



PUBLIC WORKS CONSTRUCTION CODE

CITY OF TUALATIN

COMMUNITY DEVELOPMENT DEPARTMENT

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TUALATIN, OR 97062-7092

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ENGINEERING MANAGER

CHAPTER 300

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301 MOBILIZATION

301.1.00 General

This section covers, but is not limited to, work necessary to obtain all bonds, insurance, licenses, and permits; move in personnel and equipment; set up all offices, buildings, and facilities; provide all required light, power and water; construct project information signs if required; prepare for construction; demobilize including removal of all facilities and clean up.

301.2.00 Materials

Provide all materials required to accomplish the work as specified.

301.3.00 Workmanship

301.3.01 General

Set up construction facilities in a neat and orderly manner within designated or approved work area. Supply all labor and equipment necessary to accomplish the work as specified. Conform to applicable requirements of the GENERAL SPECIFICATIONS including, but not limited to required notifications, protection of surveying monuments and other markers, temporary traffic control, temporary utility connections, protection of property, and dust control.

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302.0.00 TRAFFIC CONTROL

302.1.00 General

Prior to the issuance of the Permit, the Contractor shall provide to the City Engineer a proposed traffic control plan. The traffic control plan shall be prepared in accordance with this Code, and the "2003 Manual of Uniform Traffic Control Devices".

The Contractor shall provide for the safe and proper routing of vehicular and pedestrian traffic in a manner that will minimize congestion and delay, and shall furnish, install, and maintain all construction signs and detour signs, temporary signs, temporary striping and pavement markings, lights, flares, barricades, cones, guard rail, runways, pavement, bridges, stairs, and other devices and facilities necessary to safeguard the general public and the work. Such devices and facilities shall be relocated as necessary to accomplish the proper routing of traffic as the work progresses and when no longer needed, shall be removed from the site of the work.

The Contractor shall conduct his/her operations with proper regard for the convenience of the public and shall not unnecessarily obstruct or discontinue any public street, way, sidewalk, or access to properties.

The Contractor shall notify the City Engineer, Fire Department, other Emergency Services, Police Department, appropriate School District, and Tri-Met before closing any street or portion of a street. No closing shall be made without the City Engineer's approval. Notify those departments when the streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets without special written permission from the Fire Department. Conduct operations with the least interference to the fire equipment access, and at no time prevent such access.

The Contractor shall leave his/her night emergency telephone number or numbers with the City Engineer, Police Department, and Fire Department, so that contact may be made easily at all times in case of barricade and flare trouble or other emergencies.

302.2.00 Work Hour Restrictions

To reduce impacts on traffic and the public, all work on collectors and arterials (as defined and listed in the Tualatin Development Code) shall be subject to the following restrictions:

1. In non-residential areas, the work shall be performed between the hours of 7:00 p.m. and 5:00 a.m., unless otherwise approved by the City Engineer.
2. In residential areas, and areas of exception to 1. Above, no work that impedes traffic in any way will be allowed between the hours of 6:00 a.m. and 9:00 a.m. and between the hours of 3:00 p.m. and 6:00 p.m.

The City Engineer may revise, reduce, or extend the work hour restrictions, and apply restrictions to work in local streets, as necessary to reduce and minimize impacts to traffic.

The Contractor shall conduct its operations such that no work occurs during the restricted time periods. If at any time the Contractor's operations extend into the restricted time periods, all permit work shall immediately cease.

302.3.00 Project Information Signing

On all public works permit projects, including franchise utility projects, where the work duration will exceed one week, the Contractor shall provide and install project information signs.

The signs shall be a minimum of 48" x 60" and shall contain the following information:

Project: _____
Estimated Duration: ____ (Date) ____ to ____ (Date)
Project Owner: _____
Project Contractor: _____
For More Information Contact: ____ (name / phone #)

The signs shall consist of 4" to 6" black letters on a white background, and the signs shall be the product of a commercial sign manufacturer.

The Contractor shall prominently display the signs so that they are visible to the public with one sign facing each direction of traffic, as directed by the City Engineer. No project work will be allowed until the installation of the information signs is complete, and the Contractor shall maintain the signs through the duration of the project.

302.4.00 Maintenance Of Traffic

The Contractor shall not store, stockpile or place on a public street, way or sidewalk, any equipment, materials or supplies without first obtaining the authorization of the City Engineer and then only within the limits the City Engineer may designate.

Those parts of public streets, ways and sidewalks that are occupied by the Contractor shall be immediately vacated by the Contractor and returned to public use when his/her use thereof is no longer necessary for the prosecution of the work.

The Contractor shall not impede, at any time, free access for vehicles and pedestrians to warehouses, offices, dwellings, garages and other properties in the vicinity of the work and on adjacent streets. The Contractor shall provide for local access by phasing operations,

bridging or employing other approved means, however, he/she may make special mutual arrangements with occupants and the City Engineer for temporary impediment of such access.

The Contractor shall maintain postal service facilities in accordance with the requirements of the U.S. Post Office Department. The Contractor shall move mailboxes to temporary locations designated by the Post Office Department, and at the completion of the work in each area, replace them in their original location and in a condition satisfactory to the U.S. Post Office Department.

302.5.00 Diversion Of Vehicular Traffic

When it becomes necessary to close one or more lanes to vehicular traffic or to otherwise divert such traffic from its normal paths, the Contractor, upon approval of the City Engineer, shall clearly delineate a temporary centerline separating two-way traffic, and dividing lines for other temporary traffic lanes, by employing cones, barricades, reflectors or other approved methods or devices. Placing of devices shall commence sufficiently in advance of the obstruction or other cause of the diverting of traffic, to minimize congestion and shall enable traffic to enter, traverse and leave the site of the work without abrupt or unwarranted changes in direction. The Contractor shall not place devices in the roadway until the City Engineer has approved the type of device and its location.

302.6.00 Use Of Construction Area Signs, Lights, Barricades, Delineators And Other Devices

Construction area signs, lights, barricades, delineators and other devices furnished by the Contractor for use on an existing public travel way shall be in accordance with the "2003 Manual of Uniform Traffic Control Devices" (MUTCD). Regulatory and construction signs shall conform to OSHD specifications and drawings. During the hours of darkness, approved lights shall be maintained in sufficient numbers, in proper working order, and locations to adequately alert approaching traffic.

All construction area signs shall conform to the dimensions, color, legend and reflectorization or lighting requirements of the plans, the 2003 MUTCD and these special provisions. All sign panels shall be the product of a commercial sign manufacturer, but used sign panels, in good repair as determined by the City Engineer, may be furnished.

Construction area signs shall not be used until needed and when no longer needed they shall be removed from the site of the work. The Contractor may be required to cover certain signs during the progress of the work.

Covers for construction area signs shall be of sufficient size and density to completely block out the message so that it is not visible either during the day or night and shall be securely fastened to prevent movement by wind action.

Signs damaged by any cause shall be repaired or, if determined by the City Engineer to be irreparable, replaced by the Contractor at the Contractor's expense. To properly provide for changing traffic conditions and damage caused by public traffic or otherwise, the Contractor shall be prepared to furnish on short notice additional construction sign panels, posts and mounting hardware or portable sign mounts. The Contractor shall maintain an inventory of the commonly required items at the job site or shall make arrangements with a supplier who is able, on a daily basis, to furnish such items on short notice.

Prior to starting work which will affect the normal flow of traffic, the Contractor shall furnish and install, wherever necessary or directed by the City Engineer, approved signs mounted on pedestals, posts, barricades or other supports which will orient the sign vertical and normal to the direction of traffic.

Barricades shall be furnished and maintained by the Contractor to channelize traffic in the normal path of travel or to direct traffic along a limited channel. Delineators include lane, edge and channelizing striping, raised pavement markers, various forms of posts, and cylindrical or cone shaped objects commonly known as delineators. Delineation for night time use must be reflectorized.

302.7.00 Relocation And Removal Of Existing Permanent Traffic Control And Other Signs

On projects, such as rechannelization and street widening work, where changes in traffic patterns require either relocation, removal or installation of permanent regulatory traffic control and other signs, the Contractor shall relocate, remove or install signs and standards shown on the plans, or directed by the Engineer.

For all existing permanent traffic control signs which are to be removed and not relocated, the Contractor shall remove signs, hardware and standards and place them where directed by the City Engineer. Any signs, standards or hardware damaged by the Contractor through his/her negligence shall be replaced by the Contractor, at no cost to the City.

Temporary relocation of each STOP or other traffic regulatory sign shall be done by the Contractor immediately upon its removal. The relocation of each sign shall be as close as possible to the original position of the sign or as directed by the City Engineer.

302.8.00 Use Of Flaggers

During the time of any approved temporary use of any part of the roadway where traffic must be directed through or around the work, the Contractor shall provide trained and properly equipped flaggers, whose sole duty shall be to assist the movement of traffic through or around the work, as applicable.

303.1.00 General

This section covers work necessary for the completion of all clearing and grubbing including, but not limited to, the removal and disposal of all debris and vegetation such as stumps, trees, logs, roots, shrubs, vines, grass and weeds, and the removal of curbs, pavement, driveways and other structures as required.

303.2.00 Workmanship**302.2.01 General**

Clearing and grubbing shall consist of the removal of trees, stumps, debris, plant materials, curbs, pavement, driveways, guard rails, barbed wire fence, and other structures as required. Existing catch basins, culverts, or similar structures which are to be abandoned shall be removed.

Areas to be excavated or occupied by embankment, shall be cleared of all grass and other plant material and all stumps shall be completely removed by grubbing, or other suitable means. All roots and other embedded wood shall be removed to a depth of not less than one foot below the limit lines of excavation. Holes resulting from any grubbing operations shall be filled with suitable materials and thoroughly compacted.

The area on which clearing and grubbing is to be performed shall normally be the area within the right-of-way or slope easements or any area affected by the improvements, or on each side of the roadway centerline to a width of two feet outside of excavation and embankment slope lines or in the case of private driveways, one foot outside of the excavation and embankment slope lines for the driveway.

Where portions of existing driveways and streets are to be removed, the Contractor shall sawcut the driveway and street at the limits of removal. The removal operation shall be performed without damage to any portion of the existing driveway or street that is to remain. Any damage to the existing driveway or street which is to remain in place shall be repaired to a condition equal to that existing prior to the beginning of removal operations. The cost of repairing existing concrete damaged by the Contractor's operations shall be at his expense.

Protect all trees, shrubbery, and other vegetation, not designated for removal, from damage caused by the work as directed. Cut and remove tree branches only where approved. When directed, remove branches other than those required to provide a balanced appearance of any tree.

The Contractor shall give reasonable notice to occupants or owners of adjacent property to permit them to salvage or relocate plants, trees, fences, sprinklers, and other improvements within the right-of-way which are designated for removal and would be destroyed because of the work.

303.2.02 Disposal of Waste Material

Remove and dispose of all waste materials or debris at approved disposal sites.

303.2.03 Backfilling and Cleanup

In areas not subject to future excavations, fill all holes and depressions caused by clearing and grubbing with material acceptable to the City Engineer and reshape area to conform to adjacent undisturbed topography.

Leave work area in a clean and sightly condition, free from litter and debris.

304 ROAD EXCAVATION AND EMBANKMENT

304.1.00 General

304.1.01 Scope

This section covers the work necessary for excavation, construction of embankment, foundation stabilization, and disposal of excess material required in construction of the street improvements.

304.2.00 Materials

304.2.01 General Excavation

Excavation is unclassified. Excavate all materials regardless of formation encountered. Contractor shall make his own estimate of the kind and extent of materials that may be encountered.

304.2.02 Embankment Foundation Excavation

Excavate all unsuitable material where indicated on the plans or established by the City Engineer and made for the purpose of preparing and stabilizing embankment foundations within areas to be occupied by embankments.

304.2.03 Embankment

Embankment shall be suitable excavated materials originating from the project site or where necessary, an approved imported material. The embankment materials shall be free of peat, humus, muck, organic matter, debris, rock fragments in excess of 6 inches in dimension, or other materials detrimental to construction of firm, dense and sound embankment. The Contractor shall make his own investigation and analysis of existing conditions to determine on-site material availability, as the amount suitable for embankment construction is unknown.

Imported material shall be from one source with reasonable grading to be approved by the City Engineer. The Contractor shall notify the City Engineer, as soon as possible, the proposed source of the material and arrange access for the City Engineer's designated geotechnical representative to obtain a test sample, if this is considered necessary.

304.2.04 Foundation Stabilization

Foundation stabilization material shall be 4" minus or 1-1/2" minus crushed rock, well graded from coarse to fine, and free of clay or organic material. A suitable geotextile may also be specified at the discretion of the City geotechnical Engineer or the designated representative.

304.3.00 Workmanship

304.3.01 Excavation

Excavation shall be carried to the lines and grades shown on the Plans and approved by the City Engineer. Special care shall be taken to not excavate below subgrade. Where the street has been excavated below subgrade due to faulty workmanship, it shall be brought to grade with base course material or other suitable material approved by the City Engineer.

304.3.03 Embankment

304.3.03A Preparation of Embankment Foundations

Prior to construction of embankments, excavate unstable or unsuitable foundation material and dispose of as directed. Limit excavation to lines, grades, and cross sections shown on the Plans or approved by the City Engineer. Scarify, moisture condition and compact natural ground underlying embankments to the depth of grubbing or a minimum of 12-inches, to percentage density specified for the embankment material to be placed. The requirement to scarify and recompact the subgrade may be waived at the discretion of the City Engineer or the City Engineer's designated geotechnical representative on the basis of proof rolling, probing, or other evaluation. On ground with slopes steeper than 5:1 (horizontal:vertical) bench into the existing slope "stair-step" fashion, approved by the City Engineer, to place the embankment material in relatively horizontal compacted lifts to prevent slippage at the embankment-existing slope interface.

304.3.03B Embankment Construction

Place embankments and fills of all kinds in approximately horizontal layers of a maximum of 8-inches in thickness and compact each layer separately and thoroughly to density specified.

In the immediate vicinity of curbs, walks, driveways, inlets, manholes and

similar structures, in holes, and where embankment and fill materials cannot be reached by normal compacting equipment, compact to specified density by approved methods.

304.3.03C Embankment Compacting and Density Requirement

Density of compacted materials in place will be determined by AASHTO T 191, T 205, or T 238 and maximum density by AASHTO T 180. Compact all embankments, fills and backfills to a minimum density in place of 91% of maximum density. Where materials are utilized that cannot be tested utilizing the above methods (such as coarse aggregates or foundation stabilization material) a method compaction specification will be required. The method compaction specification shall be provided by the City Engineer or the City Engineer's designated geotechnical representative based on the material characteristics and appropriate compaction equipment.

Perform watering of materials to provide compaction of embankments and backfills and to alleviate dust nuisance. Water by means of tank trucks equipped with spray bars, by hose and nozzle, or by other approved equal means which ensure uniform and controlled application. The use of splash boards will not be permitted without prior approval.

Embankment or backfill materials shall not be placed in final position until moisture in excess of optimum moisture has been stabilized near optimum. Fill or backfill shall be placed and compacted at a moisture content near optimum to provide a compact stable grade. Where unstable conditions are evident due to moisture deviation from optimum and/or disturbance due to construction traffic, the unstable fill shall be removed or reworked and recompacted to provide a stable grade meeting the compaction requirements outlined above.

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305 SUBGRADE

305.1.00 General

This section covers work necessary for preparation of the subgrade, complete. See also Section 303 for Clearing and Grubbing, and Section 304 for Road Excavation and Embankment.

Subgrade is defined as the area of new or existing roads, streets, alleys, driveways, sidewalks, or other public places upon which additional materials are to be placed as a part of work covered in other sections or by future work. Where applicable, subgrade is considered to extend over the full width of the specified base course. Subgrade is classified as untreated or treated.

305.1.01 Untreated Subgrade

The uppermost material placed in embankments or cuts in the normal grading of the roadbed and which is brought to true line and grade, shaped and compacted as necessary to provide a foundation for the pavement structure.

305.1.02 Treated Subgrade

Subgrade which is improved by the addition of stabilizers and prepared as in 305.1.01 Untreated Subgrade.

305.2.00 Materials

305.2.01 Soil Stabilizing Materials

Soil stabilizing materials shall conform to the following requirements:

Material	Type	Grade
Granular Quicklime (CaO)	AASHTO T 27 and T 219 for grading and hydroxide content, with min. 85% calcium hydroxide	100% passing, 3/8-inch sieve, max 25% passing, 100 sieve
Calcium Chloride	ASSHTO M 144, sample and testing in accordance with ASSHTO T 143	---
Sodium Chloride	AASHTO M 143	---
Portland Cement	ASSHTO M 85	Conform to Portland Cement in Section 310

Storage of materials shall conform to storage and protection of materials in General Specifications.

305.2.02 **Water**

Conform to the requirements in Section 306 Watering.

305.3.00 **Workmanship**

305.3.01 **Preparation**

In advance of setting line and grade, clear and dispose of brush, weeds, vegetation, grass, and debris off the subgrade. Drain all depressions or ruts which contain water. Blade and drag subgrade to remove irregularities and secure a uniform surface.

Complete all underground work contemplated in the area of the subgrade including backfill before subgrade work is started. This requirement includes work under the permit, work to be performed by the City or by others.

305.3.02 **Untreated Subgrade**

Excavate and shape subgrade to line, grade, and cross section. Compact to the depth of grubbing or a minimum of 12-inches, not less than 91% of maximum density as determined by AASHTO T 180. Testing methods for density requirements shall be determined by AASHTO T 191, T 205, or T 238. Remove all soft or otherwise unsuitable material disclosed by the proof-rolling as directed and replace with approved material. Compact to a line 1-foot beyond the edge of paving, curb, or form.

Subgrade areas which cannot be compacted to specified density, but which in the judgment of the City Engineer otherwise meet the requirements herein, may be removed and aerated or stabilized with an approved soil stabilizing material.

Contractor shall not excavate or shape subgrade in the rain.

305.3.03 **Treated Subgrade**

305.3.03A **General**

At Contractor's option, the subgrade material may be moistened and/or loosened by scarifying to the depth to be treated prior to application of the stabilizing materials, as approved.

Dry and reduce cemented soil clods to moisture content and size

specified. Shape and size the subgrade material blanket to the size that can pass through the mixing machine. Apply stabilizing materials only when temperature is above freezing, or when wind and other weather conditions are not detrimental to the work or to the public, as approved. Take all precautions necessary to prevent injury to persons, livestock, or property. Any material which is spilled or deposited at places other than on areas designated to be treated must be immediately picked up, buried, or made harmless.

305.3.03B Addition of Stabilizing Material

Apply stabilizer at a uniform rate as specified. Use equipment and methods that will ensure the uniformity of stabilizer distribution. Immediately discontinue use of any equipment or methods which result in excessive loss or displacement of the stabilizer, as directed. Replace stabilizer lost, displaced by blowing, washing, or misplaced by other causes before it is mixed with or incorporated in the soil. The use of blade graders to distribute lime and cement will not be permitted. No equipment except that used for watering and for applying and mixing the stabilizer will be permitted to pass over spread stabilizer until after it is mixed into the soil. If necessary, add water during mixing operations to provide an optimum moisture content.

Apply at a uniform rate, as specified, calcium chloride or sodium chloride or Portland Cement to the scarified subgrade in the same manner as for lime.

305.3.03C Mixing

Spread soil stabilizing material on a treated subgrade with approved equipment which uniformly distributes the required amount of material for the full width of the prepared subgrade. Continue mixing or remixing operations until the mixture is uniform, free of streaks or pockets of soil stabilizing material, and all material other than stones will pass a 2-inch sieve and at least 60 percent of which will pass a No. 4 sieve.

The stabilizing material content of samples taken periodically from the spread mixtures shall be within 1 percent of the content specified or approved.

305.3.03D Compaction

Immediately after mixing of a treated subgrade, spread the mixture to specified line, grade and cross section and compact entire depth of the mixture to not less than 91% of maximum density as determined by AASHTO T 180. Testing methods for density requirements shall be determined by AASHTO T 191, T 205, and T 238.

Compact and finish the cement treated surface within 3 hours after cement is applied and compact and finish other treated surfaces within 12 hours after compaction begins. If not compacted and finished within this time period, loosen the mixture and add stabilizing material and water as directed, remix, relay, and compact. During compaction, maintain surface of the mixture at proper grade and cross section and lightly water to retain optimum moisture content.

Accomplish final finishing by rolling accompanied by light watering and reshaping to provide a surface free of hairline cracking.

305.3.04 Tolerances

Rework areas found to be deficient in thickness by more than 0.04-foot or excessive in thickness by more than 0.08-foot, except that fresh stabilizing material shall be added in an amount equal to one-half of the original amount, as specified.

The finished surface of treated and untreated subgrade shall not vary more than 0.04-foot from established grade and cross section at any point. The finished surface, when tested with a 10-foot straightedge, shall not vary from the testing edge by more than 0.08-foot at any point.

305.3.05 Curing Treated Subgrade

Limit traffic over treated subgrade to wheel loads which do not cause any damage to the subgrade and which do not visibly deflect, ravel or wear the surface. Keep the finished surface moist and protected from rutting, spalling, displacement, and disfiguration until a subsequent course of planned construction, which will prevent drying of the mixture by evaporation or absorption, is placed thereon.

306 WATERING

306.1.00 General

This section covers work necessary to furnish and apply water or combinations of water and compatible binders or additives for roadway excavations, embankments, subgrades, road beds, backfills, subbases, bases and surfacings, and water for the alleviation or prevention of dust within the project limits, as directed.

Excluded from this section is watering used in connection with Portland Cement concrete construction, wetting foundations preparatory to placing concrete thereon, curing concrete, and watering which is specified as incidental.

306.2.00 Materials

306.2.01 Water

Water shall be free of silts and other deleterious matter. Maintain an adequate supply of water at all times, as approved. Where the Contractor proposes using water from the City's water system, including hydrants, all necessary meters and/or permits from the City Operations Department shall be obtained prior to any usage.

306.2.02 Binders and Additives

When shown, specified or directed use a mixture of water and an approved compatible binder or additive material.

306.3.00 Workmanship

Watering shall at all times be under the direction and subject to control of the City Engineer, as approved.

Water by means of tank trucks equipped with spray bars, by hose and nozzle, or by other approved equal means which ensure uniform and controlled application. The use of splash boards will not be permitted without prior approval.

Perform watering at any hour of the day and on any day of the week necessary. Sprinkle directly on the road only when loss by evaporation is at a minimum, unless otherwise directed.

When compatible binder material or additive is combined with water in the work, mix in conformance with the manufacturer's directions, as specified or as directed.

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307 GEOTEXTILE FABRIC

307.1.00 General

307.1.01 Scope

This section consists of furnishing and placing geotextile fabric in drains, under embankments and riprap, behind retaining structures, over roadbed subgrades, and beneath pavement overlays as shown on the Plans or as directed by the City Engineer.

307.2.00 Materials

307.2.01 General

The geotextile shall be composed of a polymeric yarn or fiber oriented into a stable network which retains its relative structure during handling, placement and design service life. Geotextiles may be rejected by the City Engineer if dimensional stability or resistance to ambient temperatures, acid and alkaline conditions and micro-organisms/insects does not appear to be satisfactory for the intended purpose.

307.2.02 Acceptance Requirements

Acceptance will be based on either the manufacturer's certification or the manufacturer's brochure of geotextile properties.

(a) If a manufacturer's certification is furnished, it shall state that the geotextile delivered meets or exceeds the minimum average roll values for each of the specified properties.

(b) If a brochure is furnished, it shall be current and accurate and indicate that all specified properties have been met or exceeded.

(c) The City Engineer reserves the right to require samples and to test for compliance.

307.2.03 Property Requirements

Both monofilament-woven or non-woven fabric (except pavement overlays, use non-woven fabric only) shall be furnished, manufactured specifically for use in civil engineering applications with fibers consisting of long chain synthetic polymers. Slit film or slit tape fabrics will only be permitted for subgrade or embankment applications.

The following requirements shall apply:

MINIMUM TEST VALUES

Geotextile Property	Geotextile Application				
	Drainage	Riprap	Subgrade	Embankment	Overlay
Grab Tensile Strength lbs. ASTM D 4632	180	260	180	230	80
Grab Elongation % ASTM D 4632	15	15	-	-	50
Burst Strength psi (Diaphragm Method) ASTM D 3786	290	430	290	430	-
Puncture Strength lbs. ASTM D 3787	80	110	80	110	-
Apparent Opening Size (or smaller opening) US Std Sieve ASTM D 4751)	70	70	30	30	-
Water Permeability cm./sec. ASTM D 4491	0.1	0.1	0.005	0.005	-
Ultraviolet Stability % strength retained ASTM D 4355 @ 500 hours	-	70	-	-	-
Asphalt Retention gal./sq.yd. OSHD TM 817	-	-	-	-	0.2
Melting Point F ASTM D 276	-	-	-	-	300

307.3.00 Workmanship

307.3.01 General

The geotextile shall be installed as described herein and as shown on the plans, or as directed by the City Engineer. The geotextile will be rejected if, at the time of installation, it has defects, deterioration, or damage, as determined by the City Engineer.

The surface receiving the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris, unless otherwise directed by the City Engineer. The geotextile shall be placed loosely and without wrinkles so that placement of the overlying material will not tear the geotextile, with laps as specified, at the ends and sides of adjoining sheets, adequately secured to prevent slippage. The machine direction shall be oriented up-down the slope and the upper sheets shall lap over the top of the lower sheets.

Placement of fill material shall start at the toe of the slope and proceed upwards.

Geotextile placed under water shall not progress more than 50-feet ahead of the backfill material; and when placed on soft ground allow sufficient extra fabric at the edges to maintain a separation layer between the fill material and soft ground with settlement/consolidation of the underlying soil.

307.3.02 Protection of Geotextile

Traffic or construction equipment will not be permitted directly on the geotextile and it shall be protected from surface runoff or other possible sources of contamination until the placement of cover material; uncovered conditions shall not exceed 7 days. Specified cover material shall be placed in such a manner that the textile is not torn, punctured, or shifted.

