

- A. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- B. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Drawings-Fabrication/Erection/Installation: Drawings for reinforcement and accessories, without reference to the contract drawings.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.
- G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Form materials and form-release agents.
 - 3. Steel reinforcement and reinforcement accessories.
 - 4. Admixtures.
 - 5. Curing materials.
 - 6. Floor and slab treatments.
 - 7. Bonding agents.
 - 8. Adhesives.
 - 9. Vapor retarders.
 - 10. Joint-filler strips.

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11. Pigmented dry-shake floor hardener.

8.03 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. **Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
 2. Material manufacturers shall be ISO 9001/9002 registered proof of documented quality assurance system. Quality system must be independent auditing registrar. ISO 9001/9002 certification shall be included with material submittals.
- D. **Testing Agency Qualifications:** An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- E. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- F. **Welding:** Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- G. **ACI Publications:** Comply with the following, unless more stringent provisions are indicated:

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1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
2. ACI 211, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete."
3. ACI 212, "Chemical Admixtures for Concrete."
4. ACI 301, "Specification for Structural Concrete."
5. ACI 302.1R, "Guide for Concrete Floor Slab Construction."
6. ACI 305R, "Hot Weather Concreting."
7. ACI 306R, "Cold Weather Concreting."
8. ACI 308, "Standard Practice for Curing Concrete."
9. ACI 309R, "Guide for Consolidation of Concrete."
10. ACI 315, "Details and Detailing of Concrete Reinforcement," latest edition.
11. ACI 318, "Building Code Requirements for Reinforced Concrete," latest edition.
12. ACI 347, "Recommended Practice for Concrete Form Work."

8.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
1. Avoid damaging coatings on steel reinforcement.
 2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D3963/D3963M.

8.05 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Mixers: Concrete may be job mixed or ready-mixed. Shrink mixing will not be permitted. Transit mixed concrete shall be mixed and have water added only at the site. All mixing equipment must, in the opinion of the inspector, be suitable for the job. A standard type of batch mixer shall be used and no hand mixing will be permitted. Ready-mixed concrete shall conform to ASTM C94. Contractor is to maintain a readily available file of delivery tickets stating design strength, mix slumps, aggregate and admix (if applicable) and yards delivered for all concrete.
- C. Charging Procedure: Mix shall be kept at a consistency which can be placed readily without segregation. Aggregates shall be measured in grated hoppers by weight, in a manner which can easily be checked. Cement shall be measured by volume or by

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weight. Air slacked cement or cement which is lumpy, whatever the cause, shall not be used. Worming of cement directly into truck mixers shall not be permitted.

- D. **Mixing Procedure:** In stationary mixers, mixing time shall be a minimum of ten minutes after addition of water. If an extra charge of water is required because of too low slump, the drum shall be turned a minimum of 30 revolutions after adding such charge. Once initial set has taken place, no attempt shall be made to temper the concrete by the addition of water. Any concrete so tempered will be rejected and shall be removed from the site. Mixers shall not be charged in excess of the rated speed. Mixer shall be completely discharged before recharging.
- E. **Time Limit:** When either Type I or Type II Portland cements are in use, the elapse time between the initial contact of the cement with water and the discharge of the batch on the job shall not be more than 1 ½ hours or 300 revolutions.
- F. **Project-Site Mixing:** Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least one and one-half minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

8.06 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class B, 1/4 inch (6 mm).

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- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 - 1. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

8.07 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required.
 - 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls,

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where flashing is shown at lintels, shelf angles, and other conditions.

8.08 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork, for structural elements that support weight of concrete in place until concrete has achieved the following:
 - 1. At least 70 percent of 28-day design compressive strength.
 - 2. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

8.09 SHORES AND RESHORES

- A. Comply with ACI 318 (ACI 318M), ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

8.10 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
- B. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).

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8.11 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

8.12 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
 - 2. Locate joints for beams, slabs, and walls in the middle third of spans.
 - 3. Space vertical joints in walls as indicated.
 - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth

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equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: For sidewalks and as indicated, form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete as soon as cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

8.13 WATERSTOPS

- A. Self-Expanding Strip Waterstops: Install in wall to base slab intersections and at other locations indicated, according to manufacturer's written instructions, bonding fastening and firmly pressing into place. Install in longest lengths practicable.

