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DIVISION 1 GENERAL REQUIREMENTS

Section 1.01 PURPOSE OF DOCUMENTS

The purpose of these Standard Specifications and Standard Drawings is to govern any work done or improvements installed within Public right-of-ways or across easements. Construction work shall comply with Lindon City Code, [Title 17](#) Planning and Zoning. Developers/Contractors should thoroughly read and understand these specifications and standards before constructing public improvements.

The Developer/Contractor shall contact Public Works/Engineering at the Lindon City Public Works Office, 946 West Center Street, Lindon, Utah 84042 for all matters dealing with construction work within a City right-of-way or with any work connecting onto a City utility. **SPECIAL PERMITS AND BONDING ARE REQUIRED FOR ALL SUCH WORK.**

Section 1.02 PERMIT, FEES AND BONDING REQUIRED

It shall be unlawful to do any construction, excavation work on any street, curb, gutter, sidewalk, sewer line, water line, pressure irrigation line, storm drain or other infra-structure addition or improvement in the City of Lindon without a Public Works permit from the City to do so. The City of Lindon and all utility companies are bound by these standard specifications. No work shall be started until a permit is secured. In order to obtain a Public Works Permit, the Developer's/Contractor's authorized signature is required. If a contract to do such work for the City has been finalized, the contract fulfills the permit requirement.

Sub-Section A. Permit Application:

All Public Works' permit applications shall include:

- 1) Start and completion dates of the project.
- 2) The exact address or location of the work to be done.
- 3) The type of work to be done.
- 4) A request to locate water and sewer lines, notification 48 hours previous to start date of work.
- 5) A request for all utility companies to be contacted through Blue Stakes 1-800-662-4111.

Sub-Section B. Fee Assessment:

Before a permit is issued, a permit fee and an inspection fee shall be paid to the City. These fees will be set by Council resolution. Fees shall be assessed on the following items:

- 1) Sewer and water lateral installation inspection
- 2) Pressure irrigation service connection.
- 3) Re-inspection (When an inspection has been requested, the inspection is performed and the work is not complete, a re-inspection fee shall be assessed.)
- 4) Barricades (provided by, or called out by the City)
- 5) Bond

All public improvement projects done for Public Works shall be bonded. Each contractor doing work in the City is required to maintain a \$1,000.00 bond with the City. Bond requirements are to guarantee the following:

- a) Construction work is completed.
- b) Final inspection is conducted.
- c) Repairs and/or replacement of required public improvements are finished and accepted.

The bonds shall be in the form of an irrevocable letter of credit from a bank, a bond from a surety company, or a cash bond paid directly to the City. The City shall approve all bonds submitted. No bond shall be released until all improvements are completed and accepted by the City.

Section 1.03 CONTRACTOR AND CONSTRUCTION PLAN APPROVAL

Before a Contractor performs any work within the City, the City shall approve the Contractor. Approval is granted for a period of one (1) year upon submission of the following:

- a) A current Utah State Contractor's License. Work will be restricted to that authorized by the license.
- b) Proof of comprehensive general liability insurance. Bodily injury insurance will be in an amount of not less than \$600,000.00 for any one occurrence. Property damage insurance will be in an amount of not less than \$400,000.00 for any one occurrence and shall include underground exposure. Combined liability insurance will be in an amount of not less than \$1,000,000.00 for any one occurrence.
- c) A \$1,000.00 performance bond owing to the City, that will be in effect for a period of one (1) year or one (1) year after the completion of work performed by the contractor, whichever is greater.

The Public Works Representative/Engineer shall approve construction plans and cut sheets before any work begins. Developers/Contractors proceeding with work without such approvals shall have the project shut down until such approvals are obtained. Repeated offenses may result in the Contractor losing its pre-qualification to perform work in the City.

Section 1.04 PRE-CONSTRUCTION CONFERENCE

A pre-construction meeting with the Developer and the Contractor(s) involved in the subdivision construction shall be held with the Public Works Representative/Engineer prior to commencement of any work. The location of the meeting shall be at the Lindon City Public Works Office, 946 West Center Street, Lindon, Utah 84042. The following items shall be furnished at the meeting:

- a) A detailed outline showing the sequences of construction of principle items of work. The outline shall show the beginning and ending dates of the major items of work on the Project.
- b) A list of names, titles, addresses, and telephone numbers of the Developer/Contractor's responsible personnel, indicating those who may be reached outside normal working hours.
- c) A list of Sub-Contractors and Materials Suppliers to be involved with the project and the items of work they are going to perform or furnish materials for. The City will notify the Developer/Contractor of any concerns or pre-qualification deficiencies of the companies they plan to use.
- d) A finalized Storm Water Pollution Prevention Plan (SWPPP) and Notice of Intent (NOI) as applicable.
- e) The Developer is responsible to see that Developers Engineer, the Contractor(s), and representatives of each utility company are notified of the date, time and place of the pre-construction conference.

Other items may be discussed at this pre-construction conference as determined by the Public Works Representative/Engineer. Official minutes of this meeting as prepared by the Public Works Representative/Engineer shall become part of the project file for the project.

Section 1.05 TIMELY COMPLIANCE WITH THE ISSUED PERMIT

The Developer/Contractor shall perform in accordance with the terms of the permit and the Standard Specifications and Standard Drawings in effect at the date of the permit. The work shall be done in a timely manner. Time limits may be a condition of the permit and may be shortened because of safety concerns. Permits may be suspended if compliance is not met.

Sub-section A. Inspections:

All work covered by a Public Works permit shall be inspected by the Public Works Representative prior to the following:

- 1) Backfilling and compacting.
- 2) Placing concrete and asphalt
- 3) Placing any underground piping
- 4) Making any connection into a City utility line
- 5) Other work done in a public right of way.

Public Works shall also be notified prior to starting any Public Works project.

Sub-section B. Notification of Needed Inspections:

- 1) Inspection performed during regular working hours requires at least four (4) hours' notification.
- 2) Inspections needed after 4:00 p.m., require notification be given by 1:00 p.m. on the day of the inspection.
- 3) Inspections needed on the weekend, require that notification be given by 1:00 p.m. on the preceding Friday.
- 4) A charge shall be assessed for inspection call backs.

Sub-section C. Responsibility of the Developer:

The developer is responsible for the complete development, including construction of the entire subdivision, until it is finalized and accepted by the City.

Sub-section D. Definition of "Public Works Representative/Engineer":

The term "Public Works Representative/Engineer" as used in these specifications refers to the Public Works Director, Public Works Inspector, City Engineer, Public Works staff and others as designated by the Public Works Director.

Sub-section E. Conflict:

These Standard Specifications and Standard Drawings are the minimum requirements of the City of Lindon. In the event that any provisions herein conflict with general industrial standards, or with other requirements specified by the City, the more stringent of the standards will apply.

Section 1.06 ELECTRONIC AND RECORD DRAWINGS

When the Developer's Engineer has the capability, plat and improvement drawings shall be furnished electronically in MicroStation Format (.dgn), AutoCAD format (.dwg) or Data Exchange Format (.dxf). These electronic files shall be provided to the City after final approval but before recording of the Plat.

After completion of all public works improvements the Developer shall provide the City with two sets of velum or sepia (reproducible) "record drawings" which have been corrected to show the constructed improvements. The Developer must submit record drawings before the City will hold a prepave inspection.

Section 1.07 TEMPORARY SERVICES

Any temporary services and utilities such as telephone, electrical, water toilet facilities, etc., shall be the responsibility of the Developer/Contractor.

Section 1.08 CODES AND STANDARDS

Where codes and standards are referred to they shall be current, approved copies. It shall be the duty of the supplier of any material on this work to submit evidence, if requested, that its material is in compliance with the applicable codes and standards.

Section 1.09 STATE AND LOCAL LAWS

The Developer/Contractor shall conform to all applicable state and local laws in carrying out its obligations under the Contract.

This shall include, but is not limited to, compliance by the Developer/Contractor with the requirements of Chapter 30, of Title 34, of the Utah Code Annotated, 1953 as Amended. If the provisions of Section 34-30-1, of the Utah Code Annotated, 1953 as amended, are not complied with, this Contract shall be void.

Section 1.10 COMPLIANCE WITH GOVERNMENTAL REGULATIONS

The Developer/Contractor's personnel, equipment, and operations shall comply fully with all applicable standards, regulations, and requirements of existing Federal, Utah State, and Local governmental agencies. This shall include, but not necessarily be limited to, the following:

Sub-section A. United States Occupational Safety and Health Administration Regulations:

Title 29 of the Code of Federal Regulations, Part 1926 (29 CFR Part 1926), Safety and Health Regulations for Construction.

Sub-section B. Utah State Industrial Commission Regulations:

The Utah Occupational Safety and Health Act (1973) and Employer-Employee Safe Practices for Excavations and Trenching Operations (Jan. 1, 1974), as published by the Utah State Industrial Commission, including any and all amendments or revisions effective prior to performance of the work.

Sub-section C. City Ordinances:

The Developer/Contractor shall be required to comply with all Lindon City Ordinances.

Sub-section D. UDOT Requirements:

When crossing or working within Utah Department of Transportation (UDOT) rights-of-way the Developer/Contractor shall be responsible to obtain all necessary permits and comply with all appropriate UDOT regulations including applicable sections in "State of Utah Standard Specifications for Road and Bridge Construction," latest edition.

Sub-section E. Permits:

The Developer/Contractor is responsible to obtain all required business licenses and building permits applicable to this project. Developer/Contractor shall be subject to the conditions of all permits and agreements between the Owner and the permitting agencies. See Division 14, Utah Department of Transportation Rights-of-Way.

Section 1.11 FEDERAL, STATE, AND LOCAL INSPECTING AGENCIES

The site of construction is to be open at all reasonable times and places for periodic observation by accredited representatives of the Federal, State, and local agencies who have regulatory or supervisory authority over any part of the work proposed or regulated thereto.

Section 1.12 PUBLIC SAFETY AND CONVENIENCE

The convenience of the general public and the protection of persons and property is of prime importance and shall be provided for by the Developer/Contractor during this project. The Developer/Contractor shall use every reasonable precaution to safeguard persons and property. Failure of the Owner or the Public Works Representative/Engineer to notify the Developer/Contractor of any deficiencies in providing for public safety and convenience shall not relieve the Developer/Contractor from its responsibility. The Developer/Contractor shall be required to comply with the requirements of the **Manual on Uniform Traffic Control Devices (MUTCD)**.

Sub-section A. Compliance with Rules and Regulations:

The Developer/Contractor shall comply with all rules and regulations of the City, County, and State authorities regarding the closing of public streets, or highways, to the use of public traffic. If conditions justify, the Public Works Representative/Engineer may authorize the Developer/Contractor to close general traffic to not more than one (1) City block at any given time. No such closure shall be made without authorization of the Public Works Representative/Engineer. Closure of streets or highways shall be in conformance with the MUTCD.

Sub-section B. Road Closures and Obstructions:

No road shall be closed by the Developer/Contractor to the public except by express permission of the Public Works Representative/Engineer. The Developer/Contractor shall, at all times, conduct its work so as to insure the least possible obstruction to traffic and normal commercial pursuits.

Sub-section C. Protection of the Traveling Public:

All obstructions within traveled roadways shall be protected by signs, barricades, and lights where necessary for the safety of the traveling public. All barricades and obstructions shall be protected at night by signal lights that shall be suitably distributed across the roadway and kept lit from sunset to sunrise. Barricades shall be of substantial construction. Failure of the Owner or the Public Works Representative/Engineer to notify the Developer/Contractor to maintain barricades, barriers, lights, flares, danger signals, or guards shall not relieve the Developer/Contractor from its responsibility.

Sub-section D. Hazardous Conditions:

Whenever the Developer/Contractor's operations create a hazardous condition, it shall furnish flaggers and guards to give adequate warning to the public of any dangerous conditions to be encountered. It shall furnish, erect, and maintain fences, barricades, signs, lights, and other devices that may be necessary to prevent injury and damage to persons and property. Flaggers and guards shall be UDOT trained and shall hold current certification and shall be equipped with signs, flags, etc. as required by the UDOT regulations.

Sub-section E. Dust and Debris Control:

The Developer/Contractor shall control dust and debris that originates in the construction right-of-way or site. Dust, trash, and other debris shall be controlled on a daily basis by methods that shall include, but not be limited to, the use of a dust settling spray, a "pick-up broom" or street sweeper and trash disposal. The Developer/Contractor shall maintain on the project site a water truck with a minimum two thousand (2,000) gallon capacity. The Developer/Contractor shall be responsible to secure a source of water and shall obtain the necessary permission for its use. Failure by the Developer/Contractor to adequately control dust and debris may result in the Owner initiating dust and debris control measures and deducting the cost from payment due to the Developer/Contractor.

Section 1.13 CONFINEMENT OF WORK AND ACCESS TO RIGHT-OF-WAY AND EASEMENTS

The Developer/Contractor will be required to confine construction operations within the dedicated right-of-way for public thoroughfares or within areas for which construction easements have been obtained unless it has made special arrangements with the affected property owners in advance. The Developer/Contractor will be required to protect stored materials, lawn, trees, and other features located adjacent to the proposed construction site. During construction operations, the Developer/Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to their residences or places of business for a period exceeding eight (8) hours, unless the Developer/Contractor has made special arrangements with the affected persons prior to commencing work in the area.

Section 1.14 NOTIFICATION OF RESIDENTS

All property owners and residents adjacent to the streets or easements affected by the construction shall be notified by the Developer/Contractor at least forty-eight (48) hours in advance of time construction begins. The Developer/Contractor can satisfy this requirement by placing a written notice on the door of each residence or business reading "Notice of Construction Operation. (Developer/Contractor) will be working on the construction of street improvements on your street starting about _____." The Developer/Contractor shall provide a copy of the notification form at the pre-construction meeting and the method to be used (hang on door, etc.)

Section 1.15 WEATHER CONDITIONS

In the event of temporary suspension of work, or during inclement weather, the Developer/Contractor will, and will cause its SubDeveloper/Contractors to, protect any project work or materials against damage from the weather. If, in the opinion of the Public Works Representative/Engineer, any Project work or materials become damaged by reason of failure on the part of the Developer/Contractor or any of its SubDeveloper/Contractors to so protect its work, such work or materials shall be removed and replaced at the expense of the Developer/Contractor.

Section 1.16 LAND MONUMENTS

The Developer/Contractor shall preserve existing City, County, State, and Federal land monuments whenever possible. When these monuments cannot be preserved, the Developer/Contractor shall notify the Public Works Representative/Engineer at least two (2) weeks in advance of the proposed construction in order that the Public Works Representative/Engineer will have ample opportunity to reference these monuments for later replacement.

Section 1.17 SOURCE OF MATERIALS

All materials furnished or incorporated into the work shall conform to the requirements of these Specifications.

The Developer/Contractor shall acquire the necessary rights, at its own expense, to take material from aggregate sources and to use properties for plant site, hauling roads, and other purposes.

The Developer/Contractor may select areas for disposal of surplus materials; however, the Developer/Contractor will be responsible for acquiring the necessary right, at its own expense, to use the property for such purpose.

Section 1.18 OPERATION AND MAINTENANCE MANUALS

The Developer/Contractor shall furnish the Public Works Representative/Engineer with two (2) sets of all operation and maintenance manuals, drawings, diagrams, etc., for all pumps, motors, control panels, valves, meters, etc., for use in the Operation and Maintenance Manual.

Section 1.19 INTERFERING STRUCTURES, UTILITIES AND FACILITIES

The Developer/Contractor shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. While these structures and utilities may be shown on the improvements plans, the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented simply as a guide to possible difficulties. The Developer/Contractor shall notify all utility offices concerned at least forty-eight (48) hours in advance of construction operations in which a utility agency's facility may be involved. Notification to blue stakes does not necessarily cover all buried lines. This shall include, but not be limited to, irrigation, water, telephone, electric, sewer, storm drain, gas, and cable television. The Developer/Contractor shall be responsible for any and all changes to, relocation of, or re-connection to public utility facilities encountered or interrupted during the prosecution of the work, and all costs relating thereto shall be at the Developer/Contractor's expense. The Developer/Contractor shall contract with and pay Public Utility Agencies for work required in connection with all utility interference's and handle all necessary notifications, scheduling, coordination and details.

It shall be the responsibility of the Developer/Contractor to relocate and expose all existing underground structures and utilities in such a manner as to prevent damage to the same. Any structure or utilities damaged by the Work shall be repaired or replaced at the Developer/Contractor's expense.

If the Developer/Contractor encounters existing structures that will prevent construction, it shall notify the Public Works Representative/Engineer before continuing with the construction in order that the Developer's Engineer or Public Works Representative/Engineer may make such field revisions as necessary to avoid conflict with the existing structures.

Section 1.20 MATERIAL AND COMPACTION TESTING

During the course of the work, a Geotechnical Engineer/Testing Company may perform such tests as are required to identify materials, to determine gradation, to determine compaction characteristics, to determine moisture content, to determine density of fills in place, to determine concrete strength, to determine density and mixture of asphalt. These tests will be used to verify that the construction conforms to the requirements of the specifications. Such tests are not intended to provide the Developer/Contractor with the information required by it for the proper execution of the work and their performance shall not relieve the Developer/Contractor of the necessity of completing the construction in accordance with these specifications and Standard Drawings.

The estimated cost of such testing will be included in the Developer's bond posted with the City. Public Works shall contract with a geotechnical or certified testing company to perform the necessary tests. The Developer shall reimburse the City the actual cost of testing prior to final release of the bond. Copies of the tests will be furnished to the Developer/Contractor upon request.

The Owner/Contractor shall be responsible for all sampling, delivery of samples to a qualified testing agency, testing, and delivery of test results or materials certifications to City at no charge to the City. Failure to comply with the provisions of this Section may result in withholding final inspections, acceptance of work, occupancy permits, release of bond money or other measures.

Submittals shall consist of two types:

- 1) Field Test Report: When possible submit original report immediately to Public Works Representative/Engineer, but in no case later than end of following day.
- 2) Laboratory Test Report: Submit original report to Public Works Representative/Engineer within 48 hours after test results are determined.

Sampling:

- 1) Sampling of materials shall be as specified in each test.
- 2) The Public Works Representative/Engineer may require that sampling be performed in their presence.
- 3) The presence of a Public Works Representative/Engineer shall not relieve the Owner/Contractor of any requirements in this Section.
- 4) Each sample or test shall be accompanied by the following written data, which shall be reported to the City with test results:
 - a) Name of Project
 - b) Name of Owner/Contractor
 - c) Project Street Address
 - d) Appropriate Test Name
 - e) Date of Sampling
 - f) Sample Number (if more than one sample per day)
 - g) Name of technician who performed the testing
 - h) Location of sample

Native Soil Classification Test:

- 1) The soil classification test shall be conducted to determine the suitability of native soils for construction purposes.
- 2) The soil shall be classified according to the Unified Soil Classification System and/or AASHTO soil classifications
- 3) The AASHTO soil classification test shall conform to AASHTO M-145 of latest revision
- 4) One soil classification test shall be required for each test area of soil proposed for use. A test area shall be an area of homogenous soil. If all soil proposed for use appear to be homogenous, test two samples of the soil to establish soil characteristics and to confirm uniformity of the soil. The Public Works Representative/Engineer may modify this requirement on a case by case basis.
- 5) The soil sample shall be taken from a test area at a minimum depth of 24-inches below the future design grades, of native soil, and shall be free from foreign material, asphalt, concrete, ice or manmade materials. Soil classification tests at several depths may be required in each test area if so indicated by the geotechnical engineer or required by the Public Works Representative/Engineer.

The results of all determinations, including an assessment of the appropriate engineering characteristics of the soil, shall be reported to the City in writing prepared by the geotechnical engineer. The City may reject proposed use of native soil. The City's allowing the use of native soil does not relieve the Owner/Developer/Contractor of any responsibility associated with use of the soil.

Section 1.21 TELEVISIONING SEWER AND STORM DRAIN MAINS

Prior to the City accepting newly constructed sewers and storm drains the Contractor/Developer must flush the pipes and then must provide the City with a DVD of the televising of the pipes (performed in the presence of the Public Works Representative) or request that the City televise the pipes. The Contractor/Developer shall pay the cost of televising the pipes whether performed by the City or others. The televising equipment used must record on the DVD a continuous distance from the point of beginning.

DIVISION 2

TRENCH EXCAVATION AND BACKFILL

Section 2.01 GENERAL

This section covers the requirements for trenching and backfilling for underground pipelines. Unless otherwise shown or ordered, pipe shall be laid in an open trench. All incidental clearing, preliminary grading, structure removal, and benching shall be considered a part of the trenching operation.

Section 2.02 BARRICADES

Barriers shall be placed at each end of all excavations, and at such places as may be necessary along excavations, to warn all pedestrians and vehicular traffic of such excavations. Lights shall also be placed along excavations from one hour before sunset each day to one hour after sunrise of the next day, until such excavations are entirely refilled, compacted, and surfaced or final graded. All excavations shall be barricaded in such a manner as to prevent persons from walking into, falling into, or otherwise entering those excavations.

Section 2.03 BLASTING

Blasting will not be allowed except by permission from the Public Works Representative/Engineer. The Developer/Contractor shall comply with all laws, regulations, ordinances, and safety codes relative to the handling, storage, and use of explosives. The Developer/Contractor shall be fully responsible for all damage to life and property attributable to its blasting operations. Excessive blasting or overshooting will not be permitted. The Developer/Contractor shall remove any material outside the authorized cross section, which may be shattered or loosened by blasting.

Section 2.04 SHEETING, BRACING AND SHORING OF EXCAVATIONS

Excavations shall be sheeted, braced, and shored as required to support the walls of the excavations. These measures shall be taken to protect the workers, the work in progress, existing utilities, structures, and improvements, from damage due to sliding and settling of trench walls. All such sheeting, bracing, and shoring shall comply with the regulations of the Utah State Industrial Commission, and accident prevention and safety provisions of the Contract.

The Developer/Contractor shall be fully responsible for the adequacy of methods and materials used in trench sheeting, bracing, shoring, and other systems provided to protect workers. Injury to or death of workers resulting from inadequate trench safety measures shall be the full and complete responsibility of the Developer/Contractor. All damages resulting from lack of adequate sheeting, bracing and shoring shall be the responsibility of the Developer/Contractor, and the Developer/Contractor shall affect all necessary repairs or reconstruction at its own expense resulting from such damage.

Sheeting or shoring that does not extend below the centerline of the pipe may be removed at the discretion and responsibility of the Developer/Contractor after the pipe embedment has been placed and compacted to a level twelve inches (12") above the top of the pipe. Following removal of the sheeting or bracing, the trench shall be immediately backfilled and compacted or consolidated.

Section 2.05 CONTROL OF GROUNDWATER

All trenches shall be kept free from water during excavation, fine grading, pipe laying and jointing, and pipe embedment operations. Where the trench bottom is mucky or otherwise unstable because of the presence of groundwater, and in all cases where the static groundwater is above the bottom of any trench or bell hole excavation, such groundwater shall be lowered to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. The discharge from excavation dewatering shall be conducted to natural drainage channels, gutters, drains, or storm sewers. No sanitary sewer shall be used for disposal of trench water. Surface water shall be prevented from entering trenches.

Section 2.06 TRENCH EXCAVATION

Excavation for pipelines shall be located as shown on the Drawings or as staked in the field. Trenches shall be excavated to the depths and widths required to accommodate the construction of the pipelines, as follows:

Sub-section A. Normal Excavation:

Except in ledge-rock, cobbles, stones, or water-saturated earth, mechanical excavation of trenches shall not extend below an elevation four inches (4") above the bottom of the pipe after placement in its final position. All additional excavation necessary for preparation of the trench bottom shall be made manually.

Sub-section B. Authorized Over-Excavation:

Where ledge-rock, cobble rock, stones or other material render the trench material unsuitable for pipe bedding, as determined by the Public Works Representative/Engineer, bedding material shall be imported and placed. The trench shall be excavated to a minimum of four-inches (4") below the bottom of the pipe after placement in its final position.

Where unstable material is encountered in the excavation, foundation material may be required, as determined by the Public Works Representative/Engineer. In such cases, a minimum of eight inches (8") below the bottom of the pipe after placement in its final position shall be removed. Over-excavation not ordered, specified, or shown shall be considered to be unauthorized excavation.

Sub-section C. Unauthorized Over-Excavation:

Any excavation carried below the elevation required to install the pipe as specified in these Specifications, or directed by the Public Works Representative/Engineer, shall be considered to be unauthorized. Such excavation shall be backfilled in accordance with these Specifications for "Imported Granular Material" and "Gravel Foundation for Pipelines and Pipeline Structures," all at the Developer/Contractor's expense.

Sub-section D. Trench Width:

The trench shall be excavated such that the pipe is always centered in the trench. The minimum clear trench width at the horizontal diameter of the pipe must not be less than the outside diameter of the pipe plus twelve inches (12"). The maximum clear width of trench at the top of the pipe must not be more than the outside diameter of the pipe plus eighteen inches (18"). If a trench is excavated to a greater width, the Developer/Contractor will be required to restore the trench to an acceptable condition by following the steps outlined in these Specifications for "Trenches in Embankments."

Trench width for pipeline structures, valves, or other accessories shall be sufficient to leave at least twelve inches (12") clear between their outer surfaces and the trench. Backfill with earth under structures or valves will not be permitted. Any unauthorized excess excavation below the elevation indicated for foundation of any structures shall be backfilled in accordance with these specifications for "Imported Granular Materials," and "Gravel Foundation for Pipe & Pipeline Structures," at the Developer/Contractor's expense.

Sub-section E. Trenches in Embankments:

Before laying pipes that are to be in fill or embankment areas, the embankment shall first be placed and compacted to the specified density to a depth of not less than two feet (2') above the top of the proposed pipe. After placing and compacting the embankment, the trench for the pipe or conduit shall be excavated through the fill and fine graded and the pipe installed as specified.

Sub-section F. Placement of Excavated Material:

All excess material shall be hauled away from the construction site and disposed of in an area obtained by the Developer/Contractor and approved by the Public Works Representative/Engineer. The Developer/Contractor shall be responsible for all rights-of-way, easements, and access associated with the disposal of excess excavated material. It shall further be responsible to obtain permission from the property owner or person controlling the property where the Developer/Contractor plans to dispose of excavated material. No compensation will be made to the Developer/Contractor for disposal of excess excavated material.

Non-excess excavated material shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters and irrigation ditches shall be kept clear or other satisfactory provisions shall be made for street drainage and continuity of irrigation.

Grading of the area surrounding the trenches, including excavated materials, shall be performed as necessary to prevent surface water from flowing into trenches, or other excavations. Control of groundwater shall be as specified in section 2.05, Control of Groundwater.

Sub-section G. Fine Grading the Trench Bottom:

The bottom of the trench shall be accurately graded and prepared to provide uniform bearing and support on undisturbed soil or compacted granular bedding at every point along the entire length of the pipe. Bell holes shall be hand excavated after the trench bottom has been fine graded. Bell holes shall be only large enough to permit making the joints and to assure that any portion of the joint or bell does not support the pipe.

Section 2.07 TRENCH BACKFILL

Trench backfill for piping consists of four zones: foundation, bedding, initial backfill, and final backfill. "Pipe embedment" is a commonly used term that refers to the region including the bedding and initial backfill zones, or any region within one foot (1') of any pipe, pipeline structure, or accessory. The foundation is defined as the region between eight inches (8") and four inches (4") below the bottom of the pipe. The bedding is defined as the region between four inches (4") below the bottom of the pipe and the bottom of the pipe. The initial backfill is defined as the region between the bottom of the pipe and twelve inches (12") above the top of the pipe. The final backfill is defined as the region above twelve inches (12") above the pipe.

The Public Works Representative/Engineer shall determine the suitability of excavated materials for use as foundation, bedding, initial backfill, and final backfill. He may request that the soil be tested as described below or may choose to visually accept or reject excavated materials.

Native Soil Classification Test

- 1) The soil shall be classified according to the Unified Soil Classification System and/or AASHTO soil classifications
- 2) The AASHTO soil classification test shall conform to AASHTO M-145 of latest revision
- 3) Soil classification tests at several depths may be required in each test area if so indicated by the geotechnical engineer or required by the Public Works Representative/Engineer.
- 4) The results of all determinations, including an assessment of the appropriate engineering characteristics of the soil, shall be reported to the City in writing prepared by the geotechnical engineer.

The City may reject proposed use of tested native soil. The City's allowing the use of native soil does not relieve the Owner/Developer/Contractor of any responsibility associated with use of the soil.

All fill materials shall be compacted as specified in this section.

When the excavated materials are not satisfactory for foundation, bedding, or backfill, the Developer/Contractor shall provide imported granular material.

Sub-section A. Imported Granular Material:

Imported granular material for foundation, bedding, and backfill shall be cleaned crushed rock or gravel, free from sod, vegetation, and other organic or deleterious material. Slag will not be allowed in the pipe embedment. Imported granular material shall conform to the following gradation specifications:

1) Embedment Material:

- i. Foundation Material: One hundred percent (100%) less than two-inch (2") and maximum of five percent (5%) less than one-half-inch (1/2").
- ii. Bedding and Initial Backfill Material:
 - a. Ductile-iron pipe - One hundred percent (100%) less than two-inch (2") and maximum of five percent (5%) passing a No. 200 sieve.
 - b. PVC or polyethylene pipe - One hundred percent (100%) less than one-inch (1") and maximum five percent (5%) passing a No. 200 sieve.
 - c. Steel - One hundred percent (100%) less than 3/4" and a maximum five percent (5%) passing a No. 200 sieve.
 - d. Concrete pipe - Refer to Section 4.06 (Concrete Pipe / Pipe Bedding)

2) Final Backfill Material: One hundred percent (100%) less than three-inch (3") and maximum of fifteen percent (15%) passing a No. 200 sieve.

Sub-section B. Foundation Placement:

When over-excavation is authorized by the Public Works Representative/Engineer, foundation material shall be placed in the foundation zone and below. The foundation material shall be placed so that the trench can be properly fine graded as specified. The foundation material shall be deposited over the entire trench width and compacted in layers. The layers shall have a maximum uncompacted thickness of six-inches (6").

The material shall then be fine graded in accordance with the specification for fine grading herein.

Sub-section C. Pipe Embedment:

Embedment material for other than PVC pipe may be excavated materials consisting of loose earth, sand, or gravel having no material larger than two-inches (2") in any dimension. For PVC pipe, the material must be no greater than one inch (1") in any dimension. If the excavated materials are not satisfactory, the specified imported granular material shall be used for pipe embedment.

- 1) Bedding: The bedding material shall be deposited over the entire trench width to a compacted thickness of no less than four inches (4"). The material shall have a maximum uncompacted thickness of six inches (6").
- 2) Initial Backfill: After the pipe is in place, initial backfill material shall be placed at any point below the mid-point of the pipe simultaneously and uniformly on both sides of the pipe in un-compacted layers not to exceed six-inches (6") or one-half the diameter of the pipe, whichever is less. Initial backfill material shall be placed with care to prevent displacement of or damage to the pipe during the embedment process. Initial backfill material shall be scattered alongside the pipe and not dropped into the trench in compact masses.

That section of the pipe zone from the mid-point of the pipe to twelve inches (12") above the top of the pipe shall then be filled with initial backfill materials and compacted.

Sub-section D. Final Backfill:

Final backfill shall be from twelve inches (12") above the top of the pipe to the level shown on the Drawings. Excavated materials consisting of fines, sand, and gravel shall be used for final backfill. No oil cake, bituminous pavement, concrete, rock, or other lumpy material shall be used in the final backfill unless these materials are scattered and do not exceed six inches (6") in any dimension. Perishable or spongy material shall not be used in final backfilling.

Sub-section E. Compaction:

Backfill shall be compacted by means of sheepfoot rollers, pneumatic tire rollers, vibrating rollers, or mechanical tampers.

Under pavements or other surface improvements the in-place density shall be a minimum of 95% of laboratory standard the maximum dry density as determined by AASHTO T-180 (Modified Proctor). In shoulders and other areas the in-place density shall be a minimum of ninety percent (90%) of the maximum dry density as determined by AASHTO T-180 (Modified Proctor).

Fill material shall be placed at a moisture content and un-compacted lift thickness such that after compaction the required relative densities will be produced. In no event will the material be placed in lifts that, prior to compaction, exceed six inches (6") for foundation and embedment and twelve inches (12") for final backfill.

Prior to compaction each layer shall be evenly spread, moistened, and worked by disk harrowing or other equivalent means.

Compact around water valves and manholes using mechanical tampers.

If the required relative density is not attained, test sections will be required to determine any adjustments in compaction equipment, thickness of layers, moisture content and compactive effort necessary to attain the specified minimum relative density.

Approval of equipment, thickness of layers, moisture content, and compactive effort shall not be deemed to relieve the Developer/Contractor of the responsibility for attaining the specified minimum relative densities. The Developer/Contractor, in planning its work, shall allow sufficient time to perform the work connected with test sections and to permit the Public Works Representative/Engineer to make tests for relative densities.

At least one random density test shall be taken per 200 cubic yards placed, with a minimum of two random density tests per day, for each type of backfill material placed during the day.

In addition, one density test shall be taken within two feet of the edge of each manhole and water valve.

Section 2.08 TRENCH CROSSINGS AND EASEMENTS

At road crossings or where existing driveways occur on a road, the Developer/Contractor shall make provisions for trench crossings either by means of backfill, tunnels, or temporary bridges.

Any disturbance to property caused by the Developer/Contractor's activity within easements shall be restored to the satisfaction of the owner of the property. If necessary, shrubs, fences, or other objects shall be removed carefully. If work must occur on a lawn, the lawn shall be cut to a width of two feet (2') wider than the intended work area (one

foot (1') on each side). The lawn sod shall be stacked separately from and shall not be mixed with other excavated material.

After the sod is removed, if excavation is necessary, the topsoil shall be removed to a depth of twelve inches (12"), or the actual depth of the topsoil, whichever is less. The topsoil shall be stored separately from and shall not be mixed with other excavated material.

Following completion of the backfilling and the compaction of the trench, the Developer/Contractor shall replace topsoil, lawn sod, shrubs, fences, and other items that may have been removed from within the easement area and shall clean up and remove any rocks, dirt or any other debris that remain from the construction work. The Developer/Contractor shall obtain a release from the property owner stating that the repairs have been made to the satisfaction of the Owner. A copy of said release shall be delivered to the Public Works Representative/Engineer.

Section 2.09 RESTORATION OF CONSTRUCTION SITE

During the progress of the Work, the Developer/Contractor shall clean up all construction debris, excess excavation, and excess materials, and shall restore all fences, irrigation structures, ditches, culverts, and similar items. The Developer/Contractor shall stockpile the excavated trench material so as to do the least damage to adjacent grassed areas, or fences, regardless of whether these are on private property or public rights-of-way. All excavated materials shall be removed from grassed and planted areas and these surfaces shall be left in a condition equivalent to their original surface and free from all rocks, gravel, boulders, or other foreign materials.

Section 2.10 OPEN TRENCH IN PUBLIC THOROUGHFARES

Trenches in public thoroughfares, regardless of trench depth, the Developer/Contractor shall safely barricade and limit open trenches to a maximum of 200 lineal feet in the daytime. In traveled roadways a maximum of 80 lineal feet of open trench will be allowed. All pipeline excavations need to be backfilled and compacted within 24 hours. Trenches shall be closed during nighttime conditions by but not limited to backfill and place metal plates over the trench or backfill and place a fence along the trench.

Section 2.11 DEVELOPER/CONTRACTOR'S RESPONSIBILITY

The Developer/Contractor will be responsible to see that the backfilling and compaction are properly and adequately done. Settlement of trenches within a period of two- (2) years after final acceptance of the project shall be considered incontrovertible evidence of inadequate compaction, and the Developer/Contractor shall be responsible for correcting the condition in accordance with the provisions of these Specifications. This includes the replacement of sidewalk, curb and gutter, and other surface improvements.

(Division 2 was last updated June 2015)

DIVISION 3
PRESSURE PIPE
PRESSURE IRRIGATION

Section 3.01 GENERAL

This division covers furnishing and installing pressure pipe as shown on the Drawings or established in the field, and all flushing, testing, repairing, as required to ensure adequate and safe operation of the water system.

Section 3.02 DUCTILE IRON PIPE

Sub-section A. Materials:

Ductile iron pipe shall conform to all requirements of ANSI/AWWA C151/A21.51, "American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined molds, for Water or Other Liquids." The minimum Pressure Class will be 200. If thickness class pipe is used, the minimum shall be Thickness Class 50.

All pipe shall be made of good quality ductile cast iron and of such chemical composition and structure as is required to meet the physical and mechanical property requirements of the standard.

Sub-section B. Joints:

- 1) Mechanical Joints: All mechanical joints and gaskets shall meet the requirements of ANSI/AWWA C111/A21.11. All gaskets shall be smooth and free of porous areas, foreign materials, and visible defects. Gaskets shall be less than one (1) year old.
- 2) Push-on Joints: All push-on joints and gaskets shall meet the requirements of ANSI/AWWA C111/A21.11. All gaskets shall be smooth and free of porous areas, foreign materials, and visible defects. Gaskets shall be less than one (1) year old.

Lubricants shall have no deteriorating effects on gasket materials. Lubricants shall conform to ANSI 21.11.

- 3) Flanged Joints: Flanges, when required, shall conform to ANSI/AWWA C115/A21.15-83. Flanged joints shall meet the requirements of ANSI/AWWA C110/A21.10, "American National Standard for Ductile Iron and Gray Iron Fittings, 3-inch Through 48-inch for Water and Other Liquids." Flanged joints shall be bolted firmly with machine, stud, or cap bolts of proper size. Flanges may be cast integrally with the pipe or may be screwed on a threaded pipe. Flanges shall be faced and drilled and dimensioned properly for the size and pressure required. Bolts and nuts, unless otherwise specified, shall be made of the best quality refined iron or steel, and have clean, well-fitting threads. Bolts will be provided with standard hexagonal nuts and standard hexagonal heads. Bolts shall be of the diameter required for each flange, and when installed shall be of length so that no more than three-eighths inch (3/8") nor less than one-eighth inch (1/8") extends past the face of the nut. All buried metallic fittings and bolts shall be coated with a non-oxide wax and wrapped with polyethylene.

Gaskets shall be rubber, either ring or full face, and shall be one-eighth-inch (1/8") thick.

Sub-section C. Coatings and Linings for Ductile Iron Pipe:

All exterior surfaces of pipe and fittings shall be coated with hot coal tar at least one (1) mil thick. All interior surfaces shall be cement mortar lined with a standard thickness according to ANSI/AWWA C104/A21.4-80.

Sub-section D. Fittings:

Fittings for ductile iron pipe shall conform to the provisions of ANSI/AWWA C110/A21.10-82 or C153/A21.53-58.

All fittings shall be Mechanical-Joint-(MJ)-type unless otherwise specified by the Public Works Representative/Engineer. FM grease shall be applied to the threads of the bolts on all fittings.

When the Public Works/Engineer determines that a potential for corrosive conditions exists such as poor drainage or reactive soils, fittings shall be incased in polyethylene wrap. Polyethylene encasement shall meet the requirements of ANSI A21.5 or AWWA C105.

Sub-section E. Caution Tape:

All pipe shall include a three-inch (3") caution tape installed in the pipeline trench approximately twelve inches (12") below the ground surface. This tape shall be prepared with white or black printing on a purple field, color Pantone 512C, having the words:

CAUTION: NONPOTABLE WATER - DO NOT DRINK.

Sub-section F. Tracer Wire:

All pipe shall include a 12 gauge solid THHN tracer wire installed according to NESC standards. The tracer wire shall be installed in the pipeline trench approximately 6-inches above the top of pipe. The tracer wire shall be brought up in the valve boxes to permit connecting to when doing line location.

Section 3.03 PVC PIPE**Sub-section A. Materials:**

Pipe for the transmission and distribution of water shall be manufactured in accordance with AWWA C900 (latest revision), "AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch through 12-inch, for Water:" PVC pipe fourteen-inches (14") and larger shall be manufactured in accordance with AWWA C905 (latest revision), "AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14-inch through 36-inch." All PVC pipe four-inch (4") and larger shall be dimension ratio (DR) 18 with a working pressure of 150 psi. The PVC pipe shall have a cast-iron-pipe-equivalent outside diameter. Pipe smaller than four-inches (4") shall be schedule 40 PVC.

Sub-section B. Joints:

Joints shall be the push-on rubber-gasket type. Lubrication shall be water soluble, non-supporting of bacteria growth, and have no deteriorating effect on the PVC pipe or rubber gaskets.

Sub-section C. Fittings:

All fittings to be used with the PVC pipe shall be the same as fittings for ductile iron pipe and shall conform to the provisions of ANSI/AWWA C110/A21.10-82 or C153/A21.53-58. All fittings shall be

Mechanical-Joint-(MJ)-type unless otherwise specified by the Public Works Representative/Engineer. FM grease shall be applied to the threads of the bolts on all fittings.

When the Public Works/Engineer determines that a potential for corrosive conditions exists such as poor drainage or reactive soils, fittings shall be incased in polyethylene wrap. Polyethylene encasement shall meet the requirements of ANSI A21.5 or AWWA C105.

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CAUTION: NONPOTABLE WATER - DO NOT DRINK.

Sub-section E. Tracer Wire:

All pipe shall include a 12 gauge solid THHN tracer wire installed according to NESC standards. The tracer wire shall be installed in the pipeline trench approximately 6-inches above the top of pipe. The tracer wire shall be brought up in the valve boxes to permit connecting to when doing line location.

Section 3.04 PIPE INSTALLATION

Installation of ductile iron pipe shall be in accordance with ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances. Installation of PVC pipe shall be in accordance with AWWA C900, C905, ASTM D2774, and PVC Pipe, AWWA Manual M23 and with applicable manufacturer's instructions.

Sub-section A. Cutting:

Cutting of pipe for closure pieces or for other reasons shall be done in a neat and workmanlike manner by a method recommended by the manufacturer. After cutting, the pipe shall be beveled and filed to prevent gasket damage in joint assembly.

Sub-section B. Dewatering of Trench:

Where water is encountered in the trench, it shall be removed during pipe-laying operations and until the ends of the pipe are sealed. See "Control of Groundwater" in Division 2 Trench - Excavation and Backfill section 2.05.

Sub-section C. Laying of Pipe:

The pipe and pipe coating (where applicable) shall be inspected for defects before installation. Any defects shall be repaired or the pipe shall be replaced, whichever is deemed necessary by the Public Works Representative/Engineer.

All pipe shall be laid and maintained to the required lines with fittings and valves at the required locations, as shown on the Drawings.

All pipe, fittings, and valves shall be moved carefully, either when lowering from the truck, or when placing in the trench. Under no circumstances shall materials be dropped or dumped from the truck or into the trench.

The Developer/Contractor shall take the necessary precautions to ensure that foreign materials do not enter the pipe. No debris, tools, or other materials shall be placed in the pipe during laying operations. When laying of pipe is not in progress, the pipe shall be closed with a water tight plug.

Maximum deflections at pipe joints shall not exceed the joint specifications of AWWA C600 of latest revision, or the recommendations of the pipe manufacturer.

Deflections in PVC pipe shall be made by longitudinal bending of the barrel of the pipe rather than deflecting the pipe joints. Longitudinal bending shall be limited to eighty percent (80%) of the manufacturer's recommended minimum bending radius.