For geotextile under riprap, the Contractor shall demonstrate to the satisfaction of the City Engineer that the combination of the rock fill drop height (not to exceed 3-feet) and the thickness of any aggregate cushion, when specified or required, is adequate so as not to puncture or damage the geotextile. After placement of the riprap, all voids in the riprap face that allow the geotextile to be visible shall be satisfactorily backfilled so that the geotextile is completely covered.

For roadbed subgrade separation geotextile placement, construction vehicles shall be limited in size and weight such that rutting in the initial lift above the geotextile is no greater than 3-inches deep. The turning of vehicles on the first lift will not be permitted. Geotextile failures, as evidenced by soil pumping or roadbed distortion, shall be corrected by removing any covering material in the affected area and repairing any damaged or distorted geotextile.

All geotextiles that are torn, punctured, or contaminated during construction shall be repaired or replaced by the Contractor. The repair shall consist of a patch of the same type of geotextile placed over the affected area, overlapping a minimum of 2-feet from the edge of any part of the rupture.

307.3.03 Overlaps

Minimum overlap requirements for geotextiles are one foot for drains and two

feet for all other applications, except overlays which shall have an overlap of not more than 6-inches in the direction of the paving.

307.3.04 Overlay Sealant

Apply PBA-5 asphalt at normal application temperature at the rate of 0.20 to 0.30 gallons per square yard. A cationic emulsion may be used as approved, but do not use cutbacks.

308 BASE AND LEVELING COURSES

308.1.00 General

308.1.01 Scope

This section covers the material quality and work necessary for the construction of the base and leveling courses, including the gravel base under concrete sidewalks and driveways, complete as shown on the plans and specified under these items.

308.1.02 Subgrade Approval

Base course work shall not start until subgrade preparation work has been completed and approved by the City Engineer.

308.2.00 Materials

Aggregates for base and leveling coarse shall be crushed gravel or crushed rock conforming to the requirements contained herein.

308.2.01 Base and Leveling Course Rock

Base and leveling course rock shall conform to the following:

GRADING REQUIREMENTS

Sieve Size Passing	Base 1-1/2"	Leveling 3/4"
2"	100	
1-1/2"	95-100	
1"		100
3/4"	55- 75	90-100
3/8"		55- 75
1/4"	35- 50	40- 60
Fraction Pass 1/4"		
# 10	40- 60	40- 60

Where a tolerance range is set forth in the above grading requirements, the midpoint of the tolerance range is the target value and the product shall conform as closely as realistically possible to this target value. The purpose of the tolerance range is only to permit occasional minor variations from the target value that are, for

practical reasons, unavoidable. The determination of sizes and grading of aggregate shall conform to AASHTO T27.

LIQUID LIMIT AND PLASTICITY INDEX

Test	Test Method	Requirements
Liquid Limit	AASHTO T 89	N.P. or 33 max.*
Plasticity Index	AASHTO T 90	N.P. or 6 max.*

* When tested as specified, both the liquid limit and plasticity index test results shall conform to the following:

Percent of Material Passing # 40 Sieve	Liquid Limit (Max.)	Plasticity Index (Max.)
AASHTO T 90		
0.0 to 5.0, incl.	33	6
5.1 to 10.0, incl.	30	5
10.1 to 15.0, incl.	27	4
15.1 to 20.0, incl.	24	3
20.1 to 25.0, incl.	21	2
Over 25.0	21	0 or N.P.

FRACTURE OF ROUNDED ROCK

Fracture of rounded rock will be determined according to ODOT TM 213. Provide at least one mechanically fractured face based on the following percentage of particles retained on the ¼" sieve for the designated size:

Designated Size	Minimum % of Fractured Particles (by mass) of Material Retained on ¼" Sieve
1½" – 0 and larger	50
Smaller than 1½" – 0	70

DURABILITY

Base aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	30.0% Max.
Degradation (Coarse Aggregate):		
Passing 850µm sieve	ODOT TM 208	30.0% Max.
Sediment Height	ODOT TM 208	3.0" Max.

308.2.02 Gravel Base Under Sidewalks and Driveways

Gravel base rock shall be the same as leveling course rock described in Section 308.2.01 above.

308.3.00 Workmanship

No rock shall be placed or compacted against concrete, curb or gutter, or other structures, until seven days after the concrete has been placed, and they have been backfilled to provide lateral support.

308.3.01 Base Course

Spread base course material on the prepared subgrade to such a depth that when thoroughly compacted it will conform to the grades and dimensions shown on the Plans, with proper allowance for the leveling course hereinafter specified. The base course shall be built up in layers, none of which shall exceed 6 inches in compacted thickness. Crushed rock shall be spread in an even course of uniform thickness from vehicles equipped with spreading devices. Segregation of material shall be avoided and the material as spread shall be free from pockets of large or fine material.

In general, the spreading shall begin at the end of the work farthest from the point of loading materials. The dumping of base course materials in piles upon the subgrade will not be permitted.

After the base course has been spread and brought to line and cross section, it shall be compacted with approved equipment to achieve a minimum of 91 percent of the maximum density when tested in accordance with AASHTO Standard T 180, , as determined by the City Engineer. Sufficient water shall be added as needed to facilitate the movement of key material into the voids. Remove all soft or otherwise unsuitable material disclosed by the proofrolling as directed and replace with an approved material as specified herein.

The surface of the base course shall parallel the cross section and grade established for the top of base course within 0.04 foot.

308.3.02 Leveling Course

Spread leveling course material on the completed base course to such a depth that when thoroughly compacted, it will conform to the grades and dimensions shown on the Plans with proper allowance for the finished pavement. The leveling course shall be bladed and rolled to a true surface and cross section. The finished surface of the leveling course shall not vary more than 0.02 foot above or below the specified cross section or grade at any point. The compaction and watering of the leveling

course shall be performed as hereinbefore specified for the base course.

308.3.03 Care of the Work

Following construction of each layer and following completion of the subbase or base, the Contractor shall do such work as the City Engineer determines necessary to prevent or repair segregation, raveling or rutting, and to maintain the layer or course to specified condition until it is covered with a following layer or course, or until all permit work is completed, as pertinent.

ASPHALT CEMENT CONCRETE PAVEMENT**309.1.00 General****309.1.01 Scope**

This work consists of constructing one or more courses of asphalt cement concrete pavement, plant mixed into a uniformly coated mass, hot laid on a prepared foundation, compacted to specified density and finished a specified smoothness to the lines, grades, thicknesses, and cross sections shown on the Plans or established by the City Engineer.

Asphalt concrete shall be a hot mixture of asphalt cement (HMAC); well graded, high quality aggregate; mineral filler and additives as required.

The Contractor may substitute warm mixed asphalt concrete (WMAC) where HMAC is called for.

Warm mixed asphalt concrete is an asphalt concrete mix following all requirements of HMAC, except that through use of additives or processes, it is mixed and placed at lower temperatures.

309.1.02 Prior Approval

Asphalt concrete work shall not start until base and leveling course work has been completed and approved and all underground utility tests (e.g. mandrel, pressure test, television inspection) have been completed and approved by the City Engineer. Repair or replace curbs prior to top/final lift.

309.2.00 Materials**309.2.01 New Aggregates****309.2.01A General**

New aggregates shall be hard, sound, durable, and free of deleterious substances. No sandstone, shale, or other soft material will be allowed.

Prior to producing aggregates, the Contractor shall advise the City Engineer as to the type of bituminous mixing plant to be used and the size or sizes of coarse and fine aggregate to be produced. The supplier shall maintain current records of the test results at the plant and make them available to the

Engineer for information and use in the approval of mixtures. The Contractor shall modify or adjust crushing and screening operations as necessary to produce materials meeting the specifications. During production of aggregates, samples of each size shall be provided as frequently as the Engineer considers necessary to determine conformance to the specifications.

When treatment of aggregates with hydrated lime is required, all testing requirements will apply prior to treatment.

The aggregate shall be stockpiled and removed from stockpiles in a manner that will minimize segregation.

Provide and stockpile new aggregates and RAP aggregates according to the following requirements:

(a) General - Produce and stockpile aggregate as follows:

- (1) Separated Sizes – Advise the Engineer of the separated size(s) of coarse and fine aggregate that will be used and the proposed targets for each individual sieve size for each stockpile. If the contractor wishes to produce coarse and fine aggregates in separated sizes other than those specified, request the proposed size changes in writing, and state the proposed target value and specified tolerance for each of the individual sieve sizes of the proposed materials.
- (2) Scalping – Scalp the rock on a ¾” sieve screen deck (after it has passed through the primary crusher if quarry rock is used). The material remaining may be accepted for use by visual inspection. The Engineer may perform verification testing of the gradation. The material shall meet the following:

Table 1 - Scalping

<u>Sieve Size</u>	<u>Percent Passing (by Mass)</u>
8”	95-100
¾”	5 Max.

309.2.01B Fracture of Gravel

A minimum of 75 percent of crushed gravel retained on the 1/4-inch sieve shall have two fractured faces. A minimum of 75 percent of the material passing the 1/4-inch sieve but retained on the #10 sieve shall have one fractured face. Testing for fracture shall conform to WAQCT TM 1.

309.2.01C Sand Equivalent

Sand equivalent shall not be less than 45 when tested in accordance with AASHTO T 178, except as follows. Fine aggregate produced in two separate sizes (1/4" - #10 and #10 - 0) shall be blended together at a 1:1 ratio when testing for sand equivalent.

309.2.01D Durability

The material from which the aggregates are produced and the crushed aggregates shall meet the following test requirements.

Table 2 - Durability

Test	Test Method	Maximum Values	
		Course Aggregates	Fine Aggregates
Soundness (5 cycles)	AASHTO T 104	12%	12%
Degradation			
Passing No. 20 Sieve	ODOT TM 208	30%	30%
Sediment Height	ODOT TM 208	3"	4"
Los Angeles Abrasion	AASHTO T 96	30%	-

309.2.01E Deleterious Substances

The amount of deleterious substances in each test fraction of the crushed aggregate material shall not exceed the following values.

Table 3 - Deleterious Substances

Test	Test Method	Maximum Percentages (By Weight)
Light Weight Pieces	AASHTO T 113	1.0
Wood Particles	TM 225	0.1
Friable Particles		
Coarse	AASHTO T 112	1.0
Aggregate		
Fine Aggregate	AASHTO T 112	1.5
Flat and Elongated Pieces		
Coarse	TM 229	10.0
Aggregate		
Plasticity Index	AASHTO T 89 AASHTO T 90	0 or NP

The aggregates shall be free from all other deleterious substances such as soft or disintegrated pieces, clay, loam, or vegetative matter, either in a free state or adherent to the aggregate.

309.2.01F Coarse Aggregate Grading

That portion of the aggregate retained on a 1/4-inch sieve with allowable undersize will be known as coarse aggregate and shall be crushed rock or crushed gravel.

The grading of the separated sizes of coarse aggregate shall conform to the following target values:

Table 4 – Coarse Aggregate Grading

Sieve Size Passing	Separate Sizes (Percentage of Weight)					
	3/4" - 1/4"		3/4" - 1/2"		1/2" - 1/4"	
	Target Value	Tolerance	Target Value	Tolerance	Target Value	Tolerance
1"	100	0	100	0	-	-
3/4"	90	+/- 5	75	+/- 7	100	- 1
1/2"	60	+/- 8	8	+/- 8	95	+/- 5
1/4"	8	+/- 8	7	+/- 7	8	+/- 8
#10	5	+/- 5	5	+/- 5	5	+/- 5
#40	3	+/- 3	3	+/- 3	3	+/- 3
#200	1	+/- 1	1	+/- 1	1	+/- 1

309.2.01G Fine Aggregate Grading

That portion of the aggregate passing the 1/4-inch sieve with allowable oversize shall be known as fine aggregate and shall consist of finely crushed rock or finely crushed gravel and fine sand. No more than 15 percent by weight of natural or uncrushed material passing the #10 sieve shall be re-blended into the total fine aggregate.

The grading of the fine aggregate shall conform to the following target values.

Table 5 – Fine Aggregate Grading

Sieve Size Passing	Separate Sizes (Percentage of Weight)					
	1/4" - 0		1/4" - #10		#10 - 0	
	Target Value	Tolerance	Target Value	Tolerance	Target Value	Tolerance
3/8"	100	-1	100	-1	-	-
1/4"	93	+/- 7	90	+/- 10	100	- 1
#10	52	+/- 4	10	+/- 7	90	+/- 10
#40*	42	+/- 10	5	+/- 5	37	+/- 8
#200	14	+/- 5	2	+/- 2	12	+/- 4

* Not required for Class "E" and "F" mix aggregates.

309.2.01H Aggregate Treatment

When specified or directed, new aggregates shall be treated with lime in the following proportions to undergo an aging process.

Table 6 – Lime Treatment

<u>Separated Sizes</u>	<u>Percent Hydrated Lime (by Weight of Aggregate)</u>	<u>Tolerance (Percent)</u>
3/4"-1/4", 3/4"-1/2", 1/2"- 1/4"	0.35	+0.15
1/4"-0	1.5	+0.15
1/4"-#10	1.0	+0.15
#10-0	2.0	+0.15

Each size of aggregate shall be stockpiled separately. One of the following treatment procedures shall be used.

- 1) Dry Hydrated Lime Added to Wet Aggregates - At the time of mixing the aggregate and hydrated lime, the minimum moisture content of the coarse and fine aggregate shall be 2.5 percent and 5.0 percent, respectively. Hydrated lime, water, and aggregate shall be thoroughly mixed in a pug mill or other approved mechanical mixer and shall then be stockpiled. If the aggregate contains free water (water not adhering to the aggregate surface), the excess moisture shall be removed before adding hydrated lime. The mixed material shall remain in the stockpile for a minimum of 24 hours before being used in the production of asphalt concrete mixture.
- 2) Lime Slurry Added to Aggregates - The lime shall be added to the aggregate in the form of a slurry. The lime slurry shall contain a minimum of 70 percent water by weight. The slurry and aggregate shall be thoroughly mixed in a pug mill or other approved mechanical mixer and shall then be stockpiled. The mixed material shall remain in the stockpile for a minimum of 24 hours before being used in the production of asphalt concrete mixture.

309.2.02 Recycled Aggregates

Recycled material used in the asphalt concrete pavement shall have a maximum size of 1 inch prior to entering the cold feed. Any recycled material larger than 1 inch shall be separated by screening or broken down by mechanical means to pass a 1-inch sieve and reincorporated with the balance of the recycled material to form a mixture acceptable to the Engineer.

309.2.03 Asphalt Concrete

Asphalt concrete pavement shall be Class B or Class C, as shown on the project plans conforming to and manufactured in accordance with the applicable provisions of this section. The asphalt cement shall be PG64-22.

309.2.04 Job Mix Formula (JMF)

The contractor shall submit a complete mix design with material and mix test results to the City Engineer at least 7 days prior to paving. Should a change in source of material be made or should conditions arise which the City Engineer determines to justify, a new complete mix design with associated material tests shall be submitted for approval by the City Engineer.

Class "B" and "C" asphalt concrete shall meet the following qualifying test requirements:

Table 7 – Qualifying Test Requirements

		<u>Level 2</u>	<u>Level 3</u>
Design Method:	Base	50 Blow Marshall	75 Blow Marshall/ Hveem or Superpave
	Wearing	50 Blow Marshall	Hveem
Air Voids %		4.0	Base 4.0 Wearing 4.0 – 4.5
VMA % Minimum		½” – 14.0	¾” – 13.0 ½” – 14.0
Pass #200/Effective AC Ratio		0.8 to 1.6	0.8 to 1.6
TSR % Minimum		80	80
VFA %		65-78	65-75
IRM _R		70	70

Prior to producing any asphalt concrete pavement, the Contractor shall use a job mix formula according to one of the following options:

309.2.04A Previously Approved

The job mix formula has been approved within the previous year by the City Engineer, for the material sources to be used.

309.2.04B Contractor Provided

The Contractor may submit to the City Engineer for approval, a mix formula developed by an approved laboratory. Upon written request, plant adjustments to the JMF to establish a new JMF without a new mix design may be approved within the following tolerances:

Table 8 – Allowable JMF Variation

Aggregate Passing Sieve Size	% from JMF
1/4"	±2
No. 10	±1
No. 200	±0.5

A new JMF is required if the asphalt cement grade, additives (if any), or the source of the aggregate or RAP, change during production.

309.2.05 Composition and Proportion of Mixtures

The class of asphalt concrete to be used shall be as shown and shall conform to the following requirements:

Table 9 – Composition and Proportions of Mixtures

Sieve Size Passing	Broadband Limits		
	Class "B"	Class "C"	Class "D"
1"	99 - 100		
3/4"	92 - 100	99 - 100	
1/2"	75 - 91	90 - 100	99 - 100
1/4"	50 - 70	52 - 80	85 - 100
No. 10	21 - 41	21 - 46	37 - 57
No. 40	6 - 24	8 - 25	13 - 29
No. 200*	2 - 7	3 - 8	4 - 9
Asphalt Cement**	4 - 8	4 - 8	4 - 8

* Including Lime or Cement Filler.

** Percent of total mix by weight.

Aggregate proportions are given in percentages by weight.

309.2.06 Reclaimed Asphalt Pavement Material

The use of processed reclaimed asphalt pavement (RAP) material in the production of new asphalt concrete is optional. A maximum of 30 percent material will be allowed and the asphalt content when blended with new material shall provide properties equivalent to the asphalt specifications of this section.

The aggregates shall be hard, sound and durable and no larger than 1 inch before entering the cold feed. Blend the RAP material with new aggregate, asphalt and other constituents to provide a mix conforming to the job mix formula within the tolerances specified.

309.2.07 Tolerances

After the JMF is determined, the mixture shall conform to the formula within the following tolerances:

Table 10 – JMF Tolerances

Constituents of Mixture	Narrow Band Tolerance (from job mix formula)	
	Leveling Courses	Base and Surface Course
Aggregate passing 1", 3/4", and 1/2" sieves specified in subsection 309.2.03	Within the broadband ranges specified in subsection 309.2.03	
Aggregate passing 1/4" sieve	± 7.0%	± 6.0%
Aggregate passing #10 sieve	± 5.0%	± 4.0%
Aggregate passing #40 sieve	± 5.0%	± 4.0%
Aggregate passing #200 sieve	± 2.0%	± 2.0%
Asphalt cement	± 0.6%	± 0.5%
Moisture content at time of discharge from the mixing plant (upper limit)	0.6% max.	0.6% max.
RAP Material (if used in mixture)		±2.0%
Temperature of mixture, after adjustment, at the time placed in final position		±20°F
Temperature at mixer		325°F Max
Temperature behind paver		240°F Min

Compaction Density (lower limit):

- Normal Lift Pavement (asphalt concrete thickness 1 1/2" or greater) - 91 percent of the theoretical maximum density (AASHTO T 209).
- Control Strip Method (asphalt concrete thickness less than 1 1/2" or at Engineer's discretion) - 98 percent of target density or 91 percent of theoretical maximum density, whichever is lower.

309.2.07A Modification of Mixes

The City Engineer reserves the right to modify specified mixes for use under various traffic conditions on various segments of the work and for feathering, spot patching, and other special purposes. The Contractor shall provide mixes proportioned as directed by the City Engineer for such purposes.

Modifications of the mix as directed may require changes in the Contractor's plan and sequence of operations. Such changes shall be allowed for by the Contractor.

Upon written request from the Contractor, the City Engineer may approve field adjustments to the JMF of up to 2 percent of the aggregate passing the 1/4-inch sieve, 1 percent for the aggregate passing the #10 sieve, and 0.5 percent for the aggregate passing the #200 sieve. These field adjustments to the JMF may be made by the City Engineer provided the change will produce material of equal or better quality. The above adjustments, or any further adjustments ordered by the City Engineer, will be considered the JMF. Adjustments beyond these limits will require development of a new JMF. The adjusted JMF, plus or minus the allowed tolerances, shall be within the broadband limits.

309.2.08 Asphalt Tack Coat

Tack coat shall be cationic emulsified asphalt type CSS-1 or CSS-1h.

309.2.09 Overlay Fabric

The fabric shall be a non-woven polypropylene fabric which conforms to the following properties (AASHTO M 288:

Grab Strength, min.	80 lbs.
Elongation at Break, min.	50%
Asphalt Retention by Fabric, min.	0.20 gal./yd ²
Melting Point, min.	300°F

309.2.10 Warm Mix Asphalt Cement Additives

If WMAC is proposed for use, only Warm Mixed Asphalt Concrete (WMAC) additives or processes listed on the approved list below may be used.

WMAC Technology	Process Type	Supplier
Advera (Synthetic Zeolite)	Foaming Process	PQ Corporation
Aspha-Min (Synthetic Zeolite)	Foaming Process	Aspha-Min
Evotherm	Chemical Additive	MeadWestvaco Asphalt Innovations
Redi-Set WMX	Chemical Additive	Akzo Nobel Surfactants, Inc.
Sasobit	Organic Additive	Sasol Wax Americans, Inc.
Plant Foaming Equipment	Foaming Process	Various Suppliers

If WMAC is proposed the Contractor shall submit the proposed WMAC technology to be used and a plan for its implementation at the preconstruction conference.

309.3.00 Workmanship

309.3.01 Reinforcing Fabric

At the discretion of the Engineer, reinforcing fabric may be used as a remedial treatment to correct distress of existing pavement surfaces scheduled for Asphaltic Concrete overlay. Subsequent to this determination, reinforcing fabric shall be placed in the proper sequences of the paving operation over the designated areas.

The fabric shall be placed with equipment recommended by the fabric manufacturer and specifically designed for the purpose of laying pavement reinforcing fabric. The fabric shall be placed in an asphalt sealant without wrinkles prior to the asphalt sealant's cooling and loss of tackiness. The fabric shall be unrolled so that the bearded (fuzzy) side is down. Wrinkles ½-inch or larger in height and/or 3 inches or larger in length shall be split, laid flat, and additional tack coat applied to ensure fabric saturation.

The fabric shall be overlapped 4 to 6 inches at all joints. No joints shall be lapped with more than two (2) layers of fabric. Transverse joints shall be shingled in the direction of the paving to prevent edge pick-up by the paver. The paving operation shall closely follow fabric placement and no more fabric than can be covered up with the hot mix that working day shall be placed.

Utility covers, such as manhole lids and valve covers shall have the fabric neatly cut around to cover to allow for smooth transition of the cover to finish grade.

309.3.02 Hauling Equipment

Vehicles used for hauling asphalt concrete mixtures shall have tight, clean, and smooth metal beds equipped with covers.

Provide a 3/8-inch diameter hole near the middle of the left sidewall of the bed for temperature testing.

Coat the beds with a minimum amount of an approved material to prevent the mixture from adhering to the beds. Prior to loading, the vehicle bed shall be drained of all excess coating material by raising the truck bed, opening belly dump gates or operating the conveyor belt as appropriate.

Do not use diesel oil unless approved by the City Engineer. Its use will be terminated by the City Engineer if it is not being used as specified or is a source of contamination of the asphalt mix.

Vehicles which cause excessive segregation, which leak badly, or which the City Engineer has determined delay normal operations, shall not be used.

309.3.03 Asphalt Concrete Pavers

Pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing layers of asphalt concrete material in widths applicable to the specified typical sections, and to required thicknesses, lines, grades and cross sections.

Extensions added to the paver when used on travel lanes shall have the same auguring and screeding equipment as the rest of the paver.

The paver shall be equipped with a receiving and distribution system of sufficient capacity for a uniform spreading operation and capable of placing the mixture uniformly in front of the screed without segregation of materials.

The paver shall be designed to compensate for minor irregularities of the base on which it is supported so that such will not be reflected immediately in the surface of the layer being placed. The weight of the paver shall be supported on tracks or wheels, none of which shall contact the mixture being laid. The contact area of the screed or strike-off assembly shall be uniform over the entire width of the strip of mixture being placed.

Pavers shall be equipped with a paver control system which shall automatically control the laying of the mixture to specified slope and grade. The control system shall be automatically actuated from independent line and grade control references through a system of mechanical sensors and sensor directed devices which shall automatically maintain the paver screed in proper position to provide specified results.

The screed or strike-off assembly shall produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

309.3.04 Compactors

Rollers shall be steel wheel, pneumatic tire, vibratory or a combination of these types as specified. They shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the asphalt concrete mixture.

Rollers shall be operated at speeds recommended by the roller manufacturer. The type, number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still within the specified temperature requirement. The use of equipment which crushes the aggregate to an appreciable extent will not be permitted.

309.3.04A Steel Wheel Rollers

Breakdown or intermediate steel wheel rollers shall have a minimum gross static weight of 8 tons and a minimum static weight on the drive wheel of 250 pounds per inch of width. For finish rolling a roller with a 6 ton minimum gross static weight is acceptable and the 250 pounds per inch of width will not be required.

309.3.04B Vibratory Rollers

Vibratory rollers shall be equipped with amplitude and frequency controls capable of, and operated at, not less than 2,000 vibrations per minute and shall be specifically designed for the compaction of asphalt concrete mixtures.

309.3.04C Pneumatic Rollers

Pneumatic rollers shall be self-propelled, tandem or multiple axle, multiple wheel type with smooth-tread pneumatic tires of equal size staggered on the axles at such spacings and overlaps as will provide uniform compacting pressure for the full compacting width of the roller. Ground pressures shall be at least 80 pounds per square inch of tire contact area with a minimum total load of 2,800 pounds per tire. The maximum rate of travel of pneumatic-tired rollers shall not exceed 5 MPH.

Pneumatic-tired rollers shall be fully skirted to insulate the tires from significant heat loss during compaction.

309.3.05 Weather Limitations

Asphalt cement concrete shall be placed on an approved, dry, prepared surface, when the air temperature in the shade and the surface to be paved is not less than:

Table 11 – Ambient/Base Temperature Requirements

Individual Nominal Compacted Thickness	<u>Air/Base Temperature</u>	
	<u>Wearing Course</u>	<u>Other Course</u>
Less than 1-1/2 inch	60°F	55°F
1-1/2 inch to 2-1/2 inch	50°F	45°F
2-1/2 inch and over	40°F	40°F

Minimum ambient temperatures encountered must be ascending or forecasted to remain above the minimum for the duration of the placement.