8.14 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

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- D. Dropping of concrete over 4 feet or through a cage of reinforcing steel will not be permitted.
- E. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
 3. Provide a minimum of 2 vibrators in good working condition on the job at all times.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Concrete shall not be deposited during rain. Concrete shall not be deposited into areas of standing or running water.
- H. Maximum Pours: Maximum length of wall pours shall be 40 feet (12.1 m), unless otherwise noted or approved by Engineer. All joints shall be as approved by the Engineer or as detailed on the drawings. All reinforcement, forms and ground with which concrete is to come in contact, shall be free of frost.
- I. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete

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work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
 4. Protection After Placement: Suitable means as defined in ACI 306 shall be provided for maintaining a temperature in the concrete of at least 50 degrees F for not less than three days after the concrete is placed. For a period of seven days, the concrete shall not be exposed to a temperature below 40 degrees F.
 5. Concrete placement shall be made when air temperature is at least 32 degrees F and rising, unless special precautions acceptable to the Engineer,
- I. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

8.15 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and

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to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

- C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot (3.05-m) long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
 - a. 1/4 inch (6.4 mm).
- D. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

8.16 CONCRETE PROTECTION AND CURING

- A. General: Take curing measures immediately after casting and extend period according to the Engineer's/Architect's recommendation based upon prevailing temperature, wind, and relative humidity.
 - 1. Keep concrete continuously moist for minimum 14 days after casting.
 - 2. Maintain concrete temperature at minimum 50 degrees Fahrenheit for seven days after casting.
 - 3. Avoid alternate wetting and drying and fluctuations of concrete temperature.
 - 4. Protect fresh concrete from direct rays of sun, rain, drying winds, soiling, and damage.
 - 5. Do not permit curing method to affect adversely finished or treatments applied to finished concrete.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot,

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dry, or windy conditions will cause moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Curing/Sealing Methods for Slabs: Cure all concrete surfaces with one or a combination of the following methods. Where a specific curing procedure is not specified, at the Contractor's selection, one or more of the following methods shall be used.
1. Water curing: Keep concrete surfaces continuously wet with clean water during the curing period by immersion, maintaining a continuous flow of water over the surface, continuous spraying, continuous sprinkling or a combination of these. For all curing methods, the difference in temperature between the water used for curing and the concrete shall not exceed 20 degrees Fahrenheit.
 2. Wet Coverings: Cover the concrete surfaces with burlap, cotton mats, sand, earth, or other suitable moisture retaining materials and keep these materials saturated during the curing period. Lap all fabrics at least 8 inches at all joints. On exposed concrete, do not use any type covering which will discolor the concrete surface.
 3. Waterproof coverings: As soon as possible after finishing, thoroughly wet the concrete surfaces and cover the concrete surfaces with waterproof paper or plastic film immediately after wetting. For a period or at least 8 hours after the concrete has taken its initial set, maintain a continuous flow of clean water over the concrete surface under the covering. Lap all joints in the covering at least 8 inches and provide weights and other means and methods to keep the waterproof covering in direct contact with the concrete during the curing period.
 4. Membrane forming curing compounds: All exposed interior slabs, not receiving a liquid densifier, and troweled slabs receiving mastic applied adhesives or "shake-on" hardeners shall be cured with the specified curing and sealing compound. Exterior slabs, sidewalks, curbs, and architectural concrete, not receiving a penetrating sealer, shall be cured with the specified clear, non-yellowing curing and sealing compound. Maximum coverage shall be 4000 ft²/gallon on steel troweled surfaces and 300 ft²/gallon on floated or broomed surfaces for the curing/sealing compound.
- C. Other Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

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1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - A. Water.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

8.17 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

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8.18 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Test reports shall be submitted to the Town inspector, contractor and concrete manufacturer, within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- B. Testing Services: Testing of composite samples of fresh concrete shall be obtained and tested as per most recent version of BOCA National Building Code, Section 1908.3.

END OF SECTION

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