Sub-section D. Thrust Blocking:

Thrust blocking shall be applied at all tees, valves, plugs, caps, and at bends that deflect twenty-two and one-half (22-1/2°) degrees or more. The fitting shall be encased in a 12 mil protective plastic wrap before the thrust block is poured. Reaction blocking shall be concrete, having a compressive strength of not less than three-thousand (3000) psi at twenty-eight (28) days. Blocking shall be placed between undisturbed soil and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as shown in the Drawings. The blocking shall be placed so that the pipe and the fittings will be accessible for repair.

Sub-section E. Connections to Existing Water Lines:

Information on the Drawings regarding existing water lines is taken from "record" drawings from the City or utility company files and may or may not be accurate as to size, type of material, or location of those lines. The Developer/Contractor will be responsible to determine the proper fittings and materials required, obtain the Public Works Representative/Engineer's approval of the planned connection, and perform the construction in a suitable fashion.

Section 3.05 PRESSURE IRRIGATION SERVICE CONNECTION

Pressure irrigation service laterals shall be constructed with materials specified and at the locations shown on the Standard Drawings or at the actual location established during construction. This section covers the installation of the service connection from the main to right-of-way line.

Sub-section A. Service Saddle Specifications:

(For use with AWWA C900 C1 O.D. for PVC plastic pipe.)

All service clamps shall be of a "Full encirclement design," and shall be I.D. controlled, which design will eliminate the possibility of pipe crushing due to the over torquing of the nuts upon installation.

A rigid liner shall be used inside of tubing at the compression fitting on a 1-inch single service connection. No rigid liner will be required inside of tubing at compression fittings on 1 1/2-inch or 2-inch service lines.

All service clamps shall be manufactured of brass cast in conformance to AWWA C800, General Section - 1, Paragraph 1.2 (ASTM B62).

The two sides of the clamp shall be held together by high quality Silicon Bronze Hex Bolts (in sizes 1" and over) or Silicon Bronze Slotted Screws (in sizes under 1"), no dis-similar metals shall be allowed at this point thus eliminating the possibility of galvanic corrosion.

All service clamps shall be Mueller Model H-13490 Series, or Ford Model S-91 Series and Romac 305 Series for 14" or larger.

Sub-section B. Polyethylene Tubing:

Pipe for the transmission of irrigation water from main to utility box shall be Polyethylene CTS tube. Polyethylene CTS tube shall be manufactured in accordance with the standard specification for

Polyethylene PEP plastic tubing as issued by the American Standard for Testing and Materials under ASTM D 2737 and AWWA C901.

Material designation code:

Bimodal Polyethylene
PE 4710

Minimum Cell Classification:

445574E (purple color)
or 445574C with purple outer layer,
as defined by ASTM D 3350

Standard pipe dimension ratio CTS (SDR) 9 – 200 or 250 psi pressure rating.

All tubing for service lines shall be cut and installed in a neat and workmanlike manner by a method recommended by the manufacturer.

Sub-section C. Compression Connection:

- 1) The interior surface of the coupling nut, including threads, shall have a baked on, fluorocarbon coating to reduce assembly friction and prevent the gasket from turning and twisting during tightening. The nut shall bottom on a cast or machined shoulder on the body when properly assembled. This design will provide a visual check to assure connection is properly assembled.
- 2) The sealing gasket shall be of molded synthetic rubber (ASTM D2000) with molded in place bronze spring (ASTM A134 Alloy #6) to eliminate the possible cold flow of the gasket between the pipe and fitting. A gripper band of hardened stainless steel (ANSI Type 401) shall be fitted into the gasket. When the gasket is compressed it will cause the gripper ring to distort the pipe giving the fitting a high resistance to pull out. The gripper band shall overlap itself to prevent cold flow of the gasket into the cavity under the band.
- 3) When Mueller 110 compression fittings are used with P.E. Pipe, Stainless Steel pipe stiffeners are required to eliminate cold flow of plastic pipe.
- 4) All fittings are to be for CTS Polyethylene pipe.
- 5) The Minimum pull out load for the fitting when used with PE plastic pipe shall be as follows for each given size:

<u>SIZE</u>	<u>MINIMUM PULL OUT (FT.LBS.)</u>
3/4"	400
1"	400
1 1/2"	500
2"	500

MUELLER 110 COMPRESSION COUPLINGS AND FITTINGS OR EQUIVALENT ARE TO BE USED ON ALL P.E. PLASTIC PIPE INSTALLATIONS.

Sub-section D. Service Fittings:

All service fittings such as brass tees, and brass ells shall be Mueller Insta-Tite connections or equivalent.

Sub-section E. Ball Straight Service Valve:

All components shall be manufactured of brass cast in conformance to AWWA C-800, General Section -1, paragraph 1.2. The valve shall have a strong, reliable ball/stem connection that provides strong, reliable performance and resists breakage. The stem design must be totally blow-out-proof to prevent separation and assure dependable, safe operation. The stem shall have double O-ring seals supported in precision machined grooves and provide secure, leak-tight sealing. The end pieces shall be O-ring sealed to provide additional protection against leaking. The ball shall be manufactured of 85-5-5-5 waterworks brass; no other composition will be accepted. The ball shall be fluorocarbon coated for ease of operation. The valve shall be quarter turn valve and the fully open and closed positions shall be controlled by check lugs integrally cast on body to assure positive action. The valve shall have a lock wing to permit locking the valve in the closed position. The Inlet shall be a compression connection and the Outlet shall be F.I.P. thread.

All brass castings shall conform to ASTM B62, latest revision, Standards for composition brass or ounce metal castings of 85-5-5-5. The valve shall be manufactured and tested in accordance with ANSI/AWWA C800, latest revision. A notarized certificate stating compliance with the Standards may be required. All component parts, body, key, washer, nut and tube nut, shall have the same metal analysis.

The valve must maintain a working pressure of 300 PSIG.

All fittings are to be CTS (Copper Tube Size) size, used on CTS Polyethylene pipe. No IPS polyethylene pipe or fittings are to be used.

Ball straight service valve shall be MUELLER B-25172, 110 Conductive Compression Connection by F.I.P. thread.

Sub-section F. Service Box:

Service box shall be an 11 3/4-inch by 16-inch standard green, fiberglass irrigation box with cover. Service Box shall be installed over the Ori-Seal valve and hose bib. A sign shall be attached or embossed to or on the cover indicating as follows: "IRRIGATION." Box shall be Brooks 1419 series utility box with lid recessed and shall be provided with Waterworks Pentagon Head locking device or equivalent.

Sub-section G. PVC Pipe:

Pipe for the transmission of irrigation water from the PVC MIPT adapter to the homeowner's property line shall be Schedule 40 PVC pipe. Pipe shall be manufactured to meet the requirements of Materials - ASTM D1684, Product Design ASTM D1685, and Cell Class - ASTM D12454A. Joints shall be of solvent weld type recommended by the manufacturer of the pipe. A solvent weld cap will be installed on the end of the pipe near property line. No joints will be allowed under sidewalks or other paved surfaces.

Sub-section H. Hose Bib:

All hose bibs used in the service connection assembly shall be a 3/4-inch NIBCO, Figure No. 74, Boiler Drain or equal.

Sub-section I. Service Pipe Installation:

The polyethylene service pipe shall be installed by use of a "Hole Hog" or other similar device under all existing paved surfaces. Where subsurface materials or conditions will not permit installation by this method, open trenching will be permitted with the approval of the Public Works Representative/Engineer. Open trenching will be used in new streets not yet paved.

Section 3.06 TESTING AND FLUSHING

All newly laid pipes or any valved section thereof shall be subjected to a hydrostatic pressure test. A leakage test shall be conducted concurrently with the pressure test. All new lines, and extensions therefrom, shall be flushed thoroughly before being placed into service.

Sub-section A. Pressure Test:

If the pipe section being tested includes concrete thrust blocking, the concrete shall be allowed at least twenty-four (24) hours to set before any testing is conducted.

- 1) Test Pressure Restrictions: Test pressures shall,
 - i. Be at least 1.5 times the working pressure at the highest point along the test section, but not less than 120 psi.
 - ii. Not exceed the pressure rating of the pipe.
 - iii. Be of at least 2 hour duration.
 - iv. Not vary by more than plus or minus five (± 5) psi for the duration of the test.
 - v. Not exceed twice the rated pressure of the valves or hydrants when the pressure boundary of the test section includes closed gate valves or hydrants.
 - vi. Not exceed the rated pressure of the valves when the test boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.
- 2) Pressurization: Each valved section of pipe shall be filled slowly with water to the specified test pressure. Pressurization of the pipe shall be based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gage. Pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Public Works Representative/Engineer.
- 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 Developer/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, the corporation cocks shall be removed and plugged.
- 4) Examination: All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or hydrants that are discovered during the pressure test shall be repaired or replaced with sound materials and the test shall be repeated. Repairs or replacements to the pipeline and subsequent pressure testing shall be repeated as necessary for the pipeline to pass the pressure test.

Sub-section B. 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 any valved section thereof, to maintain pressure within 5 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:

$$L = \frac{SD(P)^{0.5}}{133,200}$$

In which L is the allowable leakage, in gallons per hour; S is the length of pipeline tested in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure (gage) during the leakage test, in pounds per square inch. See Table 1.

- i. Allowable leakage at various pressures is shown in Table 1.
- ii. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in. of nominal valve size shall be allowed.
- iii. When hydrants are in the test section, the test shall be made against the closed hydrant.

TABLE 1
Allowable Leakage per 1000 ft of Pipeline - gph

Average Test Pressure psi (Bar)	Nominal Pipe Diameter-in.															
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.
 **To obtain leakage in liters/hour, multiply the values in the table by 3.785.

- 3) **Examination:** All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or hydrants that are discovered during the leakage test shall be repaired or replaced with sound materials and the test shall be repeated. Repairs or replacements to the pipeline and subsequent leakage testing shall be performed as necessary for the pipeline to pass the leakage test.

Sub-section C. Acceptance of Installation:

Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than specified, the Developer/Contractor shall, at its own expense, locate and repair the defective material until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

Sub-section D. Flushing:

Flushing shall be accomplished through temporary flushing valves, or end of line blow-off assemblies at a minimum flushing velocity of two and one-half feet per second (2.5 fps). Flow volumes to produce this velocity are shown in the following chart:

FLOW RATE AND OPENINGS TO FLUSH PIPELINES (40 psi Residual Pressure)
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Pipe Size (inches)	Flow Required to Produce 2.5 fps velocity (gpm)
2	26
4	100
6	220
8	390
10	610
12	880
14	1,200
16	1,565
18	1,980
20	2,450
24	3,525
30	5,507
42	10,800
48	14,100

DIVISION 3A
PRESSURE PIPE
CULINARY WATER

Section 3A.01 GENERAL

This Division covers furnishing and installing pressure pipe to the lines and grades shown on the drawings and/or established in the field, and all flushing, testing, repairing, and required to ensure adequate and safe operation of the water system. Ductile iron pipe shall be used in all areas east of Geneva Road and PVC pipe will be used in all areas west of Geneva Road unless a soil corrosivity evaluation, as reviewed and approved by the Engineer/Public Works Representative, dictates otherwise.

Section 3A.02 DUCTILE IRON PIPE

Sub-section A. Materials:

Ductile iron pipe shall conform to all requirements of ANSI/AWWA C151/A21.51, "American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined molds, for Water or Other Liquids." Minimum pressure Class will be 250 for pipes larger than 12-inch diameter. Pipes of 12-inch diameter and smaller shall be pressure Class 350. If thickness class pipe is used, pipes of diameters from 4 inches through 10 inches shall be minimum Class 51 and pipe from 12-inch diameter and larger shall be minimum Class 50.

All pipe shall be made of good quality Ductile Cast Iron and of such chemical composition and structure as is required to meet the physical and mechanical property requirements of the standard.

Sub-section B. Joints:

- 1) Mechanical Joints: All mechanical joints shall meet requirements of ANSI/AWWA C111/A21.11. All gasket surfaces shall be smooth and free from imperfections. Gaskets shall conform to tests in accordance with specifications and shall be less than one year old.
- 2) Push-on Joints: All push-on joints shall meet the requirements of ANSI/AWWA C111/A21.11. Gaskets shall be free from defects and not over one year old.

Lubricants shall be non-toxic and have no deteriorating effects on gasket materials. It shall not impart taste to water in a pipe. It shall conform in every way to ANSI 21.1

- 3) Flanged Joints: Flanges shall meet the requirements of ANSI/AWWA C110/A21.10, "American National Standard for Ductile Iron and Gray Iron Fittings, 3-inch Through 48-inch for Water and Other Liquids." Flanged joints shall be bolted firmly with machine, stud or cap bolts of proper size. Flange may be cast integrally with the pipe or may be screwed on threaded pipe. Flanges shall be faced and drilled and of proper dimensions for size and pressure required. Bolts and nuts, unless otherwise specified, shall be made of the best quality refined iron or metal steel and have clean, well-fitting threads. Bolts will be provided with standard hexagonal nuts and standard hexagonal heads. Bolts shall be of the diameter required for each flange and when installed shall be of length so that no more than 3/8-inch nor less than 1/8-inch extends past face of nut. All buried fittings having steel bolts shall be coated with a non-oxide wax and wrapped with polyethylene.

Gaskets shall be rubber, either ring or full face, and are 1/8th-inch thick. A gasket for each flanged joint of proper size as shown on the drawings.

Sub-section C. Coatings and Linings for Ductile Iron Pipe:

All exterior surfaces of pipe and fittings shall be coated with hot coal tar approximately 1 mil thick. All interior surfaces shall be cement mortar lined with a standard thickness according to ANSI/AWWA C104/A21.4-80.

Sub-section D. Corrosion Protection and Soil Tests:

When the Public Works/Engineer determines that a potential for corrosive conditions exists such as poor drainage or reactive soils, pipe and fittings shall be incased in polyethylene wrap. Polyethylene encasement of ductile iron pipe shall meet the requirements of ANSI A21.5 or AWWA C105.

Sub-section E. Flanges:

Flanges when required shall conform to ANSI/AWWA C115/A21.15-83.

Sub-section F. Fittings:

Fittings for Ductile Iron Pipe shall conform to the provisions of ANSI/AWWA C110/A21.10-82 or C153/A21.53-58. FM grease shall be applied to the threads of the bolts on all fittings.

Sub-section G. Caution Tape:

All pipe shall include a three-inch (3") caution tape installed in the pipeline trench approximately twelve inches (12") below the ground surface.

Identification tape shall be furnished with white or black printing on a colored field having the words:

CAUTION: POTABLE WATER - BELOW.

Sub-section H. Tracer Wire:

All pipe shall include a 12 gauge solid THHN tracer wire installed according to NESC standards. The tracer wire shall be installed in the pipeline trench approximately 6-inches above the top of pipe. The tracer wire shall be brought up in the valve boxes and along and fastened to each fire hydrant to permit connecting to when doing line location.

Section 3A.03 PVC PIPE**Sub-section A. Materials:**

Pipe for the transmission and distribution of water shall be manufactured in accordance with AWWA C900-07, "AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch through 12-inch, for Water". The PVC pipe shall have a cast-iron-pipe-equivalent outside diameter. PVC pipe 14 inches and larger shall be manufactured in accordance with AWWA C905-88, "AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14-inch through 36-inch". All PVC pipe 4-inch and larger shall be DR. 18 with a working pressure of 150 PSI. Pipe smaller than 4-inch shall be schedule 40 PVC.

Sub-section B. Joints:

Joints shall be push on rubber gasket type. Lubrication shall be water soluble, non-toxic, non-objectionable in taste and odor imparted to the water, non-supporting of bacteria growth, and have no deteriorating effect on the PVC pipe or rubber gaskets.

Sub-section C. Fittings:

All fittings to be used with the PVC pipe shall be the same as fittings for Ductile Iron Pipe and shall conform to the provisions of ANSI/AWWA C110/A21.10-82 or C153/A21.53-58. FM grease shall be applied to the threads of the bolts on all fittings.

When the Public Works/Engineer determines that a potential for corrosive conditions exists such as poor drainage or reactive soils, fittings shall be incased in polyethylene wrap. Polyethylene encasement shall meet the requirements of ANSI A21.5 or AWWA C105.

Sub-section D. Caution Tape:

All pipe shall include a three-inch (3") caution tape installed in the pipeline trench approximately twelve inches (12") below the ground surface.

Identification tape shall be furnished with white or black printing on a colored field having the words:

CAUTION: POTABLE WATER - BELOW.

Sub-section E. Tracer Wire:

All pipe, including service laterals, shall include a 12 gauge solid THHN tracer wire installed according to NESC standards. The tracer wire shall be installed in the pipeline trench approximately 6-inches above the top of pipe. The tracer wire shall be brought up in the valve and meter boxes and along and fastened to each fire hydrant to permit connecting to when doing line location.

Section 3A.04 PIPE INSTALLATION

Installation of ductile iron pipe shall be in accordance with ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances. Installation of PVC pipe shall be in accordance with AWWA C900, C905, ASTM D2774, and PVC Pipe, AWWA Manual M23 and with applicable manufacturer's instructions.

Sub-section A. Cutting:

Cutting of pipe for closure pieces or for other reasons shall be done in a neat and workmanlike manner by a method recommended by the manufacturer. After cutting, the pipe shall be beveled and filed to prevent gasket damage in joint assembly.

Sub-section B. Dewatering of Trench:

Where water is encountered in the trench, it shall be removed during pipe laying operations and the trench so maintained until the ends of the pipe are sealed. See "Control of Groundwater" in Division 2 Trench - Excavation and Backfill.

Sub-section C. Laying of Pipe:

The pipe and pipe coating (where applicable) shall be inspected for defects before installation. Any defects shall be repaired or the pipe shall be replaced, whichever is deemed necessary by the Public Works Representative/Engineer.

All pipe shall be laid and maintained to the required lines and grades with fittings and valves at the required locations. The pipes shall be installed with a 48-inch minimum cover from finished road surface for culinary water. The Developer/Contractor shall be responsible to install the pipe line to the alignment set by the Public Works Representative/Engineer or as shown on the Drawings.

All pipes, fittings and valves shall be carefully lowered from the truck when unloading or when installing into the trench. This should be done one piece at a time in order to prevent damage to pipe materials and protective coatings and linings. Under no circumstances shall materials be dropped or dumped from the truck or into the trench.

The Developer/Contractor shall take the necessary precautions such that foreign materials do not enter into the pipe. No debris, tools, or other materials shall be placed in the pipe during laying operations. When laying of pipe is not in progress, the pipe shall be closed by a water tight plug.

Maximum deflections at pipe joints shall not exceed the joint specifications of AWWA C605 of latest revision, or the recommendations of the pipe manufacturer.

Deflections in PVC pipe shall be made by longitudinal bending of the barrel of the pipe rather than deflecting the pipe joints. Longitudinal bending shall be limited to eighty percent (80%) of the manufactures recommended minimum bending radius.

Sub-section D. Pipe Bedding:

All pipes shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedding.

In the event trench materials are not, in the judgment of the Public Works Representative/Engineer, satisfactory for pipe bedding, imported granular bedding will be required. See Division 2 of these specifications.

Sub-section E. Thrust Blocking:

Thrust blocking shall be applied at all tees, valves, plugs, caps and at bends deflecting 1 1/4 degrees or more. The fitting shall be encased in a 12 mil protective plastic wrap before the thrust block is poured. Reaction blocking shall be concrete having a compressive strength of not less than 3000 pounds per square inch at 28 days. Blocking shall be placed between undisturbed soil and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as shown in the Drawings. The blocking shall be so placed that the pipe and the fittings will be accessible for repair.

Sub-section F. Connections to Existing Water Lines:

Information on the drawings regarding existing water lines is taken from "record" drawings from the City or utility company files and may or may not be accurate as to size, type of material or location. The Developer/Contractor will be responsible to determine the proper fittings and materials required, obtain the Public Works Representative/Engineer's approval of the planned connection, and perform the construction in a suitable fashion. Where fitting sizes, such as tees and crosses, are shown on the plans, those sizes will be used. However, no attempt has been made to show all needed fittings or materials.

Section 3A.05 WATER SERVICE LATERALS

Water service laterals shall be constructed with materials specified and at the locations shown on the Standard Drawings or at the actual location established during construction.

Pipe for water service laterals shall be one-inch (1") blue polyethylene pipe CTS O.D. tube or larger. Polyethylene CTS tube shall be manufactured in accordance with the standard specification for Polyethylene PEP plastic tubing as issued by the American Standard for Testing and Materials under ASTM D 2737 and AWWA C901.

Material designation code: Bimodal Polyethylene (PE 4710)

Minimum Cell Classification: 445574E (blue color) or 445574C with blue outer layer, as defined by ASTM D 3350

Standard pipe dimension ratio: CTS (SDR) 9 – 200 or 250 psi pressure rating.

Sub-section A. Extent of Laterals:

New water service laterals shall extend from the water main to five-foot (5') past the meter box. New polyethylene pipe water services shall not have any joints between the corporation stop at the main and the meter setter.

Water service laterals relocated during construction of new pipelines shall extend from the water main to the water meter if the existing service is other than copper or polyethylene or is in poor condition. Water services other than copper and polyethylene shall not have any joints between the corporation stop and the meter.

Sub-section B. Excavation and Backfill:

Trench excavation and backfill shall conform to the applicable paragraphs of Division 2. Bedding shall meet the requirements of Division 2.

Sub-section C. Connection to Main:

A 24-inch gooseneck shall be formed with the tubing for all connection types. No connections shall be made to the main within 24" of the end of the pipe joint. On existing services the existing connection to main will be used unless damaged or leaking. All connections shall be made using pack joints (compression) type fittings.

- 1) Connection to Ductile Iron Main. All connections of services to ductile iron main lines shall be direct tap with a corporation type stop. The corporation stop shall be a one-inch (1") Mueller H-15008 "CC" thread.
- 2) Connection to PVC Main (For use with AWWA C900 C1 O.D. for PVC plastic pipe). All service clamps shall be of a "Full encirclement design," and shall be I.D. controlled, which design will eliminate the possibility of pipe crushing due to the over torquing of the nuts upon installation. A rigid liner shall be used inside of tubing at the compression fitting on a 1-inch service connection. No rigid liner will be required inside of tubing at compression fittings on 1 1/2-inch or 2-inch service lines. All service clamps shall be manufactured of brass cast in conformance to AWWA C800, General Section - 1, Paragraph 1.2 (ASTM B62). The two sides of the clamp shall be held together by high quality Silicon Bronze Hex Bolts (in sizes 1" and over) or Silicon Bronze Slotted Screws (in sizes under 1"), No dis-similar metals shall be allowed at this point thus eliminating the possibility of galvanic corrosion. All service clamps shall be Mueller Model H-13490 Series, or Ford Model S-91 Series and Romac 305 Series for 14" or larger.

Sub-section D. Meter Setter, Box and Cover:

The meter setter shall be one-inch (1") Ford dual check. The meter box shall be 21-inch (21") diameter by thirty-six-inch (36") high corrugated with groove to fit over the inlet and outlet line. The meter cover to be D&L Supply L-2242-16 with recessed standard waterworks pentagon head locking device, raised cast center rim, and 2" knockout. Cover to be three-eighths-inch (3/8") above top back of sidewalk. Centerline of cover shall be one-foot (1') behind back of walk. The cover shall be marked "Water."

Sub-section E. Special Joints and Fittings:

- 1) Copper Tubing Solder and Sweat Joints: Joints in copper tubing shall be made by the appropriate use of approved brass or copper fittings. Surface to be joined by soldering shall be thoroughly cleaned bright by manual or mechanical means. The joints shall be properly fluxed with an approved non-corrosive type flux and made up with approved solder. All solders and fluxes shall not have a lead content that exceeds current EPA guidelines.
- 2) Copper Tubing to Screw Pipe Joints: Joints from copper tubing to threaded pipe shall be made by the use of brass adapter fittings.
- 3) PE Compression Fitting Coupling Nut: The interior surface of the coupling nut, including threads, shall have a baked on, fluorocarbon coating to reduce assembly friction and prevent the gasket from turning and twisting during tightening. The nut shall bottom on a cast or machined shoulder on the body when properly assembled. This design will provide a visual check to assure connection is properly assembled.
- 4) PE Compression Fitting Sealing Gasket: The sealing gasket shall be of molded synthetic rubber (ASTM D2000) with molded in place bronze spring (ASTM A134 Alloy #6) to eliminate the possible cold flow of the gasket between the pipe and fitting. A gripper band of hardened stainless steel (ANSI Type 401) shall be fitted into the gasket. When the gasket is compressed it will cause the gripper ring to distort the pipe giving the fitting a high resistance to pull out. The gripper band shall overlap itself to prevent cold flow of the gasket into the cavity under the band.
- 5) PE Pipe Stiffeners: When Mueller 110 compression fittings are used with P.E. Pipe, Stainless Steel pipe stiffeners are required to eliminate cold flow of plastic pipe.
- 6) PE Fittings: All fittings are to be for CTS Polyethylene pipe.
- 7) PE Pull Out Load: The Minimum pull out load for the fitting when used with PE plastic pipe shall be as follows for each given size:

<u>SIZE</u>	<u>MINIMUM PULL OUT (FT.LBS.)</u>
3/4"	400
1"	400
1 1/2"	500
2"	500

MUELLER 110 COMPRESSION COUPLINGS AND FITTINGS OR EQUIVALENT ARE TO BE USED ON ALL P.E. PLASTIC PIPE INSTALLATIONS.

Sub-section F. Separation:

Maintain separation of water main from sewer piping in accordance with the current Plumbing Code and Utah Division of Drinking Water Standards (R309-550-7). A minimum of eighteen-inch (18") vertical and

ten-foot (10') horizontal separation shall be maintained unless the Division of Drinking Water grants an exception.

Sub-section G. Flushing, Testing and Disinfecting:

Flushing, testing and disinfecting shall be done at the time the water main is flushed, tested and disinfected. The end of the trench where the stub out past the meter is located shall be left open to allow for discharging water out of the service line for proper flushing and to insure that the line has been adequately disinfected. The line shall be flushed thoroughly following installation. Flushing, testing and disinfecting shall conform to the applicable paragraphs of this division.

On existing services the Developer/Contractor shall take precautions to prevent contamination of the pipe and connections during installation. The line shall be flushed thoroughly following installation.

Section 3A.06 DAMAGE AND REPAIR OF WATER MAINS AND APPURTENANCE

The Developer/Contractor shall be responsible for any damage to water mains and water facilities caused by his operations. The Developer/Contractor may be relieved of the responsibility under the following conditions:

- 1) He has not excavated below or beyond the required excavation lines, and
- 2) He has given proper and timely notice of his work plans, and
- 3) He has used reasonable care, and cooperated, minimizing the damage.

Any damage to water gates, hydrants, valve chambers, meter boxes, and other surface appurtenances that result from the Developer/Contractor's operation shall be its sole responsibility.

Section 3A.07 FLUSHING, DISINFECTING, AND TESTING

Sub-section A. Flushing:

All new water systems or extensions to existing systems shall be thoroughly flushed before being placed in service. Flushing shall be accomplished through hydrants, or end of line blow-off assemblies at a minimum flushing velocity of 2.5-feet per second. See chart below.

FLOW RATE AND OPENINGS TO FLUSH PIPELINES
(40- psi Residual Pressure)

Pipe Size (inches)	Flow Required to Produce 2.5 fps velocity (gpm)
2	26
4	100
6	220
8	390
10	610
12	880
14	1,200
16	1,565
18	1,980
20	2,450
24	3,525
30	5,507

Sub-section B. Disinfection:

After flushing, all culinary water lines shall be disinfected by chlorination. Chlorination shall provide a minimum of 25 ppm residual after 24 hours contact in the pipeline. This may be expected with an application of 50 ppm, although some conditions may require more. Chlorine in the form of a 1% slurry of high-test calcium hypochlorite (HTH, Perchloron, Pittchlor, etc. which are 70% available chlorine by weight) shall be fed into the pipeline in such a manner as to mix with the water flowing in the pipeline. (A 1% slurry - 10,000 ppm - results from mixing one pound of calcium hypochlorite with 8.40 gallons of water.)

The following table provides information as to the required quantity of slurry to be used per 100 feet of pipe to provide a chlorine concentration of 50 ppm:

Pipe Size (in.)	Vol. of 100 ft. Length (gal)	Required Amount of 1 % Chlorine Slurry (gal)
1 ½	9.18	0.07
2	16.32	0.12
2 ½	25.50	0.18
3	36.73	0.26
4	65.28	0.47
6	146.90	1.05
8	261.10	1.87
10	408.10	2.92
12	587.60	4.20

During the process of chlorinating the pipeline, operate all valves and other pipeline appurtenances several times to provide sufficient contact with the chlorinating agent. Following chlorination, drain and thoroughly flush the water line according to Section A above. The Public Works Representative shall obtain a water sample, upon which the City will have a bacteriological test performed. The Contractor/Developer shall pay the cost of the bacteriological test. Rechlorinate the water line and retest the water, if necessary, until the results of the bacteriological test are satisfactory.

After chlorination is completed, dechlorination of the lines shall be performed until the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or that is acceptable for domestic use.

Disinfection shall conform to the requirements of AWWA C651-05 (or latest edition).

Sub-section C. Pressure Test:

All newly laid pipes or any valved section thereof shall be subjected to a hydrostatic pressure. A leakage test shall be conducted concurrently with the pressure test.

- 1) Test Pressure Restrictions: Test pressures shall,
 - i. Not be less than 1.5 times the static pressure at the highest point along the test section.
 - ii. Not exceed pipe or thrust restraint design pressures.
 - iii. Be of at least 2-hour duration.
 - iv. Not vary by more than plus or minus five (± 5) psi for the duration of the test.
 - v. Not exceed twice the rated pressure of the valves or hydrants when the pressure boundary of the test section includes closed gate valves or hydrants.
 - vi. Not exceed the rated pressure of the valves when the test boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.

- 2) **Pressurization:** Each valved section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gage, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Public Works Representative/Engineer.
- 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 Developer/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, the corporation cocks shall be removed and plugged.
- 4) **Examination:** All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test shall be repaired or replaced with sound materials and the test shall be repeated until it is satisfactory to the Owner.

Sub-section D. 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 any valved section thereof, to maintain pressure within 5 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:

$$L = \frac{SD(P)^{0.5}}{133,200}$$

In which L is the allowable leakage, in gallons per hour; S is the length of pipeline tested in feet; 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.

- i. Allowable leakage at various pressures is shown in Table 1.
- ii. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in. of nominal valve size shall be allowed.
- iii. When hydrants are in the test section, the test shall be made against the closed hydrant .

**TABLE 1
Allowable Leakage per 1000 ft of Pipeline - gph**

Average Test Pressure psi (Bar)	Nominal Pipe Diameter-in.															
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

**To obtain leakage in liters/hour, multiply the values in the table by 3.785.

- 3) Examination: All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or hydrants that are discovered during the leakage test shall be repaired or replaced with sound materials and the test shall be repeated. Repairs or replacements to the pipeline and subsequent leakage testing shall be performed as necessary for the pipeline to pass the leakage test.

Sub-section E. Acceptance of Installation:

Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than specified, the Developer/Contractor shall, at its own expense, locate and repair the defective material until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

(Division 3A was last updated June, 2015)

DIVISION 4

CONCRETE PIPE

Section 4.01 GENERAL

This section covers the requirements for concrete pipe materials and installation in sanitary sewer, storm drain, and other gravity line construction.

Section 4.02 PIPE

Concrete pipe used in sewer line, storm drain line and other gravity line construction shall be reinforced concrete pipe or non-reinforced concrete pipe, as required by design loading and fill heights and as follows:

Sub-section A. Reinforced Concrete Pipe:

All reinforced concrete pipe used in the construction shall be of the rubber gasket type, bell and spigot joint design, conforming to the requirements of the latest revision of ASTM Designation C76 (class III). Pipe class shall be as shown on the Drawings. The minimum joint length of all pipes provided shall be 7 1/2 feet. All pipe 12-inch diameter and larger shall be reinforced concrete.

Sub-section B. Non-Reinforced Concrete Pipe:

All non-reinforced concrete pipe used in the construction shall be of the rubber gasket type, bell and spigot joint design, conforming to the requirements of the latest revision of ASTM Designation C14. Pipe class shall be as shown on the Drawings. The minimum joint length for pipe shall be four feet for pipe up to ten inches and seven and a half feet for all other pipe.

Sub-section C. Bell and Spigot Joints:

Bell and spigot joints, including rubber gaskets, shall conform to the requirements of the latest revision of ASTM Designation C443. The pipe joint shall be so designed as to provide for self-centering, and when assembled, to compress the gasket to form a water tight seal. The gasket shall be confined in a groove on the spigot, so that pipe movement or hydrostatic pressure cannot displace the gasket.

Sub-section D. Minimum Size and Slope Requirements:

In no case shall sanitary sewer mains be less than eight inches in diameter. Sewers shall be laid with uniform slope between manholes. All sewers shall be designed and constructed to give mean velocities of not less than 2 feet per second when flowing full, based on Manning's formula using an n value of .013. Absolute minimum slope allowed shall be those published by the Utah Department of Environmental Quality, Division of Water Quality as Administrative Rules for Design Requirements for Wastewater Collection, Treatment and Disposal System, R317-3, **Table R317-3-2.3 (D)(4) Minimum Slopes**.

Whenever possible the slope should exceed 0.006 ft/ft. The pipe should be sized to meet anticipated hydraulic loads, increasing the pipe size to reduce the minimum slope requirements shall not be allowed. Sewer slopes shall not exceed 0.12 ft/ft, drop manholes shall be used when steeper slopes are needed, drop manholes shall be used to keep line grade below maximum grade allowed.

Section 4.03 PIPE LAYING

All concrete pipe installation shall proceed upgrade on a stable foundation, with joints closely and accurately fitted. Rubber gaskets shall be fitted properly in place, and care shall be taken in joining the pipe sections to avoid twisting of gaskets. Joints shall be clean and dry, and a joint lubricant as recommended by the pipe supplier shall be applied uniformly to the mating joint surfaces to facilitate easy positive joint closure.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.

Select material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and re-jointed as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

Section 4.04 GRAVEL FOUNDATION FOR PIPE

Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, or where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place.

Gravel for concrete pipe foundation shall be clean crushed rock or gravel as specified in Division 2, Trench Excavation and Backfill.

Section 4.05 INSTALLATION REQUIREMENTS FOR LINE AND GRADE

All concrete pipe shall be installed accurately to the defined line and grade with the following limits:

Variance from established line and grade shall not be greater than one-sixteenth (1/16) inch per inch of pipe diameter in ten feet, and not to exceed one-half inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one-sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum.

Section 4.06 PIPE BEDDING

All pipes shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Bell holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Pipe bedding materials placed at any point below the mid-point of the pipe shall be deposited and compacted in layers not to exceed ten inches (10") in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed in the trench in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall be loose earth, free from lumps; sand or gravel, free from rocks larger than two-inch (2") diameter. All materials shall be free from roots, sod, or other vegetable matter.

In the event trench materials are not satisfactory for pipe bedding, modified bedding will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of twelve inches (12") above the top of the pipe.

Modified bedding material shall be graded as follows: One-hundred percent (100%) passing a one and one-half inch (1-1/2") screen and five percent (5%) passing a No. 4 sieve.

Section 4.07 TESTS

The Developer/Contractor will be required to conduct an air test and displacement test in the presence of the Public Works Representative/Engineer or his representative. If these tests prove to be inconclusive, any or all of the other required tests shall be conducted in the presence of the Public Works Representative/Engineer or his representative. Tests shall be performed as follows:

Sub-section A. Displacement Test:

In conducting the displacement test a light will be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned or displaced pipe or other defects, the defects designated by the Public Works Representative/Engineer shall be remedied at the Developer/Contractor's expense.

Sub-section B. Infiltration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making infiltration tests of the completed line before it can be placed into service. The Developer/Contractor shall furnish and install the measuring weirs or other measuring devices. The length of line to be tested at any time shall be subject to the approval of the Public Works Representative/Engineer. The maximum allowable infiltration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per twenty-four hours (24 hrs) for all installed pipe. If the quantity of infiltration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section C. Exfiltration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making ex-filtration tests of the completed line before it can be placed into service. The length of line to be tested at one time shall be limited to the length between adjacent manholes. The maximum allowable ex-filtration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per 24 hours for all installed pipe. The end of the line, which projects into the manhole, shall be plugged. The pipe shall then be filled with water from the upper manhole, and the line maintained under a light pressure of four feet (4') of head. The inflow of water necessary to maintain this head shall be recorded as the leakage of the system. If the quantity of ex-filtration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section D. Air Testing:

The Developer/Contractor or his representative (a qualified firm or individual agreed upon by the Public Works Representative/Engineer and the Developer/Contractor) shall furnish labor, equipment, and materials, including pumps and compressors, and shall perform, in the presence of the Public Works Representative/Engineer, air tests of the completed pipe before it can be placed in service. Each section of sanitary sewer pipeline between manholes shall be tested after all the four-inch service laterals (and plugs) have been installed. Each test section shall be pressurized to 4.0 psi. For the purpose of stabilizing the air pressure in each test section, the 4.0 psi pressure shall be maintained for a two-minute period. Each test section shall then be re-pressurized to 4.0 psi for a period of four minutes. The test section shall be accepted if, after four minutes, the pressure gauge indicates 3.5 psi or greater. Failure of the Developer/Contractor's testing equipment to properly function shall render the test unacceptable. All faulty sections of pipeline shall be repaired and re-tested until the minimum air testing requirements have been met.

Section 4.08 MANHOLE CONNECTIONS

Concrete pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber gaskets, positive seal gasket system with 300 series nonmagnetic corrosion-resistant steel bands, or grouting a bell or spigot pipe at the appropriate locations. Connections shall meet the requirements of Division 5 MANHOLES.

Section 4.09 SEWER SERVICE LATERALS

New service laterals shall be constructed with materials and procedures as specified herein.

Existing service laterals shall be constructed with materials compatible with the existing laterals with appropriate connections for joining the ends of existing laterals. All laterals shall be four-inch (4") in diameter unless shown otherwise.

Sub-section A. Extent and Location of Laterals:

New sewer laterals installed to lots shall be located ten feet (10') uphill of the lowest front property corner. Service laterals shall extend from the sewer main to a point ten feet (10') beyond the street right-of-way line unless shown or staked otherwise. A two-inch (2") by four-inch (4") by six-foot (6') marker, with the top twelve inches (12") painted green, shall be installed to clearly mark the end of each lateral line. In addition to the marker, the Developer/Contractor shall station (give a distance) the location of the lateral connection to the main from the nearest downstream manhole. Laterals shall be capped with a cap suitable to withstand test pressure and prevent any leakage into or out of the lateral.

When an existing sewer lateral is encountered along the line and grade of a new pipeline it shall be relocated using appropriate pipe and fittings and graded to insure adequate slope to drain properly. Minimum slope shall be one-quarter-inch (1/4") per foot.

Sub-section B. Excavation and Backfill:

Trench excavation and backfill shall conform to the applicable paragraphs of Division 2 and the bedding requirements of this Division.

Sub-section C. Pipe:

Pipe used for new service laterals shall be PVC Plastic Pipe conforming to ASTM D3034 SDR 35.

Sub-section D. Connection to Main:

Connection to a new main shall be made using a precast wye or tee installed in the main line at time of installation with a 4-inch PVC adapter or rubber gasket into which the 4-inch PVC lateral is inserted to form a water tight connection. In pipes 12 inches and larger the connection may be made using a cored hole in the pipe and a rubber boot. Recommendations of the manufacturer of the materials used shall be carefully followed.

Connections onto existing sewer mains shall be made with field installed service saddles (gasketed and clamped). All connections by field installed service saddles on existing sewer mains shall be done with a sewer tapping machine and all required fittings and materials. Connections shall be made as shown on the Standard Drawing and at the location specified herein, shown on the improvement drawings or as staked in the field.

Sub-section E. Cover Over Sewer Lateral Lines:

There shall be a minimum of 3 feet of cover over all sewer lateral lines (3'6" minimum at property line.)

Sub-section F. Sewer Clean Outs:

There shall be a maximum distance of 5 feet from the foundation wall to the first exterior clean out with a maximum distance between clean-outs of one hundred (100) feet. There shall be a clean out when a combination of bends is ninety degrees (90°) or greater.

Sub-section G. Testing:

The service laterals shall be tested as a part of the sewer main to which they are connected.

Sub-section H. Damage and Repair of Sewers and Appurtenances:

The Developer/Contractor shall be responsible for the protection of existing improvements, and any damage resulting from its operations shall be its sole responsibility.

Damage to the sewers, laterals, or appurtenances shall be repaired by acceptable and approved methods.

DIVISION 4A**PVC PLASTIC PIPE****Section 4A.01 GENERAL**

This section covers the requirements for PVC plastic sewer pipe materials and installation in sanitary sewer, storm drain, and other gravity line construction.

Section 4A.02 PIPE

PVC gravity sewer pipe and fittings shall conform to ASTM D3034, for diameters from four-inch (4") to fifteen-inch (15") and ASTM F679 for eighteen-inch (18") to twenty-seven-inch (27"), with integral bell gasket joints. Rubber gaskets shall be factory installed and conform to ASTM F477. Pipe joints shall conform to ASTM D3212. Pipe shall be made of PVC plastic having a cell classification of 12454 or 12364 as defined in ASTM D1784 and shall have a SDR of 35 and minimum pipe stiffness of 46 PSI according to ASTM test D2412.

Pipe shall be installed in compliance with ASTM D2321 and the manufacturer's requirements.

Sub-section A. Minimum Size and Slope Requirements:

In no case shall sanitary sewer mains be less than eight inches in diameter. Sewers shall be laid with uniform slope between manholes. All sewers shall be designed and constructed to give mean velocities of not less than 2 feet per second when flowing full, based on Manning's formula using an n value of .013. Absolute minimum slope allowed shall be those published by the Utah Department of Environmental Quality, Division of Water Quality as Administrative Rules for Design Requirements for Wastewater Collection, Treatment and Disposal System, R317-3, **Table R317-3-2.3 (D)(4) Minimum Slopes**.

Whenever possible the slope should exceed 0.006 ft/ft. The pipe should be sized to meet anticipated hydraulic loads, increasing the pipe size to reduce the minimum slope requirements shall not be allowed. Sewer slopes shall not exceed 0.12 ft/ft, drop manholes shall be used when steeper slopes are needed, drop manholes shall be used to keep line grade below maximum grade allowed.

Section 4A.03 FITTINGS

Fittings shall be made of PVC plastic conforming to ASTM D1784 and a cell classification as outlined in ASTM D3034.

Section 4A.04 PIPE LAYING

All pipe installation shall proceed upgrade on a stable foundation, with joints closely and accurately fitted. Joints shall be clean and dry, and a joint lubricant as recommended by the pipe supplier shall be applied uniformly to the mating joint surfaces to facilitate easy positive joint closure.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.

Select material shall be compacted around the pipe to firmly bed the pipe in position. Haunching material (bed to springline) should be carefully worked under the haunches of the pipe and compacted from the pipe to the trench wall or two and one half (2-1/2) pipe diameters on each side of the pipe to ensure support. If adjustment of position of a pipe length is required after being laid, it shall be removed and re-jointed as for a new pipe. When pipe laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall rigidly adhere to the specific requirements of the pipe manufacturer.

Section 4A.05 GRAVEL FOUNDATION FOR PIPE

Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place.

Gravel for PVC pipe foundation shall be clean crushed rock or gravel with one hundred percent (100%) passing a two-inch (2") screen and a maximum of five percent (5%) less than one-half-inch (1/2").

Section 4A.06 INSTALLATION REQUIREMENTS FOR LINE AND GRADE

All PVC pipe shall be installed accurately to the defined line and grade with the following limits:

- a) Variance from established line and grade shall not be greater than one-sixteenth (1/16) inch per inch of pipe diameter in ten feet, and not to exceed one-half inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one-sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum.