Do not place asphalt cement concrete during rain or other adverse weather conditions, when the underlying layer is frozen, or when existing weather conditions will prevent its proper handling, finishing or compacting.

Asphalt cement concrete in transit at the time adverse conditions occur may be placed if it has been covered during transit, its temperature is satisfactory, and it will be placed on a surface free from pools or flow of water.

309.3.06 Tack Coat

Spread asphalt by means of pressure-spray equipment which will provide uniformity of application at prescribed rates. Do not apply aggregate cover material to the tack coat. Normally, asphalt shall be applied to the prepared surface at a rate within a range of 0.05 to 0.20 gallons per square yard of surface. The actual rate shall be as directed with a variation of not more than 10% from the specified rate.

Immediately before applying the tack coat, the surface shall be clean and dry. Clean all loose material by brooming, flushing with water, or other approved method. The tack coat shall not be applied during wet or cold weather, or during darkness, and shall be applied only so far in advance as is appropriate to maintain a tacky, sticky condition of the asphalt. Apply tack coat only when the air temperature in the shade is not less than the minimum air temperature for the appropriate temperature requirements in Section 309.3.04. The temperature of the emulsified asphalt shall be from 125°F to 165°F when applied. Apply tack coat in such a manner as to offer the least interference to traffic and to permit at least one-way traffic without pickup or tracking of asphalt.

The Contractor shall take care during the application of the tack coat so that no excess tack coat is applied to the gutter or curb face. Any tack coat inadvertently or inappropriately applied to the gutter or curb face shall be promptly removed.

309.3.07 Control of Line and Grade

The Contractor shall either manually or automatically control line and grade. If automatically controlled, use a floating beam device of adequate length and sensitivity to control the grade of the paver.

309.3.08 Hauling, Spreading, and Placing

309.3.08A Hauling

Hauling vehicles shall be so constructed and equipped with covers to protect against moisture and heat loss which would allow the mixture to drop below specified laydown temperatures or cause solidifying, crusting or excess moisture to occur.

If rain or cold air temperatures are encountered during any period between loading and laydown, covers shall be used to protect the mixture.

Whenever the mixture prior to laydown is found to be:

- (a) below specified laydown temperature limit, or
- (b) solidifying or crusting, or
- (c) absorbing moisture,

the mixture will be subject to rejection until corrective action has been taken.

Except for unavoidable delay or breakdown, delivery of the mixture to the paving machines shall be at a rate sufficient to provide continuous operation of the paving machines. If paving operations result in excessive stopping of the paving machine, as determined by the City Engineer, paving operations shall be suspended until the Contractor can synchronize the rate of delivery of the mixture with the capacity of the paving machines.

No loads of mixture shall be transported from the mixing plant to the point of use so late in the day as to prevent the spreading and compacting of the mixture during daylight, unless adequate lighting is provided and the work is otherwise approved by the City Engineer.

309.3.08B Spreading

The mixture shall be laid on an approved surface, spread and struck off to established grade and elevation.

The hauling or loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine nor cause vibrations or other motions which could have a detrimental effect on the riding quality of the completed pavement.

In areas where patching, irregularities or unavoidable obstacles make the use of specified equipment impracticable, the mixture may be spread with special hopper equipment with adjustable strike-off or by other equipment and means approved by the City Engineer, provided the surface finish is within a tolerance of 0.01 foot of that hereinafter set forth.

309.3.08C Placing

Asphalt shall not be placed against concrete, curb or gutter, or other structures, until seven days after the concrete has been placed, adequate strength of the concrete has been achieved, and they have been backfilled to provide lateral support.

Place the mixture in the number of lifts and courses, and to the nominal compacted thickness per lift shown on the plans. The nominal compacted thickness for any lift other than irregular leveling shall not exceed 3 inches.

When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches. The actual compacted thickness of intermittent areas of 1,000 square feet or less may exceed 2 inches, but not more than 4 inches. This may require portions of the mixture to be laid in two or more lifts.

When more than one lift of asphalt is required, no subsequent lifts shall be placed until the prior lift has adequately cooled and set sufficiently to prevent marking and has achieved minimum compaction requirements. Generally, the Contractor shall sequence his operations so that each lift of asphalt is placed on different days.

309.3.09 Compaction

309.3.09A General

309.3.09A-1 Rolling and Surface Repair

Immediately after the asphalt concrete mixture has been spread, struck off and surface irregularities and other defects remedied, it shall be thoroughly and uniformly rolled until the mixture is compacted as hereinafter set forth.

Any displacement of any course, regardless of thickness, occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised not to displace the line and grade of edges. Steel roller wheels shall be moistened with water or other approved material to the least extent necessary to prevent pickup of mixture and not cause spotting or defacement of the surface of the mixture.

Any mixture that becomes loose and broken, mixed with dirt or is any way defective shall be subject to removal and to replacement with fresh hot mixture, which shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of asphalt cement shall be subject to removal and to replacement. Removal and replacement under these provisions shall be at the expense of the Contractor.

309.3.09A-2

Temperature

The surface of each layer and of each course shall be rolled when the mixture is in proper condition. All breakdown and intermediate compaction shall normally be performed while the temperature of the mixture is above 180°F.

For WMAC, complete breakdown and intermediate compaction before the WMAC temperature drops below the threshold recommended by the additive supplier or equipment manufacturer.

When the rolling causes undue tearing, displacement, cracking or shoving the Contractor shall, with approval of the City Engineer, make changes in compaction temperature, type of compaction equipment and/or rolling procedures necessary to achieve the applicable density requirements.

No additional compactive effort with rollers in the vibratory mode shall be undertaken when the temperature of the mixture has dropped below 180°F. Finish rolling shall continue until all roller marks are eliminated.

Unless otherwise directed by the City Engineer, compaction shall be completed before the temperature of the mixture has fallen below 180°F.

309.3.09A-3

Rollers

Rollers shall move at a slow but uniform speed with the drive rolls or wheels nearest the paver. Normally rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one-half the roller width, gradually progressing to the center. On superelevated curves the rolling shall begin at the low side and progress to the high side, each trip overlapping one-half the roller width. When paving is in echelon or when abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure. Rollers shall not make sharp turns on the course being compacted and they shall not be parked on the hot asphalt mixture. Alternate trips of a roller shall terminate in stops at least five feet distant longitudinally from adjacent preceding stops.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option provided specified densities are attained.

Finish rolling shall be performed with tandem steel-wheeled rollers and shall continue until all roller marks are eliminated.

309.3.10 Density Requirements

309.3.10A Normal Lift Density Requirements

For a specified lift thickness of 1 1/2" or greater, the mixture shall be compacted to at least 91 percent of the theoretical maximum density as determined by AASHTO T 209.

309.03.10B Control Strip Density Requirements

For a specified thickness of less than 1 1/2", or at the Engineer's discretion, the asphalt concrete shall be compacted to 98% of the target density established by the control strip procedures described below, or compacted to 91% of the theoretical maximum density as determined by AASHTO T 209, whichever is the lower value.

Complete breakdown and intermediate compaction of each layer and each course by applying the established rolling procedure (pattern and equipment) before the temperature of the asphalt concrete has fallen below 180 degrees F, unless otherwise specified or directed by the Engineer.

Compaction shall be performed with steel-wheeled vibratory and/or pneumatic tired rollers. It is recommended at least one pneumatic-tired roller be used in the breakdown or intermediate compaction sequence.

At the beginning of the work on each course of pavement, construct a control strip at least 200 feet long that is:

- part of the roadway;
- placed to the specified width and thickness;
- composed of the same materials as the rest of that course;
- compacted with the same equipment as the rest of that course.

The control strip shall be compacted with at least four coverages by the rollers, excluding finish rolling. The density obtained during the compaction process will be monitored by testing the compacted surface with a nuclear gauge. Roller coverages shall be continued until the density tests indicate that maximum density has been achieved. Once maximum density has been achieved, five density tests will be taken at randomly selected sites within the control strip. The average of these five tests will be established as the Target Density. The equipment and roller pattern used to obtain the maximum density in the control strip shall be designated as the established rolling procedure and thereafter be used for compaction until a new procedure is established by another control strip.

A new control strip shall be constructed when:

- there is a new job mix formula;
- a change in equipment or roller pattern is proposed;
- a new lift of pavement is started;
- the Engineer determines that the target density being used is suspect.

309.3.10C Modification of Compacting Requirements

On detours and in areas of restricted width or limited length where the City Engineer determines that it is impracticable to achieve compaction to a specified density, compaction shall be achieved in conformance with the following:

309.3.10C-1 Restricted Areas

Compacting of restricted width or limited length areas with sufficient width (normally 8 feet or more) shall be performed with a steel-wheeled roller having a minimum gross static weight of 8 tons and a minimum static weight on the drive wheel of 250 pounds per inch width, or with a pneumatic tired roller. The mixture shall be compacted with at least four coverages by the roller and such additional coverages as the City Engineer may elect.

309.3.10C-2 Irregular Areas

Along curbs and walls, on walks, irregular areas, and other areas not practicably accessible to specified rollers, the mixture shall be compacted with small self-propelled rollers, mechanical tampers, hot hand tampers or heavy hand rollers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

309.3.10C-3 Detours

On temporary detours, compaction shall be performed as set forth in 309.3.08B-1 above.

309.3.11 Quality Control/Quality Assurance

The Contractor is responsible for process control and shall conduct sampling, testing, measurement and inspection as necessary. The Engineer will determine the suitability of the final product through final acceptance testing.

Results of these tests will be used to determine payment deductions, if any, to be assessed against the contract.

Compliance with the density requirements for pavement courses that have a nominal compacted thickness of 1-1/2 inches or greater will be determined by random testing of the compacted road surface with nuclear gauges, or laboratory analysis of pavement core samples by the City or its appointed representative.

The density of each section of pavement will be determined by random acceptance tests with the nuclear gauge operated in the backscatter or AC mode or laboratory analysis of pavement core samples. Acceptance tests will not be made within one foot from the edges of the panel or from areas where the nominal compacted thickness is less than 1-1/2 inches. Nuclear gauge density testing shall be performed after completion of the finish rolling the same day the section of pavement is placed. The Engineer shall have the right to test any areas that appear defective in compaction. If the areas are found deficient, the Engineer may require the contractor to bring the areas into conformance with the specifications.

309.3.11A Sampling

The samples shall be taken on a random basis at the rate of one sample per 500 tons of production or at least one sample per day of production but not from the first 25 tons of mix produced each day.

The samples shall be taken in accordance with AASHTO T 168. Samples shall be marked with the project name, class of mix, date and time of sampling, and the daily tonnage.

309.3.11B Testing

- 1) Testing to determine aggregate gradation and asphalt cement content shall be conducted for each sample of the mix. Testing shall be conducted in accordance with AASHTO T 308, "Determination of Asphalt Content of Hot Mix Asphalt Concrete Mixtures by the Ignition Method" (calibration in accordance with ODOT TM 323 with a 60 minute burn time).
- 2) Asphalt cement content shall be determined by the nuclear method in accordance with OSHD TM 319.
- 3) Testing to determine the theoretical maximum density of the mix shall be conducted on the initial sample of each day's production for work whose compaction is specified as

a percentage of the theoretical maximum density. The theoretical maximum density test shall be conducted in accordance with AASHTO T 209.

309.3.11C

Test Results

Results of the testing through the last completed section of pavement will be made known to the Contractor as soon as possible, and indicated on the pavement, with a hard copy of the test results furnished as soon as practical, if the Contractor so desires. It shall be the responsibility of the Contractor to obtain specified density at all times, and delay in advising the Contractor of test results shall not act as a waiver of this responsibility. When it is determined that specified density is not being obtained, all paving operations shall be discontinued and the work shall not be resumed until corrective measures have been taken.

309.3.11D

Corrective Actions

In areas with a density lower than 88.0%, remove and replace the deficient course. This work shall be completed within 10 working days following notification from the City Engineer that the pavement does not meet the specified density, unless otherwise directed by the City Engineer. Upon completion of the work, if the City Engineer finds it is still not satisfactory, the Contractor shall repeat the above.

309.3.12 Longitudinal Joints

309.3.12A Dropoffs

At the end of each working day, the Contractor shall construct a wedge of asphalt concrete at a slope of 10:1 or flatter along an exposed longitudinal joint. The wedge shall be removed and disposed of prior to continuing paving operations.

Where abrupt or sloped dropoffs occur within or at the edge of the paved surface, the Contractor shall provide suitable warning signs.

309.3.12B Construction Joints

The mixture shall be laid in strips of such widths as to hold to a practical minimum the number of longitudinal joints required. Longitudinal joints in the wearing course shall not occur within the area or width of a traffic lane or auxiliary lane; and on median lanes and on shoulder areas such joints shall

occur only at points of change in the transverse slopes as shown on the Plans or designated by the City Engineer. The longitudinal joints in one layer shall offset those in the layer immediately below by a minimum of 6-inches.

309.3.13 Transverse Joints

The following refers to all specified pavement courses but does not apply to leveling courses.

Placing of the mixture shall be as continuous and uniform as possible and pavement depth, line and grade shall be maintained at least 4-feet beyond the selected transverse joint location, then a sloped end section shall be constructed.

If the pavement will be subjected to traffic, the slope shall be no less than 50:1 (horizontal to vertical). If the paved section is not subject to traffic the slope may be less, but must be a minimum of 10:1.

Transverse joints shall be constructed to a vertical face by sawing or cutting to the full lift depth, after the mixture has reached the required density.

After the vertical face is formed, if paving is not expected to continue from the transverse joint until the following day or later, paper or other suitable material shall be placed ahead of the sawed or cut joint and under the 4-foot or longer panel and its sloped end section.

Prior to continuing the permanent paving lift, the 4-foot or longer panel and its end slope shall be removed and the base shall be cleaned of all debris. A tack coat shall then be applied to vertical edge and surface of the area.

After placement and finishing of the new asphalt concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

At bridge ends or at ends of other rigid type structures, compacting shall be in the transverse direction as well as longitudinally; all as directed by the City Engineer.

309.3.14 Temperature

For HMAC, the temperature of the mixture at the time it is placed in final position will be established by the City Engineer and shall be within 20 degrees of 280°F for Class "B" and "C" mixes. The City Engineer may, however, adjust this temperature in 10°F increments upwards if the aggregate coating, moisture content, workability or compaction requirements are not attained. Similar adjustments may be made downward by the City Engineer if the aggregate coating, moisture content,

workability and compaction requirements are attained. In no case shall the lay-down temperature of the mixture be less than 240°F.

For WMAC, the maximum temperature at the mixer shall be 275°F. The minimum temperature shall be 215°F.

309.3.15 Finishing and Details

Special care shall be taken at longitudinal joints to provide positive bond and to provide density and finish of the new mixture equal in all respects to the mixture against which it is placed.

Segregation of materials, non-uniform texture, fouled surfaces preventing full bond between successive spreads of mixture and other defects in material and workmanship, determined by the City Engineer as detrimental, shall be corrected by the Contractor as directed by the City Engineer.

The plan of the work, order of paving and other details of performance shall meet with the approval of the City Engineer.

309.3.16 Pavement Smoothness

The Contractor shall furnish and operate a 12-foot straightedge or a 12-foot rolling straightedge and test parallel and perpendicular to the centerline. The City Engineer may observe this testing or may require additional testing to be done under his supervision. Areas not meeting surface tolerances shall be marked, and corrective action on the deficiencies, specified herein and approved by the City Engineer, shall be taken by the Contractor.

When tests show the pavement is not within the below tolerances, the Contractor shall take immediate action to correct equipment or procedures in his paving operation to eliminate further unacceptable pavement roughness.

309.3.16A Single Lift Construction

The pavement surface shall not vary by more than 0.02 feet.

309.3.16B Multiple Lift Construction

Where two or more lifts of pavement are being placed, the surface of the top lift of the asphalt concrete pavement shall not vary by more than 0.015 feet. The surface of base lifts shall not vary by more than 0.02 feet.

309.3.16C Utility Appurtenances

When utility appurtenances such as manhole covers are located in the traveled way and they cannot be adjusted during paving operations or are required to be adjusted before paving, these tolerances will not apply.

These tolerances shall apply when water valve boxes and other utility appurtenances can be adjusted during paving operations.

309.3.16D Corrective Action

Corrective measures by the Contractor requiring one or more of the following actions approved by the City Engineer shall be performed on deficient areas:

- (a) Remove and replace the surface course.
- (b) Grind the pavement surface up to a maximum depth of 0.3 inch and apply an emulsion fog seal coat as directed by the Engineer.
- (c) On coarse, open textured areas, apply "resurfacer" (produced by Special Asphalt Products, Inc., Portland, OR), or a like product, per the manufacturer's specifications.

All corrective work shall be completed within 10 working days following notification from the City Engineer that the pavement does not meet the specified tolerances, unless otherwise directed by the City Engineer.

After completion of the corrective work, if the City Engineer finds it is still not satisfactory, the Contractor shall perform additional corrective work on areas still not meeting the above tolerances.

309.3.17 Pavement Samples

The City Engineer shall be permitted to take samples from the truck or paver, cut samples or take cores from the separate layers and courses or full depth of compacted mixture, for testing purposes at such locations and at such frequencies as the City Engineer determines as required for proper representation. Where samples have been taken and when directed by the City Engineer, the Contractor shall furnish new like material and fill the holes as directed with no compensation beyond the unit price for asphalt concrete in place.

309.3.17A Pavement Thickness

The Engineer will select locations for non-destructive measurement or core samples to determine pavement thickness.

If non-destructive measurement indicates a pavement section is less than the thickness shown on the Plans, or is otherwise out of specification, the Contractor may take cores at the same location to verify the Engineer's measurements. If the pavement section is found to comply with the specifications, the coring and restoration will be paid for as extra work. Pavement found to be out of specification shall be subject to replacement or to payment adjusted prices.

In determining deficient or excessive thickness in asphalt concrete overlays, the Engineer shall adjust the cross section measurement sequence, average series of measurements, or take other appropriate steps to allow for the desirable leveling of low or high areas on the existing pavement.

Where a deficiency is found and the Engineer determines the deficiency serious enough to impair the traffic service expected from the pavement, the area of such deficiency shall be removed by the Contractor and shall be replaced with pavement meeting the specifications. The cost of the deficient pavement and of the removal shall be borne by the Contractor.

309.3.18 Special Protection Under Traffic

In addition to other required provisions for traffic, the following shall apply to pavement construction:

- (a) No traffic or equipment shall come in contact with the compacted mixture until it has cooled and set sufficiently to prevent marking.
- (b) Edges shall be protected from being broken down; and edge dropoffs 1" or more in height shall be marked with adequate warning devices visible by day and night to the traveling public.

309.3.19 Joint Seal Coat

Immediately after the new paving is compacted, all joints between new and original asphalt pavement shall be painted with hot asphalt or asphalt emulsion and be covered with dry paving sand before the asphalt solidifies. Width of joint seal coat shall be no less than 4-inches and no more than 6-inches.

309.3.20 Clean-Up

After the paving has been completed, the Contractor shall collect and remove from the site all debris resulting from his operations. Graded areas along the streets or driveways that have been disturbed by the paving operation shall be regraded to the satisfaction of the City Engineer.

All facilities including, but not limited to, manhole covers, valve boxes, catch basins, gutter and curb faces shall be cleaned, and all excess asphalt, debris, and tack shall be removed.

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310 PORTLAND CEMENT CONCRETE PAVEMENT

310.1.00 General

310.1.01 Scope

This work shall consist of constructing Portland cement concrete (P.C.C.) pavement, with or without metal reinforcement, composed of Portland cement, water, fine aggregate, coarse aggregate, and special purpose additives when required or permitted. The P.C.C. pavement shall be constructed on a prepared base in accordance with these specifications and in conformity to the lines, grades, thicknesses and cross sections shown on the plans or established by the City Engineer. P.C.C. paving construction shall be in accordance with these specifications, ACI 318 (Building Code Requirements for Structural Concrete) and ACI 325.9R (Guide for Construction of Concrete Pavements and Concrete Bases). All concrete, unless otherwise specified, shall be mixed and deposited in accordance with ASTM C 94 (Specifications for Ready-Mixed Concrete). Concrete placed during hot weather or cold weather shall be mixed, placed, cured, and tested in accordance with the recommendations of ACI 305R or ACI 306, respectively. When a conflict exists between various governing codes, the more stringent code requirement shall be followed.

310.1.02 Prepaving Conference

The Contractor and the Contractor's supervisory personnel, testing personnel, plus any subcontractors and their supervisory personnel who are to be involved in the P.C.C. paving work, including P.C.C. aggregate production, shall meet with the Engineer for a prepaving conference at a time mutually agreed upon. At this conference, the Contractor shall discuss his methods of accomplishing all phases of the paving work including placement methods, techniques, equipment, consolidation, fresh properties, finishing, curing, etc. The plan of the work, order of paving and other details of performance shall meet with the approval of the City Engineer.

310.2.00 Materials

Materials shall meet the requirements of the applicable sections of the City of Tualatin Public Works Construction Code, applicable provisions of ASTM as well as modifications and/or additions given in this Specification and the Special Provisions, Section 201.0.00.

310.2.01 Portland Cement

The Portland cement shall be Type I, IA, II, IIA, III, or IIIA, conforming to the requirements of ASTM C 150 for low alkali cement (total equivalent alkali content not exceeding 0.6%, sodium and potassium oxide calculated as $\text{Na}_2\text{O} + 0.658\text{K}_2\text{O}$) and shall contain a maximum of 8% tricalcium aluminate (15% type III and IIIA).

310.2.02 Aggregates

Aggregates shall conform to the requirements of Section 308.0.00 of the City of Tualatin Public Works Code, ASTM C 33 and the following:

310.2.02A Fine Aggregates

Must be graded coarse to fine within the following limits:

GRADING REQUIREMENTS

<u>Sieve Size Passing</u>	<u>Percentages by Weight</u>
3/8"	100
# 4	95 - 100
# 8	80 - 100
# 16	50 - 85
# 30	25 - 60
# 50	10 - 30
# 100	2 - 10

Shall have a sand equivalent of not less than 68.

The fineness modulus as determined according to ASTM C136 shall not show a variation greater than 0.20 from the fineness modulus used in the Contractor's mix design, at the option of the City Engineer, who may accept a change in mix proportions, necessary by reason of such variation.

310.2.02B Coarse Aggregates

The size of coarse aggregate to be used shall be 1-1/2" to # 4.

Sieve Size	GRADING REQUIREMENTS	
	Separated Sizes	(Percentages by Weight)
Passing	1-1/2" to 3/4"	3/4" to #4
2"	100	
1½"	90 – 100	
1"	20 – 55	
¾"	0 – 15	100
½"	- - -	90 – 100
3/8"	0 – 5	40 – 70
No. 4		0 – 15
No. 8		0 – 5

310.2.03 Air Entraining Admixtures

Shall conform to the requirements of ASTM C 260 using one or another of the several tests as the City Engineer may consider pertinent. Chloride content of the admixture shall not exceed 0.5% by weight.

310.2.04 Tie Bars

Shall be Grade 40 deformed steel bars conforming to ASTM A 615.

310.2.05 Dowels

Shall conform to the requirements of ASTM A 615, A 616, A 617 grade 60 or 75.

310.2.05A Steel Wire Fabric Reinforcement

Shall conform to the requirements of ASTM A 185, A 497, or A 884

310.2.05B Bar Mats

Shall conform to the requirements of ASTM A 184.

310.2.06 Joint Filler

Shall be rubber-asphalt poured filler or other suitable materials as approved by the Engineer conforming to ASTM D 1751 or D 994.

310.2.07 Concrete Mixture Limits and Tolerances

The Portland cement concrete shall be a workable mixture uniform in composition and consistency, having the following properties and limits:

<u>Material or Property</u>	<u>Test Method</u>	<u>Quantity</u>
Entrained Air	ASTM C 138 ASTM C 173 ASTM C 231	6% ± 1.5
Slump	ASTM C 143	3" max except slip form Paving 1½" max
Modulus of Rupture	ASTM C 78	650 psi min. @ 28-day
Compressive Strength	ASTM C 39	4,500 psi min @ 28-day
Water-Cement Ratio		0.45 max
Temperature	ASTM C 1064	50 – 90

If the 650 psi flexural strength specification requires a compressive strength in excess of 4,500 psi, the higher compressive value shall be used as a minimum for all compressive strength cylinder tests taken during construction.

The relationship between compressive strength f'_c and modulus of rupture f_r shall be:

$$f_r = k(f'_c)^{1/2}$$

with k derived from the test results.

310.2.08 Proportioning of Concrete

The proportions of any P.C.C. mix proposed for use shall be determined by a qualified Technician. This shall include the proportions by weight of cement, water, fine aggregate, coarse aggregate, air-entraining admixture, and any other materials or admixtures needed to produce a workable and durable concrete which conforms to the contract specifications.

Each design shall be prepared and computed in accordance with the requirements of ACI 211.1 or a modification of that method employing the "absolute volume" theory.

Each mix design calculation proposed for use shall be identified by a unique mix design number and submitted to the City Engineer for review.

The Contractor may proceed with P.C.C. placement after the City Engineer determines the mix design, materials and tests comply with the specifications.

Review of P.C.C. mixes, materials, and production procedures by the City Engineer will not relieve the Contractor of responsibility to provide P.C.C. conforming to the specifications.

Proportions of materials for concrete shall be established to provide:

- (a) Workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding;
- (b) Resistance to special exposures as required;
- (c) Conformance with strength test.