Section 4A.07 PIPE BEDDING

All pipe sewers and drains shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Bell holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Pipe bedding materials placed at any point below the mid-point of the pipe shall be deposited and compacted in layers not to exceed ten inches (10") in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed in the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall be loose earth, free from lumps; sand or gravel, free from rocks larger than one-inch (1") diameter; with all materials free from roots, sod, or other vegetable matter.

In the event trench materials are not satisfactory for pipe bedding, modified bedding will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of twelve inches (12") above the top of the pipe.

Modified bedding material shall be graded as follows: One-hundred percent (100%) passing a one inch (1") screen and maximum five percent (5%) passing a No. 200 sieve.

Section 4A.08 TESTS

The Developer/Contractor will be required to conduct an air test and displacement test in the presence of the Public Works Representative/Engineer or his representative. If these tests prove to be inconclusive, any or all of the other required tests shall be conducted in the presence of the Public Works Representative/Engineer or his representative. Tests shall be performed as follows:

Sub-section A. Displacement Test:

In conducting the displacement test a light will be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned or displaced pipe or other defects, the defects designated by the Public Works Representative/Engineer shall be remedied at the Developer/Contractor's expense.

Sub-section B. Infiltration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making infiltration tests of the completed sewer before it can be placed into service. The Developer/Contractor shall furnish and install the measuring weirs or other measuring devices. The length of line to be tested at any time shall be subject to the approval of the Public Works Representative/Engineer. The maximum allowable infiltration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per twenty-four hours (24 hrs) for all installed sewer pipe. If the quantity of infiltration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section C. Exfiltration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making exfiltration tests of the completed sewer before it can be placed into service. The length of line to be tested at one time shall be limited to the length between adjacent manholes. The maximum allowable exfiltration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per 24 hours for all installed sewer pipe. The end of the sewer line, which projects into the manhole, shall be plugged. The pipe shall then be filled with water from the upper manhole, and the line maintained under a light pressure of four feet (4') of head. The inflow of water necessary to maintain this head shall be recorded as the leakage of the system. If the quantity of exfiltration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section D. Air Testing:

The Developer/Contractor or his representative (a qualified firm or individual agreed upon by the Public Works Representative/Engineer and the Developer/Contractor) shall furnish labor, equipment, and materials, including pumps and compressors, and shall perform, in the presence of the Public Works Representative/Engineer, air tests of the completed pipe before it can be placed in service. Each section of sanitary sewer pipeline between manholes shall be tested after all the service laterals (and plugs) have been installed. Each test section shall be pressurized to four (4.0) psi. For the purpose of stabilizing the air pressure in each test section, the four (4.0) psi pressure shall be maintained for a two-minute period. Each test section shall then be re-pressurized to 4.0 psi for a period of four minutes. The test section shall be accepted if, after four minutes, the pressure gauge indicates 3.5 psi or greater. Failure of the Developer/Contractor's testing equipment to properly function shall render the test unacceptable. All faulty sections of pipeline shall be repaired and re-tested until the minimum air testing requirements have been met.

Section 4A.09 MANHOLE CONNECTIONS

PVC pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber gaskets, or positive seal gasket system with 300 series nonmagnetic corrosion-resistant steel bands. PVC may not be grouted directly to concrete. Connections shall meet the requirements of Division 5 MANHOLES.

Section 4A.10 SEWER LATERAL CONNECTIONS

All sewer lateral connections onto new sewer mains shall be made through preformed tee fittings installed in the main line at the time of main line installation.

Connections onto existing sewer mains shall be made with field installed Inserta Tee fittings. All connections by field installed Inserta Tee fittings on existing sewer mains shall be done with a sewer tapping machine and all required fittings and materials. Connections shall be made as shown on the Standard Drawing and at the location specified herein, shown on the improvement drawings or as staked in the field.

Section 4A.11 SEWER SERVICE LATERALS

New service laterals shall be constructed with materials and procedures as specified herein.

Existing service laterals shall be constructed with materials compatible with the existing laterals with appropriate connections for joining the ends of existing laterals. All laterals shall be four inch (4") in diameter unless shown otherwise.

Sub-section A. Extent of Laterals and Location of Laterals:

New sewer laterals installed to lots shall be located ten feet (10') uphill of the lowest front property corner. Service laterals shall extend from the sewer main to a point ten feet (10') beyond the street right-of-way line unless shown or staked otherwise. A two-inch (2") by four-inch (4") by six-foot (6') marker, with the top twelve inches (12") painted green, shall be installed to clearly mark the end of each lateral line. In addition to the marker, the Developer/Contractor shall station (give a distance) the location of the lateral connection to the main from the nearest downstream manhole. Laterals shall be capped with a cap suitable to withstand test pressure and prevent any leakage into or out of the lateral.

When an existing sewer lateral is encountered along the line and grade of a new pipeline it shall be relocated using appropriate pipe and fittings and graded to insure adequate slope to drain properly. Minimum slope shall be one-quarter-inch (1/4") per foot.

Sub-section B. Excavation and Backfill:

Trench excavation and backfill shall conform to the applicable paragraphs of Division 2 and the bedding requirements of this Division.

Sub-section C. Pipe:

Pipe used for new service laterals shall be PVC Plastic Pipe conforming to ASTM D3034 SDR 35.

Sub-section D. Connection to Main:

Connections to the main shall be made as specified in Section 4A.10 SEWER LATERAL CONNECTIONS. Recommendations of manufacturer of the materials used shall be carefully followed.

Sub-section E. Cover Over Sewer Lateral Lines:

There shall be a minimum of 3 feet of cover over all sewer lateral lines (3'6" minimum at property line.)

Sub-section F. Sewer Clean Outs:

There shall be a maximum distance of 5 feet from the foundation wall to the first exterior clean out with a maximum distance between clean-outs of one hundred (100) feet. There shall be a clean out when a combination of bends is ninety degrees (90°) or greater.

Sub-section G. Testing:

The service laterals shall be tested as a part of the sewer main to which they are connected.

Sub-section H. Damage and Repairs of Sewers and Appurtenances:

The Developer/Contractor shall be responsible for the protection of existing improvements, and any damage resulting from its operations shall be its sole responsibility.

Damage to the sewers, laterals, or appurtenances shall be repaired by acceptable and approved methods.

Section 4A.12 "GO/NO-GO" MANDREL PROOF TESTING

Not less than thirty (30) days after installation of the flexible sewer or drain pipe, the Developer/Contractor shall test the buried pipe to insure that ring-deflection of the pipe does not exceed five percent (5%) of the pipe's specified minimum inside diameter (ID). This proof test shall establish that the Developer/Contractor has installed the flexible pipe in full compliance with the Project Specifications thereby providing required pipe/soil structural strength.

The Developer/Contractor, with Inspector present, shall pull a "Go/No-Go" Mandrel, inspected and approved by the Public Works Representative/Engineer, through the full length of installed flexible pipe. The Mandrel shall be fabricated from suitable metal with a minimum of nine (9) properly sized radial fins mounted upon a center pulling shaft. In any case, the Mandrel shall be provided with an odd number of rigidly mounted radial fins. The Mandrel shall be provided with a proof-sizing ring that can demonstrate that the Mandrel's minimum outside diameter (OD) is not less than ninety-five percent (95%) of the specified minimum inside diameter of the installed flexible pipe. The Mandrel shall be pulled by the Developer/Contractor through one hundred percent (100%) of the installed flexible pipe without using mechanical equipment. Failure of the Mandrel to pass through a pipeline shall be deemed evidence of inadequate installation by the Developer/Contractor not in compliance with the Project Specifications.

The Public Works Representative/Engineer may require, if deemed appropriate or necessary, additional proof testing of designated lengths of the buried flexible pipe approximately one year (1 yr.) after installation but prior to the expiration of the Developer/Contractor's Maintenance Bond. The flexible pipeline shall be cleaned adequately prior to performing the "Go/No-Go" Mandrel ring deflection proof test. The Developer/Contractor, with Inspector present, shall pull a Mandrel, approved by the Public Works Representative/Engineer, through the designated length of pipeline without using mechanical equipment. Failure of the Mandrel to pass through the pipeline shall be deemed evidence of inadequate installation by the Developer/Contractor not in compliance with the Project Specifications.

(Division 4A was last updated July 28, 2010)

DIVISION 4B

POLYETHYLENE CORRUGATED PIPE

Section 4B.01 GENERAL

This section covers the requirements for high-density polyethylene corrugated pipe with integrally formed smooth interior for use in storm drains.

Section 4B.02 PIPE

This specification is applicable to nominal sizes 12 - 36 inch diameter and larger if and when available. Requirements for test methods, dimensions, and markings are those found in AASHTO Designation M-294.

Pipe and fittings shall be made of polyethylene compounds that meet or exceed the requirements of ASTM F 405 or ASTM F 667, Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM Designation D1248 with the applicable requirements defined in ASTM D1248. Clean reworked material may be used.

Minimum parallel plate pipe stiffness values at 5% deflection shall be as follows:

<u>Diameter</u>	<u>Pipe Stiffness*</u>
12"	50 psi
15"	42 psi
18"	40 psi
24"	34 psi
30"	28 psi
36"	22 psi

*Per ASTM Test Method D2412
with exceptions stated in M 294

The pipe and fittings shall be free of foreign inclusions and visible defects. The ends of the pipe shall be cut squarely and cleanly so as not to adversely effect joining.

The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Corrugated fittings maybe either molded or fabricated by the manufacturer. Fittings produced by manufacturers other than the supplier of the pipe shall not be permitted without the approval of the Project Public Works Representative/Engineer. A manufacturers' certification that the product was manufactured, tested, and supplied in accordance with this specification shall be furnished to the Project Public Works Representative/Engineer upon request.

Pipe installation shall be in accordance with ASTM Recommended Practice D2321 and the manufacturer's requirements.

Section 4B.03 JOINTS

Joints shall be made with split couplings, corrugated to match the pipe corrugations, and shall engage a minimum of 6 corrugations for 12" - 24" diameter and 4 corrugations for 30" and 36" diameter pipe.

Section 4B.04 PERFORATIONS

All perforated pipe used in the construction shall have either circular or slotted perforations. Circular perforations shall not be more that 5/16 in. nor less than 3/16 in. in diameter, and arranged in rows parallel to the axis of the pipe. Perforations shall be 3 in. center-to-center, along rows. The spigot or tongue end shall not be perforated for a length equal to the depth of the socket, or depth of the groove plus 3/4 in. and perforations shall continue at uniform spacing along the entire length of the barrel. There shall be a total of 8 rows for an 18-inch pipe. The rows shall be

spaced over not more than 165 deg of circumference. Rows shall be symmetrically arranged with respect to the intended top of bottom of the pipe.

Slots shall be circumferential in direction, not more than 3/16 in. or less than 1/8 in. in width, and 3 in. long. The slots shall be spaced 6 in. apart. There shall be two rows of slots, spaced 120° apart. The distance from the spigot end, or from the shoulder of the tongue end, to the first pair of slots shall be not more than 1 in. greater than the specified slot spacing, nor less than 1 in. less than the specified slot spacing. Slots shall continue at uniform spacing along the entire length of the barrel.

Section 4B.05 PIPE LAYING

All pipe installation shall proceed upgrade on a stable foundation, with joints closely and accurately fitted.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe joints.

Select material shall be compacted around the pipe to firmly bed the pipe in position. Haunching material (bed to springline) should be carefully worked under the haunches of the pipe and compacted from the pipe to the trench wall, or two and one-half (2-1/2) pipe diameters on each side of the pipe, to ensure support. If adjustment of position of a pipe length is required after being laid, it shall be removed and re-jointed as for a new pipe. When pipe laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall rigidly adhere to the specific requirements of the pipe manufacturer.

Section 4B.06 GRAVEL FOUNDATION FOR PIPE

Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place.

Gravel for pipe foundation shall be clean crushed rock or gravel with one hundred percent (100%) passing a two-inch (2") screen and a maximum of five percent (5%) less than one-half-inch (1/2").

Section 4B.07 INSTALLATION REQUIREMENTS FOR LINE AND GRADE

All pipe shall be installed accurately to the defined line and grade with the following limits:

- a) Variance from established line and grade shall not be greater than one-sixteenth (1/16) inch per inch of pipe diameter in ten feet, and not to exceed one-half inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one-sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum.

Section 4B.08 PIPE BEDDING

All pipe sewers and drains shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Joint holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Pipe bedding materials placed at any point below the mid-point of the pipe shall be deposited and compacted in layers not to exceed ten inches (10") in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed in the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall be loose earth, free from lumps; sand or gravel, free from rocks larger than one and one-half inch (1-1/2") diameter; with all materials free from roots, sod, or other vegetable matter.

In the event trench materials are not satisfactory for pipe bedding, modified bedding will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of twelve inches (12") above the top of the pipe.

Modified bedding material shall be graded as follows: One-hundred percent (100%) less than one-inch (1") and maximum five percent (5%) passing a No. 200 sieve.

Section 4B.09 TESTS

The Developer/Contractor will be required to conduct a displacement test in the presence of the Public Works Representative/Engineer or his representative. If this test prove to be inconclusive, other required tests shall be conducted in the presence of the Public Works Representative/Engineer or his representative. The test shall be performed as follows:

Sub-section A. Displacement Test:

In conducting the displacement test a light will be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned, or displaced pipe or other defects, the defects designated by the Public Works Representative/Engineer shall be remedied at the Developer/Contractor's expense.

Section 4B.10 MANHOLE CONNECTIONS

Corrugated polyethylene pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber boots with 300 series nonmagnetic corrosion-resistant steel bands, or grouted directly to concrete.

Section 4B.11 LATERAL CONNECTIONS

All lateral connections into new storm drain mains shall be through preformed tee fittings installed in the main line or with field installed service saddles. All connections by field installed service saddles on new or existing storm drain mains shall be done in accordance with manufacturer recommendations and with all required fittings and materials. Connections shall be at the locations shown in the Drawings.

DIVISION 4C**POLYETHYLENE CORRUGATED PIPE
WITH WATER TIGHT JOINTS****Section 4C.01 GENERAL**

This section covers the requirements for high density polyethylene corrugated pipe with integrally formed smooth interior for use in storm drains with water tight joints.

Section 4C.02 PIPE

This specification is applicable to nominal sizes 4 - 18 inch and 30 - 36 inch diameter. Requirements for test methods, dimensions, and markings are those found in AASHTO Designation M-252 and M-294 and ASTM F405 and F-667.

Pipe shall be made of polyethylene compounds that meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM Designation D1248 with the applicable requirements defined in ASTM D1248. Clean reworked material may be used.

Minimum parallel plate pipe stiffness values shall be as follows:

<u>Diameter</u>	<u>Pipe Stiffness*</u>
4"	50 psi
6"	50 psi
8"	50 psi
10"	50 psi
12"	50 psi
15"	42 psi
18"	40 psi
24"	34 psi
30"	28 psi
36"	22 psi

*Per ASTM Test Method D2412 with exceptions stated in M 294

The pipe and fittings shall be free of foreign inclusions and visible defects. For pipe sizes 12" diameter and greater, holes of any kind in the corrugation crests or sidewalls shall be considered unacceptable. The ends of the pipe shall be cut squarely and cleanly so as not to adversely effect joining.

The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Fittings shall be molded by the manufacturer. Fittings produced by manufacturers other than the supplier of the pipe shall not be permitted.

A manufacturer's certification that the product was manufactured, tested, and supplied in accordance with this specification shall be furnished to the Project Public Works Representative/Engineer upon request.

Section 4C.03 FITTINGS

Fittings shall be molded from SDR-35 PVC pipe manufactured in accordance with the applicable requirements defined in ASTM D3034.

Section 4C.04 PIPE LAYING

Pipe installation shall be in accordance with ASTM Recommended Practice D2321 and the manufacturer's requirements.

All pipe installation shall proceed upgrade on a stable foundation, with joints closely and accurately fitted.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe joints.

Select material shall be compacted around the pipe to firmly bed the pipe in position. Haunching material (bed to springline) should be carefully worked under the haunches of the pipe and compacted from the pipe to the trench wall or two and one half (2-1/2) pipe diameters on each side of the pipe to ensure support. If adjustment of position of a pipe length is required after being laid, it shall be removed and re-jointed as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall rigidly adhere to the specific requirements of the pipe manufacturer.

Section 4C.05 GRAVEL FOUNDATION FOR PIPE

Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, or where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place.

Gravel for pipe foundation shall be clean crushed rock or gravel with one hundred percent (100%) passing a two-inch (2") screen and a maximum of five percent (5%) less than one-half-inch (1/2").

Section 4C.06 INSTALLATION REQUIREMENTS FOR LINE AND GRADE

All pipe shall be installed accurately to the defined line and grade with the following limits:

- a) Variance from established line and grade shall not be greater than one-sixteenth (1/16) inch per inch of pipe diameter in ten feet, and not to exceed one-half inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one-sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum.

Section 4C.07 PIPE BEDDING

All pipe sewers and drains shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Joint holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Pipe bedding materials placed at any point below the mid-point of the pipe shall be deposited and compacted in layers not to exceed ten inches (10") in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed in the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall be loose earth, free from lumps; sand or gravel, free from rocks larger than one and one-half inch (1-1/2") diameter; with all materials free from roots, sod, or other vegetable matter.

In the event trench materials are not satisfactory for pipe bedding, modified bedding will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of twelve inches (12") above the top of the pipe.

Modified bedding material shall be graded as follows: One-hundred percent (100%) less than one-inch (1") and maximum five percent (5%) passing a No. 200 sieve.

Section 4C.08 TESTS

The Developer/Contractor will be required to conduct an air test and displacement test in the presence of the Public Works Representative/Engineer or his representative. If these tests prove to be inconclusive, any or all of the other required tests shall be conducted in the presence of the Public Works Representative/Engineer or his representative. Tests shall be performed as follows:

Sub-section A. Displacement Test:

In conducting the displacement test a light will be flashed between manholes or, if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned or displaced pipe or other defects, the defects designated by the Public Works Representative/Engineer shall be remedied at the Developer/Contractor's expense.

Sub-section B. Infiltration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making infiltration tests of the completed line before it can be placed into service. The Developer/Contractor shall furnish and install the measuring weirs or other measuring devices. The length of line to be tested at any time shall be subject to the approval of the Public Works Representative/Engineer. The maximum allowable infiltration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per twenty-four hours (24 hrs) for all installed pipe. If the quantity of infiltration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section C. Ex-filtration Test:

The Developer/Contractor shall furnish labor, equipment, and materials, including pumps, and shall assist the Public Works Representative/Engineer in making ex-filtration tests of the completed line before it can be placed into service. The length of line to be tested at one time shall be limited to the length between adjacent manholes. The maximum allowable ex-filtration shall not exceed one-hundred-fifty (150) gallons per inch diameter per mile per 24 hours for all installed pipe. The end of the line, which projects into the manhole, shall be plugged. The pipe shall then be filled with water from the upper manhole, and the line maintained under a light pressure of four feet (4') of head. The inflow of water necessary to maintain this head shall be recorded as the leakage of the system. If the quantity of ex-filtration is in excess of the maximum allowable, the leaking joints shall be repaired to the satisfaction of the Public Works Representative/Engineer at the expense of the Developer/Contractor.

Sub-section D. Air Testing:

The Developer/Contractor or his representative (a qualified firm or individual agreed upon by the Public Works Representative/Engineer and the Developer/Contractor) shall furnish labor, equipment, and materials, including pumps and compressors, and shall perform, in the presence of the Public Works Representative/Engineer, air tests of the completed pipe before it can be placed in service. Each section of sanitary sewer pipeline between manholes shall be tested after all the four-inch service laterals (and plugs) have been installed. Each test section shall be pressurized to 4.0 psi. For the purpose of stabilizing the air pressure in each test section, the 4.0 psi pressure shall be maintained for a two-minute period. Each test section shall then be repressurized to 4.0 psi for a period of four minutes. The test section shall be accepted if, after four minutes, the pressure gauge indicates 3.5 psi or greater. Failure of the Developer/Contractor's testing equipment to properly function shall render the test unacceptable. All faulty sections of pipeline shall be repaired and retested until the minimum air testing requirements have been met.

Section 4C.09 MANHOLE CONNECTIONS

Corrugated polyethylene pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber boots with 300 series nonmagnetic corrosion-resistant steel bands, or grouted directly to concrete.

Section 4C.10 LATERAL CONNECTIONS

All lateral connections into new storm drain mains shall be through preformed tee fittings installed in the main line or with field installed service saddles. All connections by field installed service saddles on new or existing storm drain mains shall be done in accordance with manufacturers recommendations and with all required fittings and materials. Connections shall be at the locations shown in the Drawings.

Section 4C.11 "GO/NO-GO" MANDREL PROOF TESTING

Not less than thirty (30) days after installation of the flexible sewer or drain pipe, the Developer/Contractor shall test the buried pipe to insure that ring-deflection of the pipe does not exceed five percent (5%) of the pipe's specified minimum inside diameter (ID). This proof test shall establish that the Developer/Contractor has installed the flexible pipe in full compliance with the Project Specifications thereby providing required pipe/soil structural strength.

The Developer/Contractor, with Inspector present, shall pull a "Go/No-Go" Mandrel, inspected and approved by the Public Works Representative/Engineer, through the full length of installed flexible pipe. The Mandrel shall be fabricated from suitable metal with a minimum of nine (9) properly sized radial fins mounted upon a center pulling shaft. In any case, the Mandrel shall be provided with an odd number of rigidly mounted radial fins. The Mandrel shall be provided with a proof-sizing ring that can demonstrate that the Mandrel's minimum outside diameter (OD) is not less than ninety-five percent (95%)

of the specified minimum inside diameter of the installed flexible pipe. The Mandrel shall be pulled by the Developer/Contractor through one-hundred percent (100%) of the installed flexible pipe without using mechanical equipment. Failure of the Mandrel to pass through a pipeline shall be deemed evidence of inadequate installation by the Developer/Contractor not in compliance with the Project Specifications.

The Public Works Representative/Engineer may require, if deemed appropriate or necessary, additional proof testing of designated lengths of the buried flexible pipe approximately one year (1 yr) after installation but prior to the expiration of the Developer/Contractor's Maintenance Bond. The flexible pipeline shall be cleaned adequately prior to performing the "Go/No-Go" Mandrel ring deflection proof test. The Developer/Contractor, with Inspector present, shall pull a Mandrel, approved by the Public Works Representative/Engineer, through the designated length of pipeline without using mechanical equipment. Failure of the Mandrel to pass through the pipeline shall be deemed evidence of inadequate installation by the Developer/Contractor not in compliance with the Project Specifications.

DIVISION 5**MANHOLES****Section 5.01 GENERAL**

This division covers the requirements for manhole materials and installation. Manholes shall be installed at the locations and at the depth shown on the drawings. Manholes shall be furnished complete with cast-iron rings and covers.

Section 5.02 CONCRETE BASE

Unless otherwise noted manhole bases shall be precast and shall have pipe inverts and a resilient connection between pipe and manhole for each pipe connecting to the manhole.

Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross section, conforming to the details shown on the Drawings. Changes of direction of flow within the manholes shall be made with a smooth curve with as long a radius as possible. The floor of the manhole outside the flow channels shall be smooth and slope toward the channel at not less than one inch (1") per foot.

Concrete pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber gaskets, positive seal gasket system, or grouting a bell or spigot pipe at the appropriate locations. Rubber gaskets or boots shall be made of rubber compound meeting ASTM C923 Specifications for resilient connections between pipe and manhole. They shall meet all other applicable ASTM specifications, including ASTM F477.

Positive seal gasket systems boot shall have a wall thickness of three-eighths inch (3/8"). The boot shall either be "cast-in-place" in the precast base or attached to the precast base by means of an internal expanding band. When the boot is attached to the precast base, a water tight seal between the boot and the precast base must be accomplished. An external band (take-up clamp) shall be supplied and used to clamp and seal the boot to the pipe. The band shall be made of 300 series nonmagnetic corrosion-resistant steel. After the band has been placed, it shall be completely coated with a bituminous material approved by the Public Works Representative/Engineer.

PVC pipe connections to manholes shall be achieved by use of manhole coupling adapters, rubber gaskets, or positive seal gasket system. PVC may not be grouted directly to concrete.

The maximum size pipe that can be used in a 48-inch manhole is twenty-four (24") inch PVC or twenty-one (21") inch concrete. For pipes larger than these require a 60-inch manhole or concrete box.

Concrete for manhole bases shall comply with the requirements of Division 8, Concrete, of these Specifications.

Section 5.03 WALL AND CONE SECTIONS

All manholes shall be precast, sectional, reinforced concrete pipe of forty-eight-inch (48") or sixty-inch (60") diameter as specified. Both cylindrical and taper sections shall conform to all requirements of ASTM Designation C478-88 (or latest revision) for Precast Reinforced Concrete Manhole Sections with the following exceptions:

- a) The throat section of the manhole shall be adjustable, by use of manhole sections, up to forty-eight inches (48") in height.
- b) The taper section shall be a maximum of thirty-six inches (36") in height for 48-inch manholes and thirty-nine inches (39") for 60-inch manholes, shall be of eccentric conical design, and shall taper uniformly to thirty inches (30") inside diameter.
- c) The pipe used in the base section shall be furnished in section lengths of one, two, three, and four-feet (1, 2, 3, and 4 feet) as required.

All joint surfaces of precast sections and the face of the manhole base shall be thoroughly cleaned and wet prior to setting precast sections. All joints, including grade rings, shall be set in mortar or butyl rubber gasket. The mortar shall consist of one (1) part cement and one and one-half (1-1/2) parts sand with sufficient water added to bring the mixture to workable consistency or the joints shall be sealed with a butyl rubber gasket that is permanently flexible and non-shrinking. All joints shall be water tight and free from appreciable irregularities in the interior wall surface.

Sub-section A. Manholes Shall Be Furnished With Steps:

The steps are to be made of co-polymer polypropylene. The co-polymer polypropylene used shall conform to ASTM D4101-82 PP200B33450Z02. The steel used in manufacturing of this product shall be a deformed 1/2" reinforcing rod. This material shall be grade 60 and conform to the requirements of ASTM A615.

Section 5.04 DROP MANHOLES

When the difference in elevation of an incoming sewer is 12 inches or greater a drop manhole shall be used. The drop manhole shall be constructed as shown in the Standard Drawings. The piping from the wye to the manhole on both legs shall be ductile iron or PVC pipe with appropriate fittings. If the sewer main that the drop manhole is a part of is concrete, then a transition coupling (Fernco) shall be used to connect the main with the drop pipe assembly.

The drop pipe assembly shall be encased in flowable fill. The flowable fill shall be placed to the minimum thickness as shown on the Standard Drawings.

Sub-section A. Cement:

Use Portland Cement, Type II per Division 8, Portland Cement Concrete.

Sub-section B. Fly Ash:

Supply fly ash that complies with ASTM C618 Class F except that the loss on ignition must be 3 percent or less.

Sub-section C. Fine Aggregate:

Use natural sand. The sand shall meet the following gradation when tested in accordance with AASHTO T-27.

Fine Aggregate

Sieve Size	Percent Passing
No. 3/4	100
No. 100	0-10

Sub-section D. Mix Design:

The mix design shall meet the following requirements:

- 1) Mix design compressive strength (28 day) – between 50 to 150 psi.
- 2) Portland Cement – at least 50 pounds per cubic yard.
- 3) Fly Ash – at least 300 pounds per cubic yard.
- 4) Slump – 6 to 10 inches maximum.

Section 5.05 MANHOLE RINGS AND COVERS

All iron casting shall conform to the requirements of ASTM Designation A48 (Class 35) for grey iron castings, and ASTM Designation A-536 for ductile iron castings and shall be free from blowholes and shrinkage defects. Castings shall be free from fins and burrs and shall be shot-blasted to remove sand and other foreign matter. The castings shall also meet the applicable requirements of AASHTO M106 and M306 and shall be designed for H-20 and HS-20 loading.

Rings and covers shall be equal to the twenty-four inch (24") Standard circular, with machined bearing surfaces, gravity, solid, non-rocking type. The minimum weight of the cover shall be one hundred sixty (160) pounds. The minimum weight of the ring shall be two hundred eighty (280 lbs.). No flat rings and covers shall be allowed. **Each cover shall contain one (1) pick hole but shall not contain air vent holes.** The tops of the cover and ring shall be flush and there shall be 1/8-inch clearance between the cover and the ring. In addition to the foundry name and year of manufacture, the cover shall be marked "SEWER," "STORM DRAIN," "DRAIN," or "IRRIGATION" as appropriate.

Sub-section A. Setting of Manhole Frames and Covers and Placement of Concrete Collars

Manhole rings shall be set in place in with the shaft in a bed of cement sand mortar, which mix shall be one part cement to two parts sand or Kent Seal. Covers shall be set to the finished grade and contour of the existing street. Rings and covers shall be protected during backfilling and compaction of the soil and during the placing or replacing of road surfaces. Any rings or covers loosened from the manhole sections shall be reset in cement mortar and any rings or covers damaged or broken shall be replaced by the Developer/Contractor at its expense. Prior to paving, the manhole ring and cover shall be set no higher than the finished road base elevation. After paving the asphalt shall be jack hammered out, and the manhole ring and cover shall be raised to match the grade and slope of the finished road surface. Road base around the manhole ring and cover shall be recompacted, and the concrete collar placed. Manholes placed in asphalt surfacing shall be constructed such that the cast iron ring is one-sixteenth inch (1/16") lower than the pavement. Cast iron rings more than one-half inch (1/2") below the pavement will not be accepted. Brick shall not be used to raise the manhole. Cones shall not be broken out to lower the ring to meet the road grade. Sections shall be removed and grade rings or adapter rings (riser) used.

Section 5.06 CONNECTIONS TO EXISTING SEWER

Manholes used to connect the sewer to the existing sewer shall be plumb and centered on the existing pipe at the elevation designated and the base placed as specified. Care shall be taken not to disturb the alignment of the existing sewer.

The cutting of the existing sewer pipe shall be done in the presence of the Public Works Representative/Engineer. The cut shall be full area of the new pipe and shall be finished so as to leave no projections that will restrict the flow or catch solids.

Every precaution shall be taken to prevent any material from entering the sewer main. Any such materials entering the sewer shall be removed.

Section 5.07 INCOMING SEWER LINES

In no case shall an incoming sanitary sewer be allowed to drop more that 12 inches to the base. In Sewer lines where the grade is higher than 12 inches above the existing base, a drop manhole connection shall be used. In all cases the base shall have a channel for the incoming sewage.

DIVISION 6**VALVES, COUPLINGS, AND FIRE HYDRANTS****Section 6.01 GENERAL**

This section covers distribution valves to be used in the water system, valve boxes, couplings, fire hydrants, blow-off valves, air inlet and removal facilities, and pressure irrigation drains.

Section 6.02 RESILIENT SEATED GATE VALVE

Valves in sizes 4" through 12" shall be of the iron body, non rising bronze stem, resilient seated type, manufactured to equal or exceed all applicable AWWA standards of C515 latest revision and all specific requirements outlined in these specifications.

- a) Valves shall open left and be provided with 2" square operating wrench nuts unless otherwise specified.
- b) When valves have Mechanical Joints, they shall be furnished with all necessary glands, followers, and bolts and nuts to complete installation.
- c) The disc shall have integrally cast ASTM B62 bronze stem nut to prevent twisting, binding or angling of the stem. Designs with loose stem nuts are not acceptable.
- d) Bronze valve stems shall be interchangeable with stems of the double disc valves of the same size, direction of opening and manufacture.
- e) All internal ferrous surfaces shall be coated, holiday free, to a minimum thickness of 4 mills with a two part thermo setting epoxy coating. Said coating shall be non-toxic, impart no taste to the water, formulated from materials deemed acceptable in the Food and Drug Administration Document Title 21 of the Federal Regulations on food additives, Section 121.2514 entitled Resins and Polymeric Coatings. It shall protect all seating and adjacent surfaces from corrosion and prevent build-up of scale or tuberculation.
- f) The sealing element shall be secured to the disc with self-locking stainless steel screws, and it shall be field replaceable, and shall be such that it cannot be installed improperly.
- g) Stem failure from over torquing in either the open or closing position shall occur externally at such a point as to enable the stem to be safely turned by use of a readily available tool after exposure of the valve through excavation.
- h) Valve design shall incorporate a positive metal-to-metal stop to prevent over-compression of the sealing element.
- i) A full-faced composition gasket placed between machined body and bonnet flanges is required to eliminate cold flow or creep action present with "O" ring gasketed bodies.
- j) Valves shall have a test plug in the bonnet area to vent air and allow line pressure testing.
- k) The exterior of the valves shall be Asphalt Varnish, JAN-P-450. If exterior epoxy is used, all bolts and nuts shall be made of Stainless Steel to prevent galvanic corrosion of said nuts and bolts due to insulation from the ferrous valve and line.

Section 6.03 BUTTERFLY VALVE

All butterfly valves shall conform to the latest revision of AWWA Standard C504, Class 150-B, and comply with the following:

- a) Valve bodies shall be cast iron, ASTM A126 Class B. Body ends shall be flanged with facing and drilling in accordance with ANSI B16.1, Class 125; or mechanical joint in accordance with AWWA C111. All mechanical joint end valves shall be furnished complete with joint accessories (bolts, nuts, gaskets, and glands). All valves shall conform to AWWA Standard C504, Table 3, Laying Lengths for Flanged Valves and Minimum Body Shell Thickness for all Body Types.
- b) Valve disc shall be ductile iron ASTM A536, grade 65-45-12. Valve disc shall be of the offset design providing 360-degree uninterrupted seating.
- c) The resilient seat shall be natural rubber bonded to an 18-8, Type 304 stainless steel retaining ring secured to the disc by 18-8, Type 304 stainless steel screws. The seat shall be capable of mechanical adjustment in the field and field replaceable without the need for special tools. Valve body seat shall be 18-8, Type 304 Stainless Steel.
- d) Valve shafts shall be 18-8, Type 304 stainless steel. Shafts shall be of the two piece stub design and attached to the disc by means of "O" ring sealed taper pins with lock nuts.
- e) The valve assembly shall be furnished with a non-adjustable factory set thrust bearing designed to center the valve disc at all times.
- f) Shaft bearings shall be contained in the integral hubs of the valve body and shall be self-lubricated sleeve type.
- g) Valve shaft seal shall consist of "O" Rings. Where the valve shaft projects through the valve body for actuator connection, the "O" Ring packing seal shall be field replaceable as a part of a removable bronze cartridge.
- h) When manual actuators are required they shall be of the traveling nut design capable of withstanding 450 foot pounds of input torque against the open and closed stops. All actuators shall have adjustable mechanical stop limits. The closed position stop shall be externally adjustable. Valves shall be installed with the shaft horizontal unless otherwise directed by the Public Works Representative/Engineer and shall be provided with a 2-inch square operating nut for manually operating the valve with a "T" handle wrench.
- i) All valves shall be coated with epoxy in conformance to AWWA Standard C550, latest revision. Interior wetted ferrous surfaces shall be coated nominal 10 mils thick for long life; and body exterior shall have a minimum of 3 to 4 mils coating thickness in order to provide superior base for field-applied finish coats.

Section 6.04 VALVE BOXES

All buried valves shall be installed complete with two-piece, cast iron, screw type, 5-1/4-inch shaft valve box with locking lid. The lid shall have the words "Water" or "IRR." cast in the metal depending on the application.

Valves and valve boxes shall be installed where shown on the drawings. Valves and valve boxes shall be set plumb. Valve boxes shall be centered directly over the valve. Valves shall be aligned with property lines where possible. Earth fill shall be carefully tamped around the valve box to a distance of four (4) feet on all sides of the box, or to the undisturbed trench face if less than four (4) feet. Valves shall have the interiors cleaned of all foreign matter before installation. All valve boxes located in streets shall be installed to grade. Valves placed in asphalt surfacing shall be constructed such that the cast iron ring is one-sixteenth inch (1/16") lower than the finished surface. After paving the asphalt shall be jack hammered out, road base around the valve box shall be recompacted, and the concrete collar placed.

Valve boxes in off-road areas shall extend six (6) inches above grade.

Section 6.05 COUPLINGS

Couplings shall be equal to the product of Smith-Blair or Dresser with ductile iron couplings being used on all ductile iron and PVC pipe. Couplings shall be of the straight, transition, or reducing style as required by the specific installation. Where the coupling is used to join a ductile iron line to a steel line appropriate transition gaskets will be used. All steel fittings and bolts shall be coated with a non-oxide coating and wrapped with 12 mil polyethylene.

Section 6.06 FIRE HYDRANTS

Fire hydrants shall be "traffic model" type designed to conform to AWWA Specification C502 and shall be of either the compression or toggle joint type. Hydrants shall be Mueller "Super Centurion 200" or Waterous "Pacer".

Hydrant valves shall be a minimum of 6-inch size. Hydrants shall be supplied complete with two 2 1/2-inch hose nozzles and one 4 1/2-inch pumper nozzle. All nozzles shall be provided with National Standard threading. A one cubic yard gravel sump shall be provided at each hydrant. All hydrants shall be mechanical joint end and shall be connected to the main by means of a mechanical joint by flanged tee and flanged by mechanical joint auxiliary gate valve and box as shown on the Standard Drawings. Each hydrant shall also be supplied with O-ring seals, a National Standard pentagon operating nut which is designed for clockwise rotation closing, and a 6-inch mechanical joint inlet. Set the hydrant so that the flange is one-tenth of a foot (0.10') higher than the back of sidewalk.

Section 6.07 BLOWOFF VALVE

A blow-off valve is required on the culinary system in cul-de-sacs and in temporary dead-end streets. The installation in cul-de-sacs shall be permanent and shall come off near the end of the culinary water line. On temporary dead-ended streets the connection shall be made using a main size by three-inch MJ tee.

The blow-off valve shall be an Eclipse Model 85 blow-off hydrant.

Section 6.08 2-INCH AIR INLET AND REMOVAL FACILITY

The connection to the main for the air inlet and removal facility shall be by a line size by 2-inch tapped tee for line sizes 4-inch through 12-inch and by a bronze service clamp, Mueller Model H-13490 for line sizes 14-inches and larger. Air inlet and removal facilities shall be placed at high points or uphill end points in the system. Tapping the main through the service clamp will be accomplished with standard tapping equipment before the system is put into service.

Connection to the tapped tee or service clamp shall be by a 2-inch PVC MIPT adapter. Piping and bends shall be 2-inch Schedule 40 PVC pipe with solvent weld joints. This piping shall extend from the main to the utility box. The utility box shall house a 2-inch brass ball valve with screwed ends, 2-inch brass nipples, 2-inch brass 90° elbow, 2-inch by 2 1/2-inch brass reducer, 2 1/2-inch brass nipple and 2 1/2-inch fire hose connection. All threads except the fire hose connection shall be standard pipe threads. The fire hose connection shall have standard fire hose connection threads for a 2 1/2-inch fire hose. A fire hose cap with chain secured to the standpipe shall be installed at the end of the vertical standpipe. For units installed near curb and gutter a 11 3/4-inch by 17-inch standard green fiberglass irrigation box with cover shall be installed over the 2-inch gate valve and 2-inch stand pipe. A sign shall be attached to or embossed on the cover indicating as follows: "IRRIGATION AIR RELEASE". Box shall be Brooks 1419 series utility box and lid with recessed standard waterworks pentagon head locking device. For Units installed where there is no curb and gutter, the irrigation box shall be a 30-inch by 2-foot (30" X 2') concrete pipe section with a 24-inch CI manhole ring and grate equal to D&L Supply C2670 as shown on the Drawings.

The Developer/Contractor shall provide smooth bore, circular woven suction hose reinforced with spring steel wire. The rubber friction cover shall be durable and resistant to wear and abrasion. The fire hose shall be two and one-half inch (2 1/2") National Fire hose 55-HD-77 or equivalent. Each hose shall be fitted with a two and one-half inch (2 1/2") male end adapter and a two and one-half inch (2 1/2") female end adapter firmly attached to withstand working pressures of 200 PSI. Each hose furnished for a unit with a fiberglass box shall also be provided with an Akron swivel elbow #632 or equivalent for connection of the fire hose to the air inlet and removal valve.

Section 6.09 4-INCH FLUSHING, AIR INLET AND REMOVAL FACILITY

A 4-inch flushing, air inlet and removal facility is intended to allow high enough velocities to flush an irrigation main, to allow air into the system during draining and to allow air out of the system when filling.

Each 4-inch flushing, air inlet and removal facility shall be constructed as detailed and placed at the locations shown on the drawings. The work is to include excavation, gravel foundation, backfill, piping, fittings, concrete thrust blocks and collars, valves, utility boxes, sod replacement, and appurtenances.

- a) **Configuration:** Use reducers as needed to transition from the size of the main line to the 4" flushing, air inlet and removal facility. Install a vertical MJ bend or tee (with thrust block) on the main line, followed by a vertical MJxPE 4-inch diameter ductile iron spool pipe. The pipe shall be of a length necessary to bring it to a point in relation to the finished ground surface as described below.
- b) **Gate Valve:** The 4-inch flushing, air inlet and removal facility requires a 4-inch gate valve between the flushing, air inlet and removal facility and the last service on the main line, placed just beyond the service.
- c) **Installation in Streets:** In paved street areas, the 4-inch diameter ductile iron pipe shall extend to a point 6 inches below the finished ground surface, and shall include a brass plug in the top of the pipe. A cast iron valve box top shall be placed over the 4-inch diameter ductile iron pipe. It shall be a 5 1/4" shaft, slip-type (flange on bottom of unit), 16 inch tall valve box top, with a drop-type lid having "IRR" cast in the top. The valve box shall be a minimum of 12 feet from the air inlet. The valve box top shall be set flush with the road surface, and installed as described in Division 6, Valves, Couplings and Fire Hydrants, including the square concrete collar.
- d) **Installation outside of Streets:** In areas outside of street pavement, the 4-inch diameter ductile iron pipe shall extend to the ground surface, and shall include a cap and chain secured to the pipe. Place an irrigation box consisting of a 30-inch diameter by 2-foot long concrete pipe section with a 24-inch cast iron manhole ring and grate equal to D&L Supply C-2670 over the pipe, as shown on the Drawings. For additional details see Division 5, Manholes

Section 6.10 PRESSURE IRRIGATION DRAINS

When system drains are necessary to be installed on extensions of the pressure irrigation system they shall be constructed as a system drain to a curb inlet box or system drain to a storm drainpipe. The drain shall be constructed as shown on the Standard Drawings. The materials used shall meet the requirements of Division 3, Pressure Pipe Pressure Irrigation. The connection to the box or pipe shall be by coring a hole and grouting the drainpipe in. A non-shrink grout shall be used.

When a section of pressure irrigation pipeline has to be laid such that there is a belly in it then a local drain sump will need to be constructed. The drain shall be constructed as shown on the Standard Drawings. The materials used shall meet the requirements of Division 3, Pressure Pipe Pressure Irrigation, Division 4, Concrete Pipe, and Division 5, Manholes.

DIVISION 7 EARTHWORK

Section 7.01 GENERAL

This section defines the requirements for excavation and backfill for structures, construction requirements of earth embankments and earth fills, and subgrade preparation required by the Standard Drawings and Specifications.

Section 7.02 EXCAVATION FOR STRUCTURES

Where suitable subgrade soils exist, structures shall be founded on undisturbed original subsoil. All unauthorized excavation below the specified subgrade shall be replaced with concrete, monolithic with that of the slab above or with coarse gravel thoroughly compacted into place.