310.2.08A Proportioning on the basis of field experience or trial mixtures, or both

310.2.08A1 Standard deviation

1. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated:
 - (a) Shall represent materials, quality control procedures, and conditions similar to those expected and changes in materials and proportions within the test records shall not have been more restricted than those for proposed work;
 - (b) Shall represent concrete produced to meet a specified strength for strengths f'_c within 1000 psi of that specified for proposed work;
 - (c) Shall consist of at least 30 consecutive tests or two groups of consecutive tests totaling at least 30 tests
2. Where a concrete production facility does not have test records of 30 consecutive tests, but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and modification factor of table 1. The test record shall represent only a single record of consecutive tests that span a period of not less than 45 calendar days.

TABLE 1 MODIFICATION FACTOR FOR STANDARD DEVIATION WHEN LESS THAN 30 TESTS ARE AVAILABLE	
No. of tests	Modification factor for standard deviation
Less than 15	Use table 2
15	1.16
20	1.08
25	1.03
30 or more	1.00

310.2.08A2 Required average strength (f'_{cr})

- Required average compressive strength f'_{cr} used as the basis for selection of concrete proportions shall be the larger of Eq. (1) or (2) using a standard deviation calculated in accordance with the previous section.

$$f'_{cr} = f'_c + 1.34s \quad (1)$$

$$f'_{cr} = f'_c + 2.33s - 500 \quad (2)$$

TABLE 2 REQUIRED AVERAGE COMPRESSIVE STRENGTH WHEN DATA IS NOT AVAILABLE TO ESTABLISH A STANDARD DEVIATION	
Specified compressive strength, f'_c , psi	Required average compressive strength, f'_{cr} , psi
Less than 3000	$f'_c + 1000$
3000 - 5000	$f'_c + 1200$
Over 5000	$f'_c + 1400$

310.3.00 Workmanship

310.3.01 Batching Plant

Bins shall have adequate separate compartments for fine aggregate, each separate size of coarse aggregate, and cement. Bins and compartments shall be tight and ample to prevent spilling from one bin to another. Separate compartments, including weighing hoppers, shall discharge freely and efficiently with minimum segregation into the weighing hopper.

Scales for weighing aggregates and cement may be either the beam type or the springless dial type. They shall be accurate within 0.5% under operating conditions throughout the range of use and shall be tested and adjusted at the Contractor's expense as often as the City Engineer may deem necessary to assure their continued accuracy.

Equipment for dispensing water and admixtures shall provide a separate feed, accurate quantity measurement, and shall inject the water and admixture at the time in the mixing process to insure thorough and complete mixing throughout the batch of P.C.C.

Automatically controlled batchers shall have automatically interlocked mechanisms providing the following:

- 1) Positive weighing and discharge of cement, and of each separate size of aggregate.
- 2) Interlocking between weighing hoppers to prevent any part of the batch from being discharged until each separate hopper has been filled with the correct proportion.
- 3) Simultaneous discharge of all hoppers.
- 4) A lockable compartment containing the time setting controls.

310.3.02 Mixers

Each mixer shall carry a clearly visible manufacturer's plate showing the capacity of the mixer and other pertinent operating rates and limits. Provision shall be made at the mixer for the controlled addition of air-entraining admixtures or other special components of the mix, when such items are required.

Central plant mixers shall be equipped with a timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. The means of storing, measuring and introducing water into the

310.3.03 Handling, Measuring, and Batching of Materials

The plant site, layout, equipment, and provisions for transporting materials shall be adequate to assure a continuous supply of material to the work site.

The aggregate shall be stockpiled and removed from stockpiles in a manner that will hold segregation to a minimum. Aggregates from different sources and of different gradings shall not be stockpiled together.

Aggregates that become segregated or mixed with earth or foreign material shall not be used. Frozen aggregates or aggregates containing frozen lumps shall not be used.

The fine aggregate, each separated size of coarse aggregate, and cement shall be separately weighed into the hoppers in the respective amounts set by the mix design. A device to indicate positively that the full amount of cement was discharged

into the batch box or container shall be provided. Water may be measured either by volume or by weight.

Batching shall be conducted so that the individual weights of each material required are within tolerances of 1 percent for cement and water, 2 percent for aggregates, and 3 percent for admixtures.

The use of wash water as a portion of the mixing water for succeeding batches should not be permitted unless the quantity of wash water is accurately measured .

310.3.04 Mixing Portland Cement Concrete

The P.C.C. shall be mixed at a central plant meeting the standards of the Concrete Plant Manufacturers Bureau as follows, except as provided in 310.3.02.

- 1) Material containing frost or lumps of hardened material shall not be used.
- 2) The batch shall be charged into the receiving drum so that some water will enter before the solids and continue to flow uniformly for a portion of the mixing time.
- 3) Intermixing of batches shall not be permitted.
- 4) The skip and the throats of drums shall be kept free of accumulations.
- 5) The P.C.C. shall be mixed only in the quantity required for immediate use.
- 6) Retempering P.C.C. by adding water or by other means will not be permitted.
- 7) The mixing time shall be at least 60 seconds but not more than 90 seconds.

310.3.05 Batch Ticket Information

At a minimum, batch tickets shall indicate the following:

- 1) Name of batch plant
- 2) Serial number of ticket
- 3) Date
- 4) Truck number
- 5) Name of purchaser
- 6) Specific designation of job (name and location)
- 7) Specific class or designation of the concrete
- 8) Amount of concrete

- 9) Time loaded or of first mixing of cement and aggregates
- 10) Water added by receiver
- 11) Type and brand, and amount of cement
- 12) Type and brand, and amount of admixtures
- 13) Information necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on the aggregates, water, and ice batched at the plant, and water added by the truck operator from the mixer tank.
- 14) Maximum size of aggregate
- 15) Weights of fine and coarse aggregate

310.3.06 Hauling Equipment

P.C.C. may be transported in nonagitating equipment or truck mixers. Hauling equipment shall conform to the Truck Mixer Manufacturer's Bureau of the National Ready Mixed Concrete Association. If non-agitating hauling equipment is used, discharge should be completed within 45 minutes. If truck mixers are used, discharge should be completed within 90 minutes.

310.3.07 Paving Equipment

310.3.07A Slipform Paver

The P.C.C. shall be placed with two separate machines, one a spreader and one a slipform paver. The machines, when operating in tandem shall spread, consolidate, screed, and float-finish the freshly-placed P.C.C. in one pass with a minimum of hand finishing. Each machine shall be fully self-propelled and equipped with electronic controls to control line and grade from both sides.

The spreader shall be able to deliver the mix without segregation or displacing the reinforcing steel.

The slipform paver shall be able to vibrate the P.C.C. for the full width and depth of the P.C.C. being placed, and be equipped with vibrating tubes or arms to work in the P.C.C. The sliding forms shall be held together rigidly to prevent them from spreading. The form shall be long enough so that slumping of the P.C.C. will not exceed 1/4-inch, according to 310.3.14.

310.3.07B Bridge Deck Finisher/Paver

A bridge or similar finishing/paving machine may be used with the prior approval of the City Engineer, utilizing the previously constructed and cured

curb and gutter as side forms, and support for machine rails. Any damage or displacement to the curb or gutter shall be corrected by removal and replacement of the curb and gutter and/or P.C.C. pavement at the discretion of the City Engineer.

310.3.08 Concrete Saws

The Contractor shall provide power driven concrete saws for sawing joints, adequate in number of units and power to complete the sawing at the required rate. The saws and related equipment shall be of proven adequacy and design to perform efficiently and shall be subject to immediate replacement if the specified results are not obtained. A standby saw shall be available at the site.

310.3.09 Smoothness Testing Equipment

Two 12-foot straightedges for determining smoothness shall be supplied by the Contractor.

310.3.10 Weather Limitations

It will be the Contractor's responsibility to protect the pavement from weather damage, and placement of P.C.C. pavement shall not occur when a descending air temperature falls below 40°F, nor shall it resume until an ascending air temperature reaches 35°F. Air temperature shall be measured in the shade and away from artificial heat.

When P.C.C. is being placed during cold weather, or has been in place less than 7 days, and the air temperature is forecast to drop below 35°F, insulating materials shall be placed on the pavement deep enough to prevent freezing of the P.C.C. Any weather damaged P.C.C. shall be removed and replaced at the Contractor's expense. P.C.C. pavement shall not be placed on frozen bases.

Placing P.C.C. pavement during periods of rain will not be permitted. The Contractor shall protect the unhardened P.C.C. from precipitation with protective material.

During the hours of darkness, work areas shall be illuminated at the Contractor's expense to the satisfaction of the City Engineer.

310.3.11 Preparation of Base

Before paving operations begin, the base on which the pavement is to be constructed shall be brought to the finished condition required by the specifications.

The full width and length of the area on which the tracks of the paving equipment is to operate shall be brought to the density and surface tolerance required.

Manholes, inlets, and other such structures shall be completed, adjusted, cured, and otherwise prepared, as applicable, and made clean and ready to have concrete placed in contact with them. Manhole frames and other independent metal structures in the pavement area shall be painted with suitable asphalt material over all concrete contact areas.

310.3.12 Construction Widths

When the pavement consists of up to three traffic lanes, the full width shall be constructed monolithically in one strip.

When the pavement consists of more than three traffic lanes, a minimum of two lanes shall be constructed monolithically in one strip except when the plans direct otherwise. The other lanes may be constructed either monolithically with the adjacent lanes or constructed separately in a minimum group of two lanes.

If the Contractor proposes a method of placement other than that shown on the plans and described in the specifications, the Contractor shall bear all costs to implement the change. Any changes must be approved by the City Engineer.

310.3.13 Placing Reinforcement

- a) At the time concrete is placed, reinforcement shall be free from mud, oil, or other non-metallic coatings that decrease bond. Steel reinforcement with rust or mill scale shall be considered satisfactory provided the minimum dimensions and weight of a hard-wire-brushed specimen complies with applicable ASTM bar specification.
- b) Reinforcement shall be accurately placed and adequately supported before concrete is placed and shall be secured against displacement. Never lay reinforcing steel on the subgrade and attempt to pull it up into position after concrete is placed.
- c) The width of welded wire fabric or bar mats should be such that, when properly placed in the work, the extreme longitudinal members of the sheet or mat will be located not less than 2 inches (50 mm) or more than 6 inches (150 mm) from the edges of the PCCP slab.
- d) When reinforcing bar assemblies are shown on the plans, the bars should be firmly fastened together at all intersections and adjacent ends should lap not less than 30 bar diameters.
- e) Reinforcement shall have a minimum cover of 2 inches(50 mm) and shall not fall below the mid depth of the PCCP slab, unless otherwise specified or shown on the plans.

310.3.14 Placing Portland Cement Concrete

The P.C.C. shall be delivered from the hauling vehicles to the paving machine hopper. The Contractor's equipment hauling P.C.C. or reinforcement will not be permitted on the subgrade but will be allowed on the base, with turns or other maneuvering kept to a minimum. Any damage to the subgrade or base due to the Contractor's operations shall be corrected by the Contractor, at the Contractor's expense, to the satisfaction of the City Engineer.

The P.C.C. shall be placed in final position by the slipform or other approved method, uniformly in one layer, so that a minimum of finishing will be necessary to provide a dense, homogenous pavement conforming to true grade and cross section.

- 1) The spreader shall receive the P.C.C. mixture in its hopper and uniformly spread and strike it off at the proper thickness for the full width of the area being paved.
- 2) The paver shall vibrate, consolidate, and finish the slab to the proper grade and cross section.

The paver shall be operated with as nearly continuous forward movement as possible, and all operations of mixing, delivering, and spreading P.C.C. shall be coordinated to provide uniform progress. Stopping and starting the paver shall be held to an absolute minimum. If, for any reason, it is necessary to stop the forward motion of the paver, the vibratory and tamping elements shall also be stopped immediately. No external force shall be applied to the paver except with the approval of the City Engineer.

While placing P.C.C., provision shall be made for constructing joints, placing dowels, tie bars, and other devices as called for by the plans, as directed by the City Engineer, and as provided in 310.3.13.

P.C.C. shall be rejected if it:

- 3) Has exceeded the batch to discharge time requirements of 310.3.05,
- 4) Has begun to take an initial set prior to placement, or
- 5) Has been retempered with water.

Supports of the paver, and other equipment which ride on previously placed pavement which meets the requirements of 310.3.06, shall be equipped to prevent marring, edge breaking, or chipping of the previously placed pavement.

Hand spreading and distributing shall be with shovels, not rakes. The P.C.C. shall not be fouled with foreign matter. The Contractor shall furnish hand operated mechanical vibrators satisfactory to the City Engineer. These vibrators shall be used

to consolidate the P.C.C. pavement at least 6 feet each side of construction and expansion joints, or when using bridge finishing or other approved machines.

310.3.15 Joints

Joints shall be the kinds called for by the plans and/or otherwise directed by the City Engineer. Joints in the P.C.C. pavement will be referred to as contraction or construction either of which may be transverse or longitudinal, as called for by the plans or as directed by the City Engineer. All joints and joint filler shall extend to pavement edges or to each other, as the case may be, and shall be constructed normal to the surface of the pavement. Joints shall not vary from specified or indicated line by more than 1/4-inch.

The Contractor shall submit to the City Engineer for approval, a jointing plan, 7-days prior to placement of any concrete street. The Contractor shall take into consideration the placement of joints in curb and gutter, at catch basins, and the position of manholes and other structures, as well as the other limitations herein mentioned.

Compensation for jointing and fillers shall be incidental to paving.

310.3.15A Contraction Joints

Contraction joints shall be of the sawed type with poured rubber-asphalt filler. Sawing shall be to a depth of 1/4 the thickness of the P.C.C. with a maximum width of 1/4-inch and a minimum width of 1/8-inch, in straight lines as shown or directed. Saw-cuts shall be performed as soon as the P.C.C. has set enough to permit sawing without tearing or raveling, before uncontrolled cracking results, and within 24-hours of placing the P.C.C. Saws may be single or tandem, as the Contractor may elect, and shall be controlled by guides to true line. The Contractor is wholly responsible for the timing of sawed concrete joints. The joints shall be thoroughly cleaned of all foreign matter before pouring the approved rubber-asphalt filler. The tops of joint filler shall be true to pavement cross section within 1/8-inch and shall be protected from damage by P.C.C. operations. Any area containing uncontrolled cracks shall be removed and replaced by the Contractor, at the Contractor's expense, at the direction of the City Engineer. Curing agents broken or damaged by the sawing operations shall be restored.

Longitudinal joints shall be spaced as shown on the plans at the interface between lanes, normally at intervals between 10 to 14-feet.

Transverse joints shall be skewed (except at intersections) as shown on the plans or as approved by the City Engineer, with intervals of 12 to 15-feet. A transverse type joint shall also be placed radial to and at the 1/2-angle point of a curb return, extended to meet a transverse or longitudinal contraction joint.

310.3.15B Construction Joints

Construction joints shall be constructed when there is an interruption of longer than 45 minutes in the P.C.C. placing operations or where herein specified. Both free edges of joints shall be tooled with 1/8-inch radius rounder to remove lattice and mortar resulting from finishing operations and to provide a clean rounded edge. Tooling shall not form ridges on the surface of the concrete.

The new P.C.C. placed contiguous to the joint shall conform closely to the proportions and consistency of the previously placed concrete and shall be vibrated and consolidated to a greater degree, with more care and to a closer surface tolerance than is usual in normal construction.

No transverse construction joint shall be constructed within 3-feet of a transverse contraction joint. If sufficient P.C.C. has not been mixed at the time of interruption to place a construction joint at least 3-feet from a planned contraction joint, remove excess P.C.C. back to a position to satisfactorily meet these criteria to the satisfaction of the City Engineer. Transverse construction joints shall be of the doweled type using 1-1/4-inch diameter by 18-inch dowels at 12-inch centers coated with plastic, grease, heavy oil or other approved material that will neither bond with nor be harmful to the P.C.C., supported and maintained in position during the P.C.C. placing operation at a depth of 1/2 the pavement thickness parallel to the street centerline. Fill any transverse construction joint which has opened to a width of 1/8-inch or greater, during the construction or maintenance periods with approved poured rubber-asphalt filler.

Longitudinal construction joints shall be of the tied type using #8 by 36-inch deformed tie bars at 12-inch centers, and shall be placed at all radiused sections of a curb return with a P.C.C. gutter as well as a normal longitudinal construction joint. Tie bars shall not be required at the construction joint between the P.C.C. pavement and gutter except where shown on the plans and mentioned above. Tie bars shall be placed by:

- 1) Inserting the tie bars into the plastic P.C.C. before vibrating and finishing the P.C.C.
- 2) Drilling the hardened concrete section and then inserting and grouting the tie bars into place. The holes shall be drilled large and deep enough to allow the tie bars to be inserted with adequate approved grout and shall be performed any time after the P.C.C. has attained enough strength to resist any damage caused by drilling. Tie bars shall be grouted a maximum of 3-hours prior to placement of adjacent P.C.C.

Any loose tie bars shall be replaced by drilling and grouting as described, at the Contractor's expense.

310.3.16 Surface Finishing

After the P.C.C. has been given a preliminary finish by means of the finishing devices incorporated in the slipform paving or other approved equipment, the surface of the fresh P.C.C. shall be checked by the Contractor with a straightedge device. Deviations indicated by the straightedge more than 0.01 foot shall be corrected. Each successive check with the straightedge device shall lap the previous check path by at least half the length of the straightedge.

- 1) Any edge slump of the concrete in excess of 1/4-inch shall be corrected before the concrete has hardened. Low spots exceeding 1/4-inch in depth, if in hardened concrete, may be filled with an approved epoxy grout provided the filling is neat and blends inconspicuously with adjoining concrete.
- 2) Upon completion of the machine floating, straightedge testing, and, if necessary, hand floating, but before any required edge tooling or joint tooling, and before initial set of the surface P.C.C., the surface of the P.C.C. shall be given a textured finish.

The textured finish shall be accomplished by an automatic machine finisher with a steel-tine tool, or approved alternate, that will mark the finished P.C.C. to a depth of $1/8 \pm 1/16$ -inch. The markings shall be about 1/8-inch in width spaced about 3/4-inch on centers without overlaps. Markings shall be transverse to the roadway center line and full roadway width in straight parallel lines.

310.3.17 Stationary Side Form Construction

Where the width of pavement is narrow, tapering, or of irregular pattern not lending itself to being constructed by prescribed machine methods, the Contractor will be permitted to perform the strike-off, consolidation, final floating, and surface finishing with equipment, tools, means, labor, and methods other than those specified, provided the work meets with the approval of the City Engineer and the following requirements:

- 1) Striking-off and consolidating the P.C.C. shall be done without causing segregation of material and include thorough vibration uniformly throughout the mass as the concrete is being placed until it is uniformly compacted.
- 2) The P.C.C. shall be struck-off by means of templates or screeds designed and manipulated to shape the P.C.C. to specified cross section between the forms, carrying a slight excess of P.C.C. in front of the leading edge of templates or screeds at all times. The P.C.C. shall be tamped to reduce voids to a minimum.
- 3) Floating shall follow the vibrating, striking-off and tamping operations and shall include transverse floating or other smoothing and finishing action. This shall provide a surface and evenness within a 12-foot straightedge tolerance of 0.01-foot. Testing of the hardened surface will be done by the Contractor in the

presence of the Engineer. The surface shall be free from laitance, soupy mortar, marks, or irregularities.

- 4) The surface shall be finished as set forth in 310.3.14.

Any areas of minor honeycomb or other minor defect in composition of the P.C.C. along the exposed edges of P.C.C. shall be filled with a stiff mortar of cement and fine aggregate and applied to the moistened P.C.C. to the satisfaction of the Engineer. Areas showing serious defects in composition of the concrete shall be removed and replaced with pavement of specified quality for full width of strip between longitudinal joints or edges and for a length not less than between the nearest transverse joints.

310.3.18 Curing of Portland Cement Concrete

Concrete (other than high-early-strength) shall be maintained above 50°F and in a moist condition for at least the first 7 days after placement. High-early-strength concrete shall be maintained above 50°F and in a moist condition for at least the first 3 days after placement.

Immediately after the finishing operations have been completed and the water film has evaporated from the surface or as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete should be covered and cured for at least 72 hours in accordance with one of the following methods:

- a) Membrane curing – Immediately after the water film has disappeared from the surface of the pavement, the surface should be uniformly coated with liquid membrane curing material conforming to ASTM C 309 type 2 white pigmented curing compound) by a suitable means of an approved mechanical spray machine at the rate of not less than 1 gal. Per 150 ft² of surface (one L per 2 m²), or as recommended by the manufacturer. To insure uniform consistency and dispersion of the pigment in the curing material, it should be agitated in the supply container immediately before transfer to the distributor and kept thoroughly agitated during application.

Irregular areas or sections of pavement where the use of a mechanical spraying machine is impracticable may be sprayed with approved hand spraying equipment. The sides of the pavement slab should be coated within 60 minutes after the removal of forms. Any areas of the coating which are damaged within the specified curing period should be immediately repaired.

- b) Mono-molecular coatings – This type of membrane coating material may be desirable under adverse drying construction conditions to retard surface evaporation. This is not a substitute for curing.
- c) Cotton mats or burlap – The surface and edges of the pavement should

be entirely covered with mats. Prior to being placed, the mats should be saturated thoroughly with water. The mats should be so placed as to cause them to remain in intimate contact with the surface, but these should not be placed until the surface has hardened sufficiently to prevent marring. They should be maintained fully wetted and in position for the specified curing period. The material should be in good condition, free from holes, dirt or any other substance which interferes with its absorptive quality. Burlap should be made of jute or kenaf. Burlap that will not absorb water readily when dipped or sprayed and that weighs less than 7 oz/yd² (240 g/m²) when clean and dry should not be used.

- d) Waterproof paper – As soon as the pavement has hardened sufficiently to prevent marring of the surface, the pavement should be entirely covered with waterproof paper (ASTM C 171). The paper units should be lapped 12 in (300 mm). The waterproof paper should be sufficiently wide to overlap and completely cover the sides of the slab after the forms have been removed unless additional strips of paper are furnished for curing the sides. The curing paper should be placed and maintained in intimate contact with the surface and sides of the pavement during the curing period. Damaged curing paper which cannot be effectively patched or repaired should be discarded. Curing paper should be placed only on a moist surface. If the surface appears dry, it should be wetted by a spray fine enough to prevent damage to the fresh concrete.
- e) White polyethylene sheeting – The surface and sides of the pavement should be entirely covered with white polyethylene sheeting. It should be placed while the surface of the concrete is still moist. If the surface appears dry it should be wetted with a fine spray before the sheeting is placed. Adjacent sheets should be lapped 18 in (460 mm). The sheeting should be weighted to keep it in contact with the pavement surface and it should be large enough to extend beyond the pavement edge and completely cover the sides of the slab after the forms have been removed. The polyethylene sheeting should remain in place for the duration of the curing period. A minimum polyethylene thickness of 4 mils (1 mm) should be specified.

310.3.19 Protection of Concrete

The Contractor shall erect and maintain suitable barriers to protect the concrete from traffic or other detrimental trespass until the pavement is opened to traffic. The Contractor shall maintain watchmen after normal working hours for at least a 24-hour period to insure that these barriers are not removed or destroyed, that trespass and vandalism upon the pavement does not occur.

Wherever it is necessary that traffic (including Contractor's vehicles and equipment) be carried from one side of the pavement to the other, the Contractor shall construct suitable bridges over the pavement, and shall maintain them in good

condition as long as they may be required. Leaving gaps in the pavement to facilitate movement of traffic will not be allowed unless prior written permission is obtained from the City Engineer.

All joints that have been constructed in the concrete surface shall be protected from impact and the infiltration of foreign matter before the installation of joint filler, in a manner satisfactory to the City Engineer.

The Contractor shall not operate construction equipment or allow traffic on newly placed P.C.C. until the following requirements are met:

- 1) The joints have been filled as per 310.3.13.
- 2) The concrete shall have attained a compressive strength of at least 4,000 pounds per square inch (corrected f_c as per 310.2.07).
- 3) The concrete shall have been in place at least 14 days.

If the Contractor desires to allow traffic on the P.C.C. before 14 days have elapsed, but no earlier than 7 days, the Contractor shall have requested the Engineer prior to pouring the pavement that the City designated test facility retrieve sufficient material for an extra five compressive strength tests for each 1,500 square yard increment in pavement, which extra cost shall be paid to the City by the Contractor.

- 4) The surface of the concrete shall be protected from scarring or abrasion and shall be free of stones, loose mortar and other matter apt to be deleterious to the concrete in the paths of equipment. All equipment shall be operated without damage to the new concrete.

Any part of the pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced by the Contractor, at the Contractor's expense, to the satisfaction of the Engineer.

310.4.00 Quality Assurance

Samples for flexural strength tests of each class of concrete placed each day shall be taken not less than once a day. Flexural strength tests shall consist of one set of four laboratory-cured specimens with one seven-day break, two twenty-eight day breaks and one sample to be retained as a hold specimen. Samples for flexural strength tests shall be taken in accordance with ASTM C 172. Beams shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 78. The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:

- (a) Every arithmetic average of any three consecutive flexural strength tests equals or exceeds the specified modulus of rupture;
- (b) No individual flexural strength test (average of two beams) falls below the specified modulus of rupture by 75 psi.

In addition, samples for compressive strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 yd³ of concrete. Compressive strength tests shall consist of one set of four laboratory-cured specimens with one seven-day break, two twenty-eight day breaks and one sample to be retained as a hold specimen. Samples for compressive strength tests shall be taken in accordance with ASTM C 172. Cylinders for strength tests shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:

- (a) Every arithmetic average of any three consecutive compressive strength tests equals or exceeds $f'c$;
- (b) No individual compressive strength test (average of two cylinders) falls below $f'c$ by more than 500 psi.

Slump (test method ASTM C 143), air content (test method ASTM C 138, C 1730, or C 231) and temperature tests shall be taken when strength specimens are made and at the option of the inspector as often as is necessary for control checks.

Prior to concreting, compliance of the reinforcing steel placement with the contract documents shall be verified. The inspector shall be present continuously during concrete placement. The inspection agency shall promptly notify the contractor and the Engineer of observed irregularities or deficiencies of work or products.