Subgrade soils for structures not suitable for proper support shall be replaced with firm, dense, thoroughly compacted and consolidated material free from mud and muck. Coarse gravel or crushed stone may be used for subsoil reinforcement if satisfactory results can be obtained thereby. Such material shall be applied in thin layers, each layer being embedded in the subsoil by thorough tamping. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone and the finished elevation of any subsoil reinforced in this manner shall not be above the specified subgrade elevation.

Section 7.03 GRANULAR FOUNDATION BORROW

Granular foundation borrow shall be compacted to not less than 95% of maximum dry density as determined by ASTM D1557.

Section 7.04 BACKFILL AROUND STRUCTURES

No backfilling around or behind structures shall be initiated until the concrete is fully cured for **seven days**. Backfill around structures shall be placed to the lines shown on the drawings, or as directed. After completion of foundation footings and walls and other construction below the elevation of the final grades, and prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction is not greater than four (4) inches. Material for backfilling shall consist of suitable excavated material or imported sand, gravel, or other suitable material with no rocks whose greatest dimension is larger than two (2) inches.

Fill shall be placed in a manner that will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure. Each layer shall be compacted by hand or machine tampers or by other suitable equipment to a density equal to 95% of maximum dry density as measured by ASTM D1557.

Section 7.05 CONSTRUCTION OF EMBANKMENTS AND FILLS

Sub-section A. Foundation Preparation:

Foundations for earth fill shall have unsuitable materials, such as weeds, sod, roots larger than 1/4-inch in diameter, vegetation, or other organic material shall be removed by clearing, stripping, and/or grubbing. Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of six inches. The moisture content of the loosened material shall be controlled as specified for the earth fill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earth fill as specified for subsequent layers of earth fill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of 2 inches in depth normal to the slope and shall be at such a moisture content that the earth fill can be compacted against them to affect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose material by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earth fill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Sub-section B. Placement:

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Public Works Representative/Engineer and any Regulatory Agency having authority over the project. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually-directed power tampers, shall be placed in layers whose thickness before compaction is not greater than four (4) inches. All rock whose greatest dimension is larger than two-inch (2") shall be removed from the material receiving compaction by manually directed power tampers.

Earth fill designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

- 1) The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material.
- 2) If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill, to a depth of not less than 2 inches before the next layer is placed.
- 3) The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of not less than 2 percent shall be maintained to ensure effective drainage, and except as otherwise specified for drain fill zones. If the Drawings or specifications require or the Public Works Representative/Engineer directs that fill be placed at a higher level in one part of the embankment than another is, the top surface of each part shall be maintained as specified above.
- 4) Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction of inlet and outlet pipes are specifically authorized in the contract.
- 5) Embankments built at different levels as described in 3 and 4 shall be constructed so that the slope of the bonding surfaces between the embankment in place and embankment to be placed is not steeper than 2 feet horizontal to 1-foot vertical. The bonding surface of the embankment in place shall be stripped of all loose material, scarified, moistened and recompactd when the new fill is placed against it. This is needed to ensure a good bond with the new fill, to obtain the specified moisture content and specified density at the junction of the in-place and new fill.

Sub-section C. Borrow:

When the embankment or fill exceeds the amount of excavation, sufficient additional material shall be obtained from borrow pits provided by the Developer/Contractor. All material proposed to be imported shall be subject to the review and approval of the Public Works Representative/Engineer prior to starting of hauling operations.

The materials used for embankment and fill construction shall be free from sod, grass, roots larger than 1/4-inch diameter, trash, clods, rocks larger than six inches in diameter, and all other material unsuitable for

construction of compacted fills. Rotomilled asphalt meeting the large rock requirement may be used as borrow.

Grading of completed embankments and fills shall bring the surfaces to a smooth, uniform condition with final grades being within 0.1 foot of the design grade.

Section 7.06 COMPACTION OF MATERIALS

The material shall be deposited in horizontal layers having a thickness of not more than eight inches (8") prior to being compacted as hereinafter specified. The distribution of materials shall be such that the compacted material will be homogeneous and free from lenses, pockets, or other imperfections.

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range, and the moisture content shall be uniform throughout the layers. Discing, blading or other approved methods prior to compaction of the layer shall obtain uniform moisture distribution. The moisture shall be controlled at a level to permit compaction of the fill as specified, but in no case greater or less than two percent plus or minus of the optimum moisture as determined by AASHTO T-180 (Modified Proctor).

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary.

Material that is too wet when deposited on the fill shall either be removed or dried to specified moisture content prior to compaction.

If the top surface of the preceding layer, a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall be scarified and moistened by sprinkling to the required moisture content prior to placement of the next layer of fill.

When the material has been conditioned as here in before specified the backfill or embankment shall be compacted to a minimum of 95% of maximum dry density as determined by AASHTO T-180 (Modified Proctor). Densification of earth fill shall be performed by equipment designated solely for that purpose. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Sub-section A. Under Roadways:

Under roadways and extending one foot beyond the proposed curb-line the fill or embankment material shall be compacted to a minimum of 95% of maximum density specified above.

Sub-section B. Under Sidewalks and Driveways:

Under sidewalks and driveways extending one foot each side of the edge of slab the fill or embankment material shall be compacted to a minimum of 95% of maximum density specified above.

Section 7.07 REMOVAL AND PLACEMENT OF DEFECTIVE FILL

Fill placement at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced with acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

DIVISION 8**PORTLAND CEMENT CONCRETE****Section 8.01 GENERAL**

The work shall consist of furnishing, forming, placing, finishing, and curing Portland cement concrete, as required.

Section 8.02 MATERIALS**Sub-section A. Portland Cement:**

Portland cement shall be Type II and shall comply with the Standard Specification for Portland Cement, ASTM C150.

If air-entraining cement is to be used, the Developer/Contractor shall furnish the manufacturers written statement giving the source, amount and brand name of the air-entraining addition.

Cement shall be stored in such a manner as to be protected from weather, dampness or other destructive agents. Cement that is partially hydrated or otherwise damaged will be rejected.

Sub-section B. Aggregate:

Aggregates shall conform to Tentative Specifications for Concrete Aggregates, ASTM C33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proved prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

The potential reactivity of aggregates with the alkalis in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

- 1) Applicable test results of mortar bar tests, made according to ASTM Method C227, are available which indicate an expansion of less than 0.10 per cent at six months in mortar bars made with cement containing not less than 0.8 per cent alkalis expressed as sodium oxide; or
- 2) Concrete made from similar aggregates from the same source has been demonstrated to be sound after 3 years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with "low alkali" cement, containing less than 0.60 per cent alkalis expressed as sodium oxide.

Aggregate of each class and size shall be stored and handled by methods that prevent segregation of particle sizes or contamination by intermixing with other materials.

Sub-section C. Water:

Water shall be cleaned and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances and shall meet the requirements of ACI Standard Code (ACI 318 latest edition), paragraph 3.4.

Sub-section D. Air-Entraining Agent:

Air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM Designation C150 and C260, except that the relative durability factor in the freezing and thawing test shall be not less than 95.

Sub-section E. Steel Reinforcement:

Refer to Division 9 (Reinforcing Steel) for specifications.

Sub-section F. Water-Reducing and Set-Retarding Admixtures:

Water-reducing and set-retarding admixtures shall conform to the requirements of ASTM Specification C494, except that resistance to freezing and thawing shall be determined in all cases, and the minimum relative durability factor shall be 95.

Admixtures shall be Type A, Water-Reducing or Type D, Water-Reducing and Retarding, as defined in ASTM Specification C494.

When added, in the manner and amount recommended by the manufacturer, to the concrete used on the job, with no change in the cement content or proportions of the aggregates, admixtures shall have the following effects:

Type A or Type D: The water content at the required slump shall be at least 5 percent less with the admixture than without. The air content shall remain within the range specified, but shall not exceed 8 per-cent in any case.

Type D: The time of initial setting, determined as prescribed in ASTM C494, shall be from 1 to 3 hours longer with the admixture than without.

Sub-section G. Curing compound:

Curing compound for concrete shall meet the requirements of ASTM Specification C309.

Unless otherwise specified, the compound shall be Type 2.

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner to prevent damage to the containers and to protect water-emulsion types from freezing.

Section 8.03 CLASS OF CONCRETE

For the purpose of practical identification, concrete has been divided into four classes: Class AA(AE), A(AE), B(AE) and C(AE). The specific use for each Class is identified in the Division in which the concrete is used. The symbol (AE) designates air-entrainment. Basic requirements for each class are as follows :

<u>Class of Concrete</u>	<u>Maximum Net Water Content (gallons/bag)</u>	<u>Minimum Cement Content (bags/cubic yard)</u>	<u>Minimum 28-day Compressive Strength (psi)</u>
AA(AE)	5	6 1/2	4000
A(AE)	6	6	3500
B(AE)	7	5	2500
C(AE)	8	4	2000

Section 8.04 COMPOSITION OF CONCRETE

Sub-section A. Aggregate:

Aggregates maximum size shall be not larger than one-fifth (1/5) of the narrowest dimension between forms within which the concrete is to be cast, nor larger than three-fourths (3/4) of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For un-reinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth (1/4) the slab thickness.

Sub-section B. Water:

Water shall be added to the mix to produce concrete with the minimum practicable slump. The slump of mechanically vibrated concrete shall not exceed four-inch (4"). No concrete shall be placed with a slump in excess of five-inch (5").

Sub-section C. Air-Content:

Air-Content for air-entrained concrete shall comply with the following:

<u>Course Aggregate Size (in.)</u>	<u>Air Content (percent)</u>
1 1/2 to 2 1/2	5 ± 1
3/4 or 1	6 ± 1
3/8 or 1/2	7 ± 1

The air-entraining agent shall be added as liquid to the mixing water by means of mechanical equipment capable of accurate measurement and control.

Sub-section D. Admixtures:

Water Reducing and/or Set Retarding admixtures shall not be used except with previous approval from the Public Works Representative/Engineer and shall in such a case, conform to the standards of materials set forth in the specification.

Section 8.05 DESIGN OF THE CONCRETE MIX

The proportions of the aggregates shall be such as to produce a concrete mixture that will work readily into the corners and angles of the forms and around reinforcement when consolidated, but will not segregate or exclude free water during consolidation.

Prior to placement of concrete, the Developer/Contractor shall furnish the Public Works Representative/Engineer, for approval, a statement of the materials and mix proportions (including admixtures, if any) it intends to use. The statement shall include evidence satisfactory to the Public Works Representative/Engineer that the materials and proportions will produce concrete conforming to this specification. The materials and proportions so stated shall constitute the "job mix." After the job mix has been reviewed for conformance to specification by the Public Works Representative/Engineer, neither the source, character, grading of the aggregates, the type and brand of cement, nor admixture shall be changed without prior notice to the Public Works Representative/Engineer. If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Public Works Representative/Engineer has approved a revised job mix.

Section 8.06 OBSERVATION AND TESTING

The Public Works Representative/Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Public Works Representative/Engineer to observe the materials, equipment and processes and to obtain samples of the concrete. All tests and observations will be conducted so as not to interfere unnecessarily with manufacture and delivery of the concrete.

Section 8.07 HANDLING AND MEASUREMENT OF MATERIALS

Materials shall be stockpiled and batched by methods that will prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mix.

Except as otherwise provided in Division 8, cement and aggregates shall be measured as follows:

- a) Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless weighed.
- b) Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.
- c) Water shall be measured by weight, to accuracy within one per cent of the total quantity of water required for the batch.
- d) Admixtures shall be measured within a limit of accuracy of 3 per cent.

Section 8.08 MIXERS AND MIXING

Concrete shall be uniform and thoroughly mixed when delivered to the work. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by increasing mixing time or other means. For stationary mixers, the mixing time after all cement and aggregates are in the mixer drum shall be not less than 1 1/2 minutes. When concrete is mixed in a truck mixer, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 or more than 100.

Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted if approved by Public Works Representative/Engineer. The batching and mixing equipment shall conform to the requirements of ASTM Specification C685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and certified in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C685.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point.

Section 8.09 FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a non-staining form oil before being set into place.

Metal ties or anchors within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete.

All edges that will be exposed to view when the structure is completed shall be chamfered by placing molding in the forms, unless finishing with molding tools.

Section 8.10 PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth or uncompacted fill or frozen subgrade will not be permitted.

Unless otherwise specified, when concrete is to be placed over drain fill, the contact surface of the drain fill shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete. Forms for weepholes shall extend through this layer into the drain fill.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

Section 8.11 CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1 1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. The Public Works Representative/Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that will prevent segregation of the aggregates or loss of mortar.

Concrete shall not be dropped more than five feet vertically unless suitable equipment is used to prevent segregation.

Section 8.12 PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved. No concrete shall be placed except in the presence of the Public Works Representative/Engineer. The Developer/Contractor shall give 48-hour notice to the Public Works Representative/Engineer each time it intends to place concrete. Such notice will give the Public Works Representative/Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with the specifications before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcements and embedded items in a manner to prevent segregation of aggregates or excessive laitance. Unless otherwise specified, slab concrete shall be placed to design

thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layers being placed.

Immediately after the concrete is placed in the forms, it shall be consolidated by spading, hand tramping or vibration as necessary to insure smooth surfaces and dense concrete. Each layer shall be consolidated to insure monolithic bond with the preceding layer. If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when spaded or vibrated, the Developer/Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified.

If placing is discontinued when an incomplete horizontal layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

Section 8.13 CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the Drawings. If construction joints are needed which are not shown on the Drawings, they shall be placed in locations approved by the Public Works Representative/Engineer.

Where a featheredge would be produced at a construction joint, as in the top surface of a sloping wall, an inset form shall be used so that the resulting edge thickness on either side of the joint is not less than six inches (6").

In walls and columns, as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardening concrete has cured at least 12 hours.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Public Works Representative/Engineer. The surfaces shall be kept moist for at least one hour prior to placement of the new concrete.

Section 8.14 EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

Open joints, when specified, shall be constructed by the insertion and subsequent removal of a wooden strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of open joints shall be finished with an edging tool prior to removal of the joint strips.

Section 8.15 WATERSTOP

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be soldered, brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

Section 8.16 REMOVAL OF FORMS

Forms shall not be removed without the approval of the Public Works Representative/Engineer. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Section 8.17 FINISHING FORMED SURFACES

Immediately after the removal of the forms:

- a) All fins and irregular projections shall be removed from exposed surfaces.
- b) On all surfaces, the holes produced by the removal of form ties, cone-bolts, and she-bolts shall be cleaned, wetted and filled with a dry-pack mortar consisting of one part Portland cement, three parts sand that will pass a No. 16 sieve, and water just sufficient to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed.

Section 8.18 FINISHING UNFORMED SURFACES

All exposed surfaces on the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise.

Excessive floating or troweling of surfaces while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

Section 8.19 CURING AND PROTECTION

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period, or until curing compound is applied as specified below. Sprinkling, flooding or fog spraying shall maintain moisture or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

As soon as the concrete has hardened sufficiently to prevent damage, the finished surface shall be protected for curing one of the following ways:

- a) Ponding of water on the surface or continuous sprinkling.
- b) Application of absorptive mats such as three-inches (3") of cured hay, clean straw or fabric kept continuously wet.
- c) Application of two-inches (2") of moist earth or sand uniformly distributed on the surface and kept saturated by spraying with water.
- d) Application of light colored waterproof plastic materials, conforming to "Specifications for Waterproof Sheet Materials for Curing Concrete" ASTM C171, placed and maintained in contact with the surface of the concrete.
- e) Application of a curing compound, conforming to "Specifications for Liquid Membrane - Forming Compounds for Curing Concrete" ASTM C309. The compound shall be light in color and shall be applied

in accordance with the manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from the concrete surface.

Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items. If the membrane is damaged during the curing period, the damaged area shall be re-sprayed at the rate of application specified above.

Section 8.20 REMOVAL OR REPAIR

When concrete is honey combed, damaged or otherwise defective, the Developer/Contractor shall remove and replace the structure or structural member containing the defective concrete or, where feasible, correct or repair the defective concrete. Prior to starting repair work the Developer/Contractor shall obtain the Public Works Representative/Engineer's approval of its plan for affecting the repair. The Developer/Contractor shall perform all repair work in the presence of the Public Works Representative/Engineer.

Section 8.21 CONCRETING IN COLD WEATHER

Concrete shall not be mixed nor placed when the daily minimum atmospheric temperature is less than 40° F unless facilities are provided to prevent the concrete from freezing. The use of accelerators or antifreeze compounds will not be allowed. The contractor shall be responsible to insure the protection of the concrete regarding these requirements.

Section 8.22 CONCRETING IN HOT WEATHER

The Developer/Contractor shall apply effective means to maintain the temperature of the concrete below 90° F during mixing, conveying and placing. The contractor shall be responsible to insure the protection of the concrete regarding these requirements.

Section 8.23 CONCRETE TESTING

Sub-section A. Compressive Strength Testing of Concrete Cylinders:

- 1) Samples of concrete shall be taken at the construction site, molded in standard cylinder shapes, allowed to cure, and tested with respect to comprehensive strength.
- 2) All samples of concrete shall be taken in conformance to AASHTO T-141, latest revision. The making and curing concrete test specimens in the field shall conform to AASHTO T-23.
- 3) Compressive strength of cylindrical concrete specimens shall conform to AASHTO T-22.
- 4) Acceptance of concrete with respect to compressive strength shall be based upon the average determination of all "compressive strength tests" made in a lot.
 - a) A test lot shall be the quantity of concrete placed at one job in a construction day.
 - b) A minimum of one "compressive strength test" will be taken of three cylinders for each 50 cubic yards concrete in a test lot, or fraction thereof. If placement is less than 5 cubic yards, proceed as directed by the Public Works Representative/Engineer.
- 5) Concrete may be rejected if desired strengths are not obtained. The concrete for which the tests failed shall be removed and replaced at the Owner/Contractor's expense.

Sub-section B. Additional Concrete Testing:

- 1) Slump Test: Determine slump in accordance with AASHTO T-27, (ASTM C-143). Use one test for each 50 cubic yards or fraction thereof. Reject concrete failing slump test (see Division 8 Section 8.04, Sub-section B).
- 2) Air Test: Determine normal weight concrete air content using AASHTO T-152 (ASTM C-231) for each 50 cubic yards or fraction thereof. Light weight concrete air content use ASTM C-173.
 - a) If an air test fails, immediately retest the same load (do not mix or add water between tests).
 - b) The concrete will be rejected if the second air test does not meet the specification.
 - c) If the second air test meets the specification, a third test will be performed to establish concrete acceptance or rejection.

- 3) When requested by Public Works Representative/Engineer, test in-place concrete by impact hammer, sonoscope, or other nondestructive device.
 - a) To determine relative strengths in various locations in Work.
 - b) To aid in evaluating concrete strength.
 - c) To select areas to be cored.

DIVISION 9
REINFORCING STEEL

Section 9.01 GENERAL

Furnish and place reinforcing steel and epoxy-coated reinforcing steel. Steel reinforcement shall be free from rust, oil, grease, paint or other deleterious matter. Use deformed billet-steel bars as specified. All reinforcing bars shall be Grade 40 or Grade 60 as required. Wire Fabric shall conform to ASTM A185-70.

Before supply of steel, the Developer/Contractor shall provide all order lists and bending diagrams for approval of the Public Works Representative/Engineer. The approval of such lists and diagrams shall in no way relieve the Developer/Contractor of responsibility for the correctness of reinforcing supplied and all expenses incidental to revision of furnished reinforcing steel shall be carried by the Developer/Contractor.

All steel to conform to ACI Standard Code (ACI 318 latest edition), Section 3.5. Gages, spacing and arrangement of wires in welded steel wire fabric shall be as defined in ACI Standard Code (ACI 315 latest edition) for the specified style designations.

Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be protected from mechanical injury and corrosion.

Section 9.02 FABRICATION AND PLACING REINFORCEMENT

Sub-section A. Fabrication:

Reinforcement shall be cold bent to the shapes shown in accordance with ACI Standard Code (ACI 318 latest edition), Section 7.1.

Sub-section B. Clearances:

All bars shall be of the size specified and shall be placed in the positions shown on the Drawings in such a manner as to be firmly held during the placing of the concrete. Where not otherwise indicated, minimum clearance and cover as required by the ACI Standard Code (ACI 318 latest edition), Section 7.7 shall be maintained.

Reinforced Clearances	Minimum Cover Inches
Cast In Place Concrete (Non Prestressed)	
Concrete cast against and permanently exposed to earth	3
Concrete exposed to earth or weather:	
No. 6 through No. 18 Bar	2
No. 5 Bar, W31 or D31 wire, and smaller	1 1/2
Concrete not exposed to weather or in contact with ground:	
- Slabs, Walls, and Joists:	
No. 14 and no. 18 Bar	1 1/2
No. 11 Bar and smaller	3/4
- Beams, Columns:	
Primary reinforcements, ties, stirrups, spirals	1 1/2
- Shells, Folded Plate Members:	
No. 6 Bar and larger	3/4
No. 5 Bar, W31 or D31 wire, and smaller	1/2

Reinforcement Clearances	Minimum Cover Inches
Precast Concrete (Manufactured Under Plant Controlled Conditions)	
Concrete exposed to earth or weather:	
- Wall Panels:	
No. 14 and No. 18 Bars	1 1/2
No. 11 Bar and smaller	3/4
-Other Members:	
No. 14 and No. 18 Bars	2
No. 6 through No. 11 Bars	1 1/2
No. 5 Bar, W31 or D31 wire, and smaller	1 1/4
Concrete not exposed to weather or in contact with ground:	
- Slabs, Walls, Joists:	
No. 14 and No. 18 Bars	1 1/4
No. 11 Bar and smaller	5/8
- Beams, Columns:	
Primary reinforcement	1 1/2
Ties, stirrups, spirals	3/8
- Shells, folded plate members:	
No. 6 Bar and larger	5/8
No. 5 Bar, W31 or D31, and smaller	3/8

Sub-section C. Support:

Bars shall be tied at all intersections except where the spacing is less than twelve inches (12") where alternate intersections shall be tied. Distance from supports shall be by means of ties, hangers, or other approved supports. Metal chairs of approved design shall be used to hold reinforcement from contact with the forms. Metal chairs that are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars or when placing concrete directly on a prepared subgrade reinforcing shall be separated by precast mortar blocks or by other equally suitable devices. The use of stones, pieces of broken brick, metal pipe, or wooden blocks shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the Public Works Representative/Engineer before the placement of concrete begins. Concrete placed in violation of this provision may be rejected in which case removal will be required.

If the fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

Sub-section D. Splicing:

All splices shall be staggered so that splices in adjacent bars shall be not less than four feet (4') apart, and shall conform to ACI Standard Code (ACI 318 latest edition), Section 12.15.

Section 9.03 EPOXY COATING

Sub-section A. Prequalify all Coatings:

Ensure that epoxy coating applicator has Concrete Reinforcing Steel Institute (CRSI) fusion bonded epoxy coating applicator plant certification. Furnish a copy of the Prequalification Test Report to the Public Works Representative/Engineer. Provide an 8-ounce sample of the coating material from each batch.

Sub-section B. Coat Bars as Specified:

The following requirements shall be followed:

- 1) Maintain the coating thickness between 8 and 12 mils.
- 2) Coat bars after bending, unless the fabricator can show that satisfactory results can be obtained by coating before bending
- 3) Reject any bent bars with visible cracks or damage in the coating.

Sub-section C: Handling:

Do not damage the bars or the coating during handling and storage.

- 1) Use systems with padded contact areas when handling coated bars.
- 2) Pad all bundling bands.
- 3) Lift all bundles with strong back, multiple supports, or a platform bridge.
- 4) Do not drop or drag bars.
- 5) Repair damaged bars or coating at no additional cost to the Owner.
- 6) Use patching material per manufacturer's recommendation to repair damaged coating.
- 7) Have the coated bars inspected for damage to the coating after the bars are in place and immediately before concrete placement.
- 8) Repair all visible defects using the specified patching or repair material.

Section 9.04 FIELD CUTTING EPOXY-COATED BARS**Sub-section A. Cutting:**

Saw or shear epoxy-coated bars that are specified to be cut in the field. Do not flame cut.

Sub-section B. Repairing:

Repair the sawed or sheared end using the specified patching or repair material.

DIVISION 10**RESTORATION OF SURFACE IMPROVEMENTS****Section 10.01 GENERAL**

The Developer/Contractor shall be responsible for the protection and the restoration or replacement of any improvements existing on public or private property at the start of work or placed there during the progress of the work.

Existing improvements shall include but not be limited to permanent surfacing, curbs, gutters, sidewalks, planted areas, ditches, driveways, culverts, fences, and walls. All improvements shall be reconstructed to equal or better, in all respects, than the existing improvements removed.

Section 10.02 FIELD VERIFICATION OF IMPROVEMENTS

In submitting a bid, the Developer/Contractor will be deemed to have carefully examined the site of the work and to have acquainted itself with all conditions relating to the protection and restoration of existing improvements. The Public Works Representative/Engineer does not guarantee that all improvements are shown on the Drawings, and it shall be the Developer/Contractor's responsibility to provide in its bid for the protection and restoration of all existing improvements whether or not each is provided for specifically on the Drawings and/or Bid Form.

Section 10.03 REMOVAL OF PAVEMENT, SIDEWALKS, CURBS, ETC.

The pavement, sidewalk, curb and gutter, driveway, etc. shall be cut vertically along the lines forming the trench, or nearest full joint, in such a manner as to not cause damage to adjoining pavement, sidewalk, curb and gutter, driveway, etc. An undercut level at the rate of one inch (1") per foot of thickness or an underlap joint will be provided at the proposed junction between old and new surfaces. The portion to be removed shall be broken up in a manner that will not cause damage to the pavement or concrete outside the limits of the trench; however, any pavement damaged by operations outside the limits of the trench shall be replaced at the Developer/Contractor's expense. Broken paving materials shall be removed immediately from the site of the work.

Section 10.04 MATERIALS

Materials used for repair or replacement of surface improvements shall be equal to or better than the material removed

Sub-section A. Untreated Base Course:

Untreated base course shall comply with the requirements of Division 11, Section 11.10, Base Course. The Public Works Representative/Engineer shall take samples of the untreated base course on a random basis. All materials not meeting the tolerance requirements shall be removed from the project and replaced with specification material.

Sub-section B. Bituminous Surface Course:

The bituminous surface shall be hot-rolled plant mix in accordance with Division 11, Section 11.10, Bituminous Asphalt Cement Pavement or Division 11, Section 11.12, Open graded surface course, as applicable.

Sub-section C. Concrete:

Concrete shall comply with Division 8 of these Standard Specifications. Concrete shall be Class AA(AE).

Section 10.05 RESTORING BITUMINOUS, CONCRETE, OR ASPHALT STREET SURFACES

Where trenches are in or cross bituminous or concrete surfaced roads, traffic lanes, driveways, parking areas, etc., the bituminous or concrete surface shall be cut, restored as quickly as there is sufficient quantity to make it practical, weather permitting, and maintained as follows:

Sub-section A. Before Excavation:

All existing asphalt or concrete surfaces shall be saw cut or roto-milled to a square edge before excavation.

Sub-section B. Temporary Graded Surface:

Until resurfacing can be done in paved areas a temporary gravel surface shall be placed deep enough to provide a minimum of eight inches (8") below the bottom of the bituminous surface and shall be brought flush with the paved surface.

The untreated base shall be placed in the trench at the time it is backfilled. Excess material shall be removed from the premises immediately. The Developer/Contractor will maintain the temporary gravel surface until the asphalt is placed.

Sub-section C. Preparation for Paving:

The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than 12 tons, or with the rear wheels of a five-yard truck loaded to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches, which are broken down during the making of subgrade, shall be removed and trimmed neatly before resurfacing.

Before any permanent resurfacing is placed, the Developer/Contractor shall trim the existing paving to clean straight lines as nearly parallel to the centerline of the trench as practicable. Said straight lines shall be 50 feet minimum lengths and no deviations from such lines shall be made except as specifically permitted by the Public Works Representative/Engineer. Make transitions between lines parallel to the trench with lines that are perpendicular to the trench.

Existing bituminous paving shall be saw cut or roto-milled back a minimum of six inches beyond the limits of any excavation or cave-in along the trench so that the edges of the new paving will rest on at least six-inches (6") of undisturbed soil.

Sub-section D. Bituminous Surface:

The bituminous surface over trenches shall be restored by standard paving practices to a minimum thickness of three inches (3"). Gradation of aggregate shall conform to the 3/4-inch gradation limits as defined in the Division 11, Roadway Construction.

Pavement restoration shall include priming of pavement edges with Type MC-70 bituminous material and placing rolled plant hot mix bituminous material to the level of the adjacent pavement surfaces.

Where utility connections in an existing street in asphalt patches, replace asphalt as follows:

- 1) When the utilities have 12' or less space between each other do a single patch and leave no existing asphalt between patches.
- 2) If the trench cuts do not go past the centerline of the road but are within 12' of the centerline then replace the asphalt to the centerline of the ROW. If the trench cuts pass the centerline then replace the asphalt 12' beyond the centerline.
- 3) Excavate and replace additional asphalt as necessary in order to place utility lateral patch at a 1:8 slope from perpendicular to the direction of travel so both wheels of vehicles will not hit the patch simultaneously.

- 4) When utilities are placed parallel to the road, do not patch in a manner that would leave a strip of less than 5 feet of old asphalt between the patch and the edge of asphalt; instead, remove the narrow strip of old asphalt and pave wide enough to at least match the pre-existing asphalt width.

Section 10.06 GRAVEL SURFACE

Where trenches are excavated through gravel-surfaced areas such as roads and shoulders, parking areas, unpaved driveways, etc., the gravel surface shall be restored and maintained as follows:

Sub-section A. Layer Thickness:

The gravel shall be placed deep enough to provide a minimum of six inches of material.

Sub-section B. Placement:

The gravel shall be placed in the trench at the time it is backfilled. The surface shall be maintained by blading, sprinkling, rolling, adding gravel, etc., to maintain a safe, uniform surface. Excess material shall be removed from the premises immediately.

Sub-section C. Gradation:

Material for use on gravel surfaces shall be obtained from sound, tough, durable gravel or rock meeting the following requirements for gradation:

Passing 1-inch sieve	100%
Passing 1/2-inch sieve	79-91%
Passing No. 4 sieve	49-61%
Passing No. 16 sieve	27-35%
Passing No. 200 sieve	7-11%

Section 10.07 MISCELLANEOUS IMPROVEMENTS

It shall be the Developer/Contractor's responsibility to restore to their original condition all irrigation canals, levees, culverts, gates, fences, drainage ditches, and all such improvements, which are cut or disturbed during construction. Topsoil in farming areas or along road edges shall be stored separate from subsoil during pipe trench excavation. Topsoil shall be replaced during backfill operations as nearly as possible to its original condition, thereby assuring suitable soil for reseeded.

Section 10.08 RESTORATION OF SURFACES

Unless otherwise directed, all street surfacing, curbs, gutters, sidewalks, driveways, or other hard surface that must be removed in the performance of the work shall be restored in kind by the Developer/Contractor in accordance with the Specifications contained herein. Deviation of more than one-fourth inch (1/4") between old and new work or within new construction shall be corrected. Such measurement shall be made from a ten-foot (10') minimum length straight edge. Adjoining surfaces between old and new must be flush.

Section 10.09 CLEANUP

At the completion of each area of work all equipment, barricades, and similar items shall be removed from the area. All excess material will be removed. All rocks larger than two inches (2") shall be removed from the surface. Adjacent borrow pits and road shoulders used for storage of excavating materials will be smoothed and returned to its original contour.

Section 10.10 PAVEMENT MARKINGS

The Developer/Contractor shall be responsible for restoration of pavement markings on all City and/or County roadways. Restoration of pavement markings shall conform to the applicable local and state specifications.

On roadways under UDOT jurisdiction temporary pavement markings shall be provided for any removed or obliterated markings. The temporary markings shall conform to UDOT standards and specifications. Permanent pavement markings will be replaced by UDOT.

(Division 10 was last updated June 2015)

DIVISION 11**ROADWAY CONSTRUCTION****Section 11.01 GENERAL**

This Division covers roadway construction, including work consisting of pulverizing existing asphalt, earthwork, and roadway excavation. It also includes subgrade preparation, drain rock, imported granular borrow, granular backfill borrow, base course, asphalt surface and adjusting manholes and valve boxes to grade.

Section 11.02 PULVERIZING

The Developer/Contractor shall pulverize the existing asphalt and roadbase to a depth of 6 to 8 inches. The limits of the area to be pulverized will be as shown on the improvement drawings. This material will be used for granular borrow or untreated roadbase. The Developer/Contractor has the option of methods he feels will result in the least work and best product in breaking up the existing asphalt, provided that the maximum size for a single piece of asphalt does not exceed 3 inches. Placing, grading and compacting of this material shall comply with the requirements of borrow or roadbase. The existing asphalt edges where the pulverizing terminates shall be saw cut following or prior to being pulverized.

Section 11.03 EARTHWORK

The earthwork needed for roadway construction shall meet the requirements of Division 7, Earthwork.

Section 11.04 ROADWAY EXCAVATION

The roadway shall be excavated to the lines and grades shown on the improvements drawings. Materials not suitable for use as granular borrow or roadbase shall be removed from the road section. Excavation may be done on one-half of the road at a time.

Section 11.05 SUBGRADE PREPARATION

This work shall consist of the shaping and compacting of the subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross sections shown on the Drawings or as established by the Public Works Representative/Engineer.

Following roadway excavation the subgrade shall be proof rolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least twice. During the rolling operation moisture content of the subgrade layer shall be maintained at not less than 97% or more than 105% of the optimum moisture content. Rolling shall be continued until the entire roadbed is compacted to the specified density to a minimum depth of 8 inches.

Section 11.06 SOIL CLASSIFICATION

The Public Works Representative/Engineer shall determine the suitability of excavated materials for use as granular borrow or roadbase. He may request that the soil be tested as described below or may choose to visually accept or reject excavated materials.

Native Soil Classification Test

- 1) The soil shall be classified according to the Unified Soil Classification System and/or AASHTO soil classifications
- 2) The AASHTO soil classification test shall conform to AASHTO M-145 of latest revision
- 3) Soil classification tests at several depths may be required in each test area if so indicated by the geotechnical engineer or required by the Public Works Representative/Engineer.

- 4) The results of all determinations, including an assessment of the appropriate engineering characteristics of the soil, shall be reported to the City in writing prepared by the geotechnical engineer.

The City may reject proposed use of tested native soil. The City’s allowing the use of native soil does not relieve the Owner/Developer/Contractor of any responsibility associated with use of the soil.

Section 11.07 DRAIN ROCK

Drain rock shall be free draining natural aggregate or crushed slag material meeting the following gradation:

Sieve Size	Percent Passing
1 - ½ inch	100
1 inch	95-100
½ inch	25-60
No. 4	0-10

Section 11.08 GRANULAR BORROW

Granular borrow (foundation or roadway) material shall consist of well graded granular bank run natural aggregate material with a maximum size of 3 inches. The material shall meet the following gradation:

Sieve <u>Size</u>	Percent <u>Passing</u>
No. 10	50 max.
No. 40	30 max.
No. 200	15 max.

Granular borrow shall have a California Bearing Ratio (CBR) of no less than 30.

The granular borrow material shall be compacted to no less than 95% maximum dry density as determined by AASHTO T-180 (Modified Proctor). Granular foundation borrow shall be compacted to not less than 95% of maximum dry density as determined by ASTM D1557 (Modified Proctor). Surfaces shall be true to the established grade with thickness being not less than 1/4-inch from the required layer thickness and with the surface elevation varying not more than 3/8-inch in ten feet from the true profile and cross section.

At least one density test shall be taken per 500 cubic yards of material placed, with a minimum of two tests per day.

Section 11.09 GRANULAR BACKFILL BORROW

Granular backfill borrow material shall consist of a non-plastic, uniformly graded granular bank run natural aggregate material with a maximum size of 2 inches. The material shall meet the following gradation:

Sieve <u>Size</u>	Percent <u>Passing</u>
No. 10	50 max.
No. 40	30 max.
No. 200	15 max.

Granular backfill borrow shall have a California Bearing Ratio (CBR) of no less than 30 as determined by AASHTO T-193.

The granular backfill borrow material shall be compacted to not less than 95% maximum dry density as determined by AASHTO T-180 (Modified Proctor). Granular foundation borrow shall be compacted to not less than 95% of maximum dry density as determined by ASTM D1557 (Modified Proctor). Surfaces shall be true to the established

grade with thickness being not less than 1/4-inch from the required layer thickness and with the surface elevation varying not more than 3/8-inch in ten feet from the true profile and cross section.

At least one density test shall be taken per 500 cubic yards of material placed, with a minimum of two tests per day.

Section 11.10 BASE COURSE

Base for all streets shall consist of select material, either natural aggregate or crushed slag, and shall be graded as follows:

Sieve Size	Percent Passing
3/4 inch	100
3/8 inch	78-92
No. 4 sieve	55-67
No. 16 sieve	28-38
No. 200 sieve	7-11

Slag 4133 (3/4 inch minus) and slag 4120 (3/8 inch minus) can be used if they comply with the specification.

Base course shall have a California Bearing Ratio (CBR) of no less than 70 as determined by AASHTO T-193 with a 10 lb surcharge measured at 0.20 inch penetration.

The material shall be deposited and spread in a uniform layer, without segregation of size, with such depth that when compacted the layer will have the required thickness as stated below.

Each layer shall be compacted for the full width and depth. Alternate blading and rolling will be required to provide a smooth, even and uniformly compacted course true to cross section and grade. Places inaccessible to rolling shall be compacted with mechanically operated hand tampers.

The gravel base shall be compacted to not less than 95% maximum dry density as determined by AASHTO T-180 (Modified Proctor). Surfaces shall be true to the established grade with thickness being not less than 1/4-inch from the required layer thickness and with the surface elevation varying not more than 3/8-inch in ten feet from the true profile and cross section.

At least one density test shall be taken per 500 cubic yards of material placed, with a minimum of two tests per day.

Section 11.11 PRIME COAT AND TACK COAT

The Developer/Contractor shall apply prime coat to untreated base course and tack coat to existing asphalt concrete or Portland cement concrete edges. Prime coat or tack coat shall be applied to all surfaces that will be in contact with the bituminous asphalt. Apply tack coat to areas on the same day that they will be covered with bituminous asphalt. Asphalt sealants used with paving fabrics are not included in this section. The following criteria apply:

- 1) Prime coat shall be MC-70 or MC-250 or equivalent asphaltic material.
- 2) Tack coat shall be SS-1 or SS-1h or equivalent asphaltic material.
- 3) Provide certificate showing asphaltic material complies with these Specifications.
- 4) The tack coat shall be diluted by the manufacturer at a ratio of 2:1 – two parts concentrate to one part water, unless otherwise approved by the Public Works Representative/Engineer.
- 5) Follow notification requirements stated in these Specifications.
- 6) All existing asphalt shall be saw cut to remove fractures, cracked, or damaged asphalt. Developer/Contractor shall trim the existing pavement to clean straight lines as nearly perpendicular or parallel to the centerline of the street as practicable. Said straight lines shall be thirty feet minimum lengths and no deviations from such lines shall be made except as specifically permitted by the Public Works Representative/Engineer.
- 7) Protect all surfaces exposed to public view from being spattered or marred. Remove spattering, over-coating, or marring.

- 8) Clean the surface to be treated so that it is free of dust and other foreign material. If flushed with water, allow the surface to dry. If leaves from trees are on the surface, blow it clean.
- 9) Apply prime coat at a rate of 0.50 gallons per square yard. Apply tack coat at a rate of 0.15 gallons per square yard. These application rates may vary according to field conditions with prior approval from the Public Works Representative/Engineer.
- 10) If the prime coat fails to penetrate spread blotter material in quantities necessary to absorb the excess asphalt. Use a granular blotter material consisting in which 90% to 100% passes a No. 4 sieve, 25% to 80% passes a No. 100 sieve, and 0% to 15% passes a No. 200 sieve.
- 11) Apply prime coat or tack coat only when air and roadbed temperatures in the shade are greater than 40 degrees F. The temperature restrictions may waived only on written authorization from Public Works Representative/Engineer.
- 12) Do not apply prime coat or tack coat during rain, fog, dust, or other unsuitable weather. Do not apply coat to wet surfaces.
- 13) Prevent pedestrian pets, etc. access to primed or tacked surfaces. Do not permit vehicular traffic to travel over primed or tacked surfaces until bituminous coat is cured or is not picked up by traffic.
- 14) The prime coat or tack coat shall be applied under pressure using a spray bar or hose and nozzle. The coat shall be evenly spread with 100% coverage. Other methods of application may be used only upon approval of the Public Works Representative/Engineer.
- 15) Do not discharge bituminous material into borrow pits or gutters.

Section 11.12 BITUMINOUS ASPHALT CEMENT PAVEMENT

The surface course shall consist of a mixture of mineral aggregate and binder.

Sub-section A. Mix Design Method:

The mix design may be one of the following mix design methods outlined in Asphalt Institute MS-2 Asphalt Mix Design Methods, current edition:

- 1) Marshall Method
- 2) Superpave Method

Sub-Section B. Marshall Mix Design Criteria

Mix designs must have been from the current or previous calendar year.

Use design criteria for medium traffic.

Use a 1/2" design mix consisting of crushed aggregate conforming to the following gradation (for both roadways and trails):

Sieve Size	Percent Passing
3/4 inch	100
1/2 inch	90-100
3/8 inch	< 90
No. 8	28-58
No. 200	2-10

Aggregate shall consist of clean, hard, durable, angular, sound crushed stone/gravel, slag, or sand, or combinations of these.

Course aggregate shall have the following characteristics:

- 1) Angularity: minimum of 50% by weight of particles with at least two fractured faces (ASTM D 5821)
- 2) Hardness: maximum of 40% wear of aggregate retained above the No. 4 sieve (ASTM C 131)

- 3) Flat or elongated particles: maximum of 20% retained above 3/8 inch sieve has a 3:1 length to width ratio (ASTM D 4791)

Fine aggregate shall have the following characteristics:

- 1) Friable particles: maximum of 2% passing No. 4 sieve (ASTM C 142)
- 2) Plasticity: Aggregate passing No. 40 sieve is non-plastic (ASTM D 4318)
Liquid Limit is less than 25
Plastic Limit is less than 6

The target air voids (VA) in the mix shall be 3.5% to 4%.

The target voids in the mineral aggregate (VMA) shall be 14.5% to 15.5%.

The target voids filled with asphalt (VFA) shall be 72% to 77%.

The bituminous material shall be PG 58-28 (or higher grade) performance graded asphalt cement conforming to the requirements of ASTM D 6373.

The effective asphalt content (P_{be}) of the mix shall be no less than 5% of the mix (by weight).

Recycled asphalt pavement (RAP) may be used in the mix. Modify the asphalt binder grade as necessary to account for the effect of the RAP on viscosity. RAP content in the mix is subject to the following:

- 1) Up to 15% (by weight): no change in the asphalt binder grade is required as long as the mix meets gradation, viscosity, VMA and VFA requirements.
- 2) Over 15% and up to 20% (by weight): allowed with a change in the asphalt binder grade as long as the mix meets the following requirements the Hamburg rut test (AASHTO T2 34):
 - a) The test is performed at temperatures that correspond to the specified asphalt binder grade.
 - b) The average rut depth of 3 mix design test samples is less than 15 mm at 10,000 passes for streets in residential zones and 15 mm at 20,000 passes for streets in non-residential zones.
- 3) Over 20% (by weight): not allowed

Warm mix designs are allowed, and shall meet the above design requirements, except that it may not include RAP (since the lower temperatures of the warm mix may not result in adequate mixing of the binder in the RAP with the binder in the warm mix).

Sub-Section C. Superpave Mix Design Criteria

The mix design must be from the current or previous calendar year

The mix design must have been approved by UDOT within the current or previous calendar year for a roadway with comparable or poorer soil conditions and comparable or greater estimated traffic volumes.

Use PG 64-28 or better binder.

Design using the following gyrations (minimum): $N_{initial} = 8$; $N_{design} = 100$; $N_{final} = 160$.

Sub-Section D. Submittals:

The Developer/Contractor shall establish and submit the mix design to the Public Works Department for approval at least ten working days prior to paving. The following information shall be included:

- 1) Date of mix design
- 2) Mix design method used

- 3) Traffic criteria used
- 4) Signed and dated stamp of the professional engineer responsible for the mix design.
- 5) Additives in the mix, including cement, hydrated lime and recycled asphalt pavement (RAP), including pertinent information for each
- 6) Asphalt binder source, type and chemical composition
- 7) Source of the aggregate
- 8) Target aggregate gradation and bands
- 9) Theoretical maximum (Rice) density (G_{mm}) of the mix
- 10) Percent asphalt content (P_b)
- 11) Effective percent asphalt content (P_{be})
- 12) Percent air voids in the mix (VA)
- 13) Percent air voids in the mineral aggregate (VMA)
- 14) Percent air voids filled with asphalt (VFA)
- 15) Marshall stability and flow
- 16) Temperatures of the mix at source and site for optimum compaction

In the case of a Superpave mix design, also submit the design approval from UDOT.

Sub-section E. Paving:

The bituminous surface course shall be mixed at a mixing plant and spread and compacted on the prepared base in conformance with the lines and dimensions shown on the Drawings and in accordance with these Specifications.

Only pave when meeting the following conditions:

- 1) The base course is shaped to grade, compacted, dry, and dust-free
- 2) Prime coat has been applied
- 3) The temperature of the air and roadbed are both higher than 50° F, measured in the shade.
- 4) Only lay a hot mix mat of the thickness listed below when the air temperature measured in the shade is at least as high as the corresponding temperature listed.
 1. 1": 70° F
 2. 1-1/2": 60° F
 3. 2" or more: 50° F
- 5) Weather is not rainy or otherwise unfavorable as determined by the Public Works Representative/Engineer.
- 6) The temperature of the bituminous mix shall be between 270° F and 325° F when placing.

The bituminous mixtures shall be spread with self-propelled mechanical spreading and conditioning equipment capable of distributing at least a 12-foot width. The mixture shall be spread and struck off in such a manner that the finished surface shall result in a uniform smooth surface of the required thickness (see smoothness requirements under Acceptance sub-section below).

Lay warm mix bituminous surface course so that the temperature 10 feet behind the paver is no less than 200° F and warm mix is no less than as follows:

Minimum Hot Mix Temperature in Degrees F					
Air Temperature	Compacted Mat Thickness				
in Degrees F	1"	1-1/2"	2"	3"	4" +
50 - 59	-	-	280	270	255
60 - 69	-	285	275	265	250
70 - 79	285	280	270	265	250
80 - 89	275	270	265	260	250
90 +	270	265	260	250	250

The longitudinal joints in succeeding courses shall be offset at least 6 inches transversely to avoid a vertical joint through more than one course.

The minimum compacted thickness of a course of asphalt is 1-½ times the maximum size of aggregate in the mix. The maximum compacted thickness of a single course of asphalt is 4”.

Plan and perform placement and rolling in a manner that allows adequate compaction of longitudinal joints.

Continue rolling until the mixture is compacted to the required density.

Check thickness with a probe and density with a nuclear density gage during placement of the asphalt. However, resulting information is for information only, and shall not be used for acceptance.

The surface of the pavement after compaction shall be uniform and true to the established grade.

It is the responsibility of the Developer/Contractor to control traffic. Keep all traffic off the completed surface for a minimum period of 24 hours.

Replace removed cores with hot mix asphalt or low strength concrete within two days.

Sub-section F. Acceptance

Acceptance in terms of thickness and density shall be based on core samples as described below, not on measurements from probes or nuclear gages.

Smoothness

Immediately after compaction, test smoothness of the surface with a ten-foot straight edge placed on the surface of the pavement. The surface shall not deviate more than one-eighth of an inch from the lower edge of the straight edge at any point. Remedy all high and low spots immediately by removing the bituminous mixture over the affected areas, replacing it with fresh, hot bituminous mixture, and compacting it to conform with the surrounding area.

Mat Density

Test the mat for density as follows:

- 1) Acceptance of bituminous surface course with respect to compaction of the mat shall be based upon density tests on core samples in a test lot.
- 2) A test lot shall be the quantity of surface course placed and compacted in each construction day.
- 3) The test lot shall be subdivided into sub-lot(s) of approximately equal size and no larger than 1,000 square yards in area, with a minimum of four tests per lot.
- 4) Take samples to determine theoretical maximum (Rice) density (G_{mm}) at the time bituminous surface course is placed and before compaction as determined in accordance with ASTM D 2041 or AASHTO T 209.
- 5) Take 4” diameter core samples at random locations selected per ASTM D 3665 and ASTM D 5361; however, if a random location is within a foot of a longitudinal joint, move to a point 1 foot away from the joint.
- 6) Determine field density of core samples per ASTM D 1188 or ASTM D 2726/AASHTO T 166, as appropriate.
- 7) The test lot shall be accepted with respect to density when the average of all density determinations is a minimum of 93% and a maximum of 97% of the theoretical maximum (Rice) density (G_{mm}), with no single test less than 91%.

Longitudinal Joint Density:

Test longitudinal joints for density as follows:

- 1) At the location (ie. station) of each random mat density core, take one 6" core sample over each longitudinal joint. Determine field density of core samples per ASTM D 1188 or ASTM D 2726/AASHTO T 166, as appropriate.
- 2) Acceptance of bituminous surface course with respect to longitudinal joint compaction shall be based upon density tests on core samples in a test lot.
- 3) A test lot of longitudinal joint core samples consists of those samples taken adjacent to the set of mat density core samples that constitute a test lot. The longitudinal joint core samples taken at the multiple joints adjacent to a mat density core sample constitute a sub-lot.
- 4) Longitudinal joint density shall be accepted when the average of all longitudinal joint determinations is a minimum of 91% of the theoretical maximum (Rice) density (G_{mm}), with no single test less than 89%.

Thickness:

Test for thickness as follows:

- 1) Acceptance of the completed bituminous surface course with respect to thickness shall be based on thickness tests of core samples in a test lot.
 - a) A test lot consists of all mat density core samples within a test lot, and
 - b) One sample from all corresponding longitudinal joint density core test sub-lots, which sample shall be the thinnest sample within the sub-lot.
- 2) The thickness of each core shall be determined per ASTM D 3549.
- 3) A lot shall be accepted when the average thickness of all sub-lots is less than 1/4-inch less than the total designated bituminous surface course thickness and when no individual sub-lot shows a deficient thickness of more than 3/8-inch.

Bituminous Surface Course Characteristics

Select one random core sample per lot to test the composition of the bituminous surface course. Determine the following characteristics of the bituminous surface course:

- 1) Theoretical Maximum (Rice) Density (G_{mm})
- 2) Stability (Marshall, 50 blows) must be at least 750 lb
- 3) Flow (Marshall, 0.01in.) shall be between 8 and 18
- 4) Aggregate: must be within the gradation band of the mix design
- 5) Binder: asphalt binder content and effective asphalt binder content must be within $\pm 0.35\%$ of the mix design.
- 6) Voids:
 - a) Air voids (V_a) in the mix must be between shall be 3.5% and 5%.
 - b) The voids in the mineral aggregate (VMA) must be 14% to 16%.
 - c) The voids filled with asphalt (VFA) must be 65% to 78%.

Sub-Section G. Remedies for Deficiencies

Failures to comply with any of the specifications will result in removal and replacement of the asphalt surface course. If the Developer/Contractor proposes corrective action, and the Public Works Director/Engineer (at his sole discretion) believes that it may be in the public interest to allow it to remain, may require the following:

- 1) Density and Thickness:
 - a) Lots or sub-lots that are not acceptable because of deficient thickness or density shall be brought into compliance by placing additional surface course across the entire width of

- the roadway in a lift that is at least one 1” in compacted thickness, and more if necessary to correct a deficiency in thickness.
- b) If the average thickness or density is deficient, place the additional lift over the entire lot area.
 - c) If individual thickness or density tests are deficient, place the additional lift of bituminous surface course from the location of the non-deficient test downstation of the deficient test location(s), over the deficient test location(s), and to the location of the next non-deficient test upstation from the deficient test location(s), with a minimum length of 200.
 - d) In correcting deficient thickness or density, do not feather the edge of a lift. Mill asphalt along gutters. The width of the milling shall be from the gutter to the edge of the first travel lane (but no less than 6 feet). The depth of the milling at the gutter shall be 1/4-inch less than the additional lift thickness, tapering to zero depth at the other edge of the milling. Mill asphalt at the beginning and ending locations (stations) of the additional lift. The milling pass shall be at least 12 feet wide, and shall taper from the depth of the additional lift thickness to zero depth at the other edge of the milling.
 - e) Apply tack coat to all surfaces that are dirty or older than 24 hours.
- 2) Smoothness: At the sole discretion of the Public Works Representative/Engineer:
- a) Place an additional lift of bituminous surface course as described above (under Density and Thickness) over the entire width of the roadway with a minimum length of 200 feet, and/or
 - b) Diamond grind the surface and provide a seal coat over the entire width of the roadway with a minimum length of 200 feet.
- 3) Bituminous Surface Course Characteristics: The asphalt mix design engineer shall determine whether the deficiencies in the measured characteristics fall within the range of the mix design performance criteria. If they do, and the engineer submits written documentation to that effect with a recommendation that it remain, the Public Works Representative/Engineer (at his sole discretion) may choose to accept the bituminous surface course, require corrective action, or require that it be removed and replaced.

Section 11.13 HIGH DENSITY MINERAL BOND SEAL

This section covers the requirements for coating the asphalt concrete pavement with a high density mineral bond.

Sub-section A. Products:

Use the following products:

- 1) Emulsified Asphalt: Non-ionic thixotropic mineral colloid at 77 Deg. F. meeting the following:

Criterion	ASTM	Min	Max
Brookfield Viscosity, cPs	D2196	8,000	15,000
Acidity, pH	E70	6.5	7.5
Weight, lbs/gal	D2939	8.7	9.1
Solids, percent	D2939	47	53

- 2) Aggregate
 - a. Slate

Physical Properties			
Criterion	ASTM	Min	Max
Specific gravity	C 128		2.7
Compression, psi	C 170	11,000	
Loss on ignition at 1000 deg C, percent	C 114		5
Shipping moisture content, percent	D 2216		1

Gradation			
Sieve	ASTM	Target	Tolerance
No. 20	C 136	99	+1 and -2
No. 50	C 136	74	+/- 2
No. 100	C 136	55	+/- 2
No. 200	C 117	38	+/- 2
NOTES			
(a) Gradation analyzed according to ASTM C 136 on a dry weight and percent passing basis.			

b. Refined Corundum

Physical Properties			
Criterion	Standard	Min	Max
Specific Gravity	ASTM C 1326	--	3.92
Knoop 100 Hardness	ASTM D 721	--	2,050
Ball Mill Fiability (14 grit)	ANSI B74.8	--	50
Color	ASTM C 604	Brown	
Shape	ASTM D 2216	Blocky with sharp edges	
Gradation			
Sieve	ASTM	Target	Tolerance
No. 35	C 136	99	+1 and -2
No. 45		85	+/- 2
No. 50		35	+/- 2
No. 60		7	+/- 2
NOTE: Gradation analyzed according to ASTM C 136 on a dry weight and percent passing basis.			

Sub-section B. Mix Design

Use the following table as a guide.

Selection Guide			
Asphalt Emulsion			
Criterion	ASTM	Min	Max
Asphalt content by weight, percent	D 2172	17	
Residual asphalt by weight, percent	D 2939		30
Cone penetration viscosity, cST/sec	D 217	350	450
Weight per gallon, pounds	D 2939	11.2	
Solids volume by percent, percent	D 2697	55	65
Solids weight by percent, percent	D 1644	60	
VOC, g/l	D 3960		10
Aggregate			
Criterion	ASTM	Min	Max
Bentonite and attapulgate clay, percent	--		1.8
Refined corundum / slate content, percent	--	34.5	
Sand or other round aggregate, percent	--		6
Maximum VOC:, g/l	--		10
Wear resistance @ 12,000 cycles (70 mils wet), percent	D 2486		6.5
Pinholes on glass	--	No grazing on film	
Resistance to re-emulsification	--	Very good	

Sub-section C. Submittals

- 1) Submit the mix design for approval to the Public Works Representative/Engineer ten days prior to use. Include proportions of aggregate, filler, water, polymer, and emulsion.
- 2) Submit results of wear resistance test that were performed within the previous calendar year.
- 3) Do not change the source of emulsified asphalt or aggregate without supporting changes in the mix design.

Sub-section D. Construction Equipment:

The following equipment shall be used to apply the materials.

- 1) Paver: Continuous flow mixing unit
 - a. Capable of applying at least 15,000 square yards of material per day.
 - b. Equipped with full sweep helical mixer to assure proper suspension of fine aggregates.
 - c. Equipped with a digital operator control station that is capable of adjusting material spread rate in accordance with pre-set calibrations. It should be equipped with speed sensing equipment capable of maintaining a constant delivery rate of material per square yard of surface at variable speeds.
 - d. Equipped with two separate filters. The primary filter should be at least 200 square inches with a filter face of 3/8 inch. The secondary filter needs to be at least 1500 square inches with a filter face of 1/8 inch.
 - e. Has a retractable spray bar with spacing of 16 inches between each discharge orifice. The bar should be positioned minimum of 20 inches from the surface, no more than 23 inches from the surface.
- 2) Paver Calibration: On a test strip at least 300 feet long, determine the correct pump settings on the application equipment. Apply material with pump settings at 80% of maximum output at a ground speed of 352 feet per minute.

Sub-section E. Preparation:

- 1) Weather
 - a. Apply surface treatment when air and roadbed temperatures in the shade are 55 deg. F and rising.
 - b. Do not apply the surface treatment if pavement or air temperature is below 60 deg. F and falling or if the finished product will freeze before 48 hours.
 - c. Do not apply the surface treatment during rain, unsuitable weather, or 24 hours prior to forecast rain.
- 2) Notification – follow the notification requirements stated in these specifications
- 3) Pavement Preparation
 - a. Tack Coats
 - i. A tack coat is required on high absorbent, polished, oxidized, or raveled asphalt surfaces or to brick surfaces.
 - ii. The tack coat is to comply with these specifications, except that is to consist of one part emulsified asphalt and three parts water
 - b. Patch the surface with asphalt concrete if there are holes, raveled areas, or low areas.
 - c. Fill (if necessary) and seal cracks according to these specifications
 - d. Remove existing pavement markings
 - e. Clean existing pavement, removing loose materials, mud spots, sand, dust, oil, vegetation, and other objectionable material.
 - f. Do not flush water over cracks or apply pressurized water to cracked pavement.
- 4) Protection
 - a. Protect trees, plants, and other ground cover from damage
 - b. Prune trees to allow equipment passage underneath.
 - c. Repair all tree damage at no additional cost to the owner.
 - d. Cover valve lids and manhole covers and protect curb, gutter, and sidewalk from spatter, mar, or overcoat.

- e. Mask off end of streets and intersections to provide straight lines. Also make straight lines along lip of gutters and shoulders and keep same thickness in these areas. Vary edge lines no more than ½ inch per 100 feet.
- f. Protect surface treatment materials from traffic until it has cured.

Sub-section F. Application:

- 1) Application Rate: Two separate application coats are required. The first application must be thoroughly dry and free of any damp areas before the second application begins. Machine settings must match the following application rates:
 - a. First application: 0.20 gallons per square yard minimum.
 - b. Second application: 0.16 gallons per square yard minimum.
- 2) Spreading:
 - a. Keep constant delivery rate of material per square yard of surface, even if the forward speed of the machine varies.
 - b. Do not reduce application rate along edges or around manhole covers.
 - c. Apply both applications right to the edge of the pavement. Do not back away from curbs, manhole covers, and edges on either application.

Sub-section G. After Application:

- 1) Leave no streaks caused by plugged nozzle or improper spray bar height.
- 2) Leave no holes, bare spots, or cracks.
- 3) Expose and clean manholes, valve boxes, inlets and other service entrances and street fixtures.
- 4) Raise reflective tabs that were covered over. This will aid roadway users in finding lane delineation after installation and before permanent striping.
- 5) Do not permit traffic on product until surface has cured (minimum 8 hours).
- 6) Do not apply permanent lane markings or paint until placement has aged at least 10 days and layout has been verified with Public Works Representative/Engineer.

Sub-section H. Field Quality Control:

- 1) Density:
- 2) Testing: If density tests (ASTM D2939) show non-compliance, remove the product and halt operations until new material arrives and is shown to be in compliance. Measure the total amounts of material installed, and verify it meets the application rate.

Sub-section I. Repair:

- 1) Remove spatter and mar from curb and gutter, sidewalk, guard rails, and guide posts at no additional costs to the City.
- 2) Remove surface treatment material from street fixtures.
- 3) Make correction lines straight. Provide good appearance.
- 4) Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.
- 5) Repair collateral damage caused by construction.

Sub-section J. Acceptance:

- 1) Acceptance is by lot, which is 1 lane mile.
- 2) The surface treatment shall have a mat appearance
- 3) The surface treatment shall not have runoff onto concrete curbs and shoulders, streaking, light spots, or de-bonding due to road contaminants.
- 4) Opening pavement surface treatment to vehicular traffic does not constitute acceptance.

Sub-section K. Warranty:

- 1) The surface treatment material must carry a warranty from the Contractor and manufacturer for a period of five (5) years when applied to pavement in appropriate conditions.
- 2) The warranty includes coverage for peeling and premature wear.

Section 11.14 MICRO-SURFACE SEAL

This section covers the requirements for coating the asphalt concrete pavement with micro-surfacing material.

Sub-section A. Products:

Use the following products:

- 1) Emulsified Asphalt
 - a. The emulsified asphalt shall be polymer modified. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. In general, a three percent (3%) polymer solids, based on asphalt weight, is considered minimum.
 - b. The emulsified asphalt, and emulsified asphalt residue shall meet the requirements of AASHTO M 208 or ASTM D 2397 for CQS-1h, with the following exceptions:

Test	Test Method		Specification
	AASHTO	ASTM	
Settlement and Storage Stability of Emulsified Asphalts, 24-hr	T 59	D 6930	1% Maximum
Distillation of Emulsified Asphalt ¹	T 59	D 6997	62% Minimum
Test on Emulsified Asphalt Residue			
Softening Point of Bitumen (Ring-and-Ball Apparatus)	T 53	D 36	135°F (57°C) Minimum
Penetration of Bituminous Materials at 77°F (25°C)	T 49	D 5	40-90 ²
¹ The temperature for this test should be held at 350°F (177°C) for 20 minutes.			
² The climatic conditions should be considered when establishing this range.			

- c. The solubility test, if required, should be evaluated on the base asphalt.
 - d. Each load of emulsified asphalt shall be accompanied with a Certificate of Analysis/Compliance to indicate that the emulsion meets specification.
- 2) Aggregate
 - a. The mineral aggregate used shall be the type specified for the particular application requirements of the micro-surfacing. The aggregate shall be a crushed stone such as granite, slag, limestone, chat, or other high-quality aggregate, or combination thereof. To assure the material is 100 percent crushed, the parent aggregate will be larger than the largest stone in the gradation used.
 - b. The aggregate should meet agency specified polishing values and these minimum requirements:

Test	Test Method		Specification
	AASHTO	ASTM	
Sand Equivalent Value of Soils and Fine Aggregate	T 176	D 2419	65 Minimum
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	T 104	C 88	15% Maximum w/Na ₂ SO ₄ 25% Maximum w/MgSO ₄

Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine ¹	T 96	C 131	30% Maximum
¹ The abrasion test is run on the parent aggregate			

- c. When tested in accordance with AASHTO T 27 (ASTM C 136) and AASHTO T 11 (ASTM C 117), the mix design aggregate gradation shall be within one of the following bands (or one recognized by the local paving authority).

Sieve Size		Type II Percent Passing	Type III Percent Passing	Stockpile Tolerance
3/8	(9.5 mm)	100	100	
#4	(4.75 mm)	90 - 100	70 - 90	±5%
#8	(2.36 mm)	65 - 90	45 - 70	±5%
#16	(1.18 mm)	45 - 70	28 - 50	±5%
#30	(600 um)	30 - 50	19 - 34	±5%
#50	(330 um)	18 - 30	12 - 25	±4%
#100	(150 um)	10 - 21	7 - 18	±3%
#200	(75 um)	5 - 15	5 - 15	±2%

Type II. This aggregate gradation is used to fill surface voids, address surface distresses, seal, and provide a durable wearing surface.

Type III. This aggregate gradation provides maximum skid resistance and an improved wearing surface. This type of micro-surfacing surface is appropriate for heavily traveled pavements, rut filling, or for placement on highly textured surfaces requiring larger size aggregate to fill voids.

- 3) Mineral filler: Mineral filler may be used to improve mixture consistency and to adjust mixture breaking and curing properties. Portland cement, hydrated lime, limestone dust, fly ash, or other approved filler meeting the requirements of ASTM D 242 shall be used if required by the mix design. Typical use levels are normally 0.0 -3.0 percent and may be considered part of the aggregate gradation.
- 4) Water: The water shall be free of harmful salts and contaminants. If the quality of the water is in question, it should be submitted to the laboratory with the other raw materials for the mix design.
- 5) Additives: Additives may be used to accelerate or retard the break/set of the micro-surfacing. Appropriate additives, and their applicable use range, should be approved by the laboratory as part of the mix design.

Sub-section B. Mix Design:

The micro-surface mix design shall be subject to the approval of the Public Works Representative/Engineer and mix design should be submitted ten days prior to use.

Compatibility of the aggregate, polymer-modified emulsified asphalt, water, mineral filler, and other additives shall be evaluated in the mix design. The mix design shall be completed using materials consistent with those supplied by the contractor for the project. Recommended tests and values are as follows:

Test	ISSA TB No.	Specifications
Mix Time @ 77°F (25°C)	TB 113	Controllable to 120 Seconds Minimum
Wet Cohesion @ 30 Minutes Minimum (Set) @ 60 Minutes Minimum (Traffic)	TB 139	12 kg-cm Minimum 20 kg-cm or Near Spin Minimum
Wet Stripping	TB 114	Pass (90% Minimum)

Wet-Track Abrasion Loss One-hour Soak Six-day Soak	TB 100	50 g/ft ² (538 g/m ²) Maximum 75 g/ft ² (807 g/m ²) Maximum
Lateral Displacement Specific Gravity after 1,000 Cycles of 125 lb (56.71 kg)	TB 147	5% Maximum 2.10 Maximum
Excess Asphalt by LWT Sand Adhesion	TB 109	50 g/ft ² (538 g/m ²) Maximum
Classification Compatibility	TB 144	11 Grade Points Minimum (AAA, BAA)

The component materials shall be designed within the following limits:

Component Materials	Suggested Limits
Residual Asphalt	5.5 – 10.5% by dry weight of aggregate
Mineral Filler	0.0 – 3.0% by dry weight of aggregate
Polymer Content	Minimum of 3.0% solids based on bitumen weight content
Additives	As needed
Water	As required to produce proper mix consistency

Sub-section C. Execution:

1) Construction Equipment

- a. Mixing equipment: The unit is to be a storage and mixing device capable of accurately proportioning and delivering aggregate, emulsified asphalt, mineral filler, additive, and water on a continuous flow basis to a spreader box at a placement rate of at least 15,000 square yards per day. Its proportioning devices are to be based upon either volume or weight control. Its mixer is to be a multi-blade, multi-shaft unit.
 - i. For lay downs longer than 600 feet, autonomous mixing equipment is required.
 - ii. For lay downs less than 600 feet, truck mounted mixing equipment is permitted.
- b. Spreader: The spreader is to have a front seal so no loss of the mixture occurs at road contact and an adjustable rear seal to act as a final strike-off device. The spreader is to have a secondary strike off device to improve surface texture. Rut filling box: Wide enough to bridge ruts. To be used to fill ruts 0.5 in (12.7 mm) or greater in depth, utility cuts, depressions in the existing surface, etc. Ruts that are in excess of 1.5 in (38.1 mm) in depth may require multiple applications with the rut-filling box to restore the cross-section. All rut-filling and level-up material should cure under traffic for at least twenty-four (24) hours before additional material is placed.
- c. Rut Filling Box: Wide enough to bridge ruts.

2) Preparation

- a. Notification Plan
 - i. Follow laws and regulations concerning when and to whom notices are to be given.
 - ii. Notify neighborhood of the date and time that surface/crack repairs and micro-surfacing will take place at least 48-hours in advance of when the repairs will begin.
 - iii. Provide a written notice and include the time and when the surface can be used as well as a map signifying the specific area to be closed.
 - iv. Provide a minimum of two contacts that represent the Contractor with phone numbers which can be reached any time during the project.
 - v. Should the work not occur on the specified day, send a new notice before the end of the day.
- b. Pavement Preparation
 - i. Tack Coats
 - 1. The emulsified asphalt is to be SS, CSS, or the micro-surfacing emulsion. The micro-surfacing emulsion supplier will assist to determine dilution stability.

2. The tack coat is to consist of one part emulsified asphalt/three parts water and should be applied with a standard distributor
 3. The distributor shall be capable of applying the dilution evenly at a rate of 0.05-0.15 gal/yd² (0.23-0.68 l/m²).
 - ii. Patch the surface with asphalt concrete if there are holes, raveled areas, or low areas.
 - iii. Fill (if necessary) and seal cracks according to the Pavement Crack Seal specification
 - iv. Remove existing pavement markings
 - v. Clean existing pavement, removing loose materials, mud spots, sand, dust, oil, vegetation, and other objectionable material.
 - vi. Do not flush water over cracks or apply pressurized water to cracked pavement.
 - c. Protection
 - i. Protect trees, plants, and other ground cover from damage
 - ii. Prune trees to allow equipment passage underneath.
 - iii. Repair all tree damage at no additional cost to the owner.
 - b. If there is existing roadway striping, use reflective tabs to mark the roadway striping.
- 3) Weather Limitations
 - a. Micro-surfacing shall not be applied if either the pavement or air temperature is below 50°F (10°C) and falling, but may be applied when both pavement and air temperatures are above 45°F (7°C) and rising.
 - b. No micro-surfacing shall be applied when there is the possibility of freezing temperatures at the project location within 24 hours after application.
 - c. The micro-surfacing shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time.
- 4) Calibration: Each mixing unit to be used in the performance of the work shall be calibrated in the presence of the OWNER/ENGINEER prior to the start of the project. Previous calibration documentation covering the exact materials to be used may be acceptable, provided that no more than 60 days have lapsed. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices. Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

Sub-section D. Application:

- 1) General
 - a. When local conditions warrant, the surface shall be fogged with water ahead of the spreader box. The rate of application of the fog spray may be adjusted as the temperature, surface texture, humidity, and dryness of the pavement change.
 - b. The micro-surfacing shall be of the appropriate consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times so that complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumps or unmixed aggregate shall be permitted. No dry aggregate either spilled from the lay-down machine or existing on the road, will be permitted.
 - c. No streaks, such as those caused by oversized aggregate or broken mix, shall be left in the finished surface. If excessive streaking develops, the job will be stopped until the contractor proves to the OWNER/ENGINEER that the situation has been corrected. Excessive streaking is defined as more than four drag marks greater than 0.5 in (12.7 mm) wide and 4.0 in (101 mm) long, or 1.0 in (25.4 mm) wide and 3.0 in (76.2 mm) long, in any 29.9 yd² (25 m²) area. No transverse ripples or longitudinal streaks of 0.25 in (6.4 mm) in depth will be permitted, when measured by placing a 10 ft (3 m) straight edge over the surface.
- 2) Rate of Application

The micro-surfacing mixture shall be of the proper consistency at all times so as to provide the application rate required by the surface condition. After spot leveling, the

average application rates are to fall within the following ranges based upon the weight of dry aggregate in the mixture:

Aggregate Type	Location	Suggested Application Rate
Type II	Urban and Residential Streets	10 – 20 lb/yd ² (5.4 – 10.8 kg/m ²)
	Airport Runways	10 – 20 lb/yd ² (5.4 – 10.8 kg/m ²)
	Scratch or Leveling Course	As Required
Type III	Primary and Interstate Routes	15 – 30 lb/yd ² (8.1 – 16.3 kg/m ²)
	Wheel Ruts	As Required
	Scratch or Leveling Course	As Required

- 3) Joints
 - a. No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Partial width passes will only be used when necessary and shall not be the last pass of any paved area.
 - b. A maximum of 3.0 in (76.2 mm) shall be allowed for overlap of longitudinal joints. Also, the joint shall have no more than a 0.25 in (6.4 mm) difference in elevation when measured by placing a 10 ft (3 m) straight edge over the joint and measuring the elevation difference.
- 4) Mixture: The micro-surfacing shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess liquids which create segregation of the aggregate. Spraying of additional water into the spreader box will not be permitted.
- 5) Handwork: Areas which cannot be accessed by the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. If necessary, the area to be hand worked shall be lightly dampened prior to mix placement. As much as possible, handwork shall exhibit the same finish as that applied by the spreader box. All handwork shall be completed prior to final surfacing.
- 6) Lines: Lines at intersections, curbs, and shoulders will be kept straight to provide a good appearance. If necessary, a suitable material will be used to mask off the end of streets to provide straight lines. Longitudinal edge lines shall not vary by more than ± 2 in (± 51 mm) horizontal variance in any 96 ft (29 m) of length.
- 7) Rolling: Rolling is usually not necessary for micro-surfacing on roadways. Airports and parking areas should be rolled by a self-propelled, 10-ton (maximum) pneumatic tire roller equipped with a water spray system. All tires should be inflated per manufacturer’s specifications. Rolling shall not start until the micro-surfacing has cured sufficiently to avoid damage by the roller. Areas which require rolling shall receive a minimum of two (2) full coverage passes.
- 8) Clean Up: All utility access areas, gutters and intersections, shall have the micro-surfacing removed as specified by the B.A.R. The contractor shall remove any debris associated with the performance of the work on a daily basis.

Sub-section E. Quality Control:

- 1) Inspection
 - a. Inspectors assigned to projects must be familiar with the materials, equipment and application of micro-surfacing. Local conditions and specific project requirements should be considered when determining the parameters of field inspection.
 - b. Proper mix consistency should be one of the major areas of inspector concern. If mixes are too dry, streaking, lumping and roughness will be present in the mat surface. Mixes applied too wet will flow excessively and not hold straight lane lines. Excessive liquids may also cause an asphalt-rich surface with segregation.
- 2) Materials: To account for aggregate bulking, it is the responsibility of the contractor to check stockpile moisture content and to set the machine accordingly. At the OWNER’S/ENGINEER’S discretion, material tests may be run on representative samples of the aggregate and emulsion.

Tests will be run at the expense of the OWNER. The OWNER must notify the contractor immediately if any test fails to meet the specifications.

- 3) Sampling: If required, representative samples of the micro-surfacing may be taken directly from the micro-surfacing machine. Residual asphalt content (ASTM D2172) tests may be run on the samples at the expense of the OWNER. The OWNER/ENGINEER should notify the contractor immediately if any test fails to meet specifications. Data obtained from the proportioning devices on the micro-surfacing machine may be used to determine individual material quantities and application rate.
- 4) Non-Compliance: If any two successive tests fail on the stockpile aggregate, the job shall be stopped. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It will be the responsibility of the contractor, at his expense, to prove to the OWNER/ENGINEER that the problems have been corrected.

Section 11.15 FRICTIONAL MASTIC SURFACE TREATMENT

This section covers application of an asphalt mastic surface preservation treatment consisting of an engineered mixture of fine aggregates, clay, polymers, additives, and an asphalt emulsion that cures by evaporation.

Sub-section A. Products:

- 1) Emulsified Asphalt: Use Grades CSS-1 or CSS-1h. meeting the following:

Criterion	Standard	Min	Max
Viscosity, Saybolt Furol at 77°F, sec.	AASHTO T 59 or ASTM D 244	8,000	15,000
Particle Charge Test In case of inconclusive particle charge, material having a maximum pH value of 6.0 will be acceptable as a CSS type	AASHTO T 59 or ASTM D 244	Positive	
Sieve, percent	AASHTO T 59	0	0.1
Residue by distillation, percent	AASHTO T 59	57	--
Penetration at 77°F, 100g, 5 seconds (Test on residue from distillation)	AASHTO T 59 or ASTM D 5	15	150

- 2) Fine Aggregate: Use fine aggregate that is clean and free from organic matter or other detrimental substances meeting the following:

Physical Properties			
Criterion	ASTM	Min	Max
Water absorption	AASHTO T 84	--	4%
Micro-Deval	ASTM D 7428	--	20%
Gradation			
Sieve	ASTM	Target	Tolerance
No. 8	C 136	100	
No. 16	C 136	80-100	
No. 30	C 136	75-100	+/- 5
No. 60	C 136	50-85	+/- 5
No. 100	C 136	40-65	+/- 5
No. 200	C 117	25-65	+/- 5
NOTES			
(a) Perform physical property tests on aggregates that are received before blending into sealer.			
(b) Micro Deval on aggregate larger than #60 sieve			
(c) Includes all mineral components			

3) Plant Additives:

- a. Polymers, clays, and other additives may be used at the central plant, as necessary, to achieve mix design performance
- b. Required minimum latex content by weight shall be 4%
- c. The central plant shall use water that is clean, non-detrimental, and free from salts and contaminant
- d. Contractor shall not dilute mixture in the field with water or any other additive

Sub-section B. Mix Design

The mix design must be from the current construction season or the previous construction season.

The asphalt mastic in the mix design shall comply with the following criteria:

Test	Standard	Min	Max
Wet-Track Abrasion Loss (3 day soak), g/m ² (see note a)	ISSA TB 100 or ASTM D 3910	--	80
Asphalt content by ignition method, percent	AASHTO T 308	30%	--
Dynamic friction test number at 30 kph, ratio (see note b)	ASTM E 1911	0.90	--
<p>NOTES</p> <p>(a) Use the modified method to account for realistic application depth and fine.</p> <p>(b) Establish base friction value using prepared laboratory compacted slab of approved mix as surface to be tested. The Dynamic Friction Test (DFT) number ratio should indicate that after application of the mastic seal, the surface retains required minimum percentage DFT number of the original pavement surface.</p>			

Sub-section C. Asphalt Mastic Properties

Field samples shall comply with the following material characteristics:

Test	Standard	Min	Max
Solids content by evaporation (see note a)	AASHTO T 59	48%	--
Asphalt content by ignition method (see note b)	AASHTO T 308**	30%	--
Rotational Viscosity @ 20 RPM/RV spindle (cPs) @ 25°C	ASTM D 2196	800	4000
<p>NOTES</p> <p>(a) Sample shall be tested within 7 days and dried to a state where measurements taken 20 minutes apart do not indicate change.</p> <p>(b) Perform this test on a completely dry sample; reduce sample size to achieve asphalt quantity.</p>			

Sub-section D. Submittals

- 1) Mix Design – submit the following mix design information:
 - a. Date of mix design
 - b. Type and grade of emulsified asphalt source
 - c. Asphalt mastic properties
 - d. Fine aggregate physical properties
 - e. Target Grading Curve for blend as per mix design aggregate

- f. Application rates
- 2) Field Samples and Testing Report – sample asphalt mastic in the field, test the characteristics listed above, and submit a test report to the Public Works Representative/Engineer.

Sub-section E. Construction Equipment

- 1) Distribution Equipment
 - a. Mixing Equipment: All materials shall be thoroughly mixed as to produce a homogenous surface treatment. Individual volume or weight controls for proportioning each material in the mix shall be provided. Materials shall be added by a calibrated controlled device capable of monitoring the amount of material used at the time.
 - b. Distribution Equipment: The Distributor shall be equipped with a full sweep agitation system, a pumping system designed to handle fine aggregate mixes, and sufficient power to operate the full spray system and the agitation system at the same time. The Distribution equipment shall be equipped with a monitoring system that ensures the even distribution of material and measures the application rate of the mix.
 - c. Storage Tanks: If the mix is being delivered from a central mixing plant, then a job site storage tank shall have the minimum capacity of the entire transport load. The storage tank shall have an internal full sweep mixing system having a mixing capability of providing a homogenous mix representing the mix design at any given location within the tank.
- 2) Storage Tanks
 - a. When delivering mix from the central mixing plant to a job site storage tank, use only storage tanks with a minimum capacity to contain the entire transport load
 - b. Ensure that all storage tanks being used on the project contain the mix, have an internal full sweep mixing system, have a mixing capability of providing a homogenous mix that represents the mix design at any given location within the tank.

Sub-section F. Preparation

- 1) Weather Limitations
 - a. Temperature
 - i. Apply surface treatment material when pavement and air temperature in the shade are both 60°F and rising.
 - ii. Do not apply surface treatment material when the temperature is projected to drop below 32°F within 72 hours prior or after planned application.
 - b. Moisture and Other Conditions
 - i. Do not apply surface treatment material during rain, when road surface moisture is present, or during other adverse weather conditions.
 - ii. Do not apply surface treatment material when the temperature is projected to drop below 32°F within 72 hours prior or after planned application.
- 2) Notification – follow the notification requirements stated in these specifications
- 3) Pavement Preparation
 - a. Patch the surface with asphalt concrete if there are holes, raveled areas, or low areas.
 - b. Fill (if necessary) and seal cracks according to these specifications
 - c. Remove existing pavement markings
 - d. Clean existing pavement, removing loose materials, mud spots, sand, dust, oil, vegetation, and other objectionable material.
 - e. Do not flush water over cracks or apply pressurized water to cracked pavement.
- 4) Protection
 - a. Protect trees, plants, and other ground cover from damage
 - b. Prune trees to allow equipment passage underneath.

- c. Repair all tree damage at no additional cost to the owner.
- d. Cover valve lids and manhole covers and protect curb, gutter, and sidewalk from spatter, mar, or overcoat.
- e. Mask off end of streets and intersections to provide straight lines. Also make straight lines along lip of gutters and shoulders and keep same thickness in these areas. Vary edge lines no more than ½ inch per 100 feet.
- f. Protect surface treatment materials from traffic until it has cured per manufacturer's recommendations

Sub-section G. Application

- 1) General
 - a. Two separate application coats are required. The first application must be thoroughly set and free of any damp areas before the second application begins.
 - b. Make straight lines along lip of gutters and shoulders. Keep same thickness in these areas. No runoff on these areas will be permitted
- 2) Application Rate
 - a. First coat is 0.10 to 0.15 gallons per square yard
 - b. Total quantity after second coat is to be a minimum of 0.25 gallons per square yard.
 - c. Adjust application rate according to surface conditions only after review by Public Works Representative/Engineer.
- 3) Placement
 - a. Apply uniformly, free of noticeable light and heavy areas.
 - b. Do not reduce application rate along edges or around valve/manhole covers.
 - c. Apply mix using hand sprayers and/or squeegees in areas that cannot be reached with the distribution spray bar. Provide complete and uniform coverage without unsightly appearance from hand work.

Sub-section H. After Application

- 1) Protect surface treatment material from traffic until it has cured to task and is capable of supporting traffic without any tracking.
- 2) Do not apply permanent lane markings or paint until final application of material is dried to a tack-free condition.

Sub-section I. Acceptance

- 1) Mastic asphalt shall comply with the asphalt mastic material requirements established above.
- 2) The surface treatment shall have a homogenous mat appearance
- 3) The surface treatment shall not have runoff onto concrete curbs, gutters or shoulders, streaking, light spots, or de-bonding due to road contaminants.

Sub-section J. Warranty:

- 1) The surface treatment material must carry a warranty from the Contractor and manufacturer for a period of five (5) years when applied to pavement in appropriate conditions.
- 2) The warranty includes coverage for peeling and premature wear.

Section 11.16 PAVEMENT CRACK SEAL

This section covers filling and sealing cracks in asphalt concrete pavements. Crack filling and sealing shall comply with the requirements of ASTM D 5078: Standard Specification for Crack Filler for Asphalt Concrete and Portland Cement Concrete Pavements and ASTM D 3405: Joint Sealant, Hot-Applied, for Concrete and Asphalt Pavements. Crack filling is defined as the placement of materials into cracks to substantially reduce infiltration of water and to reinforce the adjacent pavement. The crack receives no special preparation other than cleaning. Crack sealing is the placement of specialized materials in cracks or above to prevent the intrusion of incompressible material and water into the crack. The crack receives unique crack configuration preparation. Potholes are cracks wider than 1-inch. The

Developer/Contractor shall submit manufacturer’s certification of compliance at least 5-days prior to doing the crack sealing.

Sub-section A. Quality Assurance:

The following guidelines shall be followed to assure the quality of the work:

- 1) Deliver packaged material in unopened packages with labels clearly indicating the following:
 - a. Name of manufacturer
 - b. Manufacturer’s product name or product number
 - c. Manufacturer’s batch or lot number
 - d. The application temperature range
 - e. The recommended application temperature and the safe heating temperature range
- 2) Do not use crack repair product that has been over-heated, suffered prolonged heating or which ravel or can be pulled out by hand after placement.
- 3) Do not mix different manufacturer’s brands or different types of crack repair material.
- 4) Do not depress crack repair product temperature at the wand tip below the manufacturer’s recommended application temperature when loading product into product tank.
- 5) Rework defective work.

Sub-section B. Filler and Sealer Material:

The filler shall be asphalt emulsion. The sealer shall be hot applied rubber or hot applied rubberized asphalt. Crack treatment materials shall meet the following requirements:

Material Type	ASTM	Application
Hot-applied Thermoplastic Materials		
Asphalt Rubber	D 5078	Sealing (possibly filling)
Rubberized Asphalt	D 1190, D 3405	Sealing
Cold Applied Thermoplastic Materials		
Asphalt Emulsion	D 977, D 2397	Filling

Sub-section C. Equipment:

The following equipment shall be used to apply the materials.

- 1) Sealant heating equipment shall be indirect heating using double boiler or circulating hot oil heat transfer for heating the product. Unit must have means of constant agitation.
- 2) Do not use direct heat transfer units (tar pots).
- 3) Hot compressed air lance that provides clean, oil-free compressed air at a volume of 100 cubic feet per minute at a pressure of 120-pounds per square-inch at the lance tip.

Sub-section D. Advanced Preparation:

Prior to the crack repair the Developer/Contractor shall;

- 1) With the Public Works Representative/Engineer identify the locations that are to have crack repair.
- 2) Notify neighborhood of the date and time that crack repair will take place at least 48-hours in advance of when the repairs will begin.
- 3) Allow at **least one week** for repaired cracks to cure and harden before placing thin overlays.
- 4) Repair potholes or failed spots full depth.

Sub-section E. Application:

- 1) Immediately before sealing the joints, blow cracks clean, clean 6-inches on both sides of the joint, remove foreign matter, loosened particles, and weeds.