311 CONCRETE CURB AND GUTTER/STANDARD CURB

311.1.00 General

311.1.01 Scope

This section covers the work necessary for the construction of concrete curb and gutter, and standard curb including, but not limited to: furnishing materials; forming, mixing, placing and curing all concrete; placing construction joints; finishing concrete as specified; backfill behind the curbs; and cleanup. References herein to curbs shall also be deemed to mean curb and gutter. Concrete construction shall be in accordance with these specifications and ACI 318 (Building Code Requirements for Structural Concrete). All concrete unless specified, shall be mixed and deposited in accordance with ASTM C 94 (Specifications for Ready-Mixed Concrete). When a conflict exists between various governing codes, the more stringent code requirement shall be followed.

311.2.00 Materials

311.2.01 Concrete

Mix design shall be submitted to the Engineer a minimum of 7 calendar days prior to placement of concrete for approval. Concrete shall have a minimum compressive strength of 3300 psi, 28 days after placement. An air-entraining admixture shall be used. It shall be added to the mixer at the time of mixing in such a manner as to insure uniform distribution of the admixture throughout the batch. Entrained air (percent of volume) range shall be 4 percent to 7 percent (ASTM C 138, C 173 or C 231). The maximum water/cement ratio shall be 0.52 and the slump shall be a maximum of 5 inches. Concrete aggregates shall conform to ASTM C 33 requirements.

311.2.02 Forms

Prefabricated steel forms may be used. Lumber used in forms shall be of 2-inch material free from loose knots or other defects. Forms shall be thoroughly cleaned before being reused. Reuse of forms and form lumber will be permitted only when their condition is approved by the City Engineer.

311.2.03 Curing Compound

Liquid curing compound shall meet the requirements of ASTM C 309, Type 2, white pigmented.

311.2.04 Polyvinyl Chloride Pipe

Pipe shall conform to ASTM D 1785, Schedule 40.

311.3.00 Workmanship

311.3.01 Excavation

Excavation shall be done in conjunction with the excavation of the street. Any portion of the curb subgrade excavated below grade shall be corrected with compacted leveling base rock conforming to Section 308.0.0.

311.3.02 Extruded Curb

The machine for extruding Portland cement concrete curb shall be of the self-propelled type equipped with a material hopper, distributing screw, and adjustable curb forming devices capable of placing and consolidating Portland cement concrete or asphalt concrete to the lines, grades and cross section as shown, in an even homogeneous manner. Portland cement concrete curb shall be free of honeycomb.

Set top of curb grade by an offset guide line. The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine to provide, when necessary, a variable height of curb conforming to the predetermined curb grade. A grade line gauge or pointer shall be attached to the machine in such a manner that a continual comparison can be made between the curb being placed and established curb grade as indicated by the offset guide line.

In lieu of the above method for maintaining the curb grade, the extrusion machine may be operated on approved rails or forms set at the proper relative grade.

Prior to placing the curb on Portland cement or asphaltic concrete pavements, the pavement shall be dry and cleaned of loose and deleterious material. Immediately after cleaning the pavement surface, an epoxy bonding agent meeting the requirements of ASTM C 881, shall be applied to the pavement which will bind the extruded curb to the pavement surface.

311.3.03 Forms

Forms shall conform to the shape, lines, grades, and dimensions shown on the Plans. Inside of forms shall be coated with a light, non-staining form oil. Forms shall be braced and supported to permit thorough tamping of the concrete.

311.3.04 Drainage Pipe

Polyvinyl Chloride (PVC) pipe, of 3-inch diameter shall be installed 1/2-inch above the invert of the gutter, at positions shown on the plans or determined by the City Engineer.

311.3.05 Contraction Joints

Place contraction joints in curbs, at intervals not exceeding 15 feet. Contraction joints shall be of the open joint type and shall be provided by inserting a thin, oiled steel sheet vertically in the fresh concrete to force coarse aggregate away from the joint. The steel sheet shall be inserted one-half the depth of the curb. After initial set has occurred in the concrete and prior to removing the front curb form, the steel sheet shall be removed with a sawing motion. Finish top of curb with a steel trowel and finish edges with a steel edging tool.

311.3.06 Concrete Placement

Before depositing concrete, work crews and all equipment and tools shall be on the job site, all forms, string lines and base shall be in place and approved by the City Engineer, all debris shall be removed from the space to be occupied by the concrete, and the subgrade shall not be frozen. The base shall be thoroughly wetted, but no pools of water will be permitted.

Concrete shall be deposited in its proper place without delay in a continuous operation. An interval of more than 45 minutes between any two consecutive batches or loads, or a placing rate of less than 8 cubic yards of concrete per hour, shall constitute cause for a construction joint at the location and of the type directed by the City Engineer in the concrete already placed.

In hot weather, concrete in place shall be protected until final finishing can be completed. With a hot dry breeze, windbreaks may be erected, or fog nozzles may be used. Curing operation should begin as soon as concrete has set enough to avoid surface damage.

Placing concrete during periods of rain will not be permitted. If concrete has been placed and rain commences, it shall be protected by plastic sheeting positioned off the concrete surface, and maintained to prevent ponding.

Concrete shall be placed only when the outside air temperature is 35⁰F and rising, and is forecast to remain above 35⁰F.

At time of placement, the temperature of the concrete shall not be less than 50⁰F nor more than 90⁰F.

311.3.07 Form Removal

The form on the front of formed curbs shall be removed in not less than one hour nor more than six hours after the concrete has been placed. In no event shall the front form be removed if the concrete has not reached its initial set.

311.3.08 Finish

After removal of the forms from exposed faces, any holes left shall be patched and finished. The patching mixture shall consist of one part cement and two parts mortar sand. In general, it is not anticipated that patching will be required. Plywood or metal forms shall be used to produce a uniformly smooth surface on the exposed face. The use of form ties buried in the curb wall must have the prior approval of the City Engineer, and then only to suit a special forming problem, or as part of the integral design of a prefabricated and manufactured standard curb and gutter form.

311.3.09 Concrete Curing

Protection against loss of moisture shall be accomplished by keeping the surface continuously wet for seven days or by application of an approved curing compound applied immediately after completion of the finishing. Concrete shall be maintained above 50°F for at least the first 7 days after placement.

311.3.10 Protection of Concrete

Until the concrete has set and cured, the Contractor shall erect and maintain suitable barriers to protect the concrete from vandalism, traffic, or other detrimental trespass. The Contractor shall remove and replace those sections of concrete upon which vandalism and/or trespass occurs.

311.3.11 Backfill

Backfill behind the curb and gutter shall not be started until seven days after the concrete has been placed and a minimum compressive strength has been attained. Backfill shall conform to the lines shown on the Plans. Backfill in planter strip areas shall be clean topsoil free of weeds, debris, rock, concrete, and other detrimental or toxic matter. Care shall be taken to preserve the curb and gutter alignment while backfilling. In no case shall base rock be placed and compacted in the street before the curbs are properly backfilled.

311.4.01 Quality Assurance

Samples for compressive strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 yd³ of concrete. Compressive strength tests shall consist of one set of four laboratory-cured specimens with one seven-day break, two twenty-eight day breaks and one sample to be retained as a hold specimen. Samples for compressive strength tests shall be taken in accordance with ASTM C 172. Cylinders for strength tests shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:

- (a) Every arithmetic average of any three consecutive compressive strength tests equals or exceeds $f'c$;
- (b) No individual compressive strength test (average of two cylinders) falls below $f'c$ by more than 500 psi.

Slump (test method ASTM C 143), air content (test method ASTM C 138, C 1730, or C 231) and temperature tests shall be taken when strength specimens are made and at the option of the inspector as often as is necessary for control checks.

Prior to concreting, compliance of the reinforcing steel placement with the contract documents shall be verified. The inspector shall be present continuously during concrete placement. The inspection agency shall promptly notify the contractor and the Engineer of observed irregularities or deficiencies of work or products.

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312 CONCRETE SIDEWALK, PATHWAYS, AND DRIVEWAY APPROACHES

312.1.00 General

312.1.01 Scope

This section covers the work necessary for installing and repaving concrete sidewalk, sidewalk ramps, and driveway approaches. Concrete construction shall be in accordance with these specifications and ACI 318 (Building Code Requirements for Structural Concrete). All concrete unless specified, shall be mixed and deposited in accordance with ASTM C 94 (Specifications for Ready-Mixed Concrete). When a conflict exists between various governing codes, the more stringent code requirement shall be followed.

312.2.00 Materials

312.2.01 Gravel Base

Gravel base shall conform to the 3/4-inch minus grading and compaction requirements of Section 308.0.00.

312.2.02 Concrete

Mix designs shall be submitted to the Engineer for approval a minimum of 7 calendar days prior to placement of concrete. The concrete shall have a minimum compressive strength of 3300 psi, 28 days after placement. An air-entraining admixture shall be used. It shall be added to the mixer at the time of mixing in such a manner as to insure uniform distribution of the admixture throughout the batch. Entrained air (percent of volume) range shall be 4 percent to 7 percent (ASTM C 138, C 173 or C 231). The maximum water/cement ratio shall be 0.52 and the slump range shall be between 3- and 5-inches (ASTM C 143). Temperature of the concrete at time of placement shall range from 50°F to 90°F (ASTM C 1064). Concrete aggregates shall conform to ASTM C 33 requirements.

312.2.03 Forms

Lumber used in forms shall be S4S, free from loose knots or other defects. Form material shall be 2-inches by 6-inches for driveway approaches. Reuse of thoroughly cleaned form lumber must be approved by the City Engineer.

312.2.04 Curing Compound

Liquid curing compound shall meet the requirements ASTM C 309, Type 2, white pigmented.

312.2.05 Wire Reinforcing

Wire reinforcing shall conform to ASTM A 82, 10 gauge.

312.2.06 Polyvinyl Chloride Pipe

PVC pipe shall conform to ASTM D 1785, Schedule 40.

312.3.00 Workmanship

312.3.01 Excavation, Fill, and Sidewalk Base

Excavation and fill for sidewalks shall be constructed in conformance with Section 304, Road Excavation and Embankment.

The sidewalk base shall be prepared to the thickness shown on the standard drawings and approved plans, and shall be constructed in conformance with Section 308, Base and Leveling Courses.

312.3.02 Line and Grade

Concrete walks shall be constructed so that they do not deviate more than 1/4-inch laterally or 1/8-inch vertically from the required line and grade.

312.3.03 Forms

Forms shall conform to the shape, lines, grades, and dimensions shown on the Plans, unless the City Engineer requires modifications to conform to existing site or driveway conditions.

312.3.04 Drainage Pipe

Polyvinyl Chloride (PVC) pipe, of 3-inch diameter shall be installed from the concrete curb to the right-of-way line, graded to fall to the curb and 1/2-inch above the gutter invert, at positions shown on the plans or determined by the City Engineer.

312.3.05 Score Lines

Scoring of sidewalks shall be traverse to the centerline of the sidewalk at a spacing of 5.0 foot on center. All score marks shall be straight, 1/4-inch in depth, and finished with a 1/4-inch radius edge.

312.3.06 Concrete Placement

Before depositing concrete, work crews and all equipment and tools shall be on the job site, all debris shall be removed from the space to be occupied by the concrete,

the subgrade shall not be frozen, and all forms and base shall have been approved by the City Engineer. The base shall be thoroughly wetted, but no pools of water will be permitted.

Concrete shall be deposited in proper place without delay in a continuous operation. An interval of more than 45 minutes between any two consecutive batches or loads, or a placing rate of less than 8 cubic yards of concrete per hour, shall constitute cause for a construction joint at the location and of the type directed by the City Engineer. Concrete shall be spread uniformly between forms and thoroughly consolidated with approved methods.

In hot weather, concrete in place shall be protected until final finishing can be completed. With a hot dry breeze, windbreaks may be erected, or fog nozzles may be used. Curing operation should begin as soon as concrete has set enough to avoid surface damage.

Placing concrete during periods of rain will not be permitted. If concrete has been placed and rain commences, it shall be protected by plastic sheeting positioned off the concrete surface, and maintained to prevent ponding.

Concrete shall be placed only when the outside air temperature is 35⁰F and rising, and is forecast to remain above 35⁰F.

At time of placement, the temperature of the concrete shall not be less than 50⁰F nor more than 90⁰F.

312.3.07 Finish

After the concrete has been thoroughly consolidated and leveled, it shall be floated with a wood or magnesium float and finished at the proper time with a steel float. Joints shall be edged with 1/4-inch radius edger. The surface shall be light broomed in a transverse direction to the centerline of the sidewalk with a fiber hair brush approved by the City Engineer.

The finished surface shall be free of humps, sags or other irregularities and shall be constructed within 0.02 feet of the specified line, grade, cross section, slope, and thickness.

The finish on curb ramps shall be as noted on the standard drawings.

312.3.08 Concrete Curing

Protection against loss of moisture shall be accomplished by keeping the surface continuously wet for seven days or by application of an approved curing compound applied immediately after completion of the finishing. Concrete shall be maintained above 50⁰F for at least the first 7 days after placement.

312.3.09 Protection of Concrete

Until the concrete has set and cured, the Contractor shall erect and maintain suitable barriers to protect the concrete from vandalism, traffic, weather (including rain and freezing temperatures), or other detrimental trespass. The Contractor shall remove and replace those sections of concrete upon which vandalism, trespass, or weather damage occurs.

312.3.10 Backfill

After the concrete has set for at least one day, backfill voids left by edge forms and grade backfill.

Backfill in planter strip areas and behind the sidewalk shall be clean topsoil free of weeds, debris, rock, concrete, and other detrimental or toxic matter.

312.4.00 Quality Assurance/Quality Control

Samples for compressive strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 yd³ of concrete. Compressive strength tests shall consist of one set of four laboratory-cured specimens with one seven-day break, two twenty-eight day breaks and one sample to be retained as a hold specimen. Samples for compressive strength tests shall be taken in accordance with ASTM C 172. Cylinders for strength tests shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:

- (a) Every arithmetic average of any three consecutive compressive strength tests equals or exceeds f'c;
- (b) No individual compressive strength test (average of two cylinders) falls below f'c by more than 500 psi.

Slump (test method ASTM C 143), air content (test method ASTM C 138, C 1730, or C 231) and temperature tests shall be taken when strength specimens are made and at the option of the inspector as often as is necessary for control checks.

Prior to concreting, compliance of the reinforcing steel placement with the contract documents shall be verified. The inspector shall be present continuously during concrete placement. The inspection agency shall promptly notify the contractor and the Engineer of observed irregularities or deficiencies of work or products.

312.5.0 Sidewalk Repair

Sidewalk, curb and gutter can be damaged in a variety of ways. The need for repair can be caused by vertical and/or horizontal separation of sidewalk panels.

312.5.01 Vertical Separation

Sidewalk shall be repaired when the vertical separation is ¼-inch or greater.

<u>Separation</u>	<u>Repair Method</u>
¼ - ½	Edges beveled at a slope of 1:2 to requirements of the Building Code, Section 1109.4.4 (1996 Ed.)
½ -	5-foot section of sidewalk shall be removed and replaced per the requirements of this section

Grinding shall not exceed 1-inch.

312.5.02 Horizontal Separation

Sidewalk shall be repaired when the horizontal separation is ½-inch or greater by filling the void with grout.

313 SURFACE RESTORATION

313.1.00 General

313.1.01 Scope

This section covers the work necessary for replacement of surface structures including the work necessary for the installation of driveways, extruded curb, trench repaving and the adjustment of miscellaneous structures to grade.

313.1.02 Surfacing Depths

The depths in inches, of base and leveling course rock, and asphalt cement concrete shall conform to Section 203.2.18.

312.2.00 Materials

312.2.01 Base and Leveling Course Rock

Shall meet the requirements of 308.0.00, Base and Leveling Course Rock.

313.2.02 Asphalt Concrete

313.2.02A Surface Course

Asphalt concrete for the surface course shall be Class C mix as specified in Section 309, Asphalt Concrete.

313.2.02B Base Course

When more than 3 inches of asphalt concrete is required, the asphalt concrete shall be placed in two courses. The base course shall be Class B or C mix as specified in Section 309, Asphalt Concrete.

313.2.02C Tack Coat

Tack coat shall be as specified in Section 309, ASPHALT CONCRETE.

313.2.02D Cold-Mix Asphalt

Asphalt shall be SC-800 meeting the requirements of specification series No. 2 of the Asphalt Institute. Maximum aggregate size shall be 3/4-inch. Final mixture shall contain from 4 to 6 percent liquid asphalt by weight of total mix.

313.2.03 Concrete

Concrete shall conform to ASTM C 94, Alternate 3, and shall have a design mix proportioned for 3,300 pounds per square inch compressive strength at 28 days. Concrete mix shall contain no less than 5-1/2 sacks of cement per cubic yard.

313.3.00 Workmanship

313.3.01 Driveway

313.3.01A Subgrade Preparation and Compaction

Driveway subgrade shall be brought to the required elevation and shaped, with suitable equipment, to provide a smooth transition from the back of the driveway approach to the grade of the existing driveway. After the subgrade has been graded as hereinbefore specified, it shall be thoroughly compacted by means of equipment which will achieve the desired density specified. The material in the upper one foot of the subgrade shall have a density of not less than 91 percent of maximum dry density when tested according to AASHTO T180 .

313.3.01B Crushed Rock

Spread base and/or leveling course material on the compacted subgrade to the thickness indicated hereinbefore. The base and/or leveling course shall be bladed and thoroughly compacted to provide a firm base on which to place the asphalt or Portland cement concrete.

313.3.01C Asphalt Concrete

Asphalt concrete shall be placed as specified in Section 309, Asphalt Concrete. In lieu of using a self-propelled type paver, the Contractor may use a towed-type paver meeting the approval of the City Engineer.

313.3.01D Portland Concrete

Before depositing concrete, work crews and all equipment and tools shall be on the job site, all debris shall be removed from the space to be occupied by the concrete, the subgrade shall not be frozen and all forms shall have been approved by the City Engineer. The base shall be thoroughly wetted, but no pools of water will be permitted.

Concrete shall be deposited in its proper place without delay in a continuous operation. An interval of more than 45 minutes between any two consecutive batches or loads, or a placing rate of less than 8 cubic yards of concrete per hour, shall constitute cause for a construction joint at the location and of the type directed by the City Engineer in the concrete already placed.

In hot weather, concrete in place shall be protected until final finishing can be completed. With a hot dry breeze, windbreaks may be erected, or fog nozzles may be used. Curing operation should begin as soon as concrete has set enough to avoid surface damage.

Placing concrete during periods of rain shall not be permitted. In wet weather, the concrete shall be protected by plastic sheeting positioned off the concrete surface, and maintained to prevent ponding.

Concrete shall be placed only when the outside air temperature is 35⁰F and rising, and is forecast to remain above 35⁰F.

313.3.02 Extruded Curb

Extruded curb shall be placed per Section 311.3.02, Extruded Curb.

313.3.03 Trench Repaving

313.3.03A Trench Preparation and Backfill

Bring the trench to a smooth, even grade at the correct distance below the top of the existing pavement surface, allowing for base rock, leveling rock and asphalt concrete. Sawcut existing pavement to a straight line to remove

any pavement which has been damaged or which is broken and unsound and to provide a smooth, vertical edge for joining the new pavement.

Compact the pavement subgrade to 91 percent relative density, as determined by AASHTO T 180. Accomplish supplementary compaction where required with approved mechanical vibrating or power tampers.

313.3.03B Base Course and Leveling Course

Obtain approval of the subgrade by the Engineer prior to placing any base course material on the subgrade. Workmanship in manufacturing, placing, compacting, and maintaining base, or leveling course shall be as specified in Section 308, BASE AND LEVELING COURSES.

313.3.03C Tack Coat

Prior to paving, apply an asphalt tack coat, at 0.25 to 0.45 gallon per square yard to the edges of the existing pavement and manhole frames.

313.3.03D Asphalt Concrete

Asphalt concrete pavement shall be placed as specified in Section 309, Asphalt Concrete.

313.3.03E Joint Seal Coat

Immediately after the new paving is compacted, all joints between new and original asphalt pavement shall be painted with hot asphalt or asphalt emulsion and be covered with dry paving sand before the asphalt solidifies. Width of joint seal coat shall be no less than 4-inches and no more than 6-inches.

313.3.03F Contractor's Responsibility

All trenches, within a roadway surface, shall be paved in accordance with these specifications, cold patched, or covered with steel plating acceptable to the City Engineer, prior to the end of each work day. At no time shall trenches be left such that traffic is required to traverse a crushed rock or unpaved surface.

Maintain and repair all settlement of pavement over trenches, so that traffic can traverse the roadway in a safe manner.

The Contractor shall restore all striping, traffic signal loops, and/or other facilities impacted by the trench work.

313.3.04 Manhole Frame Adjustment

The height and position of manhole frames (including cone position) of existing manholes shall be adjusted to conform to new grades and cross sections, and to avoid conflict with any new curb and gutter that may be shown on the Plans.

The Contractor shall remove the material around the manhole without disturbing a greater area than necessary, rotate the cone or adjust riser, and raise or lower the manhole frame until the top surface is at the correct elevation and position. If the cone is rotated, new steps shall be provided in the lower section of the manhole, aligned with the existing steps in the cone. The manhole frame, grade rings, steps and cone shall be mortared or gasketed to provide a watertight seal. The excavation shall be backfilled with approved material in 6-inch layers, and each layer shall be thoroughly compacted with a mechanical tamper before the next layer is placed, until the backfill is up to the subgrade elevation.

314 HYDROSEEDING AND MULCHING

314.1.00 General

314.1.01 Scope

This work shall consist of surface preparation, and the supply and application by hydraulic means, of fertilizer, seed and/or mulch, to develop plant growth for erosion control. The work and type of seeding shall be performed as indicated by the plans, and specifications or as directed by the City Engineer.

314.1.02 Construction Season

Unless otherwise specified or approved, this work is to be performed during either the spring season, between February 1st and May 15th, or the fall season, between August 1st and November 15th. Areas may be seeded between November 1st and March 31st, with the approval of the Engineer, but must be protected by clear polyethylene sheet of a minimum thickness of 6 mil., which is to remain in position until the vegetation is firmly established.

The work shall be performed in the presence of the City Engineer, only at times when local weather and the soil surface are in a condition favorable for the germination of seed and the growth of grass, otherwise the surface shall be maintained in a manner acceptable to the City Engineer until the following construction season.

314.2.00 Materials

314.2.01 Fertilizer

Fertilizer shall be of standard commercial manufacture and grade and be furnished in standard, unopened, moisture proof containers in a dry condition. The fertilizer shall be inorganic 22-16-8, which shall analyze at 22% nitrogen, 16% available phosphoric acid and 8% soluble potash, and include a minimum 2% sulfur. The fertilizer shall contain not less than 30% available water insoluble nitrogen derived by incorporating one of the following:

- 1) A minimum 800 lbs., of urea formaldehyde per ton of fertilizer which has a minimum Activity Index (AI) of 40. The AI shall be determined by the Association of Official Agricultural Chemists method.

- 2) A minimum of 500 lbs. of Isobutylidene Diurea (IBDU) per ton of fertilizer.
The application rate shall be 400 lbs per acre.

314.2.02 Seed

All seed shall be delivered in standard, sealed containers labeled with the variety and percentages of seed and date of test. Tests in accordance with Oregon Laws and Department of Agriculture regulations shall have been performed within 9 months of the delivery date and the seed shall not be moldy or show evidence of having been wet or otherwise damaged.

Seed variety type shall be as specified on the approved plans. Seed types and application rates are as follows:

Grass Seed

Grass seed, as a mixture, shall be applied at the following minimum rates:

<u>Kind of Seed</u>	<u>Lbs Per Surface Acre</u>
*Creeping Red Fescue	25
*Chewings Fescue	25
*Perennial Ryegrass	<u>50</u>
TOTAL:	100

*Acceptable varieties:

- Creeping Red Fescue - Common, Ensylva, Estica, Flyer, Fortress, Illahee, and Pennlawn.
- Chewings Fescue - Banner, Cascade, Enjoy, Epsom, Highlight, Jamestown, Mary, Shadow, Victory, and Waldorf.
- Perennial Ryegrass - All Star, Belle, Blazer, Caravelle, Citation II, Dasher, Derby, Diplomat, Fiesta, Manhattan II, Omega, Palmer, Pennant, Pennfine, Regal, Tara, and Yorktown II.

Wildflower Mix

- Valley Native Wildflowers, Pro-Time #420
Application rate: 1 oz./1000 sq. ft.
- Blue Wild Rye "Elymus Glaucus"
Application rate: 20 lb./acre

If the specified seed is not available, the Contractor shall submit other kinds of seeds and/or seed mixtures to the City Engineer for approval.

314.2.03 Wood Cellulose Fiber Mulch

The mulch material shall be free of noxious weed seeds and plants and shall contain no substance detrimental to plant life. It shall be processed so that the wood or straw fibers will remain uniformly suspended under agitation in water. The mulch shall also blend with seed, fertilizer and tackifier additive of a hydroseeding mixture to form a homogeneous slurry. The processed mulch shall have the ability to cover and hold grass seed in contact with the soil and have moisture-absorption and percolation properties to form a blotter-like ground cover. The cellulose fiber shall be colored green with a non-toxic dye to visibly aid uniform application.

Mulch shall be used as a tracer at the rate of 250 lbs., dry weight per acre in the application of a mixture of fertilizer and seed.

The application of mulch only, shall be at the rate of 2,000 lbs., dry weight per acre, but if used after the application of seed and fertilizer (within 48-hours), the 250 lbs., of mulch used as a tracer may be included as part of the required 2,000 lbs., per acre.

The following mulch materials are approved for use:

- 1) Grass Mulch, a grass straw cellulose fiber manufactured by Grass Fiber Inc., 520 E. 2nd Street, Junction City, Oregon 97448.
- 2) Silva-Fiber, a wood cellulose fiber manufactured by Weyerhaeuser, Tacoma, Washington 98447.
- 3) Spray Mulch X-80, a wood cellulose fiber manufactured by Pacific Wood Fibers, P.O. Box 2109, Redmond, Washington 98052.
- 4) Any mulch supplier approved by the Oregon State Highway Division.