- 2) Use a HCA (hot compressed air) heat lance when surfaces are wet or when air temperature is less than 40 degrees F. Do not burn the surrounding pavement. Fill cracks immediately after heating with the air lance or reheat.
- 3) Fill each crack to within 1/4-inch of the existing surface.
- 4) If a thin pavement (chip seal) is to be applied, remove crack overfill by squeegee.
- 5) Use an appropriate backer rod in the joint opening where the depth and width of the joint opening are greater than 2-inches and 1/2-inch respectively.
- 6) Place sand on surface of crack product if traffic or construction activities are likely to cause pull out. The sealant material picked up or pulled out shall be replaced by the Developer/Contractor at their expense.
- 7) The Developer/Contractor will remain liable for any damage to the traveling public resulting from sealant application or sealant pull-out. Developer/Contractor shall repair vehicles or other property damaged by the crack repair operation.

Sub-section F. Backer Rod:

Use closed-cell, polyethylene-foam rods conforming to the following requirements:

Backer Rod Requirements and Test Methods		
Diameter	Joint width + 1/8-inch	
Density	2 lbs/ft ³	ASTM D 1622
Tensile Strength	25 psi	ASTM D 1623
Absorption	0.5 percent by volume	ASTM D 509
Compression Deflection	25 percent at 8 psi	ASTM D 1621

Section 11.17 CHIP SEAL

On all new streets and to the centerline of existing streets that have been strip paved place a chip seal and fog seal on the asphalt surface. The chip/fog seal shall be placed 6-months (or less) prior to the end of the warranty period. Prior to placing the seal coat all areas of trench settlement shall be repaired and brought to grade. The seal coat is required to provide a paving asphalt and cover aggregate evenly spread as a uniform, skid-resistant roadway surface after all asphalt cuts and trench settlements have taken place so as to prevent water penetrating the asphalt surface through cracks along the edges of trench cuts and settlement.

All asphalt settlement or potholes shall be repaired by saw cutting a minimum of one-foot (1') beyond the area that is settled (see Standard Drawing Number 10), removing the existing asphalt, filling the settled area with road base compacted to 95% of the maximum density, and re-asphalting to thickness of the existing asphalt or 3-inches, whichever is greater. The surface of the patch, after compaction, shall be uniform and true to the existing grade on all sides. When tested with a ten-foot straight edge placed on the surface of the pavement, at any point, the surface shall not deviate more than one-eighth of an inch from the lower edge of the straight edge.

Sub-section A. Submittals:

Ten days prior to use submit a mix design that consists of the following:

- 1) Select type and grade of emulsified asphalt to be used per ASTM D 3628 and as specified herein..
- 2) Aggregate gradation test results.
- 3) Results of asphalt/aggregate compatibility test.
- 4) List of asphalt additives.

Submit a list of equipment to be used. Prior to placing emulsified asphalt submit a bill of lading showing:

- 1) Weight of emulsified asphalt supplied by vendor.
- 2) Weight of emulsified asphalt after water has been added as required for application purposes.

Upon request of the Public Works Representative/Engineer submit a written quality control inspections and testing report describing source and field quality control activities performed by Developer/Contractor and suppliers.

Sub-section B. Quality Assurance:

The following guidelines shall be followed to assure the quality of the work:

- 1) Determine paving asphalt weights by mix design.
- 2) Do not change source.
- 3) Reject coating products that do not meet the requirements of this Section.
- 4) Remove any product found defective after installation and install acceptable product at the Developer/Contractors expense.

Sub-section C. Paving Asphalt:

The paving asphalt shall be petroleum asphalt uniformly emulsified with water, homogeneous throughout, and when stored shows no separation within 30-days after delivery. Frozen emulsions are not accepted. The emulsion shall be the following: Cationic (breaks chemically) meeting the requirements of ASTM D 2397 Standard Specification for Cationic Emulsified Asphalt.

Use of any of the following additives to match aggregate particle charges, weather conditions, and mix design

- 1) Anti-strip to change or neutralize particle charges.
- 2) Enhancer to promote greater film thickness on the aggregate.
- 3) High Float Agent to improve temperature susceptibility of the asphalt and impart a gel structure to the asphalt.
- 4) Polymer to reduce stripping, improve coating, decrease temperature susceptibility and increase stability of mix.
- 5) Rejuvenator to adjust the penetration of the base asphalt or soften reclaimed asphalt.

Sub-section D. Cover Material:

Use crusher processed virgin aggregate consisting of natural stone, gravel, or slag meeting the following requirements:

Chip Seal Cover Material Properties		
Fractured faces	ASTM D 5821	> 60% by weight with at least 2 mechanically fractured faces or clean angular faces
Soundness	ASTM C 88	For combined course and fine aggregate < 12% using Na ₂ SO ₄ < 18% using MgSO ₄
LA wear (see Note 1)	ASTM C 131	< 30% wear of aggregate
Polishing (see Note 1)	ASTM D 3319	> 38
Flat or Elongated Particles (3:1 ratio)	ASTM D 4791	10% maximum for material on 3/8-inch sieve
Friable Particles	ASTM C 142	< 3% by weight aggregate passing the No. 4 sieve
Note 1: The Public Works Representative/Engineer has the right to wave this requirement if aggregates having higher values are known to be satisfactory		

Grade with the following limits to meet the specified test standard in ASTM C 136, portion retained on the No. 4 sieve clean and free of clay coatings, and clay content determined by washing per ASTM C 117:

Sieve Size	Grade B Percent Passing	Grade C Percent Passing
1/2 in.	--	100
3/8 in.	--	70 - 90
No. 4	100	0 - 5

No. 8	85 - 100	0 - 3
No. 16	10 - 25	--
No. 50	0 - 5	--
No. 200	0 - 2	0 - 2

Sub-section E. Preparation:

The following requirements shall be strictly followed. Any exceptions or deviations must first be approved by the Public Works Representative/Engineer.

- 1) Wait at least 7-days before placing seal coat on newly patched surfaces.
- 2) Lay seal coat if air and roadbed temperatures in the shade is greater than 70° F. and rising. Allow four weeks of warm weather cure time. This generally limits performance of work from May 15 to August 31.
- 3) Do not lay seal coat if pavement surface is above 120° F.
- 4) Do not lay seal coat during rain or unsuitable weather.
- 5) Locate and protect all street fixtures.
- 6) Use reflective tabs to mark roadway striping before applying asphalt.
- 7) Protect manholes, valve boxes, inlets, and other service entrances. Install invert covers.
- 8) Notify adjacent property owners of the day and time that the paving will take place. Notify them that vehicles will need to be moved from the street or they will be towed away. These notices shall be posted a minimum of 48 hours in advance of paving. Notification shall follow the requirements of Division 1, Section 1.14.
- 9) Should the work not occur on the specified day, a new notice shall be posted.
- 10) Protect trees, plants, and other ground cover from damage. Prune trees to allow equipment passage underneath. Repair tree damage at no cost to the Owner or City.
- 11) Direct traffic through work to provide worker and public safety. Following the requirements of Division 1, Section 1.12, Public Safety and Convenience. Provide flaggers as required.
- 12) All potholes, raveled areas, trench settlement, and low areas shall be repaired. Cracks shall be sealed. Crack sealing shall be allowed to thoroughly dry before cleaning and excess asphalt removed.
- 13) Remove vegetation from cracks, edges, and joints. Remove loose material, mud spots, sand, dust, oil, vegetation, and other objectionable material from pavement surface. Water flushing will not be permitted if pavement surface is cracked.
- 14) Run a distributor truck test strip. Show uniform application of bituminous material. Show triple pass of distributor bar.

Sub-section F. Application:

The following criteria shall be followed when applying the chip seal:

- 1) Mask off the end of streets and intersections to provide straight lines. Make straight lines along lip of gutter and shoulders. Keep lap lines out of wheel path.
- 2) Keep viscosity between 50 and 100 centistokes per ASTM D 2170 during application.
- 3) Apply cover aggregate within +1 to -2 pounds per square yard. Use a damp chip but not saturated (water running out of the back of the haul truck means the chips are too wet). Maintain a distance of not more than 100-feet between the distributor and the chip spreader. Spread larger particles first. Hand brook the cover material, if necessary, to distribute the aggregate uniformly over the surface.
- 4) If bleeding occurs, apply a blend of 25 to 50-percent hydrated lime with sand (blotting material). Use sand to cool chips.
- 5) Expose all street fixtures after seal coat operations.

Sub-section G. Rolling:

- 1) Use a rubber tired roller to seat aggregate. Make at least 2 complete rolling coverages.
- 2) Complete rolling before the bituminous material cools or hardens.
- 3) Keep traffic off at least 4-hours or until moisture leaves the remaining chips. Sweep surface before allowing uncontrolled traffic on chips.

Sub-section H. Fog Seal:

The fog seal shall be applied to the chips within 24-hours of placing chips. Keep viscosity between 50 and 100 centistokes per ASTM D 2170 during application.

Sub-section I. Cleanup and Repair:

Upon completion of the work the Developer/Contractor shall:

- 1) Remove spatter or mar from curb, gutter and sidewalk.
- 2) Remove any product found defective after installation and install acceptable product.
- 3) Fill any joints or cracks that are not covered by the coat. Leave no streaks, holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement.
- 4) Repair any damage caused by construction.

Sub-section J. Acceptance:

Opening to traffic does not constitute acceptance. Random samples will be taken by an independent testing laboratory, the cost of which will be paid by the Developer/Contractor. Acceptance is on a block-by-block basis. The samples must meet the following requirements:

- 1) Aggregate (sampled from the hauling equipment) will be accepted if the following conditions are met. There shall be one test per lot. A lot size is one days production with 500 ton sub-lots.
 - a) The average gradation of each sieve for the lot is within the target gradation band for that sieve.
 - b) The number of individual aggregate samples in each sub-lot outside the target gradation band does not exceed 2.
 - c) No aggregate sample is outside the target gradation band by more than 2% on any one sieve.
 - d) No tolerance will be allowed for the minus 200-portion of cover material
- 2) Paving asphalt application shall be uniform with no ridging.
- 3) Aggregate Embedment and Asphalt See-Through: After rolling and evaporation random sampling reveals large particles are embedded in the paving asphalt on their flat side to a depth of 50% to 70%. No more than 15% black (asphalt) can be seen through newly laid and compacted rock chip after sweeping.

Section 11.18 OPEN GRADED SURFACE COURSE

On all streets in excess of 8%, or at locations specified by the Public Works Representative/Engineer, place a 1-inch layer of open graded surface course on the asphalt surface. Due to gradually varying street slopes and the desire to maintain surface consistency, the Public Works Representative/Engineer may specify the locations requiring the plan mix seal coat differently than stipulated by the 8% slope requirement.

Where no open graded surface course is called for in a pavement design, reduce the specified bituminous asphalt cement pavement thickness by 1/2 inch, and replace it with the 1-inch layer of open graded surface course.

The open graded surface course shall consist of clean, hard fragments of 100 percent crushed virgin stone, gravel, or slag. Gradation of aggregate shall conform to the following:

Sieve Size	Percent Passing
1/2 inch	100
3/8 inch	90-100
No. 4	35-45
No. 8	14-20
No. 200	2-4

The Developer/Contractor shall establish a mix gradation, and the amount of bituminous material shall be subject to the approval of the Public Works Representative/Engineer and shall meet the requirements of the gradation selected.

The bituminous material shall be PG 58-28 performance graded asphalt cement conforming to ASTM D 6373.

The open graded surface course shall be spread with self-propelled mechanical spreading and conditioning equipment capable of distributing at least a 12-foot width. The mixture shall be spread and struck off in such a manner that the finished surface shall result in a uniform smooth surface. The longitudinal joints shall be offset at least 6 inches transversely from the underlying joints.

Place open graded surface course only when the air temperature in the shade and the pavement surface temperature is above 60° F and rising. Do not place open graded surface course during rain, when the pavement surface is wet, or during other adverse weather conditions, as determined by the Public Works Representative/Engineer.

After the mixture has been spread, the surface shall be rolled in longitudinal direction commencing at the outside edge or lower side and proceeding to the higher side. Each pass of the roller shall overlap the preceding pass at least one-half the width of the roller. Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. Rolling shall continue until 95% of the laboratory density as determined in accordance with ASTM Designation D1559 has been obtained. Density tests shall be done following the procedures of ASTM D2950.

The surface of the pavement, after compaction, shall be uniform and true to the established grade. When tested with a ten-foot straight edge placed on the surface of the pavement, at any point, the surface shall not deviate more than one-eighth of an inch from the lower edge of the straight edge. All high and low spots shall be remedied immediately by removing the open graded surface course over the affected areas and replacing it with fresh, hot open graded surface course and immediately compacting it to conform with surrounding area.

Add testing frequency

Section 11.19 ADJUSTING MANHOLES AND VALVE BOXES TO FINAL GRADE

This section covers the requirements for adjusting manholes and valves to final grade. The adjustment shall be made with cast-iron ring inserts, concrete grade rings or cast-in-place concrete rings or squares. Cast-in-place concrete rings or squares shall be constructed after the asphalt surface has been placed.

When concrete rings are used the concrete shall conform to the requirements of Division 8. Concrete shall be Class AA(AE). The concrete mix shall be one part cement to two parts sand or Kent Seal.

Manholes and valves in asphalt surfaces shall have the cast iron ring and cover constructed such that the cast iron ring is one sixteenth inch (1/16th") lower than the finished surface. Manhole rings shall be set to the grade and slope of the road – shim and grout ring into place.

Where manholes are to be raised this is to be accomplished by removing the cover and frame and raising the manhole to proper elevation with concrete.

Rings and covers shall be protected during backfilling and compaction of the soil and during the placing or replacing of road surfaces. Any ring or cover loosened from the manhole section shall be reset in cement mortar and any ring or cover damaged or broken shall be replaced by the Developer/Contractor at its expense.

Manhole rings and covers and valve boxes shall have concrete collars around them. Existing or new asphalt around the manhole ring and cover or valve box shall be jack hammered out, road base around the manhole ring and cover or valve box shall be recompact, and the concrete collar shall be placed.

Section 11.20 PAVEMENT MARKINGS

This section covers pavement markings on all streets open to public travel.

Pavement markings shall conform to the latest edition of the Manual on Uniform Traffic Control Devices.

Sub-section A. Materials:

Pavement marking paint, glass beads and pavement marking materials shall conform to the latest edition of the UDOT Standard Specifications.

Sub-section B. Preparation:

Remove dirt, loose aggregate and other foreign material and follow manufacturer's recommendations for surface preparation.

Sub-section C. Application:

Apply pavement marking paint and glass beads at rates contained in the latest edition of the UDOT Standard Specifications.

Apply pavement marking materials according to the manufacturer's recommendations.

Apply acrylic water based pavement marking paint only when air and surface temperatures are 50° F and rising.

Apply paint and pavement marking materials within 2 inches of the proper locations. Remove and reapply paint or markings that are installed outside this tolerance.

Sub-section D. Removing Pavement Markings:

Remove pavement marking paint using either high pressure water spray or sandblasting using equipment specifically designed for the removal of pavement marking material.

Do not use shot blasting and grinding to remove pavement markings.

Do not obscure pavement markings by covering with black paint or any other material, in lieu of removing pavement markings.

DIVISION 12**CONCRETE CURB AND GUTTER AND SIDEWALK****Section 12.01 GENERAL**

This section covers installation of curb and gutter, sidewalk, combination of curb, gutter and sidewalk, cross gutter, drive approaches, handicap ramps and curb returns. All improvements shall be constructed to the dimensions and thickness shown on the Standard Drawings.

Section 12.02 CONCRETE

Concrete shall be Class AA(AE) and shall meet all of the requirements of Division 8, Portland Cement Concrete. Under no condition shall the water cement ratio exceed 0.53.

Section 12.03 GRADE

After construction, gutters shall be checked by flowing water. The Public Works Representative/Engineer shall be present during the flow test. Any high spots or depressions (which exceed 0.02 feet) shall be repaired by removing concrete and replacing to the correct grade. Puddling shall not flow from flow line past lip of gutter. (Minimum flow line grade shall be 0.5 percent.)

Section 12.04 FORMS

All forms shall be steel, except at curves with a radius smaller than 200 feet. They shall be of a size to match the sections shown on the Drawings. Forms shall be held firmly in place with stakes or other approved means and shall be true to line and grade.

All forms shall be clean and coated with a light oil to prevent the concrete from adhering to them. Clamps, spreaders and braces shall be used where required to insure rigidity in the forms.

Forms shall not vary from vertical grade by more than 0.02 feet and from horizontal alignment by more than 0.05 feet. All forms shall have smooth even lines in both the horizontal and vertical plane.

Forms for curved sections shall be so constructed and placed that the finish surface of walls and edge of sidewalks, curbs and gutters will not deviate from the arc of the curve.

Section 12.05 SUBGRADE PREPARATION

The Developer/Contractor shall grade to the line and grade approved by the City. No concrete shall be placed without approved cut sheets. The sub-grade shall be properly shaped to conform with the cross section shown on the Standard Drawings, graded and compacted. Compaction shall meet the requirements of Division 7 Earthwork.

All excess material excavated by the Developer/Contractor shall be removed from the site. Removal of the excavated material shall be done before or immediately after the concrete is placed. The Developer/Contractor shall maintain adequate barricades and other devices to protect the public until excavated material is removed.

Placement of concrete on unsuitable materials shall not be permitted. The subgrade surface shall have a 4-inch roadbase foundation as shown on the Standard Drawings. Immediately prior to the placing of concrete, the subgrade shall be compacted using a mechanical foot compactor, with compaction being at least 95% of the maximum dry density as determined by AASHTO T-180 (Modified Proctor).

Section 12.06 CONSTRUCTION OF CURB, GUTTER AND SIDEWALK

Concrete curb, gutter and sidewalk may be constructed by first constructing the curb and gutter and then constructing the sidewalk behind it. If this method is used the joint between the back of curb and front edge of sidewalk shall be sealed. The curb and gutter may be placed using stationary forms or the slip method of forming.

Monolithic curb, gutter and sidewalk may be constructed. Stationary forms can be used to place combination curb, gutter and sidewalk. The slip form method can be used if it can be demonstrated that the tolerances specified herein can be met.

Curb and gutter to be installed with bituminous asphalt cement pavement shall have contraction joints placed every 10 feet by use of 1/8-inch steel template of the exact cross section of the curb and gutter. Remove the templates as the concrete takes initial set. Cut the joint 1-1/2 inches deep when using the slip form method to place the concrete. Use 1/2-inch thick, pre-molded, expansion joint filler at curb and gutter radii, where the curb and gutter abuts a solid object and at intervals not to exceed 50 feet, unless otherwise specified by the Public Works Representative/Engineer.

Joints in sidewalk, when placed separately and adjacent to the curb shall match the contraction and expansion joints in the curb and gutter as well as where the sidewalk abuts a solid object. Sidewalks not placed adjacent the curb shall have contraction joints at 10-foot intervals. The joints shall be approximately 3/16 inch wide and approximately one-half of the total slab thickness in depth. Expansion joints shall be 1/2-inch thick. They shall be placed every 50 feet and where new sidewalk adjoins existing sidewalks or abuts a solid object.

Material for 1/2-inch expansion joints shall be as specified in AASHTO M-153 and AASHTO M-213, and shall be installed with its top approximately 1/4-inch below the concrete surface.

After the concrete placed for a sidewalk has been brought to the established grade and screeded, it shall be float finished, edged and then given a light broom finish. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. Surface edges of all slabs shall be rounded to a radius of 1/2 inch.

After concrete has been placed in curb and gutter forms, it shall be consolidated so as to insure a thorough mixture, eliminate air pockets, and create uniform, smooth sides. As the concrete takes its initial set the forms shall be removed and all exposed surfaces shall be float finished, edged and broomed lightly. The curb and gutter shall be constructed to the dimensions shown in the Standard Drawings.

The top and face of the curb and also the top of the apron on combination curb and gutter must be finished true to line and grade and without any noticeable irregularities of surface. No portion of the surface or face of the curb and gutter shall depart more than 1/4 inch from a straight edge ten feet in length, placed on the curb parallel to the street center line nor shall any part of the exposed surface present a wavy appearance.

Section 12.07 CONCRETE CURB WALL

Concrete curb wall shall be Class AA(AE) and shall meet all of the requirements of Division 8, Portland Cement Concrete.

Reinforcing steel shall meet the requirements of Division 9, Reinforcing Steel.

Excavation for and backfill around the curb walls shall meet all the requirements of Division 7, Earthwork.

The curb walls shall be constructed to the dimensions and grades shown on the Standard Drawings or improvement drawings or as determined by the Public Works Representative/Engineer.

Section 12.08 6-INCH CONCRETE DRIVE APPROACH

The concrete to be used for the drive approach shall be Class AA(AE) and shall meet the requirements of Division 8, Portland Cement Concrete.

The drive approach shall be a minimum of 6-inch thick. They shall be constructed to the dimensions shown on the Standard Drawings. The concrete shall be finished as described above for sidewalks.

The drive approach shall have a compacted 4-inch untreated base course under them.

Section 12.09 ACCESSIBILITY STANDARDS IN PUBLIC RIGHTS-OF-WAY

This section sets guidelines for accessibility in public rights-of-way. These guidelines are to be applied during the design, construction, and alteration of improvements in public rights-of-way. These guidelines are to be followed inasmuch as they are technically feasible. Every attempt should be made to comply with the current guidelines of the Americans with Disabilities Act (ADA).

The construction of curb ramps and drive approaches shall conform to the Standard Drawings.

The following definitions apply:

- a) The pedestrian access route is an accessible corridor for pedestrian use within the public right-of-way.
- b) Pedestrian crossings are those locations in which pedestrians cross streets.
- c) A ramp is a portion of the pedestrian access route that makes a vertical transition between two flatter surfaces. It is sloped in the direction of travel. It does not include the side flares that exist on a perpendicular curb ramp.
- d) The side flare is the portion of a perpendicular curb ramp that transitions between the plane of the ramp surface and the plane of the flatter adjacent sidewalk.
- e) The term perpendicular curb ramps refers to all features associated with a ramp whose running slope is perpendicular to the curb line.
- f) The term parallel curb ramps refers to all features associated with a ramp whose running slope is in the direction of sidewalk travel.
- g) Blended transitions are locations along the pedestrian access route in which the street and the sidewalk are at the same level.
- h) Detectable warning is a surface feature built in or applied to walking surfaces or other elements to warn of hazards on a circulation path.

The pedestrian access route shall not be less than 4 feet wide, not including the curb, and shall have a cross slope of not more than 2%.

Concrete surfaces shall have a broom finish to increase slip resistance.

Sub-section A. Sidewalks:

The cross slope shall not exceed 2%.

Changes in level/elevation (vertical rises between adjacent surfaces) shall meet the following requirements:

- 1) Differences of up to ¼ inches can remain without beveling.

- 2) Differences of over $\frac{1}{4}$ inch but no more than $\frac{1}{2}$ inch must be beveled with a maximum grade of 2:1 (50%).
- 3) Differences of over $\frac{1}{2}$ inch must be removed or a ramp must be created having a maximum grade of 12:1 (8.33%).

Sub-section B. Curb Ramps:

Curb ramps shall be provided wherever a pedestrian access route crosses a curb.

The ramp grade shall not exceed 12:1 (8.33%).

The cross slope of the ramp shall not exceed 50:1 (2%), except that on perpendicular curb ramps at midblock crossings, the cross slope may match the slope of the adjacent street.

The minimum ramp width shall be 48 inches.

No lip shall exist at the bottom of curb ramps.

Sub-section C. Landings:

A landing shall exist at the top of curb ramps. The landing shall not have a slope in excess of 2% in any direction, and shall be a minimum of 48 inches by 48 inches in size. Parallel curb ramps and blended transitions shall have a landing at the bottom of the ramp (still in the sidewalk, not in the street) meeting the same criteria.

At the foot of diagonal curb ramps (ramps located in the curb return, whose running slope is directed diagonally into the intersection), a 48-inch by 48-inch landing of clear space must exist, beyond the curb line, entirely contained within the crosswalks, and outside of the vehicular travel lanes.

Sub-section D. Side Flares:

The slope of side flares on perpendicular curb ramps shall not exceed 10:1 (10%).

If it is not technically feasible to achieve a 4-foot landing (measured in the direction of the running slope of the ramp) at the top of a perpendicular curb ramp, the landing may be reduced to 3 feet, in which case the slope of the side flares shall not exceed 12:1 (8.33%).

Sub-section E. Detectable Warnings:

Detectable warning panels shall be placed at ramps and other locations in which the pedestrian access route crosses streets. They are intended to warn visually-impaired people of potential hazards by indicating the transition from sidewalk to street.

The detectable warning panels shall be cast-in-place and shall have the following characteristics:

- 1) Polymer composite material of homogeneous integral safety yellow color (UV stable)
- 2) Skid and abrasion resistant
- 3) Non-glare finish

They shall consist of truncated domes aligned in a square grid pattern having the following characteristics:

- 1) Base diameter of 0.9 inch – 1.4 inch
- 2) Top diameter of 50%-60% of base diameter
- 3) Height of 0.2 inch
- 4) Center-to-center spacing of 1.6 inch – 2.4 inch

The detectable warning shall be 2 feet deep (measured in the direction of pedestrian travel). They shall run across the full width of ramps or blended transitions. They should be set back 6" to 8" from the flowline of the gutter.

The detectable warning panel shall be installed so that it is flush (at the base of the truncated domes) with the adjacent concrete.

Sub-section F. Pedestrian Crossings:

Where crosswalks are marked, they shall be at least 8 feet wide.

The foot of a curb ramp shall be wholly contained within the crosswalk markings.

The cross slope (measured perpendicular to the direction of pedestrian travel) of marked or unmarked crosswalks is limited to 2%, except at mid-block crossings.

The counterslope of the gutter or street surface at the bottom of a ramp or blended transition (measured in the direction of pedestrian travel) shall not exceed 5%.

The maximum running slope (measured in the direction of travel) for crosswalks is 5%.

Section 12.10 LANDSCAPE RESTORATION

Areas of new construction that cover or disturb existing landscaped areas with fills and cuts or areas disturbed by construction of retaining walls shall have the landscape restored. Areas that have lawn or flower beds shall be restored including sprinkling systems that might be damaged or relocated because of construction. Lawn covered or removed shall be replaced by sod.

The topsoil shall be fertile, sandy loam topsoil, obtained from well-drained areas. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, sticks, plants or their roots, toxic substances or other extraneous matter that may be harmful to plant growth and would interfere with future maintenance. Topsoil pH range shall be 5.3 to 6.0.

DIVISION 13**STORM DRAINS****Section 13.01 GENERAL**

This section covers installation of storm drainpipe, manholes, and curb face inlet boxes. All improvements shall be constructed to the dimension and thickness shown on the Standard Drawings.

Section 13.02 PIPE INSTALLATION

Installation of pipe shall be in an open trench unless otherwise shown. Trench and backfill shall meet the requirements of Division 2, Trench Excavation and Backfill.

Section 13.03 PIPE

Pipe and pipe laying shall meet the requirements of Division 4, Concrete Pipe, Division 4A, PVC Plastic Pipe, Division 4B, Polyethylene Corrugated Pipe, Division 4C, Polyethylene Corrugated Pipe with Water Tight Joints. Pipe shall be laid with the bells up grade.

Storm drain pipes in public streets and others maintained by the City shall be concrete unless otherwise approved by the Public Works Representative/Engineer.

Section 13.04 MANHOLES

Manholes shall meet the requirements of Division 5, Manholes. Where the size of the storm drain does not permit use of manholes, precast or cast-in-place reinforced concrete boxes shall be used. Concrete used in precast or cast-in-place boxes shall be Class AA(AE).

Section 13.05 CONCRETE

Concrete shall meet the requirements of Division 8, Portland Cement Concrete.

Section 13.06 REINFORCING STEEL

Reinforcing steel shall meet the requirements of Division 9, Reinforcing Steel.

Section 13.07 STORM DRAIN INLET BOXES

The concrete to be used for the storm drain inlet boxes shall be Class AA(AE). The boxes shall be built to the dimensions and reinforced as shown on the Standard Drawings. The boxes may be precast or cast-in-place.

Excavation and backfill of the boxes shall meet the requirements of Division 7, Earthwork.

The storm drain inlet grate and frame shall be a D & L Supply I-3518 single unit with curb box with type "V" grate or equal. Grates and frames are to be dipped in cold tar epoxy following fabrication.

Section 13.08 PIPE CONNECTING INLET BOXES TO EXISTING STORM DRAINS

The pipe to be used for connecting a new inlet box to an existing storm drain shall be of the same type of pipe as the existing pipe to which it is being connected. Where possible such connections shall be made by installation of a manhole. The Public Works Representative/Engineer shall approve connection locations and methods.

Connections to concrete pipe shall be by coring a hole in the pipe and then grouting the connecting pipe to the concrete pipe. Connections to PVC or HDPE pipe shall be as per manufacture's recommendations. These recommendations will be reviewed with the Public Works Representative/Engineer prior to construction.

DIVISION 14**UTAH DEPARTMENT OF TRANSPORTATION
RIGHTS-OF-WAY****Section 14.01 GENERAL**

Work to be performed within UDOT rights-of-way shall be done in accordance with "SPECIFICATIONS FOR EXCAVATION ON DEPARTMENT OF TRANSPORTATION RIGHT-OF-WAY", latest revision. The Developer/Contractor shall be responsible to obtain all necessary permits and meet any bond requirements imposed by that agency.

Section 14.02 UTILITY LINE AGREEMENT

The improvements to be placed along or across UDOT rights-of-way are subject to the conditions of Utility Line Agreements between the UTAH DEPARTMENT OF TRANSPORTATION and LINDON CITY. The Developer/Contractor is bound by all conditions of the Agreement. The Developer shall be responsible for completing the Utility Line Agreement and furnishing the necessary Drawings and other information, including meeting with UDOT to insure requirements are met, required by UDOT. The Developer shall then submit the completed agreement to the City for signature and forwarding to UDOT. The Developer/Contractor shall not proceed with any work in a UDOT right-of-way until it has obtained a permit from UDOT, posted the required bond (if one is required) and provided any other information, such as traffic control plans, required by UDOT.

Section 14.03 INSPECTION FEES

The Developer/Contractor will pay UDOT fees for any UDOT inspectors.

DIVISION 15**CASINGS****Section 15.01 GENERAL**

This division defines the materials and construction requirements for steel casings under canals, railroad tracks, highways and Interstates. All construction operations shall be subject to the approval of the canal, Railroad Company or UDOT whose facility is being crossed. The Developer/Contractor shall make application to and secure permission from the canal, Railroad Company or UDOT before commencing work within the right-of-way. The Developer/Contractor shall provide all insurance and the services of all watchmen and flagmen required by the Railroad Company or UDOT. The Developer/Contractor will pay the Railroad Company and UDOT for their inspection services.

Section 15.02 MATERIALS

The pipe shall be welded steel pipe conforming to ASTM Designation A139, Grade A. Pipe wall thickness shall be as shown below, unless otherwise shown on the Drawings.

Casing Diameter	Minimum Wall Thickness	
12" or less	.2500"	1/4"
Over 12" – 18"	.3125"	5/16"
Over 18" – 22"	.3750"	3/8"
Over 22" – 28"	.4375"	7/16"
Over 28" – 34"	.5000"	1/2"
Over 34" – 42"	.5625"	9/16"
Over 42" – 48"	.6250"	5/8"

Section 15.03 CONSTRUCTION METHODS

The steel pipe casing shall be jacked under the railroad tracks, highway or Interstate using methods submitted to the Public Works Representative/Engineer for review by the Public Works Representative/Engineer. Circular pipe joints shall be field welded as the jacking process progresses. The pipe interior shall be completely excavated and cleaned prior to installation of the carrier pipe.

Steel pipe casing shall be installed by open cut under canals. These installations shall be as per details approved by the canal company.

All required approach trenches or working pits shall be excavated and shored as defined in Division 2, Trench Excavation and Backfill. Provisions shall be made for a drain sump in one corner of the working pit to allow for the accumulation and pumping of seepage water, if ground water is expected to be encountered.

Section 15.04 LINE AND GRADE

Casings shall be installed accurately to the line and grade shown on the Drawings. Casings shall be installed to grade with sufficient accuracy to permit installation of the carrier pipe to the design grade shown on the Drawings or to the cover depth required. The Developer's Public Works Representative/Engineer will provide base lines and bench marks at each casing location. Instrument checks of the line and grade shall be made by the Developer/Contractor at intervals sufficient to maintain the casing on line and grade.

Section 15.05 CARRIER PIPE INSTALLATION THROUGH CASINGS

The carrier pipe shall be installed to the grade shown on the Drawings. Casing spacers shall be fastened to the carrier pipe and spaced per the manufacturer's recommendations. Do not fill the casing with sand.

Section 15.06 CASING SPACERS

Factory manufactured casing spacers shall be installed according to manufacturer's recommendations on all carrier pipes passing through a casing pipe. Wooden skids will not be allowed as an alternative.

Casing spacer shall be a two-piece shell made from T-304 stainless steel of a minimum 14 gauge thickness. Each shell section shall be lined with a 0.090" thick material that prevents slippage. Bearing surfaces (runners) shall be ultra-high molecular weight polyethylene (UHMW) or similar material to provide abrasion resistance and a low coefficient of friction (0.12). The runners shall be attached to support structures (risers) at appropriate positions to properly support the carrier within the casing and to ease installation. Risers shall be made of 10 gauge T-304 stainless steel. Bottom risers 6" and over in height shall be reinforced.

Standard positioning within the casing pipe shall be sized such that the height of the risers and runners are to provide not less than three-fourths inch between the casing pipe and the outside diameter of the bell of the carrier pipe.

Centered & Restrained positioning within the casing pipe shall be sized such that the height of the risers and runners are to center the carrier pipe in the casing pipe with a top clearance of one-half inch minimum.

Restrained positioning within the casing pipe shall be sized such that the height of the risers and runners are to provide not less than three-fourths inch between the casing pipe and the outside diameter of the bell and a top clearance of one-half inch minimum.

When casings cross railroad or UDOT facilities, meet the clearance requirements cited above or the following, whichever is larger:

- a) Railroad facilities: The inside diameter of the casing shall be no less than 2 inches greater than largest outside diameter of carrier pipe, joints or couplings.
- b) UDOT facilities: Provide a minimum clearance of 2 inches between the outside of the barrel of the carrier pipe and the inside of the casing.

All welds and metal surfaces shall be chemically passivated and all hardware is to be stainless steel.

Section 15.07 CASING END SEALS

Casing end seals shall be used to prevent debris, soils and seepage from entering the casing. Both ends of all casings shall be sealed between the casing and carrier pipe.

Casing end seals shall be made of neoprene rubber or nitrile and secured with T-304 stainless steel bands.

Casing end seals shall be of the pull-over or wrap-around type. Where practical, use the pull-over type. Where existing utilities make this impractical, the wrap-around type may be used, provided the edge of the wrap is sealed with butyl mastic or other approved sealer to prevent seepage.

DIVISION 16
FLOWABLE FILL

Section 16.01 GENERAL

This division defines the materials and procedures for placing flowable fill.

Flowable fill is used as backfill in certain trench applications such as backfilling around the pipe work of a drop manhole, or backfilling trenches in State Highways.

Section 16.02 MIX DESIGN

The following requirements shall be met:

- a) The 28 day compressive strength shall be between 50 and 150 psi.
- b) Use at least 50 pounds of Portland Cement Type I or II per cubic yard of flowable fill.
- c) Use at least 300 pounds of Fly Ash per cubic yard of flowable fill. Supply Fly Ash as specified except that the loss on ignition must be 3 percent or less.
- d) The slump shall be between 6 inches and 10 inches.
- e) Use natural sand meeting the following gradation:

Passing ¾-inch sieve:	100%
Passing No. 100 sieve:	0%-10%

Section 16.03 CONSTRUCTION METHODS

Discharge flowable fill from the ready mix truck by any reasonable means into the trench to be filled. Place the fill up to the bottom of the surface course and finish to provide a uniform surface.

Section 16.04 CONSTRUCTION IN UDOT RIGHTS OF WAY

When used in State Highways, materials and procedures shall be in conformance with the requirements of Section 03575 Flowable Fill of the current Utah Department of Transportation Standard Specifications for Road and Bridge Construction (available on the Internet at the UDOT web site). In locations where its use would be impractical, UDOT may not require flowable fill.

DIVISION 17**CONDUIT****Section 17.01 GENERAL:**

This Division covers furnishing and installing utility and telecommunications conduit.

Section 17.02 UTILITY CONDUIT:

Developers shall be responsible to install utility conduits for placement of public utilities.

Sub-section A. Materials:

The conduit shall be of the material specified by each utility company.

Sub-section B. Location:

Conduits shall be installed at locations established by utility company engineers and approved by the City. Excavation shall be at depth and standards of utility companies. Conduits shall have bends attached to each end and placed vertically out of the ground for location verification. Conduits within street rights-of-way shall have a minimum of 18" cover below finished street grade.

Sub-section C. Magnetic Locator Tape:

All utility conduits shall include a 3" magnetic locator tape installed in the pipeline trench approximately 12" below the ground surface, with appropriate cautionary wording printing on the tape to identify the type of utility present.

Section 17.03 TELECOMMUNICATIONS CONDUIT:**Sub-section A. Telecommunications Conduit in New Developments:**

- a) **Materials:** Install two orange 1¼" diameter SDR-11 HDPE conduits meeting ASTM 3035. or in different quantities and sizes as shown in telecommunication plans.
- b) **Location:** In new developments telecommunications conduit shall be installed to serve all lots, and shall be laid in the same location as the telephone lines. The conduit shall be laid at a minimum depth of cover of 24". In the immediate vicinity of service boxes the conduit shall be laid at a shallower depth of cover of 15", so that they are directly below the bottom of the service box, so that the conduit is visible when the cover of the box is removed. The conduit is not to be cut at service boxes, but it to be laid continuously under the boxes.
- c) **Boxes:** Service boxes shall be placed at every other property line, or as otherwise shown in telecommunication plans, so that service can be provided to two lots from each box. The top of the boxes shall be placed flush with the finished ground surface. They shall be green 15" deep, 14" x 20" HDPE Newbasis Splice/Valve Box S1420 with cover assembly, including stainless steel lock bolt (part no. SGA142015Y000). The label "TELECOM" shall be imprinted on the cover.

Sub-section B. Telecommunications Conduit for Future Use (Other Than in New Developments):

- d) **Materials:** Install one orange 4" schedule 40 PVC conduit rated at 194° F meeting NEMA TC-2, NEMA TC-3, UL listed.
- e) **Location:** Conduits shall be installed across streets from right-of-way line to right-of-way line. Crossing shall be at intersections (generally at about the end of the curb return) and at approximately 400' intervals. Locations shall be shown on the improvement plans and approved

by the City. In order to mark the location of conduits, a "C" shall be stamped in the top of curb (before it is cured) at locations where the conduit crosses the curb and gutter. Conduit shall be laid 36" below the finished road grade, measured to the top of the conduit.

Sub-section C. Joints & Fittings:

The contractor shall provide all materials used in the installation of conduits, such as bends, adapters, couplings, glue, plugs and fittings, to meet or exceed all of the recommendations of the conduit manufacturer for suitable installation.

Sub-section D. Caution Tape:

Telecommunications conduit shall include a 3" caution tape installed in the pipeline trench approximately 12" below the ground surface, with the words "CAUTION: BURIED FIBER OPTIC CABLE" printed on it.

Sub-section E. Tracer Wire:

A twelve (12) gauge solid THHN tracer wire shall be installed according to NESC standards inside one conduit of every bundle of conduit that is laid together. If there is only a single conduit, place the tracer wire in it. At least four feet of slack tracer wire shall be present at every location where the conduit is accessible from the surface.

Section 17.04 INSTALLATION:

Sub-section A. Cutting:

Cutting of conduit for closure pieces or for other reasons shall be done in a neat and workmanlike manner by a method recommended by the manufacturer.

Sub-section B. Dewatering of Trench:

Where water is encountered in the trench, it shall be removed during conduit laying operations and the trench so maintained until the ends of the conduits are sealed. See "Control of Groundwater" in Division 2 Trench Excavation and Backfill.

Sub-section C. Laying of Conduit:

The conduit shall be inspected for defects before installation. Any defects shall be repaired or the conduit shall be replaced, whichever is deemed necessary by the Engineer.

All conduits shall be laid and maintained to the required lines and grades. The Contractor shall be responsible to install the conduit line to the alignment set by the Engineer or as shown on the Drawings.

The Contractor shall take the necessary precautions such that foreign materials do not enter into the conduit. No debris, tools, or other materials shall be placed in the conduit during laying operations. When laying of conduit is not in progress, the conduit shall be closed by a watertight plug.

Maximum vertical or horizontal deflections of conduit are not to exceed a ratio of 10:1 along its length (e.g. no more than 4" deflection per 40" length.)

Install all conduit bends to have a radius that is:

1. Not less than 10 times the inside diameter of the conduit.
2. Not less than the minimum bend radius called out on the plans.

At no time shall the conduit be deformed to make a bend.

The minimum separation between conduits shall be 1.5”.

The minimum separation between the conduit and trench wall shall be 1.5”.

Sub-section D. Bedding:

All conduits shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedding.

In the event trench materials are not, in the judgment of the Engineer, satisfactory for conduit bedding, imported granular bedding will be required. See Division 2 of these specifications.

DIVISION 18

STREET LIGHTING

Section 18.01 GENERAL

This division describes the design and installation of street lights. Holophane information for street lights found through the following:

Holophane
Richard Weight, Sales Rep
Tel: (801) 501-8320
Fax: (801) 501-8365
rweight@holophane.com
www.holophane.com

Section 18.02 WASHINGTON POSTLITE LED STREET LIGHTS

Sub-section A. Placement

Washington Postlite LED street lights are installed along all streets in the General Commercial, Planned Commercial, and Research and Business zones. However, at intersections on collector streets in these zones, Esplanade LED street lights are installed rather than Washington Postlite LED street lights.

They are generally placed at 100-foot intervals along the street frontage.

Along 700 North Street they are placed 2 feet in front of the sidewalk (see [Standard Drawing #2c](#)). Along State Street they are placed 2 feet behind the sidewalk. On other streets they are generally placed in the 2 feet of street right-of-way behind the sidewalk.

Installation of Washington Postlite LED street lights occurs when land is subdivided. Installation also occurs when sites are improved (in the absence of a subdivision) which contain frontage where lights would be placed if the land were being subdivided.

Sub-section B. Responsibility for Payment and Installation

The developers of land will install Washington Postlite LED street lights and are responsible for all costs associated with installation of the street lights. This includes all materials and installation costs, including all conduit and boxes from the power source to the street light, as well as any costs associated with providing power to the lights.

Sub-section C. Luminaire

The luminaire shall be Holophane Utility Washington Postlite LED, which is a glass acorn style, with finial, decorative ribs, band and medallions all painted black (see [Standard Drawing #23a](#)).

Sub-section D. Post

The post shall be Holophane Salem series, black, all aluminum, one-piece construction, with a fluted shaft and base. A banner arm, bolt-on eyebolt, and weatherproof receptacle shall be mounted on the post (see [Standard Drawing #23a](#)). The shaft shall be extruded aluminum, ASTM 6061 alloy, heat treated to a T6 temper. The base shall be heavy wall, copper free, cast aluminum produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95. The shaft shall be double welded to the base.

Sub-section E. Lamp

The lamp shall be 100 watt, 525mA Driver, 4K CCT.

Sub-section F. Foundation

The foundation may be either a cast-in-place concrete foundation or a screw-type (see [Standard Drawing #23d](#)).

The Washington Postlite LED street light shall be Holophane catalog number WAUE1004KASB5B6HL25PCS – SMA16F5J13P07LABBK S168A E120A – BAB24B4 EBB BK. Parts equivalent to the specified Holophane parts may be approved by the Public Works Representative/City Engineer. Acrylic luminaires equivalent to the specified glass luminaires with a 10 year warrantee against yellowing may be approved by the Public Works Representative/City Engineer.