314.2.04 Tackifier Additive

J-tac, an active hydrocolloid, manufactured by the Reclamare Company, 20727 7th Avenue South, Seattle, WA 98198, (206) 824 2385; shall be used with fertilizer, seed and mulch tracer, at a tackifier application rate of 80 lbs/acre. Add J-tac to the water, with agitation, before other ingredients to permit maximum gelling.

314.3.00 Workmanship

314.3.01 Preparation of Areas

The areas on which earthwork has been performed shall be at established grades, cross sections and finish, and any which have been misshapen or eroded, shall be restored just prior to seeding. All weeds, debris and other matter detrimental or toxic, shall be removed and a minimum of 1/2-inch of surface soil shall be in a loose condition, with no dirt clods larger than 1-inch.

314.3.02 Equipment

The hydraulic equipment shall continuously mix and agitate the slurry and apply the mixture uniformly through a pressure spray system, using a sweeping, horizontal motion of a nozzle.

314.3.03 Protective Measures

Care shall be exercised to prevent damage to prepared areas. Material which falls on plants, roadways, drainage ditches and areas where hydroseeding is not specified, or which collects at the ends of culverts, or accumulates to excessive depths shall be removed and redistributed as the City Engineer directs. Protective coverings shall be used on structures and objects where coverage and stains would be objectionable. Care should be taken to protect vehicles and persons from damage by drifting spray.

314.3.04 Application

The work, including the mixing of materials, shall be undertaken in the presence of the City Engineer who shall be notified at least two day's in advance, of the time and place of operations. If wind velocities would prevent uniform application or drift the materials the work shall be postponed.

Fertilizer, grass seed, tackifier and/or mulch shall be applied in one continuous application by means of hydraulic pressure equipment.

315 COLD PLANE PAVEMENT REMOVAL

315.1.00 General

315.1.01 Scope

This work shall consist of preparing a foundation for placement of new surfacing by the removal of existing surfacing to the depth, width and cross section shown on the plans, or by the City Engineer.

315.2.00 Equipment

315.2.01 General

The existing surfacing shall be removed with a self-propelled planing machine or grinder. The equipment shall be capable of accurately establishing profile grades within a tolerance of 0.02 foot by reference from either the existing pavement or from independent grade control and shall have a positive means for controlling cross slope and elevations. The equipment shall incorporate a totally enclosed cutting drum with replaceable cutting teeth and shall have an effective means for removing excess material from the surface and for preventing dust from escaping into the air. The use of a heating device to soften the pavement will not be permitted.

315.3.00 Workmanship

315.3.01 Pavement Removal

The existing pavement shall be removed to the depth, width, grade and cross section shown on the plans or directed by the City Engineer to provide a surface profile true to specified grade and transverse slope.

Except where samples are taken to establish a job mix formula, the existing surfacing shall not be removed more than five days prior to construction of the new surfacing, unless otherwise approved by the City Engineer.

315.3.02 Surface Tolerance

The new surface resulting from the pavement removal will be tested by the City Engineer for trueness to specified grade and transverse slope at selected locations. Testing will be with a 10-foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contact points shall not exceed 0.02 feet.

315.3.03 Disposal of Materials

Materials removed under this specification which are not recycled and used on the project shall become the property of the Contractor at the point of removal and shall be disposed of off the limits of the project in a manner satisfactory to the City Engineer.

316 MAILBOX INSTALLATIONS

316.1.00 General

316.1.01 Scope

This section covers the work necessary for relocating existing mailboxes and the installation of new mailboxes.

316.2.00 Materials

316.2.01 Mailboxes

Contractor shall utilize existing mailboxes for relocated installations. Damaged mailboxes shall be replaced with materials equal to or better than original.

New installations shall incorporate mailboxes conforming to the requirements of the United States Postal Service.

316.2.02 Posts

Posts shall be of adequate strength and size to support the proposed installation.

316.3.00 Workmanship

316.3.01 Location and Position

Mailbox locations shall be as directed by the Post Master and the City Engineer, and shall be located outside the vision clearance areas specified in the TDC.

All mailbox installations shall be vertically plumb and at right angles to the street. Bury depth and spacing in relation to the curb shall be as specified on the Standard Drawing, and mounting height shall be as directed by the mail carrier and City Engineer.

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317 PAVEMENT MARKING

317.1.00 General

This section covers the work necessary for the installation or removal of pavement markers, markings, and paint.

Striping paint shall be allowed for line striping only. All other pavement markings, including arrows, stop bars, railroad crossing legends, and word legends, shall be preformed thermoplastic material.

The Design Engineer shall layout the configuration of all striping, markers, and pavement markings for review and approval by the City Engineer prior to any installation.

317.2.00 Materials

317.2.01 Permanent Pavement Markers

Pavement markers shall conform to OSHD specification 02840.60

317.2.01A Type I Reflectorized

Reflectorized markers shall have one or two reflective faces as required to reflect incident light in the specified directions. Reflective pavement markers shall be of the following types:

(a-1) **Type Ia** - Prismatic reflector lens (approximately 3 sq.in.) set in a 4" x 4" base.

(a-2) **Type Ib** - Acrylic rod lens reflector (approximately 0.55 sq.in.) set in a 4-inch diameter base or 4" x 4-3/4" oval base for bidirectional reflectors.

(a-3) **Type Ic** - Prismatic reflector lens (approximately 2 sq.in.) set in a base approximately 2" x 4".

317.2.01B Type II Nonreflectorized

Nonreflectorized markers shall be polyester binder 4-inch diameter.

317.2.01C Adhesive

The adhesive shall be a two-component epoxy conforming to the requirements of AASHTO M 237, Class II, except that the viscosity of the individual components at $77\pm 1^{\circ}\text{F}$ shall be 1000 to 5000 poises. Delete the average viscosity requirement. Type I, or II shall be used.

317.2.02 Temporary Pavement Markers

Temporary flexible raised pavement markers shall be made from 0.060-inch thick amber polyurethane with a minimum tensile strength of 4600 psi (ASTM D412), 4-inches wide, 2-inches upstanding with 4-inch long by 0.25-inch wide metalized polycarbonate microprism retroreflective tape on both sides, 1-inch base with factory applied solid butyl rubber adhesive protected by release paper.

317.2.03 Striping Paint

Striping paint and glass beads shall conform to the requirements of the OSHD standard specifications.

317.2.04 Preformed Thermoplastic Pavement Markings

Preformed thermoplastic pavement markings shall be "Premark" markings, or approved equal.

317.3.00 Workmanship

317.3.01 Permanent Pavement Markers

Pavement markers shall be installed as shown on the plans by means of an epoxy adhesive. Reflectorized markers shall be placed so that future painting, if required, will not cover the marker.

The portion of the roadway surface to which the marker is affixed shall be free of dirt, curing compound, paint, grease, oil, moisture, loose or unsound layers and any other material which would adversely affect the bond of the adhesive.

Cleaning shall be accomplished by one of the following methods:

- 1) The pavement surface shall be sandblasted for a sufficient length of time to remove all surface contaminants but not so long as to expose buried aggregate. A blast of clean air shall be used to ensure removal of all loose particles from the surface.
- 2) The pavement surface shall be cleaned with a pavement grinder. The area cleaned shall not exceed 5-inches wide by 6-inches long, nor shall it be deeper than 1/8-inch below the surrounding pavement. A blast of clean air shall be used to ensure removal of all loose particles from the surface.

Markers shall be placed on dry pavement surfaces free of visible moisture.

Markers shall not be installed straddling a joint or crack in the pavement. Alignment of a full pattern of markers may be adjusted away from existing lane line to avoid installation of markers straddled across the longitudinal construction joint or crack. For any such deviation in the line of pavement markers, a gradual taper of pleasing appearance shall be constructed. Spacing between the markers may be adjusted to avoid installation of the markers straddled across a crack or joint, however, in this instance, the alignment shall be maintained.

If epoxy adhesive is used it shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in a complete coverage of the area of contact of the marker. No voids will be present and there shall be a slight excess of material after the marker has been pressed in place. The marker shall be placed in position and pressure applied until firm contact is made with the pavement. A small bead approximately 1/8-inch thick shall form around all edges and corners to insure visually that the marker is fully supported on a pad of adhesive. Excessive adhesive on the pavement, and adhesive on the exposed surfaces of the markers shall be immediately removed. The use of mineral spirits will be permitted for removing adhesive from the surfaces of pavement markers. Cleaning shall effectively remove the adhesive so that no loss in the reflective characteristic will result.

The marker shall be protected against impact until the adhesive has hardened to the degree designated by the City Engineer.

317.3.02 Temporary Pavement Markers

Unless shown on the plans, or otherwise directed by the City Engineer, markers shall be placed on dry pavement to simulate permanent markings as follows:

- Three single markers spaced 3 feet apart to simulate a 6-foot line with a gap of 34 feet between simulated lines for skip lines.
- Single markers spaced 5 feet apart for solid, no passing lines.

- Double markers spaced 5 feet apart for double solid, no passing lines.

Temporary pavement markers shall be installed as soon as practical following the paving operation, and shall be in place prior to the opening of the roadway to traffic.

The Contractor shall maintain the temporary pavement markers until such time as the permanent pavement markings are completed.

317.3.03 Painted Stripes

The area to be painted shall be dry, clean and free of loose particles. The paint machine shall be of the spray type capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly upon the pavement. Each machine shall be capable of applying two separate stripes, either solid or skip, at the same time. Each paint tank shall be equipped with a mechanical agitator. Each nozzle shall be equipped with satisfactory cutoff valves which will apply broken or skip lines automatically. Each nozzle shall have a mechanical bead dispenser that is located directly behind and synchronized with the spray nozzle which will distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides consisting of metallic shrouds or air blasts.

The Permittee shall be responsible for preliminary spotting of the lines to be painted and approval of the City Engineer must be obtained before striping may begin.

Stripes shall be as shown on the drawings.

The paint shall be thoroughly mixed prior to application and shall be applied when the air temperature is above 40 degrees F., at the following application rates:

- (a) **Premixed Beads in Paint:** Apply at a rate of 100 square feet per gallon of paint with beads premixed at the rate of 4-1/2 pounds per gallon.
- (b) **Drop-on Beads on Paint:** Apply on wet paint at the rate of 6 pounds per gallon of paint.
- (c) **Drop-on Beads on Premixed Beads and Paint:** Apply drop-on beads at the rate of 2-1/2 pounds per gallon of premixed paint and beads.

317.3.04 Preformed Thermoplastic Pavement Markings

The area of application shall be dry and free of dirt, dust, chemicals or significant oily substances. The pavement markings shall not be applied on top of existing paint or thermoplastic.

The preformed markings shall be installed according to the manufacturer's recommendation in a manner which provides a uniform surface free of defects. Splices shall be installed without overlap or gaps.

Application generally consists of cleaning the installation area; preheating the installation area; placement of the preformed marking; and heating of the marking to melting point.

317.3.05 Stripe and Marker Removal

Remove painted and thermoplastic stripe, and marker epoxy or butyl rubber adhesive, by abrasion, sandblasting, hydroblasting or surface grinding, so that the pavement surface is not damaged and has a surface texture similar to the surrounding area. Obliteration with paint or other substance shall not be permitted.

All debris collected by stripe and marker removal shall be removed from the site and disposed of at the Permittee's expense.

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318 PERMANENT TRAFFIC CONTROL

318.1.00 General

318.1.01 Traffic Signals

This section covers the removal and installation of traffic signals.

318.1.02 Signs and Traffic Control Devices

This section covers all work necessary to remove and reinstall existing traffic signs or install new traffic control signs as required on a construction project. Traffic control provisions are contained in Section 104.13.00 and Section 106.9.00 of the General Specifications.

318.2.00 Materials

318.2.01 Traffic Signals

Materials shall meet all requirements of the English-unit equivalent of the 1996 Oregon Department of Transportation Standard Specifications for Highway Construction.

318.2.02 Signs and Traffic Control Devices

318.2.02A Uniform Traffic Control Devices

Provide signs and traffic control devices built in conformance with the Manual of Uniform Traffic Control Devices (current edition), and the Oregon Supplements to the Manual published by the Oregon Department of Transportation.

318.2.02B Signs

Use aluminum only for traffic control signs. The aluminum sheet must meet ASTM B 209 requirements and be fabricated from aluminum alloy 6061-T6, 5154-H38, or approved equal. The minimum sign thickness shall be 0.063" when the sign is to be mounted more than 6-feet above the ground. If the sign is to be mounted 6-feet or less above the ground, the minimum sign thickness

shall be 0.125". Sign height is measured from the ground to the lowest portion of the sign.

318.2.02C Sign Posts

A minimum of 2" x 2" x 10' galvanized quick-punch post, or approved equivalent shall be used. When the sign, or combination of signs, is more than 36" in height, a 2" x 2" x 12' galvanized quick-punch post shall be used. Wood or round metal posts will not be permitted.

318.2.02D Post Base

The base shall consist of one galvanized quick-punch piece of square tubing, with dimensions of 2-1/4" x 2-1/4" x 30".

318.2.02E Fastening

The sign shall be fastened onto the post with drive rivets. To prevent vandalism, no nuts or bolts will be permitted to fasten any sign to the posts.

318.2.02F Reflective Material

Signs shall be diamond sheet reflectorized as per OSHD specification 02910.20.

318.2.02G Date

All traffic control signs shall have the date of installation stamped, in a permanent manner, on the back of the sign.

318.2.02H Certification

Furnish certification that signs, posts, brackets, and hardware delivered to the project site are as specified.

318.3.00 Workmanship

318.3.01 Traffic Signals

The removal and installation of traffic signals shall meet all requirements of the 1991 Oregon Department of Transportation Standard Specifications for Highway Construction.

318.3.02 Signs and Traffic Control Devices

318.3.02A Existing Signing

Remove existing traffic signing as required on the plans. Signs that are to be reused on the project will be stored by the Contractor until needed. The Contractor will be responsible for the replacement of any signs that are damaged while being stored. Signs, posts, and hardware not to be reused on the project will be removed from the project by the Contractor. When reinstalling traffic signing, use materials specified in Section 318.2.02 Signs and Traffic Control Devices (above).

Relocate existing signs to the position shown on the plans. Improperly relocated signs shall be relocated.

Reset all signs plumb with, or at right angles to the street.

318.3.02B New Signing and Traffic Devices

Provide and install all new signing as required. New signs must be of new manufacture.

318.3.02C Street Name Signs

Street name signs will be handled in the same manner as traffic control signs as provided in Section 318.3.02A, Existing Signing.

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319.0.00 TREE PRESERVATION AND PROTECTION

319.1.00 General

319.1.01 Scope

319.1.01A General Requirements

Preservation and protection of existing trees indicated on the plans to remain.

319.1.02 Project Conditions

319.1.02A Protect and preserve all trees on-site indicated to remain.

319.1.02B Comply with the requirements of the plans and specifications for protection and preservation of existing trees to remain.

319.1.02C Provide temporary construction fencing, minimum 4' high on steel fence posts (no more than 10 foot center to center spacing), as directed by the City Engineer, to protect and preserve trees which are to remain. Erect prior to commencement of clearing and demolition work and remove only after all work potentially injurious to trees is complete, or at the direction of the City Engineer.

319.1.02D Protect all trees from stockpiling, material storage, vehicle parking and driving within the drip line.

319.1.02E Protect the root systems of all trees from:

- 1) Dumping of refuse.
- 2) Chemically injurious materials and liquids.
- 3) Noxious materials in solution caused by runoff and spillage during mixing and placement of construction materials, and drainage from stored materials.
- 4) Continual puddling of water.

319.1.02F Restrict vehicular and foot traffic to prevent compaction of soil within the root zone.

319.2.00 Workmanship

319.2.01 General

319.2.01A Protect root systems of all trees to remain from damage due to noxious materials in solution caused by runoff and spillage during mixing and placement of construction materials and drainage from stored materials.

319.2.01B Protect all trees to remain from flooding, erosion, excessive wetting and drying resulting from dewatering and other operations.

319.2.01C Protect all trees to remain against cutting, breaking and skinning of roots and branches, skinning and bruising of bark.

319.2.01D Do not allow fires to be placed under or adjacent to trees to remain.

319.2.01E Removal of branches from trees which are to remain, if required for construction, tree root pruning and relocation work is to be performed under the direction of the City Engineer.

319.2.01F Cut branches and roots with sharp pruning instruments and do not break, chop, and/or mutilate.

319.2.01G Water trees which are to remain as necessary to maintain their health during the course of the project. Maintain a water schedule and documentation.

319.3.02 Excavation Around Trees

319.3.02A Excavate within the drip line of trees to remain only where indicated on the plans and as construction staked.

319.3.02B Excavate around tree roots within the drip line of the tree only under the direction of the City Engineer.

319.3.02C When trenching is required within the drip line of the trees, tunnel under and around roots by hand digging. Do not cut main lateral roots. Cut smaller roots acceptable to the consulting arborist only if they interfere with installation of new work and only with sharp pruning tools.

319.3.02D Where excavating for new construction is required within the drip line of trees, hand excavate to minimize damage to the root system. Use narrow tine spading forks and comb soil to expose roots. Relocate roots in backfill areas whenever possible. If large main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking.

319.3.02E If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 6-inches back from new construction.

319.3.02F Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover, pack with peat moss or four (4) layers of wet, untreated burlap and temporarily support and protect from damage until permanently relocated and covered with backfill.

319.3.03 Grading and Filling Around Trees

319.3.03A Maintain existing grade within drip line of trees unless otherwise indicated on the plans or acceptable to the City Engineer.

319.3.03B Lowering Grades

Where existing grade is above new finish grade shown around tree, carefully hand excavate within drip line to the new grade under the direction of the City Engineer. Cut roots exposed by excavation to approximately 3-inches below elevation of new finish grade.

319.3.04 **Repair and Removal of Trees**

319.3.04A If required by the City Engineer, engage a qualified arborist, acceptable to the City Engineer, to perform tree repair work. Repair trees damaged by construction operations promptly after damage occurs to prevent progressive deterioration of damaged trees.

319.3.04B Remove dead and damaged trees which are determined by the consulting arborist to be incapable of restoration to normal growth pattern.

320 TRENCH EXCAVATION AND BACKFILL

320.1.00 General

320.1.01 Scope

This section covers the work necessary for trench excavation and backfill, complete except for pipe base and pipe zone backfill which are included under other sections.

320.1.03 Excavation

Excavation covers, but is not limited to, work necessary to remove and dispose of all material encountered in the trench excavation to the depths and widths as shown on the Plans and as specified herein. Excavation shall include the removal of material for the installation of all valves, fittings, manholes, and other appurtenances along its length. Shoring, bracing, dewatering, drainage and all other appurtenances are incidental to this item.

320.2.00 Materials

320.2.01 Trench Excavation

Trench excavation is unclassified. Excavate all materials regardless of formation encountered. Contractor shall make his own estimate of the kind and extent of the various materials that may be encountered.

320.2.02 Foundation Stabilization

Use approved gravel or crushed aggregate ranging in size from 4-inch minus to 1-1/2 inch minus, well graded from coarse to fine, free of clay or organic material.

320.2.03 Gravel for Trench Backfill

Granular material conforming to the 1-1/2 inch-minus or 3/4 inch-minus requirements of Section 308 Base and Leveling Courses.

320.3.00 Workmanship

320.3.01 Clearing

Where clearing is necessary, complete prior to the start of trenching. Cut trees and brush as near to the surface of the ground as practicable. Stumps within 4 feet of the trench centerline shall be removed. Prior to trenching all trees, brush, and other flammable debris from the clearing shall be disposed of off the construction site in an approved location.

Do not remove existing trees or tree limbs over 2 inches in diameter on public property unless they are within 4 feet of the trench centerline, without permission from the City Engineer. Protect from damage, unless otherwise marked by the City Engineer, all trees, shrubs, or plants within the limits of the easement on private property.

320.3.02 Pavement Removal

Saw cut existing permanent pavement along trench sides prior to excavating. Width of pavement cut shall be 12 inches wider than the width of trench excavation. Cuts shall be continuous and for full depth of pavement. Pavement removal shall be of sufficient width to insure that excavating equipment can function without disturbing remaining pavement. Under no circumstances shall the remaining pavement be subject to a lifting force, either by direct contact with the excavating equipment or by inadequate pavement precutting. Any pavement beyond the trench line that is lifted shall be removed and replaced. If asphalt is removed by means of a mechanical chipper, the saw cut may be waived by the City Engineer if a clean edge can be produced.

All strips of pavement 3 feet wide or less, which are outside the limits of the pavement removal for trench excavation, shall be removed and repaved in accordance with Section 313, Surface Restoration.

320.3.03 Trench Width

Minimum width of the trench in the pipe zone shall be 18 inches greater than the inside diameter of the pipe, except by permission of the City Engineer.

Maximum width of the trench below the top of pipe shall be 1.5 times the nominal pipe diameter plus 18 inches. Trenches wider than maximum width may cause a greater backfill load than normally allowed, for the class of pipe shown on the plans. If maximum trench width is exceeded without authorization from the City Engineer, the Contractor may be required to provide pipe of higher strength classification.

320.3.04 Grade and Pipe Zone

Excavate the bottom of the trench to the trench subgrade. Trench subgrade shall be at least 4 inches below the outside bottom of the pipe barrel. If the trench is excavated below the required grade, correct with pipe base material, as directed. Place the material over the full width of the trench in compacted layers not exceeding six (6) inches deep to the established trench subgrade. Pipe zone material placed along the sides and above pipes shall also be compacted in layers not exceeding six (6) inches in thickness utilizing hand operated mechanical tampers.

320.3.05 Shoring

Whenever necessary to prevent caving during excavation, or to protect adjacent structures, property, workmen, or the public, adequately shore the trench. All sheeting, shoring, and bracing of trenches shall conform to the safety requirements of the Federal, State or local public agency having jurisdiction.

320.3.06 Excavated Materials

During trench excavation, the Contractor shall locate the excavated material so it will not completely obstruct a traveled roadway or street; and, unless otherwise approved by the City Engineer, all streets and roadways shall be kept open to at least one-way traffic. The Contractor shall place excavated material away from the trench to minimize risk of side wall failure.

When excavating trenches inside a public utility easement and/or construction easement, take care to ensure all excavated materials and construction activity are contained within the easement limits.

320.3.07 Dewatering

Excavations and trenches shall be kept free of water by dewatering equipment furnished and operated by the Contractor. Water shall be disposed of so as not to cause injury to public or private property or to cause a nuisance or menace to the public. Sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outage, and competent workmen for the operation of the pumping equipment, shall be available at all times. Dewatering equipment shall operate at all times unless written authorization is received from the City Engineer.

At all times, provide and maintain ample means and devices to promptly remove and dispose of all water entering the trench excavation during the time the pipe is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. Surface runoff shall be controlled to prevent entry or collection of water in excavations.

320.3.08 Foundation Stabilization

When, in the opinion of the City Engineer, the existing material in the bottom of the trench is unsuitable for supporting the pipe, excavate below the subgrade of the pipe base, as directed by the City Engineer, and backfill the trench to subgrade of pipe base with foundation stabilization material specified hereinbefore. Foundation stabilization material shall be compacted by mechanical means in lifts not exceeding twelve (12) inches in thickness.

320.3.09 Trench Backfill Above Pipe Zone

Push the backfill material first onto the slope of the backfill previously placed and allow to roll down into the trench. Do not push the backfill material into the trench in such a way as to permit free fall of the material into the open trench until at least 2 feet of cover is provided over the pipe. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the tramped material around the pipe. Do not use backfill material of consolidated masses larger than 1 cubic foot. Flooding or jetting shall not be allowed.

The following types of backfill shall be used as shown on the Plans or as directed by the City Engineer:

320.3.09A Class "C"

Following backfilling the pipe zone, the excavated material shall be pushed back into the trench. After the backfill has been completed, the entire working area, including the trench, shall be graded. The Contractor shall make his own estimate of the amount of settlement that will occur and shall windrow enough material over the trench to compensate for settlement. During the warranty period, if in the opinion of the City Engineer, excessive settlement occurs placing the windrowed material below normal grade, the Contractor shall correct the problem, to the City Engineer's satisfaction.

320.3.09B Class "D"

Backfill the trench above the pipe zone with gravel for trench backfill in lifts not exceeding 8-inch loose depth, and compact each lift to a minimum of 91 percent relative compaction. Backfill materials shall be moisture conditioned to near optimum moisture content prior to placement in the trench. Use mechanical vibrating or impact tampers. Maximum density of the backfill material shall be determined by AASHTO T 180.

Maintain the surface of the backfilled trench level with the existing grade

with crushed rock backfill material until pavement replacement is completed.

Any subsequent settlement of the finished surfacing during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the Contractor.

320.3.10 Maintenance of Trench Backfill

Maintain the backfilled trench surfacing until pipe section has been tested and accepted, utilities have been restored, surface restoration has been completed and all work required along the pipe section has been accomplished.

This maintenance shall include, but not be limited to, the addition of surfacing rock and a minimum of 2-inches of cold-mix asphalt to keep the surface of the backfilled trenches reasonably smooth and suitable for normal traffic flow. Temporary pavement replacement of cold-mix asphalt shall be installed on the same day as backfilling, above all trenches that cross paved streets. Trenches that run approximately parallel with streets or roads shall be maintained with cold-mix asphalt.

320.4.10 Excess Excavated Material

The Contractor shall dispose of all excess excavated materials at approved disposal sites.

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321 STORM DRAIN PIPE

321.1.00 General

321.1.01 Scope

This section and CWS's Design and Construction Standards June 2007, Chapter 8 covers the work necessary for the installation of storm drain pipe and fittings of the sizes and classes indicated, including, but not limited to, furnishing materials; laying and jointing the pipe, and connections to existing drainage structures. The standards that are more restrictive shall govern.

321.1.02 Pipe Base

For pipes 27 inches in diameter and less, the area of pipe base extends for the full width of the trench, with a minimum depth from the outside of the pipe barrel to the bottom of the trench of 4 inches. For pipes larger than 27 inches in diameter the depth is a minimum of 6 inches.