Section 18.03 GRANVILLE LED STREET LIGHTS**Sub-section A. Placement**

Granville LED street lights are installed along local streets in residential zones. However, at intersections of collector streets in residential zones, Esplanade LED street lights are installed rather than Granville LED street lights.

They are placed at intersections, at the end of cul-de-sacs, and mid-block (where the block length exceeds 650 feet).

They are generally placed in the 2 feet of street right-of-way behind the sidewalk.

Installation of Granville LED street lights occurs when land is subdivided. Installation also occurs when sites are improved (in the absence of a subdivision) which contain frontage where lights would be placed if the land were being subdivided.

Sub-section B. Responsibility for Payment and Installation

The developers of land will install Granville LED street lights and are responsible for all costs associated with installation of the street lights. This includes all materials and installation costs, including all conduit and boxes from the power source to the street light, as well as any costs associated with providing power to the lights.

Sub-section C. Luminaire

The luminaire shall be Holophane Granville II LED, which is a glass acorn style, with finial, decorative ribs and bands all painted black (see [Standard Drawing #23c](#)).

Sub-section D. Post

The post shall be Holophane North Yorkshire series, black, all aluminum, one-piece construction, with a tapered and fluted shaft and base (see [Standard Drawing #23c](#)). The shaft shall be extruded aluminum, ASTM 6061 alloy, heat treated to a T6 temper. The base shall be heavy wall, copper free, cast aluminum produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95. The shaft shall be double welded to the base.

Sub-section E. Lamp

The lamp shall be 40 watt, 215mA Driver, 4K CCT.

Sub-section F. Foundation

The foundation may be either a cast-in-place concrete foundation or a screw-type (see [Standard Drawing #23d](#)).

The Granville LED street light shall be Holophane catalog GVD404KASMB8RSBHPCSL25 – NYA14F5J17P07LABBK. Parts equivalent to the specified Holophane parts may be approved by the Public Works Representative/City Engineer. Acrylic luminaires equivalent to the specified glass luminaires with a 10 year warrantee against yellowing may be approved by the Public Works Representative/City Engineer.

Section 18.04 ESPLANADE LED STREET LIGHTS

Sub-section A. Placement

Esplanade LED street lights are installed on all collector/arterial streets in all zones and on all streets in the mixed commercial zone and industrial zones.

They are placed at intersections, at the end of cul-de-sac's, and mid-block (where the block length exceeds 650 feet).

They are generally placed in the 2 feet of street right-of-way behind the sidewalk.

Installation of Esplanade LED street lights occurs when land is subdivided. Installation also occurs when sites are improved (in the absence of a subdivision) which contain frontage where lights would be placed if the land were being subdivided.

Sub-section B. Responsibility for Payment and Installation

The developers of land will install Esplanade LED street lights and are responsible for all costs associated with installation of the street lights. This includes all materials and installation costs, including all conduit and boxes from the power source to the street light, as well as any costs associated with providing power to the lights.

Sub-section C. Luminaire

The luminaire shall be Holophane Esplanade LED, which is a teardrop style luminaire, with an asymmetric glass refractor and a shallow skirt (see [Standard Drawing #23b](#)).

Sub-section D. Post

The post shall be Holophane Salem series, black, all aluminum, one-piece construction, with a fluted shaft and base (see [Standard Drawing #23b](#)). The shaft shall be extruded aluminum, ASTM 6061 alloy, heat treated to a T6 temper. The base shall be heavy wall, copper free, cast aluminum produced from certified ASTM 356.1 ingot per ASTM B-179-95a or ASTM B26-95. The shaft shall be double welded to the base.

Sub-section E. Lamp

The lamp shall be 110 watt, 4K CCT.

Sub-section F. Foundation

The foundation may be either a cast-in-place concrete foundation or a screw-type (see [Standard Drawing #23d](#)).

The Esplanade LED street light shall be Holophane catalog number ESL1104KASSB4SSPCSR – BHDF13200BK – VGC72/1CABKH – SMA16F5J13PT1LABBK. Parts equivalent to the specified Holophane parts may be approved by the Public Works Representative/City Engineer. Acrylic luminaires equivalent to the specified glass luminaires with a 10 year warrantee against yellowing may be approved by the Public Works Representative/City Engineer.

Section 18.05 STREET LIGHT FOUNDATIONS

Street light foundations shall conform to Lindon [Standard Drawing #23d](#).

The cast-in-place concrete foundations shall be installed in accordance with Division 7, Earthwork, Division 8, Portland Cement Concrete, and Division 9, Reinforcing Steel.

The screw-type foundation shall be A.B. Chance Company Catalog Number T112-0671 (or approved equal). They are not to be used in rocky soil. The following apply:

- a) All material is to be new, unused and mill traceable.
- b) The baseplate shall be ASTM-36-(latest revision) structural steel (conform to AASHTO Technical Bulletin #270).
- c) The shaft shall be ASTM A252-(latest revision) Grade 2, steel pipe piles, or ASTM A53 (latest revision) Type E or S, Grade B, steel pipe, or ASTM A500-(latest revision) Grade B, structural steel tubing.
- d) The helix shall be ASTM A635-(latest revision) 3/8" thick hot rolled steel plate or coil.
- e) The Pilot Point shall be ASTM A575-(latest revision) 1-1/4" diameter hot rolled steel bar.
- f) The bolts shall be carriage bolts, 3/4 - 10UNC-2A per ANSI B-18.5, SAE J429 Grade-5.
- g) The baseplate shall be perpendicular to the shaft axis ($\pm 1^\circ$) and hold centerline shall be concentric ($\pm .188"$) to the shaft axis.
- h) Pilot point and shaft axes shall be concentric ($\pm .125$ FIM) and in line ($\pm 2^\circ$).
- i) There shall be bolt clearance slots in the shaft under the base plate.
- j) The baseplate shall be permanently marked to indicate the cableway opening in the shaft.
- k) Flame cut two slots in shaft perpendicular to the baseplate in order to create the cableway opening.
- l) Preheat, tumbleblast, handgrind, and clean the baseplate, helix, and pilot point on all welded areas.
- m) The baseplate shall be permanently stamped with manufacturer's identification.
- n) Hot dip galvanize to finish per ASTM-A153-(latest revision).

Section 18.06 JUNCTION BOX

Junction boxes shall be supplied and installed as shown on Lindon City [Standard Drawing #23d](#).

The junction box shall be an HDPE Carson junction box with body model 1419-12 (green) and cover model 1419-3B (flush bolt down) with pentagon head bolt. The junction box shall have a cover logo reading, "Street Lighting" or "Electrical".

A junction box shall be placed between 4' and 10' from the power source and at the base of each street light.

Section 18.07 CONDUIT

Conduit shall be supplied and installed as shown on Lindon City [Standard Drawing #23d](#).

For street lights that have a power receptacle the conduit shall consist of (2) 1-1/4" PVC electrical conduits. Only one PCV conduit is required for street lights that do not have a power receptacle.

When used with concrete foundations, the PVC conduit must exit the top of the foundation within 3" of the center of the bolt circle.

Section 18.08 WIRING

Wiring shall be supplied and installed as shown on Lindon City [Standard Drawing #23d](#).

The wiring shall be #10 copper wire.

In-line watertight fuse holders (Littelfuse WPB1 or approved equal) with a 10 amp fuse on each circuit shall be installed in each junction box.

When a concrete base is used an 8' long 3/4" CU clad ground rod must be used. It shall exit the top of the foundation within 3" of the center of the bolt circle.

(Division 18 was last updated June 2015)

DIVISION 19**UNDERGROUND IRRIGATION SYSTEMS****Section 19.01 GENERAL****Sub-section A. Summary**

- 1) Section includes:
 - a) Underground irrigation systems complete with heads, valves, controls, and accessories.
- 2) Related sections:
 - b) Section 32 94 23 Planting

Sub-section B. Reference Standards

- 1) NFPA 70: National Electric Code.
- 2) ASTM: American Society for Testing and Materials
- 3) IA: The Irrigation Association: Main BMP Document, Landscape Irrigation Scheduling and Water Management Document.
- 4) ASIC: American Society of Irrigation Consultants: ASIC Grounding Guideline
- 5) City Codes/Ordinances relating to Landscape and Irrigation

Sub-section C. Definitions

- 1) Water Supply: Culinary and/or secondary pumping, piping, and components provided and installed by others to provide irrigation water to this project. Includes but is not limited to: storage ponds, pump stations, saddles, nipples, spools, shut-off valves, corporation stop valves, water meters, pressure regulation valves, and piping or components upstream of (or prior to) the Point-of-Connection.
- 2) Point-of-Connection: Location where the Contractor shall tie into the water supply for landscape irrigation needs and use. Tie to existing piping.
- 3) Main Line Piping: Pressurized piping downstream of the point-of-connection to provide water to remote control valves and quick coupling valves. Normally piping is under constant pressure.
- 4) Lateral Line Piping: Circuit piping downstream of the remote control valves to provide water to sprinkler heads, drip system, or bubblers. Normally piping is under pressure only when control valve is in operation.

Sub-section D. Performance Requirements

- 1) The work to be performed under this Section shall consist of furnishing all labor and materials necessary to construct a complete working and tested underground sprinkler irrigation system per all drawings and specifications, providing one hundred (100) percent head-to-head coverage on all lawn and planting areas on the site without overspray onto hardscape, buildings, or other site features. Included also will be system maintenance and warranties.
- 2) The efficiency of the completed irrigation system shall meet the following minimum standards:
 - a) Circuits using spray sprinklers shall perform at a minimum 60% efficiency.
 - b) Circuits using rotor sprinklers shall perform at a minimum 70% efficiency.
 - c) Efficiency shall be determined by an independent water audit performed by a certified irrigation auditor selected by the Owner. The Contractor shall include in his bid price the cost of this audit. The audit shall be conducted after substantial completion and before final acceptance of the irrigation system.
- 3) The Contractor shall perform, but not be limited to, all of the following functions: paying all connection fees, deposits, and all other charges related to the connection to the water source; obtain all permits; complete all excavation and backfill; provide backflow device, tapping saddle, yoke, stop and waste, corp. cock, concrete vaults and miscellaneous pipe fittings; make necessary road repairs; provide safety barrier; make connection to water source; install all electric valves, valve control devices, meter base, conduit, junction boxes, and all necessary wiring. All work shall be in compliance to applicable codes and requirements of the utility companies involved.
- 4) If any or all of the above mentioned fees or charges are not listed on the bidding schedule or on plan, they shall be included in the bid lump sum price of the irrigation sprinkling system item.

- 5) Contractor shall verify with the appropriate water district the location of the water service main line and water pressure, and complete all requirements necessary to bring water service to the site. Total cost to be included in the irrigation sprinkling system bid item.
- 6) The above specification statement supersedes the graphic representation location of the contract limit line. This pertains to the water line location on either side of the street adjacent to the project site.
- 7) All work shall be done in accordance with the drawings and specifications, as well as all applicable water and electrical codes.
- 8) The Contractor shall operate, maintain until acceptance, and guarantee the new system as specified herein until all lawn and plants installed on this project have become established and have been accepted by the Owner.

Sub-section E. Submittals

- 1) Product Data: Complete set of manufacturer's technical data and installation instructions for all equipment to be installed on the project. Submittal shall be made prior to commencement of any irrigation work.
- 2) Main line and lateral line pressure test results: Submitted at the time of occurrence.
- 3) Operation and Maintenance (O&M) Manual:
 - a) O&M manual shall contain the following information:
 - i) Manufacturer cut sheets and current printed specifications for each element or component of the irrigation system.
 - ii) Parts list for each operating element of the system.
 - iii) Manufacturer's printed literature on operation and maintenance of operating elements of the system.
 - iv) Section listing instructions for overall system operation and maintenance. Include directions for spring start-up and winterization.
 - b) Manual shall be submitted at least thirty (30) days prior to final inspection and acceptance of the project.
- 4) Complete As-Built Drawings:
 - a) Drawings shall conform to the following criteria:
 - i) One (1) 22" x 34" and one (1) 11" x 17" drawing shall be submitted.
 - ii) All submitted drawings shall be made on mylar or Tyvek.
 - iii) Show detail and dimension changes made during installation.
 - iv) Include field dimension locations of sleeving, points of connection, main line piping, wiring runs not contained in main line pipe trenches, valves and valve boxes, quick coupling valves.
 - v) Dimensions shall be taken from permanent constructed surfaces, features, or finished edges located at or above finished grade.
 - b) A complete set of as-built drawings shall also be submitted in electronic digital format (.pdf).
 - c) As-Built drawings shall be submitted prior to final inspection and acceptance.
- 5) Controller Map: Each controller shall be equipped with a color-coded copy of the area that the controller services. Include valve zone number, type of plant material irrigated, and zone location on the project. Laminate map with heat shrink clear plastic and mount inside controller.

Sub-section F. Quality Assurance

- 1) Acceptance: Do not install work of this section prior to acceptance of the area by the Owner as being properly prepared to receive said work (i.e. at proper grade, properly compacted, permanent fixtures in place, etc.).
- 2) Adequate Water Supply: Contractor shall verify that proper connection is available to supply lines, and is of adequate size and volume. Perform static water pressure test prior to commencement of work. Notify Owner of problems encountered prior to proceeding.
- 3) Workmanship: It is the intent of this specification that all materials herein specified and shown on the construction documents shall be of the highest quality available and meet the requirements specified. All work shall be performed in accordance with the best standards of practice relating to the trade.

- 4) The Contractor shall provide to the City a document or resume which includes the following information:
 - a) The Contractor has been installing sprinkler systems on commercial projects for at least five (5) previous consecutive years.
 - b) The Contractor is currently licensed to perform landscape construction in the State of Utah.
 - c) The Contractor is bondable and insurable for the work to be performed.
 - d) References of at least five (5) projects of similar size and scope completed within the last five (5) years. Three (3) of the projects listed must be located in the Wasatch Front area.
 - e) List of suppliers from whom materials will be obtained for use on this project.

Sub-section G. Project Conditions

- 1) Any discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of the Owner or Owner's Authorized Representative prior to continuance of the project.
- 2) The Contractor shall use only the equipment and products specified in the construction drawings. No substitution of materials will be allowed on the irrigation system without prior authorization from the Owner or Owner's Authorized Representative and the Owner.
- 3) During delivery, installation, and storage of materials for the project, all materials shall be protected from contamination, damage, vandalism, and prolonged exposure to sunlight. All material stored at the project site shall be neatly organized in a compact arrangement and storage shall not disrupt the project Owner or other trades on the project site. All material to be installed shall be handled by the Contractor with care to avoid breakage or damage. Materials damaged by the Contractor shall not be used, but shall be replaced with new materials at the Contractor's expense.
- 4) The Contractor shall familiarize himself and his workmen with all hazards and existing utilities prior to commencing work.

Section 19.02 PRODUCTS

Sub-section A. General

- 1) The Contractor shall provide all materials to be used on this project. The Contractor shall not remove any material purchased for this project from the project site, nor mix these project materials with other contractor-owned materials. The Owner retains the right to purchase and provide project materials.
- 2) Handling and unloading of all equipment, pipe, and fittings shall be in such a manner as to insure delivery at the job site in a sound, undamaged condition. Any equipment or pipe found to be damaged or defective in workmanship or materials shall be rejected or removed and replaced if found installed.

Sub-section B. Pipe

- 1) All PVC pipe used on this project for the irrigation system shall conform to the requirements of ASTM -1685. It shall be free from cracks, holes, foreign material, blisters, inside bubbles, wrinkles, and dents.
- 2) All main line pipe, four (4) inches inside diameter and smaller shall be Schedule 40 PVC solvent weld bell end unless otherwise specified.
- 3) All main line pipe, six (6) inches inside diameter and larger, shall be PVC Class 200 gasketed bell end (except as required for conversion to metal fittings).
- 4) All lateral line pipe shall be Schedule 40 PVC solvent weld.
- 5) Maximum flows allowed through main line and lateral line pipe shall be determined by water speed in the pipe. The maximum water speed allowed in both main lines and lateral lines is five (5) feet per second. The resulting maximum gallons per minute (gpm) allowed to flow through PVC pipes are as follows:

<u>PIPE SIZE</u>	<u>GPM</u>
3/4"	8
1"	12
1 1/4"	22
1 1/2"	30
2"	50
2 1/2"	75
3"	110
4"	190
6"	425

For sizes larger than 6", consult manufacturer's recommendations.

- 6) No bends in pipe shall be permitted. The Contractor shall use elbow fittings of ninety (90), forty five (45), twenty two and one half (22-1/2), and eleven and one quarter (11-1/4) degrees as individual situations demand.
- 7) All pipe used from the main line to the control valves shall be solvent weld Sch. 80 PVC pipe unless otherwise noted or shown on the construction drawings.

Sub-section C. Fittings

- 1) All PVC fittings used on this project for the irrigation system shall conform to the requirements of ASTM D-2466.
- 2) Main Line Fittings:
 - a) All main line fittings four (4) inches inside diameter and larger shall be either M.J. or deep bell push-on, gasketed, ductile iron.
 - b) All main line fittings three (3) inches and smaller inside diameter shall be solvent weld Schedule 80 PVC.
 - c) All main line fittings three (3) inches and larger, whether ductile iron or solvent weld, shall be thrust blocked per details.
 - d) All main lines three (3) inches and larger having a horizontal change of direction shall have proper concrete thrust blocks installed. Vertical changes in direction shall require the use of M.J or ductile iron fittings with thrust restraining devices (Mega Lug or Harco Knuckle Joint Restraints) in addition to appropriate concrete thrust blocking. The size and type of thrust block depends on pressure, pipe size, type of soil, and type of fitting. As a general rule, one (1) cubic foot minimum of class AA (AE) Type II concrete is required for each thrust block. Follow thrust blocking details for calculating thrust block size.
 - e) M.J. tees, Schedule 80 tees with SxT Schedule 80 bushings, or Harco ductile iron service tees are approved on PVC main lines for automatic control valve installation. M.J. fittings shall be greased and wrapped.
- 3) Lateral Line Fittings:
 - a) All lateral line fittings shall be solvent weld Schedule 40 PVC.
 - b) All risers and exposed fittings shall be solvent weld Schedule 80 PVC, including conversions to metal pipe and fixtures, unless otherwise noted on the plans.
- 4) PVC Cement: Solvent weld or glued joints shall use the following materials:
 - a) Primer: IPS Weld-On P-70 Primer (purple), ASTM D-2564.
 - b) Cement: IPS Weld-On 711 Heavy Bodied PVC Cement (gray), ASTM F-656.

Sub-section D. Valves

- 1) Master Valve: All master valves shall be as specified in the Irrigation Equipment Schedule. Master valve assembly shall be installed according to detail in drawings.
- 2) Isolation Gate Valve:
 - a) Isolation gate valves shall only be used on the main line.
 - b) Isolation gate valves shall conform to AWWA specification C 509. They shall be of Class 200 cast iron body, resilient-seat, and have a non-rising stem with rubber "O" rings. Stems shall be of cold rolled, solid bronze, high tensile strength. Valves shall be hydrostatically pressure tested for 400 P.S.I. and shall be designated for a working pressure of 200 P.S.I. Each valve shall contain a resilient wedge urethane rubber seat. Unless otherwise shown or specified, valves three (3) inches and larger shall have flanged end connections.

- c) Buried valves shall have two (2) inch square operating nuts. No handles or wheels will be permitted. Valves inside structures (vaults or valve boxes) shall have wheel handles.
 - d) Action unions shall be installed on each side of all valves except flanged valves.
 - e) The Contractor shall provide adequate material for the connection of valves to the system, i.e., adapters, flanges, nuts, bolts, gaskets, etc.
 - f) All buried main line isolation valves shall be fitted with a four (4) inch minimum diameter pipe sleeve place over the top of the valve vertically and extended to grade. Cover with a ten (10) inch round "Carson" valve box with bolt down lid and set at finished grade.
- 3) Remote Control Valve Assembly:
- a) Remote control valves shall be as specified in the Irrigation Equipment Schedule.
 - b) Remote control valves shall be globe configuration, electrically activated, normally closed, forward flow design.
 - c) All pipe on the control valve assembly shall be Schedule 80 PVC pipe. See detailed drawings.
 - d) Action unions shall be installed on each side of the control valve assembly, allowing valve to be removed from the box for maintenance without cutting pipe.
 - e) Each control valve shall have a brass gate or ball valve installed immediately upstream of the valve and located within the same valve box.
 - f) Flows through each remote control valve shall not exceed the following limits:
- | <u>VALVE SIZE</u> | <u>GPM RANGE</u> |
|-------------------|------------------|
| 1" | 1 - 30 |
| 1 1/2" | 31 - 75 |
| 2" | 76 - 150 |
- g) Each drip remote control valve assembly shall contain the following components:
 - i. PVC ball valve.
 - ii. Inline disc or screen filter with 100 micron/150 mesh filter element.
 - iii. Remote control valve capable of operating at very low flow levels.
 - iv. Inline pressure regulator.

All components shall be installed according to manufacturer's recommendations, and located within a single valve box, one valve per box (no multi-valve assemblies permitted).
- 4) Quick Coupling Valve Assembly:
- a) Quick coupling valves shall be as specified in the Irrigation Equipment Schedule.
 - b) Quick coupling valves shall be heavy duty brass, two-piece, single lug locking cap.
 - c) The Contractor shall provide to the Owner at least 1 cap lock key and 1 quick coupling key with a swivel hose bib attached. These keys shall be delivered prior to final acceptance of the project.
- 5) Manual Drain Valve Assembly:
- a) All manual drains shall be three quarter (3/4) inch heavy duty brass ball valve.
 - b) Manual drain valves shall be required at all low points in the main lines. See plans, notes, and details.
 - c) The location of each manual drain shall be shown on the "as built" drawing with dimensions from the nearest permanent fixture, such as a building corner, etc.
 - d) Each manual drain valve will be accessed by a vertical two (2) inch PVC Schedule 40 pipe sleeve, capped by a locking valve cap with a key, enclosed within a ten (10) inch round valve box with bolt down lid. The top of the drain sleeve shall be three to six (3 - 6) inches below the lid of the valve box.
 - e) Each manual drain shall empty into a gravel sump, a minimum of eighteen (18) inches by eighteen (18) inches by twelve (12) inches deep. The gravel shall be washed three quarter (3/4) inch rock.
 - f) Automatic Drain Valves: Automatic drain valves shall not be used.

Sub-section E. Valve Boxes

- 1) All valve boxes shall be Carson series with locking lid, or approved equal.
- 2) Valve box size shall be listed in the installation details for each irrigation system component.

Sub-section F. Backflow Prevention Assembly

- 1) Backflow prevention devices shall be a reduced pressure principle backflow preventer consisting of a pressure differential relief valve located between two independently operated spring-loaded "Y" type center guided check valves. Assembly shall also have two full port resilient seated ball valves for shut-off and four resilient seated ball valve test cocks and bronze body construction. Larger sizes (2 1/2" and up) may have two non-rising stem resilient wedge gate valves in lieu of ball valves.
- 2) Backflow preventer shall be as specified in the Irrigation Equipment Schedule.

Sub-section G. Filter and Enclosure

- 1) Filters and their enclosures shall be required on all systems using secondary water. Systems using reclaimed water (from a wastewater treatment plant) may not require a filter.
- 2) Filters shall be as specified in the Irrigation Equipment Schedule. Filters may be either plastic or steel construction, with screen (perforated or weavewire stainless steel) or plastic disc filter elements.
- 3) Filter enclosures shall be either commercially or custom fabricated. They shall be constructed of solid sheet marine grade aluminum, with one hundred (100) percent stainless steel hardware, and locking mechanism. They shall exhibit vandal- and weather-resistance and offer easy access.
- 4) Enclosures shall be mounted on either a pre-manufactured mounting pad with support base or minimum six (6) inch concrete pads. See detail.

Sub-section H. Automatic Control System

- 1) Furnish a low voltage automatic control system manufactured expressly for the operation of automatic control valves used in an underground irrigation system.
- 2) Automatic controller devices shall be as specified in the Irrigation Equipment Schedule. No substitutions shall be allowed. Unless specified otherwise, install as follows:
 - a) Install in stainless steel enclosure, model as specified in the Irrigation Equipment Schedule.
 - b) Whenever a single site has 2 or more controllers, the 2nd and subsequent controllers shall also be mounted in a separate stainless steel enclosure as specified in the Irrigation Equipment Schedule.
 - c) Metered enclosures, if required, shall be mounted on a 4" thick concrete pad. Regular enclosures may use a pre-manufactured mounting system as specified in the Irrigation Equipment Schedule.
- 3) Provide adequate capacity to accommodate each valve on the system separately. Do not double valves to circuits.
- 4) The Contractor shall provide 120 volt electrical service to the controller. Install meter inside meter socket of the enclosure. Coordinate this work with the Owner and other trades involved in the project.
- 5) Every controller shall be installed to control a single point of connection (P.O.C.). That point of connection shall be exclusively associated with that controller. Each P.O.C. assembly shall consist of the main line tap, reverse pressure backflow prevention device (if required), filter (if required), master control valve, flow sensing device, manual drain valve, and quick coupling valve. No controller shall be wired to control valves which are connected to another P.O.C.

Sub-section I. Control Valve Wire

- 1) All irrigation control wire shall bear approval as U.L. listed type of underground feeder (direct burial) and each conductor shall be of electrical conductivity grade solid copper in accordance with ASTM 30.
- 2) No aluminum wire shall be used on this project.
- 3) Wire size shall be #14 gauge minimum.
- 4) Two spare wires shall be run from each controller to the farthest valve under its control in all directions and any valve which is on a dead-end line.
- 5) All wire crossing water, attached to bridges, going under paving, or where conditions require protection, shall be housed in conduit or sleeves. All out-of-ground conduits shall be rigid metal. All buried conduit may be PVC.

- 6) All splices shall be water-tight. All connections made inside the box to connect wires to the valve shall be made using a 3M DBY dry-splice connector or pre-approved equal. Each connector shall be completely sealed and water-proofed.
- 7) All other splices in control wire shall be housed in a separate valve box.
- 8) The pigment or color of the wires shall be integrated into the covering, rather than painted on. All common or ground wires shall be white in color. Where more than one controller is required, a different colored hot wire shall be used for each controller. A separate color shall be used for all spare wires.

Sub-section J. Sprinkler Heads

- 1) General:
 - a) All heads used on this project shall be as specified in the Irrigation Equipment Schedule shown on the plans.
 - b) All sprinkler heads and nozzles shall be as specified in the Irrigation Equipment Schedule.
- 2) Spray/Rotary Sprinklers:
 - a) Spray/Rotary sprinklers shall have either four (4), six (6), or twelve (12) inch pop-up height and built-in check valve. In areas where water pressures are high or fluctuating, pressure regulating series sprinklers shall be used.
 - b) Spray/Rotary sprinkler nozzles shall be plastic matching precipitation rate nozzles. Variable arc nozzles may be used to meet irregular-shaped areas.
 - c) Attachment options shall be as specified in the installation details.
- 3) Rotor Sprinklers:
 - a) Rotor sprinklers shall be equipped with stainless steel rotor sleeve and check valve.
 - b) Rotor sprinkler nozzles shall be as manufactured for each individual model.
 - c) Small rotor sprinklers (½" bottom inlet) may be installed using swing pipe per installation details. Medium (¾" bottom inlet) and large (1" or greater bottom inlet) rotor sprinklers shall be installed using swing joints as shown in the installation details. Swing joint size shall match sprinkler inlet size.
- 4) Bubblers, Tree Well, and Root Watering Systems: Installed per manufacturer's recommendations. Use only where and when specified.

Sub-section K. Drip Irrigation

- 1) Drip irrigation materials shall be as specified in the Irrigation Equipment Schedule.
- 2) Emitters shall be of the individual, self-cleaning, pressure-compensating type.
- 3) Dripline tubing shall be constructed of high quality linear, low density, UV-resistant, polyethylene resin materials with internal, integral emitters at specified intervals.
- 4) All insert barbed fittings shall be constructed of molded, UV-resistant plastic. Each fitting shall have a minimum of two (2) ridges or barbs per outlet. All fittings shall be from the manufacturer and shall be available in one of the following end configurations:
 - a) Barbed insert fittings.
 - b) Male pipe threads (MPT) with barbed insert fittings
 - c) Female pipe threads (FPT) with barbed insert fittings.
- 5) Each drip remote control valve assembly shall contain the following components (in required sequence):
 - a) PVC ball valve.
 - b) Inline disc or screen filter with 100 micron/150 mesh filter element.
 - c) Remote control valve.
 - d) Inline pressure regulator.
- 6) Provide the following equipment to each drip valve circuit, located and installed per manufacturer's recommendations:
 - a) Line flushing valve(s) - minimum of one (1) on each exhaust header, and one (1) on each supply header.
 - b) Air/Vacuum relief valve(s) at all high points in the system is required by the manufacturer.

Sub-section L. Flow Sensing Equipment

- 1) Where specified, each controller shall be installed with its own corresponding flow sensor on a single point of connection to the water source.

- 2) The flow sensor shall be compatible with the specified controller.
- 3) Size the flow sensor so that it is able to read the high and low flows of the valves used on that particular controller. Install per manufacturer’s specifications.

Sub-section M. Irrigation Equipment List

<u>COMPONENT</u>	<u>MANUFACTURER / MODEL</u>
Master Valve.....	Refer to Owner
Isolation Valve (main line)	Refer to Owner
Remote Control Valve	Rain Bird PEB Series
Quick Coupling Valve	Rain Bird 44LRC
Manual Drain Valve	Ford B11-333
Valve Box.....	Carson, Amateck
Backflow Preventer	Refer to Owner
Filters.....	Amiad Brushaway
Controller.....	Rain Bird ESP modular or ESP-LX Series
PVC Pipe Fittings	Lasco, Spears, Dura (Sch. 40 & 80)
Ductile Iron Fittings.....	Harco, Leemco, Tyler Mechanical Joint
Unions.....	Action
Spray Sprinklers.....	Rain Bird 1804 Pop-Up Series
Rotary Sprinklers	Hunter MP Rotator Series
Small Rotor Sprinklers.....	Rain Bird 5004 Series
Large Rotor Sprinklers	Rain Bird Falcon 6504 (stainless steel) Series
Drip Irrigation (emitters, dripline, filters).....	Netafim
Rigid Swing Joint.....	Lasco, Spears
Swing (“funny”) Pipe.....	Rain Bird, Hardie, Lasco
Wire Splice	3M-DBR/Y
PVC Primer	Weld-On P70 (purple)
PVC Glue.....	Weld-On (>2” = 711 gray; <2” = 721 blue)

Section 19.03 EXECUTION

Sub-section A. General

- 1) The irrigation plan is diagrammatic in nature, and some drafting liberties have been taken to maintain the graphic clarity of the drawings. All irrigation equipment shall be located in planting areas only, unless noted otherwise. The Contractor shall install piping to minimize changes in direction, avoid placement under large trees or large shrubs, and avoid placement under hardscape features. Refer to the irrigation legend, details, and specifications for equipment and proper installation.
- 2) Site Visit: The Contractor shall visit and inspect the project site. He shall take into consideration known and reasonably inferable conditions affecting the proposed work. Failure to visit the site shall not relieve the Contractor of furnishing materials and performing the work required. Any discrepancies between existing site conditions and those indicated on the plans shall be called to the attention of the Owner prior to continuance of the project.
- 3) The Contractor shall keep the premises clean and free of excess equipment, materials, and rubbish incidental to work of this project. Work areas shall be swept clean and trash and debris picked up daily. Open trenches or hazards shall be protected with yellow caution tape. The Contractor is responsible for removal and legal disposal (off site) of trash and debris generated by his work on this project.
- 4) Existing Landscapes:
 - a) Where existing landscape areas are a part of the project, the Contractor shall repair or replace work damaged by his irrigation system installation at his own expense. If the damaged work is new, the Contractor or the original installer of that work shall perform repairs at the Contractor’s expense. The existing landscape shall remain in place, protected and undisturbed.
 - b) The Contractor shall protect and work around all existing plant materials designated to remain.

- c) Coordination of trench and valve locations shall be laid out prior to any excavation work. Plant material deemed by the Owner or Owner's Authorized Representative to be damaged by the Contractor shall be replaced with new plant material at the Contractor's expense. The Contractor shall not cut existing tree roots larger than two (2) inches in diameter. Route pipe, wire, and irrigation components around tree canopy drip lines where possible to minimize damage to tree roots.
 - d) The Contractor shall leave no part of the existing landscape without water for more than forty eight (48) hours at a time.
- 5) Pre-Construction Meeting: A pre-construction shall be held prior to beginning any work on a project. The Owner, the project designer, and the Contractor and his Sub-contractors shall all be in attendance.
- a) The purpose of this meeting is to review project goals and expectations, the project schedule, and all procedures relative to inspections, permits, and changes that may arise.
 - b) In the pre-construction meeting, it shall be made clear that the construction documents (plans, details, specifications, and contract) shall be binding upon the Contractor and upon all of his work. Any work not in accordance with the plans and specifications shall be rejected, and the Contractor shall bring the project into compliance at his own expense.

Sub-section B. Construction Staking

- 1) The Contractor shall provide the necessary staking to obtain the layout shown on the plans. The points of reference shall be as indicated in the drawings, and shall include such features as the existing walks, buildings, curbs, etc. The staking may be approved by the Owner or Owner's Authorized Representative prior to commencing installation operations. Any changes in the system which appear necessary due to field conditions must be called to the attention of the Owner or Owner's Authorized Representative and approved at the time they are discovered and prior to making any changes.

Sub-section C. Excavation and Backfilling

- 1) Excavation:
- a) Excavation work shall be as deep and as wide as will be required to safely perform the work, such as making mainline connections or forming vaults.
 - b) Trenches shall be deep and wide enough to provide working space for placing two (2) inches of bedding underneath all new mainline pipe and fittings where the soil is rocky or gravelly. Place eighteen (18) to thirty (30) inches of cover over the top of all pipe and fittings on main lines. All trench bottoms shall be sloped so that the pipes will gravity-drain back to the main connection point or the nearest manual drain. If the existing main line is deeper than thirty (30) inches, the Contractor shall install a riser to a depth of eighteen (18) to thirty (30) inches and then install the new line at the required depth. At no time will the mainline be installed with less than eighteen (18) inches or greater than thirty (30) inches of cover unless prior approval is given by the Owner or Owner's Authorized Representative.
 - c) Trenches shall be deep enough to maintain twelve (12) to fourteen (14) inches of cover over the top of all lateral line pipe and fittings. They shall be deep enough to guarantee that all swing joints drain back to the lateral lines. Trenches shall be a minimum of twelve (12) inches away from any walks and/or curbs, buildings, or other hardscape improvements. They shall be of sufficient width to accommodate tees and other fittings that come out sideways (horizontally) from the lateral lines. Lateral lines may be pulled by a mechanical puller provided all other applicable specifications are met.
 - d) Any rocks or other debris over one (1) inch in diameter uncovered during excavation or trenching shall be removed from the area.
 - e) If more than one (1) pipe line is required in a single trench, that trench shall be deep and wide enough to allow for at least six (6) inches of horizontal separation (if both are lateral lines), or six (6) inches of both horizontal and vertical separation (if one line is a main line) between pipes.
 - f) Any existing utility lines damaged during excavating or trenching shall be reported immediately to the Owner or Owner's Authorized Representative, the utility Owner, and the project Owner. After proper notification to the Owner or Owner's Authorized

Representative, the utility Owner, and project Owner, repairs to the damaged utility shall be made immediately. Repair materials and methods shall meet industry standards and the utility Owner's satisfaction. Should utility lines be encountered which are not indicated on the plans, the Owner shall be notified. The repair of any damage shall be done as soon as possible by the Contractor or the utility Owner, and proper compensation to the Contractor shall be negotiated with the Owner. Such utility locations shall subsequently be noted on the "As-Built" drawings required before final payment of the irrigation system contract.

- g) Where trenching is done in established lawn, care shall be taken to keep the trenches only as wide as is necessary to accomplish the work. The trenches shall be backfilled as specified and then four (4) inches of topsoil placed to bring the trench up to existing grade so that sod can be laid. Only new sod shall be used as trench cover. It shall be established new sod of standard width and shall be laid along the trenches so as to match the existing sod. No small pieces of sod shall be used and only standard lengths shall be accepted. No sod from the construction site shall be used unless otherwise specified. In the event of any backfill settlement prior to the end of the guarantee period, the Contractor shall perform the required repairs at his own expense.
- 2) Backfilling:
 - a) No backfilling of trenches shall be done until the system has been inspected and approved by the Owner or Owner's Authorized Representative for proper trench depths, installation of equipment, control wire, and location of heads.
 - b) Before trenches are backfilled, the Contractor must show the Owner or Owner's Authorized Representative the redlined "As-Built" drawing he has been keeping on the site, indicating that changes and corresponding dimensions have been recorded where such changes have been made.
 - c) Prior to backfilling, the system shall be tested under pressure for leaks and general operation of the equipment. The main line shall be tested for a period of four (4) hours at a pressure of 120 PSI. Any failures detected during the testing period shall be repaired by the Contractor and the testing shall be repeated. The Owner or Owner's Authorized Representative shall certify the testing to insure that it has been completed and that the system has met all testing requirements. All defects discovered by the pressurization and operation test shall be corrected by the Contractor at his own expense before proceeding with further work.
 - d) Trench bedding and backfill material shall be existing site soil free of rocks larger than one (1) inch in diameter and any other debris. Wasted pipe and other excess project materials or rubbish (tape, wire, trash, wrappers, boxes, bottles, etc.) shall not be backfilled into the trenches. All trenches shall be backfilled, and then watered sufficiently to insure no settling of the surface. In the event of any backfill settlement prior to the end of the guarantee period, the Contractor shall perform all required repairs at his own expense.
 - e) Backfill under and around the lines to the center line of the pipe shall be placed in maximum layers of six (6) inches and thoroughly compacted. Compaction shall be ninety five (95) percent relative density (modified proctor) under walks and roads, and eighty five (85) percent in planting areas.
 - f) Special care shall be taken to assure complete compaction under the haunches of the pipe. Backfill compaction under the haunches of the pipe shall be compacted to the original density. Compaction requirements above the pipe shall be the same as for surrounding areas.

Sub-section D. Point-of-Connection

- 1) The Contractor shall verify the location of the irrigation point-of-connection (P.O.C.) and the static water pressure at that location prior to beginning any irrigation work. Verify water pressure during the time of day that the irrigation system is intended to operate.
- 2) If the P.O.C. location or water pressure is different than that expressed by the irrigation designer, or if the pressure appears to be unusually high or low, the Contractor shall notify the Owner or Owner's Authorized Representative immediately.

Sub-section E. Electrical Power Supply

- 1) If 120 volt ac electrical service is not already in place, the Contractor shall be required to make all necessary arrangements with the appropriate power company and perform all necessary materials and labor to provide said power, including but not limited to: paying fees, making power connections, providing poles, weatherhead and meter, etc., as specified on the plans or as required by the power company and the Owner. The exact location of the automatic controller which shall receive the power shall be determined by the Owner or Owner's Authorized Representative and the Owner

Sub-section F. Pipe and Fittings

- 1) Install pipe to allow for expansion and contraction as recommended by pipe manufacturer. Where the main line will be allowed to sit uncovered for any length of time in the trench prior to testing, shade the main line with a thin covering of backfill soil to minimize weather-related expansion or contraction of the pipe. Do not cover up valves or other installed equipment prior to inspection and acceptance.
- 2) The ends of all pipe shall be cut squarely, and remain free of all inside scale or burrs. Spigot ends of pipes three (3) inches and larger shall be beveled. Threads shall be cut clean and sharp, and to a length equal to one and one eighth (1-1/8) times the length of the female thread receiving the pipe. The threaded pipe shall be screwed into a full length of the female thread.
- 3) All threaded pipe joints shall be properly sealed using teflon tape that is properly applied to the areas to be joined.
- 4) Solvent weld joints shall not be glued unless ambient temperatures are at least forty (40) degrees F. Pipe shall not be glued in rainy conditions unless properly tented. Use only the brand and type of primer and glue specified. Glued main line pipe shall cure a minimum of four (4) hours prior to being energized. Lateral lines shall cure a minimum of two (2) hours prior to being energized and shall not remain under constant pressure unless cured for twenty four (24) hours.
- 5) Every care shall be taken during installation to prevent dirt and debris (especially rocks and pipe shavings) from getting into the pipes.
- 6) All tees coming out of main lines for valves and other fixtures shall be vertical and constructed with Sch. 80 PVC pipe.
- 7) All tees coming out of the lateral lines for heads and other fixtures shall be horizontal so that no direct weight or pressure may be exerted through the head to the top or bottom of the lateral line pipe. Tees on lateral lines shall also be SxSxT to the head swing joints.

Sub-section G. Thrust Blocks

- 1) Thrust blocks are needed wherever the main pipe line:
 - a) Changes any direction at tees, angles, and crosses vertical and horizontal.
 - b) Changes size at reducers.
 - c) Stops at a dead-end.
 - d) Valves at which thrust develops when closed.The size and type of thrust block depends on pressure, pipe size, type of soil, and type of fitting. As a general rule, one cubic foot (minimum) of class AA (AE) Type II concrete (2,000 psi minimum) is required for each thrust block. Follow the ductile iron fitting manufacturer's recommendations for the minimum thrust block size.
- 2) Thrust blocks shall rest against undisturbed original earth in the direction of thrust.
- 3) Where a fitting is used to make a vertical bend, use a three eighths (3/8) inch bar to anchor the fitting to a thrust block braced against undisturbed soil. The thrust block should have enough resistance to withstand upward and outward thrusts at the fitting.
- 4) Where concrete thrust blocking shall come in contact with PVC pipe, wrap the PVC pipe with a layer of plastic to protect the pipe from any caustic effects that may be caused by the concrete mix.
- 5) Thrust restraining devices may be used in lieu of thrust blocking, but they must be installed strictly according to manufacturer's recommendations. Use of these devices in lieu of thrust blocking shall be approved by the Owner or Owner's Authorized Representative prior to use.

Sub-section H. Pipe Sleeves

- 1) Pipe sleeves shall be required for all piping under all new concrete or other new paving. The size of the sleeve shall be at least twice the size of the pipe or wires to be sleeved. Wires shall be sleeved separately within their own sleeve. All pipe sleeves four (4) inches and smaller in diameter shall be PVC Schedule 40 pipe; sleeves greater than four (4) inches in diameter shall be Class 200 PVC.

Sub-section I. Valves

- 1) General:
 - a) Isolation valves, remote control valves, and quick coupling valves shall be installed according to manufacturer's recommendations and these drawings and specifications.
 - b) Valve boxes shall be set over valves so that all parts of the respective valve assembly can be reached for service. Valve box and lid shall be set to be flush with the proposed finished grade.
 - c) No valve box shall rest directly upon the valve or any fixture associated with it, including main line and lateral lines. Each valve box shall be centered on the valve assembly it covers. Each valve box shall have four (4) inches of three quarter (3/4) inch gravel placed in the bottom underneath the valve and lines to reduce the potential of mud and standing water therein.
- 2) Remote Control Valve:
 - a) Each control valve shall have its own gate or ball valve (as specified), and only one (1) control valve and gate/ball valve per valve box. No valve manifolds shall be allowed.
 - b) The bottom of the remote control valve shall be a minimum of four (4) inches above the gravel.
 - c) All control valve assemblies shall be placed within planting areas and in the approximate location as shown on the plans. No large grouping of valves (greater than 3) in any one spot shall be allowed.
 - d) Control valve assemblies shall be installed no closer to one another than two (2) feet.
 - e) No control valve shall be installed more than twelve (12) inches below finished grade.
 - f) Tag each control valve with a permanent and non-smearing label indicating its proper controller and valve number as shown on the irrigation plans.
- 3) Quick Coupling Valve:
 - a) Quick coupling valves shall be installed within a ten (10) inch round valve box unless next to concrete pad. In the latter case, install at finished grade.

Sub-section J. Valve Box

- 1) Where indicated in the installation details, valve boxes shall rest on concrete pavers only, thus eliminating any weight or pressure from being exerted on the main line or valve inside the valve box. There shall be a minimum of three (3) inches of clear space between the bottom of the valve box lid and the topmost part of the valve (including solenoid).
- 2) Valve box extensions shall be used where necessary to prevent soil around the valve from collapsing into the space inside the valve box.

Sub-section K. Backflow Prevention Assembly

- 1) The Contractor shall install backflow prevention equipment behind (downstream from) the point-of-connection to the supplying main and lateral lines. Installation shall comply with local, state, and national codes and regulations, and per manufacturer's recommendations (whichever is most restrictive). See plans and details for more information. Install a quick coupling valve just downstream of the backflow prevention assembly for system blowout purposes.
- 2) The Contractor shall have the backflow prevention assemblies operation tested within ten (10) days of the time of installation by a certified backflow preventer assembly tester. Testing shall be conducted per state requirements to insure proper and safe operation. Subsequent annual testing at spring start-up shall be the responsibility of the Owner.

Sub-section L. Filter & Enclosure

- 1) The Contractor shall install the filter and its enclosure just downstream from the point-of-connection and upstream from the backflow prevention assembly (if present).

- 2) The filter shall be equipped with a ten (10) foot length of hose that can be attached to the exhaust port of the filter to direct water and debris away from the enclosure during flushing operations. Auto-flush filter models shall be provided with a permanent method of capturing and directing exhaust water away from the filter assembly without creating puddles, ponding, or any other nuisance drainage problems.

Sub-section M. Wire & Cables

- 1) Multiple wires in the same trenches shall be banded together at ten (10) foot intervals for protection. Where wires pass under paved areas, they shall be installed in Schedule 40 PVC sleeves. These sleeves shall be installed prior to installation of the paving, if possible, and prior to installation of the wires. Sleeves for fourteen (14) gauge wires shall be sized as follows:

<u>NUMBER OF WIRES</u>	<u>SLEEVE SIZE</u>
1 - 10.....	1"
11 - 18.....	1 1/4"
19 - 25.....	1 1/2"
26 - 40.....	2"
41 - 56.....	2 1/2"
57 - 88.....	3"
89 - 150.....	4"

- 2) All control wires shall be bundled and taped together every ten (10) feet and installed in the pipe trench directly adjacent to the pipe. Control wires not placed in the trenches adjacent to the pipes shall be placed in PVC electrical conduit and buried eighteen (18) inches or deeper and marked on the "as built" drawings.
- 3) Two (2) spare wires shall be run from each controller to the farthest valve under its control in all directions and to any valve which is on a dead-end line. The spare wires shall be a different color from the regular wires and shall be labeled at both ends. Each spare wire shall be brought up to the surface in each valve box it passes through and coiled with twenty four (24) inches for use in future connections. Each spare wire shall be tested for continuity prior to final acceptance of the project and guaranteed by the Contractor to be functional. Should the maintenance personnel discover a defect within one (1) year afterwards, the Contractor shall locate the problem and cause it to be repaired at his own cost. Install extra wires as needed for moisture sensors.
- 4) Run a single 14 gauge wire along the top of the main line to be used for tracking the location of the main line. The color of the tracing wire shall be different than any other wire color used.
- 5) All wires shall be installed with twenty four (24) inches of excess wire (coiled) at the end of each wire run, wire splice, and at each controller.
- 6) Isolation valves, quick coupling valves, manual drain valves, and wire splices not specifically associated with the control valve shall be located in separate valve boxes.

Sub-section N. Sprinklers

- 1) General:
 - a) All sprinkler heads shall be installed above grade so as to minimize washing of the topsoil and seed during the landscaping establishment period, except those which border paving or flat work of any kind. These heads shall be installed at the finished grade of the adjacent paving or flat work. Prior to final acceptance of the project, all heads shall be raised or lowered to final lawn or planting grade.
 - b) All sprinkler heads shall be installed using the bottom inlet. No side outlets shall be used.
 - c) Rotor heads located on hillsides shall be adjusted to the downhill side to avoid cutting into the hill by the stream of water and causing erosion.
 - d) Heads installed in existing sod shall be set at the grade of the soil.
 - e) All rotary pop-up heads shall be installed at final grade on double swing joints. All swing joints must drain by gravity back to the supply lines.
 - f) All pop-up, shrub spray/rotary, turf spray/rotary, bubbler and strip spray/rotary heads shall be installed as shown in the details.
 - g) All pipes, lines, and risers shall be flushed thoroughly with water before installation of any heads. All debris and rocks found at that time shall be removed from the area as soon as possible.

- h) All spray sprinklers shall be flushed thoroughly with clean water a second time before installation of nozzles.
 - i) The Contractor shall adjust all heads to provide a uniform coverage and to keep spray off buildings, walkways, walls, parking areas, and drives.
 - j) Check valves shall be used where indicated and where necessary to prevent water flow from lower elevation heads when system is turned off. Install per manufacturer's recommendations.
- 2) Inline Drippers
- a) Inline drip tubing shall be spaced at a distance equal to or less than the inline emitter spacing. For slope applications, place drip tubing laterals parallel to the slope contour. When slopes exceed thirty (30) percent, increase the recommended lateral spacing by twenty five (25) percent on the lower one third (1/3) of the slope.
 - b) Inline dripper tubing shall be installed at finished grade with soil staples and covered with three (3) inches of specified mulch. Supply and exhaust headers shall be installed at normal lateral line depths.
 - c) All drip tubing shall be held in place by soil staples and shall conform to the following:
 - i) Sandy Soil - One staple per every three (3) feet and two (2) staples on each change of direction (tee, elbow, or cross)
 - ii) Loam Soil - One staple every four (4) feet and two (2) staples on each change of direction (tee, elbow, or cross)
 - iii) Clay Soil - One staple every five (5) feet and two (2) staples on each change of direction (tee, elbow, or cross)
 - d) Installation of inline drip circuits shall generally conform to the following steps:
 - i) Assemble and install ball valve, filter, remote control valve and pressure regulating valve assembly in accordance with installation details.
 - ii) Assemble and install supply header(s) in accordance with installation details. Tape or plug all open connections to prevent debris contamination.
 - iii) Install lateral drip lines in accordance with details and relevant specifications and manufacturer's recommendations. Tape or plug all open ends while installing to prevent debris contamination.
 - iv) Assemble and install exhaust header(s) in accordance with installation details. Tape or plug all open connections to prevent debris contamination.
 - v) Install air/vacuum relief valve(s) at the zone's highest point(s) in accordance with installation details.
 - vi) Thoroughly flush supply header(s) and connect drip lateral lines while flushing.
 - vii) Thoroughly flush drip lateral lines and connect to exhaust header(s) and any interconnecting lateral lines while flushing.
 - viii) Thoroughly flush exhaust header(s) and install line flushing valves in accordance with details.

Sub-section O. As-Built Documents

- 1) The Contractor shall keep a current and accurate record of exact dimensioned locations, grades, elevations, and the size of all exterior and interior underground piping, valves, and drains. Dimensions shall indicate distances from columns, buildings, curbs, and similar permanent features on the site. This information shall be recorded on a print as the work progresses, but shall be permanently recorded on a reproducible two (2) mil mylar or Tyvek original which shall be given to the Owner before the project is accepted. The mylar or Tyvek shall be a copy of the original plans for the project produced by a local printer at the Contractor's expense.
- 2) Final payment for the contract will not be processed until "As-Built" drawings or plans are received by the Owner.

Sub-section P. Operational Test and Major Inspections

- 1) Substantial Completion:
 - a) At substantial completion of the irrigation system, the Contractor shall call for an operational and coverage test. Substantial completion shall be defined as the complete installation of all irrigation equipment and completion of all backfilling and grading

- operations in their entirety. Substantial completion shall not be given for designated portions of the project.
- b) Notice by the Contractor shall be given, in writing, at least three (3) days in advance to the Owner so that proper scheduling can be made for those who are to attend.
 - c) At the appointed time, an inspection of all irrigation equipment, including control valve assemblies, controllers, isolation valves, quick coupling valves, drain valves, and sprinklers shall be made. The entire system will be tested for operation, coverage, and head adjustment. Please note that the pressure testing of the main lines and lateral lines shall already have been completed prior to this time.
 - d) A list of uncompleted items or repairs (punch list) shall be generated by the Owner and distributed to the Contractor and other involved parties within three (3) days of the operational testing. Each item on the punch list shall be corrected before the system will be approved and accepted by the Owner. The Contractor will be back charged for time spent by the Owner and any consultants who have been brought to the site for a final inspection when the project is not ready for said inspection.
- 2) Maintenance/Establishment Period:
- a) The duration of the irrigation maintenance period shall be equal to the plant maintenance/establishment period. It shall begin one (1) day after the substantial completion inspection. The Contractor shall complete all punch list items during the maintenance period, as well as maintain and operate the entire irrigation system.
 - b) The irrigation Contractor (if different than the landscaping Contractor) shall coordinate with the landscaping Contractor during the entire plant and lawn establishment period on the use, scheduling, and maintenance of the sprinkler system.
- 3) Final Acceptance:
- a) A second inspection shall be held at the end of the maintenance period to insure that all punch list items have been completed and the entire system is ready for acceptance by the Owner.
 - b) Upon satisfaction that the Contractor has completed all punch list items, the irrigation system is fully and completely functional, and the required As-Built drawings, mylars and maintenance manuals have been submitted, the Owner shall accept the project.
 - c) An official letter of final acceptance shall be prepared and issued to the Contractor, Owner or Owner's Authorized Representative, and the Owner. Upon acceptance of the system by the Owner, the Owner shall assume full responsibility for the system, and the guarantee period shall begin.

Sub-section Q. Guarantee and Maintenance

- 1) Guarantee:
 - a) Upon final acceptance of the irrigation system as being operational and properly installed, the Contractor shall guarantee the workmanship, materials, fixtures, and equipment to be free from defects for a period of one (1) year after that date.
 - b) The Contractor shall insure and guarantee complete drainage of the system. In working with or connecting to an existing system, the Contractor shall guarantee compatibility in operation and drainage between the two systems.
- 2) Maintenance Required During Guarantee Period:
 - a) In the fall of the year during the installation and guarantee period, the CONTRACTOR shall meet with the Owner's maintenance personnel on the site. The Contractor shall winterize the system by draining all of the water and doing everything necessary to insure protection of the system until spring. Blowing out the lines by compressor shall be permitted during the one (1) year guarantee. Maximum compressor pressure shall be 30 psi on spray circuits, 50 psi on rotor circuits, and 20 psi on all drip circuits. The individuals involved from both parties shall exchange all information necessary for the eventual take-over of the system by the Owner.
 - b) The Contractor, with the Owner's maintenance personnel and Owner in attendance, shall energize the sprinkler irrigation system again the following spring and shall repair all defects found as a result of winter damage, improper installation, improper maintenance, defective materials or inadequate sprinkler drainage.

- c) At the end of the guarantee period, when the lawn and landscaping have been accepted, the Contractor shall call for a final inspection of the sprinkler irrigation system. There shall be at least five (5) days prior notice given in writing to the Owner so that the appropriate people have opportunity to attend.
- d) Prior to that time, the Owner shall adjust all heads to their proper pattern, radii, and height. The system shall have been flushed out, checked for operation, and any defects not covered by the guarantee corrected shall be repaired. The entire system shall be inspected and checked to determine if everything is in working order. A final list of warranty items found in need of correction (if any) shall be made and the Contractor shall correct them. The Contractor shall notify the Owner when he has verified that every item is corrected.
- e) After all warranty items have been corrected, the Owner shall, in writing, officially release the Contractor from all warranty claims pertaining to the irrigation system and assume full and complete responsibility for said system.

DIVISION 20**PLANTING****Section 20.01 GENERAL****Sub-section A. Summary**

- 1) Section includes:
 - a) Trees, shrubs, perennials, vines, and groundcover requirements.
 - b) Bedding, topsoil, and temporary support.
- 2) The work to be performed under this section shall consist of furnishing all materials, labor, and plants necessary for the proper planting of all trees, shrubs, perennials, vines, and groundcovers of the kind and sizes specified at the prescribed locations, and otherwise in accordance with the drawings and specifications or as directed by the Owner or Owner's Authorized Representative.
- 3) Related sections:
 - a) Section 32 84 23 Underground Irrigation Systems

Sub-section B. References

- 1) ANN: American Associations of Nurserymen, Inc.
- 2) ANSI Z60.1: American Standard for Nursery Stock.
- 3) FS O-F-241: Fertilizers, Mixed Commercial.

Sub-section C. Quality Assurance

- 1) Perform work in conformity with applicable requirements of AAN.
- 2) Upon receiving Notice to Proceed, the Contractor shall provide written proof that the specified plant material is available and has been secured or reserved specifically for this project. Obtain nursery stock and other plant materials from reliable and stable sources prior to order and delivery.
- 3) Provide plants that are declared free of disease and insect pests.

Sub-section D. Product Delivery, Storage, and Handling

- 1) Exercise care in digging, transporting, handling, and packing of all plants.
- 2) Handle plants so roots are protected at all times. If delivery is in open vehicles, cover entire load without causing over heating.
- 3) Deliver plant material immediately prior to placement. Keep plant material moist.
- 4) Protect root balls from sun and wind by covering with soil or other suitable material if not planted immediately on delivery.
- 5) Store fertilizer in a weatherproof location such that its effectiveness will not be impaired.

Sub-section E. Acceptance

- 1) Plants in which the ball of earth surrounding roots (rootball) has been cracked or broken are not acceptable.
- 2) Plants in which burlap, staves, and ropes required in connection with transplanting are intact upon delivery are not acceptable.
- 3) Heeled in stock from cold storage are not acceptable.

Sub-section F. Samples

- 1) Samples of the materials listed below shall be submitted to the Owner or Owner's Authorized Representative for inspection and approval prior to the beginning of work under this contract.
- 2) Delivery of materials may begin only after samples have been approved. All materials furnished for the work shall conform in every respect to the approved samples. Any non-conforming materials will be rejected.

Section 20.02 PRODUCTS**Sub-section A. General**

- 1) The planting plan is diagrammatic, and all plant locations are approximate. Plant symbols take precedence over plant quantities shown on the plans and in the plant material schedule. The Contractor shall verify all plant quantities and notify the Owner or Owner's Authorized Representative of any discrepancies between the quantities and the symbols shown.
- 2) Provide plants of normal growth and uniform height, according to species, with straight canes and well developed leaders, roots, and tops.
- 3) Provide plants of sizes indicated. The size stated in each case shall be interpreted to mean dimensions of plant as it stands in its mature position in the nursery without straightening of any branches or leaders.
- 4) Provide legible labels attached to all plants, specimens, bundles, boxes, bales, or other containers indicating botanical genus, species, and size of each.
- 5) Plants cut back from larger sizes to meet specifications shall be rejected.
- 6) Balled and burlapped deciduous shrubs may be acceptable in lieu of container growth deciduous shrubs only if there is a demonstrated significant shortage of container grown stock.

Sub-section B. Plants

- 1) All plants shall comply with federal and state laws requiring inspection for plant disease and infestations.
- 2) Any inspection certificates required by law shall accompany each delivery of plants and such certificate shall be given to the Owner or Owner's Authorized Representative. All plants shall be subject to inspection and approval at the place of growth or upon delivery to the site for their quality, size, species, and variety. Such approval shall not impair the right of inspection and rejection at the site or during progress of work for size and condition of the plants, latent defects, or injuries. Any and all rejected plants shall be removed immediately from the premises by the Contractor. The Contractor shall make all replacements at his expense should he fail to comply in full with any of the specifications. Necessary replacements will be made as soon as weather conditions permit and all such plants replaced shall conform to all specifications herein.
- 3) Names and Grades:
 - a) Plant names shall conform to the nomenclature of "Standard Plant Names" or "Bailey's Encyclopedia of Horticulture." When a name is not found in either reference, consult the accepted name used in the nursery trade. All plants shall be tagged by the nursery with the proper identification labels to insure the correct varieties of plants.
 - b) Size and grading standards shall conform to those of the American Association of Nurserymen, Inc., as published in "American Standard for Nursery Stock", 1959 Edition, with all current revisions unless otherwise specified.
 - c) The caliper of trees shall be measured six (6) inches above the surface of the ground.
 - d) Measurements on all trees and shrubs shall be taken with the branches in a normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. No trees which have had their leaders cut or so damaged that cutting is necessary, will be accepted.
- 4) No substitution of size, grade, variety or any species shall be permitted except by written permission of the Owner or Owner's Authorized Representative.
- 5) Plant Size:
 - a) All plants shall conform to the size, age, and condition as specified in the plant list shown on the drawings. Undersized plant material shall not be approved. The minimum acceptable tree sizes are:
 - i) Deciduous Trees – 2" caliper
 - ii) Evergreen Trees – 6' height
 - b) No additional compensation shall be due the Contractor if larger than specified plant material is provided.
 - c) Due to the large size of the trees and evergreens being specified, only balled and burlapped or container stock shall be accepted. No bare root stock shall be accepted.

- 6) Plant List:
 - a) Plants lists indicate minimum size requirements only. Plant materials shall be equal to or greater in size than those specified.
 - b) Any discrepancies between plant lists and plans shall be immediately brought to the attention of the Owner or Owner's Authorized Representative.
 - c) In all cases the Contractor shall be held responsible for all plant materials indicated on the plans unless otherwise directed in writing by the Owner or Owner's Authorized Representative.
 - d) Each bidder shall investigate sources of supply and satisfy himself that he can supply all of the plants mentioned in the planting lists in size, variety, and quantity noted and specified before submitted his bid. Failure to take this precaution will not relieve the successful bidder from his responsibility as Contractor to furnish and install all plant material in strict accordance with the contract requirements without additional expense to the owner.
- 7) All plants shall be fresh and vigorous, of normal habit and growth, and free of disease, insects and insect eggs and insect larvae, weeds and weed seed. No heeled-in plants from cold storage shall be accepted except on approval by the Owner or Owner's Authorized Representative prior to installation.

Sub-section C. Tree Stakes & Ties

- 1) Tree stakes shall be two by two (2x2) inch square or two (2) inch diameter round wood stakes eight (8) feet in length as indicated on the plans. Steel stakes may be used if approved by the Owner or Owner's Authorized Representative and reclaimed after one year.
- 2) Tree stake ties shall be manufactured of virgin flexible vinyl meetings ASTM-D-412 standards for tensile and elongation strength. The material shall be black in color for ultraviolet resistance. Hose and wire shall not be used.

Sub-section D. Topsoil

- 1) All planting areas shall receive either a minimum of four (4) inches of stockpiled or imported topsoil in turf areas and twelve (12) inches in planting beds.
- 2) All topsoil used on this project (stockpiled or import) shall meet the following criteria:
 - a) pH:5.5 - 8.0
 - b) EC (electrical conductivity):<2.0 mmhos per centimeter
 - c) SAR (sodium absorption ratio):<3.0
 - d) % OM (percent organic matter):≥2%
 - e) Texture (particle size per USDA classification):
 - i. Sand:<70%
 - ii. Clay:<30%
 - iii. Silt:Balance
 - f) Stone Fragments (gravels or any soil particle greater than two (2) mm in size):
<5% (by volume)
 - g) Rocks Present > 1.5"None
- 3) In addition, the topsoil shall be fertile, friable, natural loam and shall be capable of sustaining vigorous plant growth. It shall be free of stones, lumps, clods of hard earth, plants or their roots, sticks, and other extraneous matter. The topsoil shall contain neither noxious weeds nor their seeds. It shall not be used for planting operations while in a frozen or muddy condition.

Sub-section E. Mulch

- 1) Shredded bark mulch shall be used as a top dressing for all planting beds unless specified otherwise.
- 2) Shredded bark mulch shall conform to the following criteria:
 - a) Bark pieces shall not exceed two (2) inches when passed through a screen of that size.
 - b) Large chunks of bark or wood shall not be mixed in with the mulch.
 - c) The bark mulch shall be primarily from coniferous trees.
- 3) Where used, the shredded bark mulch shall be place to a depth of three (3) inches on top of the topsoil.

- 4) Other mulches may be used only as specified on the drawings or in the planting notes and details.

Sub-section F. Fertilizer

- 1) Commercial fertilizer shall be uniform in composition, dry, and free flowing. Deliver fertilizer mixed as specified in bulk or bag, showing weight analysis, formula, and manufacturer's name.
- 2) A 16-16-16 balanced fertilizer shall be used. Any exceptions to this formula shall be based on horticultural recommendations resulting from a site-specific soils test, and must be approved prior to application by the Owner or Owner's Authorized Representative.

Sub-section G. Mowstrip

- 1) Where turf areas are separated from planting beds, a concrete mowstrip shall be used. No other edging materials may be used unless specifically noted on the plans and approved by the Owner or Owner's Authorized Representative.
- 2) The mowstrip shall be constructed using concrete having a compressive strength rating of two thousand five hundred pounds per square inch (2,500 psi) or greater, and a maximum slump of four (4) inches.
- 3) A three eighth (3/8) inch diameter rebar (#3) shall be placed continuously in the center of the mowstrip to provide support and help prevent differential settling of the mowstrip after cracking. Overlap joints a minimum of twelve (12) inches.

Section 3 EXECUTION**Sub-section A. General**

- 1) Site Visit: The Contractor shall visit and inspect the site. He shall take into consideration known and reasonably inferable conditions affecting work. Failure to visit the site will not relieve the Contractor of furnishing materials and performing the work required.
- 2) Prior to any planting operations, the irrigation system shall be fully operational and all planting areas shall be thoroughly moistened.
- 3) Where weeds or other undesirable vegetation are present in planting areas, the Contractor shall apply a contact herbicide a minimum of ten (10) days prior to commencement of any planting or irrigation work. Apply herbicide per manufacturer's recommendations. The poisoned vegetation shall be allowed to completely die back, including the roots, before proceeding with the work. Dead vegetation shall then be removed from the site and disposed of in a legal manner.
- 4) The Contractor shall conform to the following requirements with regard to existing vegetation:
 - a) The Contractor shall be fully responsible for any damage to existing trees or shrubs. He shall use all reasonable means to protect and preserve plants on the project not designated for demolition.
 - b) No pruning, thinning, or cutting of existing vegetation shall be allowed unless written permission is given by the Owner or Owner's Authorized Representative.
 - c) The Contractor shall replace any trees or existing shrubs damaged by him or his sub-contractors with like kind and size.

Sub-section B. Planting Seasons

- 1) All new plant installation shall be completed between April 15 and October 15. If planting must be done after October 15 or before April 15, the Contractor shall obtain specific approval to do so from the Owner or Owner's Authorized Representative prior to beginning any planting operations.
- 2) No planting shall be done in frozen soil or during unfavorable weather conditions, subject to the approval of the Owner.

Sub-section C. Topsoil

- 1) The Contractor shall obtain a soil analysis from any authorized soil testing agency of any existing stockpiled or imported topsoil to be used on the project to verify that it conforms to the topsoil specifications. Test results shall include horticultural recommendations. The soil

- samples shall be obtained per the testing agency directions. Allow ten (10) working days to obtain test results. The costs for such testing shall be the responsibility of the Contractor.
- 2) Prior to delivery of the imported topsoil to the site, the Contractor shall provide to the Owner or Owner's Authorized Representative the name and location of the topsoil source, along with the certified soil analysis of the topsoil to be used. The analysis shall verify that the proposed topsoil meets the topsoil specifications, and is capable of supporting healthy plant growth.
 - 3) The following procedure shall be followed in placing all topsoil:
 - a) All areas to receive topsoil which have a slope of less than ten (10) percent shall be cross-rippled to a depth of four (4) to six (6) inches.
 - b) The subgrade material shall be rough graded to plus or minus one tenth (± 0.1) foot of the final rough grade, which will allow the Contractor to achieve final finished grade through the placement of the topsoil.
 - c) The surface of the subgrade shall be scarified to a depth of two (2) inches to provide a transition zone between the subgrade and the topsoil. Place the topsoil on the subgrade and fine grade to the final finished grade and topsoil depths as indicated on the drawings and in these specifications.
 - d) Any required soil amendments (i.e. mulch, organic matter, etc.) shall be placed directly on the topsoil at the required rates and spread evenly over the planting area. The amendments shall then be thoroughly blended into the topsoil to a depth of four (4) inches. Where only a dry, granular fertilizer is to be added, it may be applied to the surface and raked in during the fine grading procedures.
 - 4) The Contractor shall maintain a minimum of two (2) percent drainage away from all buildings, structures, and walls. Finished grades shall be smoothed to eliminate puddling or standing water.
 - 5) All finished grades shall be approved in writing by the Owner or Owner's Authorized Representative prior to installation of any plant materials.

Sub-section D. Plant Condition

- 1) All precautions customary in commercial landscape installation practice shall be taken in preparing plants for planting. Workmanship that fails to meet these minimum standards shall be rejected. All balled and burlapped plants shall have firm and natural balls of earth around their roots. No plant shall be planted if the rootball is cracked or broken, either before or during the process of planting. Loose, broken or manufactured rootballs shall be rejected.
- 2) All plants materials in five (5) gallon containers or larger shall have been established in that container for a period of not less than six (6) months and not more than two (2) years. Plant material shall not be root bound. They shall exhibit sound, healthy, and vigorous growth and be free from diseases and pests.
- 3) The Contractor shall have the Owner or Owner's Authorized Representative approve plant material size and quality prior to installation. Any plants which are not true to form, appear stressed or unhealthy, are infested with pests, infected with disease, or are undersized for their containers shall be rejected.
- 4) All plant material shall be planted as soon upon arrival on the premises as possible. If planting cannot be done immediately, the roots shall be protected from the sun and kept in a moist condition until the time of planting. Such protection may be provided by laying the plants on the north side of the building and covering the roots with wet straw.
- 5) If it is anticipated that planting will not be done for more than twenty-four (24) hours after the arrival of plants upon the premises, the balled and burlaped stock shall be heeled-in on the north side of a building and all roots completely covered with dirt which shall be wetted down frequently. Care will be taken in the handling of all ball and burlap materials so that the earth around the roots is disturbed as little as possible.

Sub-section E. Placement of Plants

- 1) Plants shall be generally located as indicated by the drawing. The Contractor shall stake out the location of all plants and planting areas with identified plant stakes, and no excavation shall commence until such locations have been approved by the Owner or Owner's Authorized Representative.

- 2) In the event that underground construction work or obstructions are encountered during excavation of the plant holes, alternate locations will be assigned and approved by the Owner or Owner's Authorized Representative.
- 3) Except for turf and groundcovers, plants shall not be placed within twenty four (24) inches of sprinkler heads.
- 4) The Contractor must locate and stake any sprinkling head or valve box within 10' feet of proposed tree location, and must establish the direction of the lateral or main irrigation line that serves the staked sprinkler head or valve box. This procedure will help eliminate hitting underground irrigation pipes.

Sub-section F. Plant Installation

- 1) All concrete work, sprinkling systems, and finished grading shall be completed and approved by the Owner or Owner's Authorized Representative before any planting of the specified plant materials is begun.
- 2) No tree planting shall be initiated until sprinkling system is complete and tested. However, tree planting shall precede lawn planting.
- 3) Each plant will be placed in an individual plant pit. The sharing of pits shall not be allowed.
- 4) All trees and shrubs shall be planted in pits as detailed in the planting details contained herein or as noted on the drawings. Tree and shrub pits shall be circular in outline, with a diameter at least two (2) times the diameter of the rootball of each plant to be installed. They shall be one to two and one half (1 - 2 ½) inches shallower than the rootball depth. When the plant is properly placed in the plant pit, the root collar shall be approximately one (1) inch above finished grade. The sides of the plant pit shall be roughened, and not smooth or sculpted.
- 5) Plant backfill mix shall be one hundred (100) percent native site soil.
- 6) For container grown plants, remove the container and place the plant vertically in the plant pit, directly on undisturbed soil. The root crown or collar shall be at or just above the finished grade.
- 7) For balled and burlapped plants, place the plant vertically in the center of the pit, with the rootball resting on undisturbed soil. Cut and remove the wire basket and burlap or other wrapping material from the rootball. This may be done with the rootball in the pit. Any burlap or wire pieces underneath the rootball may be left in place if they cannot be removed. Do not fold the burlap over, but cut away as much as possible without disturbing the rootball. No burlap shall be pulled from under the rootball. Backfill the bottom one third (1/3) of the pit as the wire and burlap are removed. In all cases, maintain the integrity of the rootball.
- 8) Specified backfill material shall be carefully and firmly worked and tamped under and around the rootball to fill all voids. When backfilled and compacted to two thirds (2/3) the depth of the pit, thoroughly water with a hose to completely soak the roots and remove any air pockets.
- 9) The plant pit shall then be completely backfilled with the specified backfill mix and tamped well. A shallow watering basin or rain cup shall be formed around each plant. This basin will be equal in diameter to that of the original planting pit.
- 10) Monitor all plants to insure that no settling occurs. Pits which settle shall be immediately filled with additional soil mixture at no additional expense to the City.
- 11) After planting, the following operations shall be performed:
 - a) Stake and mulch all trees per installation details.
 - b) Remove all nursery stakes ties, and tags from all plants. Prune and remove any dead, damaged, or broken branches. Maintain side growth on all trees.

Sub-section G. Staking

- 1) All trees, including evergreen trees, shall be staked.
- 2) Staking shall be performed as follows:
 - a) Two (2) 2" x 2" square or 2" diameter round wood stakes, eight (8) feet in length, shall be used to support each tree planted under this contract unless otherwise indicated.
 - b) Tree ties shall conform to the staking detail shown on the planting detail sheet.
 - c) Each stake will be located adjacent to the rootball, on opposing sides, to provide maximum support to the trunk. Do not penetrate the rootball with the stake.
 - d) The stakes will be driven into the pit bottom after the tree has been placed in the pit, but before backfilling begins so as to avoid damage to the roots.

- 3) Stakes and ties shall be removed after one (1) full growing season from the time the tree was installed.

Sub-section H. Watering

- 1) All plants shall be thoroughly watered immediately after planting. This shall mean full and thorough saturation of all backfill in the pits and beds during the same day of planting. Water shall be applied only by open end hose at very low pressure to avoid creating air pockets, causing injury to the plant, or washing away of backfill. When installed, watered, and fully settled, the plants shall be vertical.
- 2) Subsequent watering shall be provided by the site's irrigation system. The Contractor shall insure that all plants, especially trees, receive sufficient water to maintain healthy growth and vigor. Overwatering shall be avoided, and prolonged saturation of the soil around the trees shall be eliminated by appropriately controlling the irrigation circuit which provides water to that area.

Sub-section I. Mulching

- 1) Shredded bark mulch shall be placed to a depth of three (3) inches on top of the topsoil in all planting beds and over tree planting pits.
- 2) The finished grade of the bark mulch shall be as follows:
 - a) Two (2) inches below the surface or finished grade of any paving, mowstrips, or walks adjacent to the planting area.
 - b) At adjacent finished grade of the turf surrounding tree planting pits.
- 3) In tree pits, the bark shall be kept six (6) inches away from the base of the tree.
- 4) Just prior to placement of the mulch, the Contractor shall treat the mulched areas with a pre-emergent herbicide according to the manufacturer's recommendations.

Sub-section J. Sod Installation

- 1) Sod shall be obtained only from approved sources. The sod shall have been mowed regularly and carefully maintained from planting to harvest.
- 2) The sod shall be free of grassy and broad-leaf weeds, contain no bare or burned spots, and be clean and strongly rooted. It shall be of the varieties noted on the plans and notes.
- 3) The sod shall be cut using approved methods and equipment. It shall be cut in pieces not exceeding one (1) square yard, with a minimum of one (1) inch and maximum one and one half (1 ½) inch thickness. For very large turf areas and all athletic fields, large roles of sod shall be used. Sod shall be placed using equipment specifically designed to lay large sod roles.
- 4) The Contractor shall notify the Owner or Owner's Authorized Representative of the source of the sod prior to placement. The sod shall be stripped and delivered to the site not more than twenty four (24) hours prior to laying. The sod shall be maintained in a moist and healthy condition to encourage immediate growth.
- 5) The following procedure shall be followed when installing the sod:
 - a) Lay the sod on smooth, moist topsoil, working off planks if required.
 - b) Rake the topsoil to loosen and level prior to placing each course of sod.
 - c) Lay strips perpendicular to the direction of the slope. Strips shall be parallel to each other, with their end seams staggered. The sod shall be neither stretched nor overlapped, and all joints shall be butted tightly together.
 - d) Roll the sod immediately after placing and thoroughly water with a fine spray to a depth sufficient that the underside of the new sod and the soil immediately below the sod are thoroughly wet.
 - e) On slopes two (2) horizontal to one (1) vertical or steeper, lay the sod perpendicular to the slope and secure every row with wooden pegs at two (2) feet maximum on center. Drive the pegs flush with the soil portion of the sod.

Sub-section K. Hydroseeding

- 1) General:
 - a) Hydroseeding operations (application) for turf grass shall be completed no later than September 1 of any given year. Hydroseeding not completed by then shall be postponed

- until the following spring on a date mutually agreeable to both the Contractor and the Owner.
- b) Wood fiber mulch shall be virgin wood fiber, free of growth- or germination- inhibiting substances. The mulch shall be air dried with not more than fifteen (15) percent moisture by weight. The total organic weight shall be a minimum of ninety eight (98) percent. Inorganic ash content shall be 0.7±0.2 percent. Water holding capacity shall be 1000G/100G (oven dried weight). The pH range shall be 4.0 - 6.0. The fiber length shall meet the following:
 - i) Fifty (50) percent shall be at least 0.15 inches in length or longer.
 - ii) Fifty (50) percent shall be retained on the twenty eight (28) mesh screen. It shall be Echofiber or Conwed or approved equal.
 - c) The seed mix shall be as specified on the plans. Provide written certification that the seed conforms to Utah seed law and is in compliance with Utah State Department of Agriculture regulations.
 - d) The tackifier shall be M-Binder or Plantego or equal.
 - e) Application rates shall be as follows:
 - i) Wood fiber mulch 50 pounds (min.)/1,000 SF
 - ii) Seed mix See plans (7 pounds/1,000 SF typ.)
 - iii) Tackifier..... 100 pounds/Acre
 - iv) Fertilizer..... 7 - 8 pounds/1,000 SF
 - v) Water..... 92 gallons/1,000 SF
- 2) One-step preparation and application of hydroseed mulch shall be as follows:
- a) The wood fiber mulch, seed, tackifier, fertilizer, and water shall be mixed together in a hydroseeding machine having a capacity of at least two thousand (2,000) gallons to allow for a homogeneous slurry which is thoroughly mixed and can be applied easily without clogging. The machine shall be mounted on a traveling unit which is either self-propelled or drawn by a separate unit. Equipment used in the hydroseeding process shall be thoroughly cleaned of all seed and other materials used in any previous hydroseeding process, prior to hydroseeding on this project.
 - b) The equipment shall have a built in agitation system and operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing not less than fifty (50) pounds of organic mulching amendment plus chemical additives and solids for each one hundred (100) gallons of water.
 - c) The slurry shall be prepared at the site and its components shall be mixed to supply the rates of application as specified. The slurry preparation shall begin by adding water to the tank when the engine is at one half (½) throttle. The engine throttle shall be open to full speed when the tank is one half (½) filled with water. All organic amendments, fiber, and chemicals shall then be added by the time the tank is two thirds (2/3) to three fourths (3/4) full. At this time and not before, the seed mix shall also be added. Spraying shall commence immediately when the tank is full and the slurry is mixed.
 - d) Apply the hydroseed to form even appearing cover over the required areas. The slurry shall be applied in a downward drilling motion via a fan stream nozzle. It is important to ensure that all of the components enter and mix with the soil. Use only qualified and trained personnel to insure uniformity of the hydroseed applications.
 - e) The hydroseeding slurry components shall not be left in the hydroseed machine for more than two (2) hours in order to avoid seed deterioration.
- 3) A two-step hydroseeding procedure may be used in lieu of the one-step method. The two-step procedure shall consist of first sowing the seed mix by broadcasting, and second, applying the hydromulch. Specifically, this procedure shall conform to the following:
- a) The seed shall be broadcast over the planting bed at the rates noted in the plant schedule. The seed shall be sown in two (2) perpendicular directions with a cyclone seeder or other similar mechanical seeder. Lightly rake the seed into the soil.
 - b) Apply a fine spray watering immediately after each area has been sown.
 - c) Prepare and apply hydromulch slurry (minus the seed mix) according to the procedure outlined in 3.11 B, steps 1 through 5 above.

Sub-section L. Clean Up

- 1) Throughout the course of planting, excess and waste materials as well as excavated subsoil shall be continuously and promptly removed. All areas shall be kept clear and all reasonable precautions taken to avoid damage to existing structures, plants, and grass.
- 2) When planting has been completed in an area, it shall be thoroughly cleaned of all debris, rubbish, subsoil, and waste materials. These shall be removed from the property and disposed of legally. All planting tools shall also be put away.
- 3) The ground surface shall be left in a condition satisfactory to the Owner or Owner's Authorized Representative.

Sub-section M. As-Built Documents

- 1) The Contractor shall keep a record of all departures from the working drawings that occur during construction. These changes shall be shown on a clean set of prints, and the prints kept on the job site at all times for review.
- 2) As a part of his observation work, the Owner or Owner's Authorized Representative shall review the as-built drawings regularly to verify that changes are being recorded. At the conclusion of the work, the Contractor shall present the drawings to the Owner or Owner's Authorized Representative and they shall become part of the permanent record of the project.

Sub-section N. Maintenance

- 1) Substantial Completion:
 - a) At substantial completion of all planting work outlined in these plans, the Contractor shall contact the City to arrange for a walk through to verify that all aspects of the work have been completed. Work must be fully completed (except for final clean-up) according to all plans, notes, and specifications and exhibit professional workmanship. Substantial completion shall be defined as the complete installation of all plant materials, staking, mulching, and other work on the project in its entirety. Substantial completion shall not be given on designated portions of the project.
 - b) Notice by the Contractor shall be given, in writing, at least three (3) days in advance to the Owner or Owner's Authorized Representative so that proper scheduling can be made for those who are to attend.
 - c) At the appointed time, an inspection of all plant materials, including staking and mulching, shall be made.
 - d) A list of uncompleted items (punch list) shall be generated by the Owner or Owner's Authorized Representative and distributed to the Contractor and other involved parties within three (3) days of the substantial completion inspection. Each item on the punch list shall be corrected before the project will be approved and accepted by the Owner or Owner's Authorized Representative. The Contractor will be back charged for time spent by the Owner and any consultants who have been brought to the site for a final inspection when the project is not ready for said inspection.
- 2) Maintenance/Establishment Period:
 - a) The maintenance/establishment period shall begin one (1) day after the substantial completion inspection. The Contractor shall complete all punch list items during this period, as well as maintain and operate the entire irrigation system.
 - b) In cases where the maintenance/establishment period runs beyond October 15 of any given year, the balance of the maintenance/establishment period days shall be extended into the spring of the following year. Counting of the balance of days shall begin no sooner than April 15, unless mutually agreed upon by both the Contractor and the City prior to that date. Early counting shall be based on weather conditions at the time.
 - c) The Contractor shall maintain all plantings until the turf is fully established. The turf shall be considered fully established when grass stands come in uniform and thick, with no bare or thin spots, and roots have begun to spread and knit together. No weeds shall be allowed in the grass. The maintenance period shall be a minimum period of sixty (60) days. If the turf grass is hydroseeded, the Contractor must complete the hydroseeding by September 1.
 - d) The maintenance work required shall include but not be limited to the following:
 - i) Appropriate watering of all plant materials.
 - ii) Weeding and removal of all weeds from groundcover and planting areas.

- iii) Replacement of any dead, dying, or damaged trees, shrubs, perennials, or groundcover.
 - iv) Filling and replanting of any low areas which may cause standing water.
 - v) Adjusting or sprinkler head heights and watering patterns.
 - vi) Filling and recompaction of eroded areas, along with any required reseeding and/or replanting.
 - vii) The grass shall be mowed when the blades reach three (3) inches tall and maintained to a minimum height of two (2) inches. No more than one third (1/3) of the blade shall be removed per cutting. The cutting frequency shall be once every five (5) to seven (7) days depending upon grass height and growth rate.
 - viii) Weekly removal of all trash, litter, clippings, and all foreign debris.
 - ix) At thirty (30) days after planting, a balanced fertilizer (16-16-16) shall be applied to the grass areas at a rate of one half (1/2) pound of nitrogen per one thousand (1,000) square ft.
 - x) At intervals of thirty (30) days after the first application of fertilizer to the grass, apply a balanced fertilizer (16-16-16) at a rate of one half (1/2) pound of nitrogen per one thousand (1,000) square feet until the grass is established.
- 3) Final Acceptance:
- a) A final inspection shall be held prior to the end of the maintenance period to insure that all punch list items have been completed and the entire project is ready for acceptance by the Owner.
 - b) Upon satisfaction that the Contractor has completed all punch list items, the irrigation system is fully and completely functional, and the required As-Built drawings, mylars and maintenance manuals have been submitted, the Owner shall accept the project.
 - c) An official letter of final acceptance shall be prepared and issued to the Contractor, designer, and the Owner or Owner's Authorized Representative. Upon final acceptance of the project by the Owner or Owner's Authorized Representative, the Owner shall assume full responsibility for the project, and the guarantee period shall begin.

Sub-section O. Guarantee

- 1) Upon final acceptance of the project as being properly installed, the Contractor shall guarantee the plant materials as follows:
 - a) All shrubs and groundcovers shall be guaranteed by the Contractor as to growth and health for a period of sixty (60) days after completion of the maintenance period and final acceptance.
 - b) All trees shall be guaranteed by the contractor to thrive and grow in an acceptable upright position for a period of one (1) year after completion of the maintenance period and final acceptance.
- 2) The Contractor shall, within fifteen (15) days after receiving written notification by the Owner or Owner's Authorized Representative, remove and replace all guaranteed plant materials which die or become unhealthy or appear to be in a badly impaired condition at any time during the guarantee period. Any plants that settle below or rise above the desired finished grade shall also be reset to the proper grade.
- 3) All replacements shall be plants of the same kind, size, and quality as originally specified in the "plant list" and they shall be furnished, planted, staked, and maintained as specified herein at no additional cost.
- 4) The Contractor will not be responsible for plants destroyed or lost due to occupancy of the project, vandalism on the part of others, or improper maintenance or lack thereof.
- 5) At the conclusion of the guarantee period and prior to final inspection of the plant materials by the Owner or Owner's Authorized Representative, the Contractor shall remove all tree stakes. This period of time shall be approximately 1 year after initial planting.
 - a) Stakes shall be removed by first cutting the ties securing the tree to stakes and secondly pulling stakes or guys out of the ground.
 - b) Stakes shall not be broken off above, at, or below ground levels but removed completely.
- 6) At the conclusion of the guarantee period a final inspection of all planting included in this contract shall be made by the Owner or Owner's Authorized Representative. At that time any plant found to be unhealthy, broken, damaged, or otherwise in an impaired condition shall be noted. Plants so noted shall be removed immediately from the site by the Contractor and

replaced by him, as specified under this section, with plants of like kind and size in the manner previously specified for the original planting without extra compensation.

(Division 20 was last updated June 2015)