321.1.03 Pipe Zone

The area of the pipe zone extends for the full width of the trench, from the bottom of the pipe barrel to 12 inches above the outside top of the pipe barrel.

321.2.00 Materials

321.2.01 Pipe

Unless a specific material is designated, pipe material shall be one of the following:

321.2.01A Concrete Pipe

Pipe 18 inches in diameter and larger shall be Class 3 reinforced concrete pipe conforming to ASTM C 76, and pipe 15 inches in diameter and smaller shall be Class 2 nonreinforced concrete pipe conforming to ASTM C 14.

Pipe ends shall normally be bell and spigot, or tongue and groove.

321.2.01B Ductile Iron Pipe

Pipe shall be push-on joint ductile iron pipe, centrifugally cast of 60-42-10 iron and shall conform to AWWA C151. Thickness class shall be determined by the methods detailed in AWWA C150.

321.2.01C Polyvinyl Chloride Pipe

Conforming to ASTM D 3034, SDR 35 for diameters from 4-inch to 15-inch, and ASTM F 679 (wall thickness T-1) with minimum pipe stiffness of 46 PSI according to ASTM D 2412 for diameters from 18-inch to 36-inch; with integral bell rubber gasket joints to ASTM F 477, PVC plastic shall have a cell classification of 12364C or 12454C as defined in ASTM D 1784. Pipe shall be laid in the longest commercially available lengths.

321.2.01D Corrugated Polyethylene Perforated Tubing

Pipe shall be double-wall, smooth interior; manufactured of high density polyethylene compounds which conform with the requirements of ASTM D 1248, Type II, Category 3, 4, or 5, Grade P33 or P34, Class C. Pipe shall be 10-inch diameter and smaller and shall meet the requirements of AASHTO M 252, Type S.

321.2.01E Aluminum Spiral Rib

Pipe shall conform to the material, fabrication, and inspection requirements of AASHTO M196, M197, M211, and M219.

321.2.02 Fittings

Pipe fittings shall be shop fabricated of the same material as the pipe and as recommended by the pipe manufacturer.

When approved by the City Engineer, concrete pipe fittings may be field fabricated in a workmanlike manner, with all holes machine cut and no protrusions, including grout, allowed to project into the pipe.

321.2.03 Pipe Base

Pipe base shall conform to the 3/4-inch-minus requirements of Section 308 Base and Leveling Courses.

321.2.04 Pipe Zone

Same as Pipe Base as specified hereinbefore.

321.2.05 Service Connection Markers

Markers shall be 2 x 4 utility grade or better, full length with no splices to the relevant pipe or fitting and projecting 4-feet above finished ground surface.

321.3.00 Workmanship

321.3.01 Line and Grade

Maximum deviation shall be 1/2-inch from line and 1/4-inch from grade.

321.3.02 Dewatering

Provide and maintain equipment, promptly remove all water entering the trench during the time the trench is being prepared for pipe laying, during the laying of the pipe, until mortar joints have set, and until the pipe zone backfill has been completed. Dispose of water in an approved manner without damage to adjacent property.

321.3.03 Pipe Bedding

Level trench and compact at subgrade elevation. Place and compact Pipe Base material and then excavate bell holes at each joint of sufficient depth that bells do not touch base material. Pipe base shall be fine graded by hand to give uniform, even support to the bottom of the pipe. Pipes shall not be laid on blocking or any material other than Pipe Base material.

321.3.04 Pipe Installation

Inspect all pipe immediately prior to installation to insure that no defective materials are being used. Clean ends of pipe and remove foreign material from inside of pipe.

After pipe joint has been made, check pipe for alignment and grade. Place sufficient Pipe Zone material around the pipe to assure that the pipe has continuous and uniform support along the barrel to assure that the pipe section will not move.

321.3.05 Pipe Zone Backfill

Install Pipe Zone material in compacted lifts, not exceeding 6 inches, up to the horizontal centerline of the pipe.

Above the horizontal centerline of the pipe, Pipe Zone material shall be placed to the top of the pipe zone.

321.3.06 Service Connection Marker

At the ends of mains, laterals, or building sewers, plug or cap, block end of pipe and install service connection marker. Extend marker 4-feet above the ground surface and paint with **white** enamel. Then, using black quick drying enamel, neatly indicate the distance from a horizontal line on the marker to the top of the pipe in feet and inches.

Take precautions during the backfilling operation to ensure the position and location of the marker. If the marker is broken or knocked out of vertical alignment, replace the marker.

321.3.07 Testing

321.3.07A TelevIEWing Inspections

Provide televIEWing inspections following NASSCO-PACP Standards in the presence of the City Engineer, with a written inspection report, videotaping (DVD format, in color), audio commentary and video lineal distance indication from a manhole of all tees, fittings, or deficiencies on all storm sewer lines. The original DVD(s) shall become the property of the City.

The complete televIEWing inspections shall be conducted immediately prior to paving (if applicable) and final acceptance of the work.

Any visual deficiencies in the storm sewer line shall be corrected and the defective line shall be reinspected by televIEWing. Inspection and correction shall be repeated until all storm sewer lines have been shown to be free of defects.

321.3.07B Deflection Test

The maximum deflection of a flexible pipe shall be limited to 5% of the pipe diameter.

Acceptance shall be determined by the insertion throughout the length of

the sewer of a ball, double-tapered mandrel or other approved gonogo gauge, with a diameter of 95% of the nominal pipe diameter. Any abnormal force required to move the gauge shall be taken to indicate noncompliance with this test.

Expose all pipe failing this test, correct any deficiency and recompact the pipe zone, and retest after placing backfill. The use of a vibrating type "rerounder", or similar device shall not be allowed.

321.3.08 Cleaning

Remove all construction debris, rocks, gravel, sand, silt and other foreign material from storm drains, catch basins and manholes prior to televising inspection and acceptance. The cleaning shall be done in such a manner so as to prevent debris, etc. from being flushed into existing downstream storm sewer facilities.

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322 SANITARY SEWER GRAVITY PIPE

322.1.00 General

322.1.01 Scope

This section and CWS's Design and Construction Standards June 2007, Chapter 8 cover all work necessary for the installation of gravity sewer pipe. The standards that are more restrictive shall govern.

322.1.02 Pipe Base

For pipes 27 inches in diameter and less, the area of pipe base extends for the full width of the trench, with a minimum depth from the outside bottom of the pipe barrel to the trench invert of 4 inches. For pipes larger than 27 inches in diameter the depth is a minimum of 6 inches.

322.1.03 Pipe Zone

The area of the pipe zone extends for the full width of the trench, from the bottom of the pipe barrel to 12 inches above the outside top of the pipe barrel.

322.2.00 Materials

322.2.01 Pipe

Unless a specified material is designated, pipe material shall be any one of the following:

322.2.01A Ductile Iron Pipe

Pipe shall be push-on joint ductile iron pipe, centrifugally cast of 60-42-10 iron and shall conform to AWWA C151, thickness Class 50. The pipe shall be cement-mortar lined in accordance with AWWA C104. Rubber gaskets and lubricant conforming to AWWA C111, are to be supplied by the pipe manufacturer, suitable for the specified pipe size, and in sufficient quantity for installing the pipe.

322.2.01B Polyvinyl Chloride Pipe

Conforming to ASTM D 3034, SDR 35 for diameters from 4-inch to 15-inch, and ASTM F 679 (wall thickness T-1) with minimum pipe stiffness of 46 PSI according to ASTM D-2412 for diameters from 18-inch to 36-inch; with integral bell rubber gasket joints to ASTM F 477. P.V.C. plastic shall have a cell classification of 12364C or 12454C as defined in ASTM D 1784. Pipe shall be laid in the longest commercially available lengths.

Higher strength AWWA C-900 pipe is allowed in applications approved by the City Engineer.

322.2.02 Pipe Base

Pipe base shall conform to the ¾ inch-minus requirements of Section 308 Base and Leveling Courses.

322.2.03 Pipe Zone Backfill

Same as Pipe Base as specified hereinbefore.

322.2.04 Tee Fittings

322.2.04A Ductile Iron Pipe

Fittings shall be ductile or gray iron mechanical joint or where shown on the plans flanged joint, conforming to AWWA C110 with a pressure rating of 250 psi, cement mortar lined as per AWWA C104, with rubber gaskets meeting AWWA C111.

322.2.04B P.V.C.

Factory manufactured gasketed sewer fittings shall be installed. Saddle tees may be approved by the City Engineer, when factory manufactured gasketed fittings are not available.

322.2.05 Service Connection Markers

Shall be 2 x 4 utility grade or better, full length with no splices to the relevant pipe or fitting and projecting 4 feet above finished ground surface.

322.2.06 **Pipe Location Tape**

Shall consist of a 3 inch width of 2 mil clear film permanently reverse printed, laminated to 1 mil aluminum foil, laminated to 2 mil clear film permanently reverse-printed, for a total minimum thickness of 5 mil, materials to be specially formulated for prolonged use underground. Minimum tensile strength shall be 60-lbs per inch of width. The words "CAUTION: SEWER LINE BURIED BELOW" in black letters on APWA color code green background shall be boldly printed on both sides of the tape, repeated continuously at least every 36-inches. Must be suitable for both conductive and inductive detection by normal pipe location equipment, and be supplied in the longest practical length commercially available.

322.3.00 **Workmanship**

322.3.01 **Line and Grade**

Maximum deviation shall be 1/2 inch from line and 1/4 inch from grade.

322.3.02 **Dewatering**

Provide and maintain equipment, promptly remove all water entering the trench during the time the trench is being prepared for pipe laying, during the laying of the pipe, and until the pipe zone backfill has been completed. Dispose of water in an approved manner without damage to adjacent property.

322.3.03 **Base**

Pipe shall be laid on pipe base material as specified in 322.1.02. Excavate bell holes at each joint of sufficient depth that bells do not touch base material. Pipe base shall be fine graded by hand to give uniform even support to the barrel of the pipe. Pipes shall not be laid on blocking or any material other than pipe base material.

322.3.04 **Pipe Installation**

Inspect all pipe immediately prior to installation to insure that no defective materials are being used. Clean ends of pipe, remove foreign material from inside pipe, and use proper tools and lubricants to join pipe sections.

After pipe joint has been made, check pipe for alignment and grade. Place sufficient pipe zone backfill material around the pipe to assure that the pipe has continuous and uniform support along the barrel and to assure that the pipe section will not move.

At any time that laying operations are not in progress, close and block the open end of the last laid section of pipe.

For shorter than standard pipe lengths, ends shall be cut square and perpendicular to the pipe axis, and beveled. Mark insertion/stop lengths as per manufacturers instructions.

322.3.05 Pipe Zone Backfill

Install pipe zone backfill material uniformly on both sides of the pipe up to the horizontal centerline of the pipe. Material shall be placed in lifts not exceeding 6 inches, extending outward to the trench walls. Each lift shall be carefully worked under the pipe haunches and compacted, from the pipe to the trench wall or 2.5 pipe diameters on each side of the pipe.

Above the horizontal centerline of the pipe, pipe zone material shall be placed without compacting to the top of the pipe zone.

322.3.06 Service Connection Marker

At the ends of mains, laterals or building sewers, plug or cap, block end of pipe and install service connection marker. Extend marker, 4 feet above the ground surface and paint with **green** enamel. Then, using black quick-drying enamel, neatly indicate the distance from a horizontal line on the marker to the top of the pipe in feet and inches.

Take precautions during the backfilling operation to ensure the position and location of the marker. If the marker is broken or knocked out of vertical alignment, replace the marker.

322.3.07 Anchor Block

Where specified, anchor blocks shall be placed immediately downhill from bells to prevent downward movement of concrete pipe.

322.3.08 Service Lateral

Shall consist of the main line pipe tee, bend, lateral pipe, plug, marker and pipe location tape. The angle of the bend and the final invert elevation or depth shall be shown on the plans.

Pipe location tape shall be installed loosely, laid flat, at a depth of 15-inches from the designed finished surface, vertically above the pipe. Tape shall be joined with a loose "clove-hitch" or similar knot with the ends laid closely parallel for a

distance of at least 3-feet. Install over all building sewers, from the main or lateral to the service connection marker.

322.3.09 Final Sewer Cleaning

Prior to the acceptance tests and final manhole-to-manhole inspection of the sewer system by the City Engineer, flush and clean all parts of the system using a flushing ball that is the same size as the inside of the pipe. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment. Under no circumstances shall any material enter the treatment plant or downstream pump stations as a result of flushing the sewer system.

Upon the City Engineer's final inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

322.3.10 Acceptance Tests

All sewers shall pass the following:

- A) Deflection test (PVC pipe only).
- B) Air and Infiltration test.
- C) Televiewing inspections.

Acceptance shall initially be performed in the order above, and only after all building sewers, manholes and backfilling are complete. Do not proceed to the next test without correcting deficiencies, and the City Engineer's approval, or it shall be deemed not acceptable.

322.3.10A Deflection Test

The maximum deflection of a flexible pipe shall be limited to 5% of the pipe diameter or as otherwise shown on the Plans.

Acceptance shall be determined by the insertion throughout the length of the sewer of a ball, double-tapered mandrel or other approved gonogo gauge, with a diameter of 95% of the nominal pipe diameter. Any abnormal force required to move the gauge shall be taken to indicate noncompliance with this test.

Expose all pipe failing this test, correct any deficiency and recompact the pipe zone and retest after placing backfill. The use of a vibrating type "rerounder", or similar device shall not be allowed.

322.3.10B Air and Infiltration Test

The Engineer may, at any time, require a calibration check of the instrumentation used. Use a pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.05 psi. All air used shall pass through a single control panel.

All plugs used to close the sewer for the test must be capable of resisting the internal pressures and must be securely braced. Place all air testing equipment above ground and allow no person to enter a manhole or trench where a plugged sewer is under pressure. Release all pressure before the plugs are removed. The testing equipment must include a pressure relief device designed to reduce pressure in the sewer under test to 9 psi and must allow continuous monitoring of the pressure in order to avoid excessive pressure. Use only qualified personnel to conduct the test.

The presence of ground water will affect the results of the test, therefore determine the average height of ground water over the sewer, by an approved method; immediately before starting the test.

Use the Time-Pressure Drop Method for all air testing. The test procedures are as follows:

- 1) Plug all upstream openings.
- 2) Plug the downstream opening, when infiltration flow from upstream sections of the sewer has ceased. Brace all plugs securely.
- 3) Check the average height of the ground water over the sewer. The test pressure required below shall be increased 0.433 psi for each foot of average water depth over the sewer.
- 4) Add air slowly to the section of sewer being tested until the internal air pressure is raised to 4.00 psig greater than the calculated pressure of the ground water above the sewer.
- 5) After the internal test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding or releasing only the air required to maintain pressure.
- 6) After the temperature stabilization period, disconnect the air supply.
- 7) Determine and record the time in seconds that is required for the internal air pressure to drop from 3.5 psig to 3.00 psig; greater than the calculated ground water pressure.
- 8) Compare the time recorded in step 7 with the test time determined as hereinafter.
- 9) Upon the successful completion of the air test and release of pressure, remove the downstream plug only. If there is any accumulation of water upstream of the plug, measure the subsequent rate of infiltration, which shall not exceed 0.05 fluid ounces per inch pipe diameter per foot per hour.

When the flow exceeds the allowable, reduce the infiltration to at least this rate and air test this section again. If a flexible pipe has to be

re-excavated and backfilled, retest the deflection. A "total" infiltration test at the downstream end of the project will not be conducted nor considered.

If the sewer fails to meet these air test requirements, determine the reason for leakage and repair and/or replace as required.

The test time shall be calculated using the following criteria:

where $T = 28.3 D K$, shortest time, in seconds, allowed for the air pressure to drop 0.5 psig.

D = Pipe nominal diameter in inches.

K = 0.000419 D L, but not less than 1.00

L = Length of pipe in feet.

For the purposes of this air test computation ignore any branch, lateral or house sewer, on the sewer under test.

322.3.10C Televieing Inspections

The Contractor shall provide televieing inspections following NASSCO-PACP Standards in the presence of the City Engineer, with a written Inspection Report, videotaping (DVD format, in color), audio commentary and video lineal distance indication from a manhole of all tees, fittings, or deficiencies on all sewer lines. The original DVD(s) shall be become the property of the City.

The televieing inspection shall be conducted immediately prior to paving and final acceptance of work. Two complete televieing inspections shall be conducted:

- 1) Prior to the acceptance of the work and the beginning of the one year maintenance period.
- 2) During a period of wet weather which would significantly raise the water table, within the maintenance and warranty period.

Any visual deficiencies in the sewer line shall be corrected and the defective line shall be reinspected by televieing. Inspection and correction shall be paid for by the Permittee and repeated until all sewer lines have been shown to be free of defects.

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323 WATER QUALITY FACILITIES

323.1.0 General

323.1.01 Scope

This section covers the work necessary for construction of water quality facilities.

323.2.00 Materials

323.2.01 Jute Matting

Jute matting shall be Geojute Plus in treatment area, Econojute for all other areas or equal.

323.2.02 Sun Mix

Freeboard area seed mix shall consist of:

Dwarf Tall Fescue	40%
Dwarf Perennial Rye	30%
Creeping Red Fescue	25%
Colonial Bent Grass	5%

323.2.03 River Rock

River rock shall be 2" - 3/4" rock.

323.2.04 Topsoil

Topsoil shall conform to Appendix A CWS Design and Construction Standards June 2007.

323.3.0 Workmanship

323.3.01 Preparation of Area

1. Water quality facility shall be over-excavated and filled to final grade with 12-inch amended topsoil. Topsoil amendments shall be garden compost, not conventional fertilizer amendments.

2. A biodegradable erosion control matting shall be placed over the topsoil throughout the swale cross section, fabric shall be held in place in accordance with the manufacturer's installation requirements. Anchor spacing shall be based on 3 fps flow over the fabric.

a. Treatment area – high-density jute matting (Geojute Plus or other approved equal)

b. All other areas – low-density jute matting (Econo-jute or other approved equal)

3. 2.5 – 3 inches of 2”–3/4” river run rock shall be placed over the matting evenly throughout the length and width of the swale.

323.3.02 Plantings

Plant materials shall be placed in accordance with the plan and plant table as shown on approved plans.

323.3.03 Application

The seed mix shall be applied at a rate of .044 ounces per square foot.

323.4.00 Inspections

The Contractor will need to call for inspections at these milestones:

1. Prior to placement of topsoil.
2. Prior to placement of seed mix.
3. Prior to placement of erosion control matting.
4. Prior to placement of river rock.
5. Prior to placement of plants.
6. After plants have been installed.

323.5.0 Timing

The facility shall be substantially complete prior to paving.

1. The water quality swale treatment area plantings can be deemed “substantially complete” once active green growth has occurred to an average growth of 3” and plant density is an average of approximately 6 plants (minimum 1-inch plugs or equivalent) per square foot.
2. The facility shall be deemed acceptable to begin the maintenance period when plant growth and density matches the engineer’s design as shown on the approved plans and all other requirements have been met. The engineer must certify the facility to be functional, in accordance with the approved plan design to begin the two-year maintenance period.

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324 MANHOLES

324.1.00 General

324.1.01 Scope

This section and CWS's Design and Construction Standards June 2007, Chapter 8 cover the work necessary for construction of manholes. The standards that are most restrictive shall govern.

324.2.00 Materials

324.2.01 Base Rock

Base rock shall conform to the 3/4 inch-minus requirements of Section 308 Base and Leveling Courses.

324.2.02 Precast Section

Conform to ASTM C 478. Minimum 48 inches in diameter with eccentric cones and steps cast in section by manufacturer.

324.2.03 Manhole Steps

Manhole steps shall be plastic conforming to the following requirements:

#4 (1/2-inch diameter) steel reinforcing bar conforming with ASTM A 615 Grade 60, encapsulated with injection molded copolymer polypropylene with serrated top surfaces.

324.2.04 Frame and Cover

Frame and cover shall conform to the standard drawings and be manufactured of gray cast iron conforming to ASTM A 48, Class 30. Bearing surfaces shall be planed or ground to provide flat and true surfaces.

Cover shall have the letter "S" cast into the center and shall have two holes of 3/4 inch diameter cast through the top plate in a symmetrical pattern for sanitary sewer or 16 holes of 3/4-inch diameter cast through the top plate in a symmetrical pattern for storm sewer.

Watertight manhole frames and covers shall be provided where specified with a continuous rubber gasket along the horizontal face between the frame and cover with the manhole frame grooved to receive and retain the rubber gasket. The frame and cover shall be secured with three stainless steel 1/2-inch NC hexagonal head cap screws.

324.2.05 Plastic Gaskets

Preformed plastic gaskets may be used in lieu of mortar to connect precast manhole sections. Gaskets shall be Ram-Nek or Kent-Seal #2 conforming to Federal Specifications SS-5-00210.

324.2.06 Pipe Stubout

Pipe stubout shall be the bell or hub section of the gravity sewer pipe specified, or a PVC manhole adapter, pipe, stop coupling and plug. Each stubout shall include a rubber gasketed watertight plug.

324.2.07 P.V.C. Manhole Adapter

Polyvinyl Chloride pipe shall be connected to the manhole with a City Engineer approved, manufactured P.V.C. gasketed manhole adapter with an abrasive exterior, to be grouted into the manhole base or wall.

324.2.08 Manhole Marker

Shall be flexible plastic Type 2 delineators, with W-1 reflectors, conforming to OSHD specification 02850.

324.3.00 Workmanship

324.3.01 Excavation and Backfill

Conform to applicable portions of Section 320, Trench Excavation and backfill. Backfill of manholes shall conform to highest trench class immediately adjacent.

324.3.02 Base Rock

Remove water from excavation, and place 12 inch minimum layer of compacted base rock.

If material in bottom of trench is unsuitable for supporting manhole, excavate below the manhole subgrade as directed by City Engineer, and backfill to required grade with foundation stabilization material as specified in Section 320, Trench Excavation and Backfill.

324.3.03 Precast Manhole Sections

Clean ends of sections of foreign materials. Place preformed plastic gasket on groove of lower section and then set next section in place. Completed manholes shall be rigid and watertight.

324.3.04 Manhole Invert

Construct manhole inverts with smooth transitions to insure an unobstructed flow through manhole. Remove all sharp edges or rough sections which tend to obstruct flow. Trowel all mortar surfaces smooth.

324.3.05 Manhole Extensions

Install watertight extensions as shown on Plans. Lay risers and/or grade rings (12 inch maximum) in mortar with sides plumb and tops level.

324.3.06 Manhole Frame and Cover

Install frame and cover on top of manholes to positively prevent all infiltration of surface or groundwater into manholes. Frame shall be set in a bed of non-shrink grout under the flange of the frame. Set frame so tops of covers are flush with surface of adjoining pavement or 6-inches above ground surface in areas outside the pavement, unless otherwise shown on Plans or directed by City Engineer.

324.3.07 Manhole Over Existing Pipe Line

Excavate around existing sewer pipe as required to provide for base rock and concrete base. Contractor shall take care not to disturb existing pipe and shall provide such bracing or other protection as may be required to maintain the function of the existing pipe during construction.

Place base rock and construct concrete base as specified in this section. Cut

out top half of existing pipe within new manhole and construct new vertical channel walls to same height as top of pipe with smooth transitions to the existing pipe entrance and exit.

Soften the exterior of PVC pipe with PVC solvent cement and cover with sand in the area of the manhole, for maximum adhesion of the concrete or grout.

324.3.08 Drop Assembly

Construct drop assemblies at locations shown on the Plans, using either PVC ASTM 3034 SDR 35 or Class 150 MJ cast iron pipe and fittings. The sewer run of cast iron pipe shall extend beyond the area of manhole excavation and the lower cast iron elbow shall be cast into the concrete manhole base.

If the sewer is PVC, the pipe and fittings for the assembly shall be PVC manufactured gasketed sewer fittings encased within a minimum of 4 inches of concrete from the manhole base to the bottom of the tee. Use PVC manhole adapters at manhole wall and base penetrations. Use a secured but removable, gasketed cap or plug, in lieu of a mortar dam.

324.3.09 Pipe Stubouts

Install pipe stubouts as shown on the Plans to a length of 1.0 pipe length outside the manhole wall. Install stubouts integrally with manhole base and construct base channel for stubout.

Install a rubber gasketed water tight plug in stubouts and secure the plug to withstand internal or external hydrostatic test pressures without leakage. Plugs shall not be grouted into place or otherwise secured by cast-in place concrete.

If stubout invert elevations are not shown on the Plans, match the elevation of the inside top of pipe stubout to the elevation of the inside top of the outlet pipe, unless otherwise directed by the City Engineer.

324.3.10 Manhole Marker

Install manhole markers adjacent to manholes in all areas outside of the paved roadway. Extend marker, 4 feet above the ground surface. Replace the marker if it is broken or bent out of vertical alignment during the driving operation.

324.3.11 Testing of Sanitary Manholes

After backfilling and compacting to finished grade, completed manholes selected by the City Engineer shall be either hydrostatically tested with water or vacuum tested. On projects with 20 or more manholes, fifteen percent (15%) shall be tested; otherwise a minimum of three, or all manholes on projects of 3 or less, shall be tested. Each manhole which fails the test, shall obligate the Contractor to test additional manholes selected at random by the City Engineer, on a one-to-one basis. All defects in manholes shall be corrected prior to paving streets.

324.3.11A Hydrostatic Testing

Plug all inlets and outlets and fill the manhole to the rim. Leakage in each manhole shall be determined by refilling to the rim, using a calibrated or known volume container, and shall not exceed 0.20 gallons per hour per foot of head above the invert.

324.3.11B Vacuum Testing

The test head shall be placed at the inside of the top of the cone, so placed as to test the grade rings and casting and shall be inflated in accordance with the manufacturers instructions. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off and valves closed, and the time shall be then measured for the vacuum to drop to 9 inches. The time shall not be less than the values indicated in the following table.

MANHOLE VACUUM TEST TIME

Depth of Manhole (feet)	Allow able Time (seconds)		
	48 inch	60 inch	72 inch
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	65
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

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325 CATCH BASINS AND INLETS

325.1.00 General

325.1.01 Scope

This section covers the work necessary for constructing catch basins and ditch inlets complete at locations and of the type shown on the Plans.

325.2.00 Materials

325.2.01 Base Gravel

Base gravel shall conform to the $\frac{3}{4}$ inch-minus requirements of Section 308 Base and Leveling Courses.

325.2.02 Concrete

Concrete shall have a minimum compressive strength of 3300 psi, 28 days after placement, using minimum 6-sack mix. An air-entraining admixture shall be used. It shall be added to the mixer at the time of mixing in such a manner as to insure uniform distribution of the admixture throughout the batch. Entrained air (percent of volume) range shall be 4 percent to 7 percent. The maximum water added per sack of cement shall be 6 gallons and the slump range shall be between 4 and 7 inches. Concrete obtained from other than standard ready-mix plants shall be subject to approval of the City Engineer for mix design, materials, batching and mixing.

325.2.03 Grate and Frame

Frames and grates for catch basins and storm drain inlets shall be fabricated of steel conforming to ASTM A 7, A 36, or A 373 in accordance with the details shown on the Standard Drawings. All connections shall be welded. Welding shall conform to requirements of current code for welding in building construction of the American Welding Society. Frames and gratings shall be tested one with the other and there shall be no more than 1/16-inch rock. When checked by a test jig, the bearings of either component shall have no more than 1/16-inch rock.

325.3.00 Workmanship

325.3.01 Excavation

Excavation shall be to neat finish lines. When concrete curb is adjacent to catch basin, excavation shall follow curb construction by at least seven days.

325.3.02 Backfill

In general, catch basins and ditch inlets shall be poured against excavated earth and backfill will not be required. When exterior forms are used and backfill is required, backfill shall be compacted, 3/4-inch minus crushed rock.

325.3.03 Forms

Interior forms shall be either prefabricated steel or smooth plywood. If excavation is to neat lines, exterior forms may not be required. Interior forms shall be constructed to insure that the inlet frame is embedded precisely as shown on the details. All forms shall be thoroughly cleaned before reuse.

325.3.04 Concrete Placement

Before depositing concrete, work crews and all equipment and tools shall be on the job site, all debris shall be removed from the space to be occupied by the concrete, and the subgrade shall not be frozen. The base shall be thoroughly wetted, but no pools of water will be permitted.

Concrete shall be deposited in its proper place without delay in a continuous operation. No construction joints will be allowed in catch basins and inlets.

In hot weather, concrete in place shall be protected until final finishing can be completed. With a hot dry breeze, windbreaks may be erected, or fog nozzles may be used. Curing operation should begin as soon as concrete has set enough to avoid surface damage.

Placing concrete during period of rain will not be permitted. If concrete has been placed and rain commences, it shall be protected by plastic sheeting positioned off the concrete surface, and maintained to prevent ponding.

Concrete shall be placed only when the outside air temperature is 35⁰F and rising, and is forecast to remain above 35⁰F.

325.3.05 Frame and Grate

The frame and grate must be installed level, transverse to the curb line.

325.3.06 Finish

After removal of the interior forms, holes shall be patched and finished. The patching mixture shall consist of one part cement and two parts mortar sand. The outside edges of the top of the catch basin shall be finished with an edging tool with 1/4-inch radius.

325.3.07 Subgrade Drains

Subgrade drains or weep holes shall be installed as shown on the details or as specified by the City Engineer.

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326.0.00 WATER PIPE AND FITTINGS

326.1.00 General

326.1.01 Scope

This section covers all work necessary to furnish and install main line water pipe and fittings.

326.1.02 Pipe Zone

The zone extends the full width of the trench to a height 12 inches above the outside top of the pipe barrel. For pipes 27 inches in diameter and less, the minimum depth of the zone from the outside of the pipe barrel to the bottom of the trench shall be 4 inches and for pipes larger than 27 inches in diameter, the depth is a minimum of 6 inches.

326.2.00 Material

326.2.01 Pipe

Pipe shall be push-on joint ductile iron pipe, centrifugally cast of 60-42-10 iron and shall conform to AWWA C151, Standard and Special Class minimums as follows:

PIPE CLASSIFICATION

<u>Nominal Size</u>	<u>Pressure Class</u>	<u>Special Class</u>
3"	N/A	54
4"	N/A	54
6"	N/A	53
8"	N/A	52
10"	N/A	51
12"	N/A	50
14" and Larger	350	

Abnormal trench conditions and/or live loads shall be checked as per AWWA C150 which may indicate a heavier special class is required.

The pipe shall be cement-mortar lined in accordance with AWWA C104. Rubber gaskets and lubricant conforming to AWWA C111, are to be supplied by the pipe manufacturer, suitable for the specified pipe size and pressure, and in sufficient quantity for installing the pipe.

326.2.02 Fittings

Fittings shall be ductile iron mechanical joint conforming to C153, or where shown on the plans flanged joint conforming to C110, cement-mortar lined as per AWWA C104, with rubber gaskets meeting AWWA C111. Flanged joints shall conform to the dimensions and drilling of ANSI B16.1, class 125 cast-iron flanges.

326.2.02A Thrust Blocks

Concrete for thrust blocks shall be ready-mix, conforming to ASTM C 94, Alternate 2, maximum aggregate size 1-1/2 inch, compressive strength 3,300 psi at 28 days.

326.2.02B Mechanical Joint Restraint

Approved, field installed mechanical joint restraint incorporated in the design of the follower gland may be used, with a minimum working pressure of not less than 250 psi and safety factor of 2:1, and shall include a restraining mechanism which when actuated, imparts wedging action against the pipe, increasing its resistance as the pressure increases and maintaining the flexibility of the joint after burial. Glands and restraining devices shall be manufactured of ductile iron, with heat treatment where necessary, and shall be used with the standard mechanical joint bell and tee-head bolts.

The Megalug series 1100 restrained joint system manufactured by EBAA Iron, Inc., and the GripRing system manufactured by Romac Industries, Inc., are approved for use.

326.02.02C Pipe Push-On Joint Restraint

American "Fast-Grip" or U.S. Pipe "Field Lok" gaskets may be used to restrain compatible straight lengths of pipe.

326.2.03 Concrete

Concrete for thrust blocking shall be ready-mixed, conforming to ASTM C 94, Alternate 2, maximum aggregate size 1-1/2 inch, compressive strength 3,300 psi at 28 days.

326.2.04 Pipe Zone

Pipe zone shall conform to the 3/4-inch minus grading requirements of Section 308 Base and Leveling Courses.

326.3.00 Workmanship

The installation of water mains shall generally be in accordance with AWWA C600, unless mentioned otherwise herein.

326.3.01 Distribution

Distribute material on the job no faster than it can be used to good advantage. In general, no more than one week's supply of material shall be distributed in advance of laying, unless otherwise approved.

326.3.02 Grade

Install pipe with a minimum cover of 30 inches, unless otherwise directed by the City Engineer. Maintain a grade consistent with the position and intended operation of air valves where shown on the plans. Where changes in grade are brought about by conflicts with other utilities or structures, which would result in a high point, without an air release valve, the City Engineer shall be informed immediately.

Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for pipe bedding. Before each section of the pipe is laid, check grade, and correct any irregularities in trench bottom. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.

326.3.03 Connection to Existing System

Before exposing the existing pressurized system, the Contractor shall contact and coordinate all work with the City of Tualatin Operations Department. Connections shall be made to existing pipe or fittings where shown on the Plans, and the Contractor shall locate the pipe or fittings through exploratory excavation.

326.3.04 Operations of Existing Valves

At no time shall the Contractor operate the existing water system valves. The Contractor shall coordinate all work with the City Operations Department, who will operate the existing water system valves. The Contractor shall provide one working day notice to the City Inspector and Operations Department prior to needing Operations personnel on-site.

326.3.05 Dewatering

Provide and maintain equipment, promptly remove all water entering the trench during the time the trench is being prepared for pipe laying, during the laying of the pipe, until concrete has set, and until the pipe zone backfilling has been completed. Dispose of water in an approved manner without damage to adjacent property.

326.3.06 Pipe Bedding

Level trench and compact at subgrade elevation. Place and compact pipe zone material and then excavate bell holes at each joint of sufficient depth that bells are not supported on zone material. Pipe bedding shall be fine graded by hand to give uniform, even support to the bottom of the pipe. Pipes shall not be laid on blocking or any material other than pipe zone material.

326.3.07 Pipe Installation

Inspect all pipe and fittings immediately prior to installation to ensure that no defective materials are used. Clean ends of pipe of all lumps, blisters, excess coal-tar coating and foreign matter from the bell and spigot ends of each pipe. Remove foreign material from inside pipe, and use proper tools and approved lubricants to join pipe sections. Use only proper implements, tools, and facilities for the safe and proper protection of materials and workmen. Carefully lower pipe into the trench to prevent damage to the pipe and do not dump or drop pipe onto ground or into trenches. If the pipe cannot be lowered into the trench and placed without earth or foreign material entering it, the City Engineer may require that a heavy, tightly-woven canvas bag of suitable size be placed over each end before lowering and left there until the connection is to be made to the adjacent pipe.

After the pipe has been lowered into the trench, assemble pipe in accordance with the directions of the manufacturer. Unless otherwise directed, lay pipe with bell end facing in the direction of the laying and after the joint has been made, align the pipe and check for grade. The deviation of any section of pipe from the line and grade shown shall not exceed 1 inch.

Place sufficient pipe zone material around the pipe to assure that the pipe has

continuous and uniform support along the barrel and to assure that the pipe section will not move laterally.

At any time that laying operations are not in progress, close and block the open end of the last laid section of pipe, so no foreign material or animals can enter.

Cut pipe for inserting valves, fittings or closure pieces in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. Use a milling or rolling pipe cutter, or cutoff wheel and do not flame cut. Dress cut ends of pipe by beveling, and mark insertion/stop lengths as recommended by the manufacturer.

326.3.08 Handling and Laying Fittings

Handle fittings carefully and lower into the trench to prevent damage to the coating. Remove all foreign material or dirt from within the fitting before lowering into position and keep fittings clean during and after laying. Provide proper implements, tools and facilities satisfactory to the City Engineer for the safe and convenient prosecution of the work.

Mechanical joint fittings vary slightly with different manufacturers, so install the particular fittings furnished in accordance with the manufacturer's recommendations. In general, the procedure shall be as hereinafter specified. Clean the ends of the fittings of all dirt, mud, and foreign matter, after which slip the gland and gasket on the plain end of the pipe. Lubricate the end of the pipe to facilitate sliding the gasket in place, then guide the fitting onto the spigot of the pipe previously laid.

326.3.09 Backfill at the Pipe Zone

After the pipe is in place and ready for backfilling, place pipe zone material at approximately the same rate on each side of the pipe such that the elevation of the backfill on each side of the pipe is approximately equal at all times. Compact the backfill by tamping in 6-inch lifts to the horizontal centerline of the pipe to the City Engineer's satisfaction. Particular attention shall be given to the backfilling and tamping procedures to assure that no unfilled or uncompacted areas occur beneath the pipe.

The remainder of the backfill in the pipe zone shall be placed without compacting. After backfilling to the top of the pipe zone, compact type "D" backfill material to a minimum of 91 percent of its maximum density as determined by AASHTO T 180.

326.3.10 Anchorage

326.3.10A Location

Securely anchor all tees, plugs, caps, bends, and other locations where unbalanced forces exist, by suitable mechanical joint restraint, bearing thrust or gravity blocks as shown on the plans or hereinafter specified. Flange connect all adjacent fittings and valves, unless otherwise directed by the City Engineer.

326.3.10B Reaction Blocking

Place bearing or gravity thrust blocks as shown on Standard Drawing No. 620 and No. 621 respectively. Place bearing thrust blocking between undisturbed ground and the fitting to be anchored and arrange all concrete placement so that the fitting joints and bolts will be accessible for repairs.

326.10C Mechanical Joint Restraint

The City Engineer shall check restraint length, with trench backfill and soil type information submitted by the Contractor before laying into the restrained joint area. Use pipe with approved restraining gaskets to meet the minimum restrained pipe length requirement. Approved mechanical joint restraint shall be installed in full accordance with the manufacturers instructions. If reassembly is required, tighten wedges or joint follower with a torque wrench, or as otherwise recommended by the manufacturer.

326.3.11 Hydrostatic Test

Make pressurized leakage tests on all newly laid pipe and valved sections of pipe. The maximum length of pipe to be tested at one time shall be the length of pipe between main line valves. Furnish all necessary equipment and material, make all taps, and furnish all closure pieces in the pipe as required. The City Engineer shall monitor the test.

Furnish the following equipment and materials for the tests, unless otherwise directed by the Engineer:

- (2) Approved graduated containers,
- (2) Pressure gauges,
- (1) Hydraulic force pump as approved by the Engineer

Suitable hose and suction pipe as required.

Conduct tests after the trench has been backfilled and compacted, and all

services are set and installed. Where any section of pipe is provided with concrete thrust blocking, do not conduct pressure test until at least 5 days have elapsed after the concrete thrust blocking was installed.

Slowly fill the line with water, and ensure that all air release valves are functioning correctly and air is expelled at all high points in the line. Pressurize the line to a test pressure of 150 psi, based at the lowest point in the line and corrected to the elevation of the test gauge, and maintain within ± 5 psi, after a period of stabilization.

Leakage shall not be measured by a drop in test pressure over a period of time, but by the quantity of water that must be pumped into the pipe section to maintain the test pressure over a period of 30-minutes. The leakage shall not be less than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD}{10,876} \quad \text{where,}$$

L = Allowable leakage, in gallons per hour.
 S = Length of test pipe, in feet
 D = Nominal diameter of pipe, in inches.

When testing against closed metal-seated valves an additional amount per valve of 0.0078 gal/hour/inch of nominal valve size shall be added to the above formula.

Where the working pressure is greater than 120 psi, the test pressure shall be not less than 1.25 times the working pressure at the highest point in the test section, and the leakage shall be determined by the following formula:

$$L = \frac{SD}{133,200} \square P$$

where,
 P = Average test pressure, in psi.

326.3.11A Correction of Excessive Leakage

Should any test of pipe laid disclose leakage greater than that allowed under the above formula, locate and repair the defective joints, pipe or fittings until the leakage is within the specified allowance.

326.3.12 Sterilization

Pipelines intended to carry potable water shall be sterilized before placing in service. Sterilizing procedures shall conform to AWWA C651 as hereinafter modified or expanded.

326.3.12A Flushing

Before sterilizing, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 3.0 fps.

326.3.12B Sterilizing Mixture

Shall be a chlorine-water solution having a free chlorine residual of 40 - 50 ppm. The sterilizing mixture shall be prepared by injecting:

- 1) Liquid chlorine gas-water mixture;
- 2) Dry chlorine gas;
- 3) Calcium or sodium hypochlorite and water mixture;

into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.

The liquid chlorine gas-water mixture shall be applied by means of an approved solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.

If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution.

The following proportions of hypochlorite to water will be required:

<u>Product</u>	<u>Quantity</u>	<u>Water</u>
Calcium Hypochlorite (1) (65 - 70% Cl.)	1 lb.	7.50 gal.
Sodium Hypochlorite (2) (5.25% Cl.)	1 gal.	4.25 gal.

- (1) Comparable to commercial products known as HTH, Perchloron, and Pittchlor.
- (2) Liquid laundry bleach known commercially as Clorox, Purex, etc.

326.3.12C Point of Application

Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of the pipeline. Water from the existing system or other approved source shall be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to water entering the pipe that the combined mixture shall contain 40 - 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

Valves on the existing system shall only be operated by City personnel per Section 326.3.04.

326.3.12D Retention Period

Chlorinated water shall be retained in the pipeline long enough to destroy all coliform organisms. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the 24-hour period, the sterilizing mixture shall have a strength of at least 10 ppm of chlorine.

Operate all valves, hydrants, and other appurtenances during sterilization to assure that the sterilizing mixture is disbursed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the treated water.

Do not place concentrated quantities of commercial sterilizers in the line before it is filled with water.

After chlorination, flush the water from the line until the water through the line is equal chemically and bacteriologically to the permanent source of supply.

326.3.12E Disposal of Sterilizing Water

Dispose of sterilizing water in an approved manner. Do not allow sterilizing water to flow into a storm drain system without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level. Disposal into the sanitary system shall only be allowed upon receipt of prior approval from the City and from the Clean Water Services.

326.3.13 Bacteriological Testing

The City Engineer shall arrange for samples to be collected no sooner than 16-hours after final flushing at intervals from the new main, including branches. The main shall not be accepted or placed in service until the tests show the absence of coliform organisms. If a sample is not acceptable, the main shall be rechlorinated by the continuous feed or slug method, or the source of contamination removed, until satisfactory results are obtained.

327.0.00 WATER VALVES AND RELATED EQUIPMENT

327.1.00 General

327.1.01 Scope

This section covers all work necessary for furnishing and installing valves, and appurtenances.

327.2.00 Materials

327.2.01 Gate and Butterfly Valves

Valves shall be non-rising stem, have operators suitable for direct burial, fitted with 2-inch square operating nuts, which shall rotate counterclockwise to open. Valves shall be flange connected to fittings, dimensioned and drilled to ANSI B16.1, class 125 cast-iron flanges.

327.2.01A Gate Valves

Valves 2-inches to 16-inches shall be AWWA C509 resilient-seat gate valves.

327.2.01B Butterfly Valves

Valves 18-inches and larger shall be rubber-seated butterfly valves and shall conform in all respects to the physical and performance requirements of AWWA C504, Class 150B, short body type.

327.2.02 Tapping Valve and Sleeve

Tapping valves shall meet or exceed AWWA C500 gate valves specifications, except that the seat rings are the necessary diameter to permit entry of the tapping machine cutters. Branch side after the gate valve shall be mechanical joint, or as shown on the plans.

Tapping sleeves shall be stainless steel fabricated construction designed to fit the diameter and type of pipe to be tapped. Gaskets shall be of Buna-N rubber and all regular fittings to meet AWWA specifications where applicable.

327.2.03 Pressure Reducing and Check Valves

This valve shall be a hydraulically operated, diaphragm-actuated, globe valve. The diaphragm assembly shall be the only major moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm assembly valve stem shall be fully guided at both ends, by a bearing in the valve cover with a valve position indicator, and an integral bearing in the valve seat. The diaphragm shall not be used as a seating surface and all normal repairs shall be possible without removing the valve from the line.

The pressure reducing controller shall be capable of maintaining a constant downstream pressure in the range of 30 psi to 100 psi., regardless of fluctuations in demand. The pressure reducing pilot control shall be a direct-acting, adjustable spring loaded, normally open diaphragm valve which closes when downstream pressure exceeds the spring setting. The check valve control assembly shall be capable of positively closing the main valve if a pressure reversal occurs. The control system shall also include a strainer-orifice assembly, closing and opening speed control needle valves, low flow stabilizer assembly and shut-off cocks which isolate the pilot system.

Pressure gauges shall be fitted to both the inlet and outlet and shall be of the Bourdon type with a 4-1/2 inch dial, certified for water use, with a pressure range of 0 to 200 psi. upstream; and 0 to 160 psi., downstream, both with 1/2 % accuracy. Provide lever-handled isolating cocks and porous metallic element pressure snubbers for each gauge.

327.2.04 Pressure Reducing and Sustaining Valve

This valve shall be a hydraulically operated, diaphragm-actuated, globe valve. The diaphragm assembly shall be the only major moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm assembly valve stem shall be fully guided at both ends, by a bearing in the valve cover with a valve position indicator, and an integral bearing in the valve seat. The diaphragm shall not be used as a seating surface and all normal repairs shall be possible without removing the valve from the line.

The pressure reducing and the pressure sustaining controllers shall be capable of maintaining constant pressures in the range of 20 psi to 120 psi., regardless of fluctuations in demand. The pressure reducing pilot control shall be a direct-acting, adjustable spring loaded, normally open diaphragm valve which closes when downstream pressure exceeds the spring settings. The pressure sustaining pilot control shall be a direct-acting, adjustable spring loaded, normally closed diaphragm valve which opens when upstream pressure exceeds the spring setting. The control system shall also include a strainer-orifice assembly, closing and opening speed control needle valves, low flow stabilizer assembly and shut-off cocks which isolate the pilot system.

Pressure gauges shall be fitted to both the inlet and outlet and shall be of the Bourdon type with a 4-1/2 inch dial, certified for water use, with a pressure range of 0 to 160 psi., and 1/2 % accuracy. Provide lever-handled isolating cocks and porous metallic element pressure snubbers for each gauge.

327.2.05 Altitude Valve

This valve shall be a hydraulically operated, diaphragm-actuated, globe valve. The diaphragm assembly shall be the only major moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm assembly valve stem shall be fully guided at both ends, by a bearing in the valve cover with a valve position indicator, and an integral bearing in the valve seat. The diaphragm shall not be used as a seating surface and all normal repairs shall be possible without removing the valve from the line.

The pilot control shall be a diaphragm-actuated, 3-way type that operates on the differential force between the height of the water in the reservoir and an adjustable spring load. The entire valve and control system shall be so designed that no surface water can be drawn into the pilot system or main valve at any time. The control system shall also include a strainer-orifice assembly, closing and opening speed control needle valves, and shut-off cocks which isolate the pilot system.

Where one-way flow is also required, the pilot control system shall also incorporate the necessary check valves for positive control.

327.2.06 Air Valves

Shall be designed for a working pressure of 150 psi, and test pressure of 300 psi. Valves shall be cast-iron bodied, with stainless trim and mechanisms, removable Buna-N seats, and stainless steel floats capable of withstanding a pressure of 1,000 psi. Materials shall be selected to reduce electrolytic action to a minimum. Sizes 1/2-inch through 3-inch shall be threaded NPT, and sizes 4-inch and larger shall be have flanged 125-pound inlets and plain outlets, with protective hoods to prevent the entry of debris and foreign matter.

Valves shall be the following or an approved equal:

<u>Valve Type</u>	<u>Manufacturer</u>	<u>Model</u>
Air Release	Val-Matic	154
	APCO	200A
Air and Vacuum	Val-Matic	100 to 108
	APCO	141 to 154
Combination	Val-matic	201C to 208C
	APCO	143C to 151C
Surge Check	Val-matic	Series 1200
	APCO	Series 1600

327.2.06A Air Release Valves

Air release valves shall be designed to automatically vent through a small orifice, small pockets of air as they accumulate at high points in a system, while the system is operating and pressurized. The orifice shall be sized for the maximum air flow venting capacity and pipeline pressure.

327.2.06B Air and Vacuum Valves

Air and vacuum valves shall be designed with a large orifice to exhaust air during the filling of a pipeline and to admit air during the draining of a pipeline or when a negative pressure occurs, but not to vent air during system operation. The float shall be guided for positive shutoff onto the seat and shall be protected by a baffle from high velocity air and water and thus prevent the float from closing prematurely.

327.2.06C Combination Air Valves

Combination air valves shall combine the operating functions of the air release, and air and vacuum valves; with valves 3-inch and smaller being of the single housing type.

Valves 4-inch and larger shall consist of an air and vacuum valve mounted on a surge check valve, with an air release valve connected to the body of the air and vacuum valve.

327.2.06D Surge Check Valve

The surge check valve shall allow unrestricted air flow but shall close to a throttling position when high velocity water enters the check valve, which shall return to an open position when the air and vacuum valve has closed.

327.2.07 Blowoff Valve Assembly

Shall conform to the details shown on Standard Drawings 605 and 606 and the relevant sections of this specification.

327.2.08 Joints

Mechanical and push-on joints shall conform in all respects to AWWA C111. All fittings shall be flanged connected to adjacent valves and fittings, with all dimensions and drilling to ANSI B16.1, class 125 cast-iron flanges. Bolts and gaskets shall conform to AWWA C207.

327.2.09 Valve Boxes

Valve boxes shall be heavy duty, by Olympic Foundry Inc., East Jordan Iron Works, or approved equal, 18-inch top section, slip type with top flange, and recessed handle cover (solid handle) manufactured of cast iron conforming to ASTM A48-76 (tensile strength 30,000 psi) and coated with a G.P.D. asphalt varnish. "W" or the word "WATER" shall be cast into the top of the lid. Valve box extensions shall be fabricated from 6-inch polyvinyl chloride sewer pipe conforming to ASTM D 3034, SDR 35. Valve stem extensions, when required, shall be fiberglass by Pipeline Products or approved equal, and shall include a lower operating nut, extension, and upper operating nut with ring.

327.2.10 Concrete

Concrete shall conform to ASTM C 94, Alternate 2, with a 28 day strength of 3300 psi. There shall be a minimum of 6-1/2 sacks of cement per cubic yard of concrete.

327.3.00 Workmanship

327.3.01 Gate & Butterfly Valves

Before installation, the valve shall be thoroughly cleaned of all foreign material, and shall be inspected for proper operation, both opening and closing, and to verify that the valves are set properly.

Valve shall be installed so that the operating stem is vertical transverse. Under no circumstances shall a valve be installed on its side, even if installed to be nonfunctional. Jointing shall conform to AWWA C600 or AWWA C603, whichever is applicable.

Face of flange shall be cleaned thoroughly before flanged joint is assembled. After cleaning, the gasket shall be inserted and the nuts tightened uniformly around the flange. If flange joint leaks under test, the nuts shall be loosened, the gasket reset or replaced, the nuts retightened, and the valve and/or pipeline retested. Valves shall be flange connected to adjacent fittings.

327.3.02 Valve Boxes

Center the valve box and set align with the operating nut of the valve. Set valve box so that they do not transmit shock or stress to the valve. Set the valve box covers flush with the surface of the finished pavement as shown, or such other level as may be required by the City Engineer. Cut extensions to the proper length so that the insertion length is between 4 and 14-inches when set at final grade.

Place backfill around the valve boxes and thoroughly compact to a density equal to that of the undisturbed ground and in such a manner that will not damage or displace the valve box from proper alignment or grade. Misaligned valve boxes shall be excavated, aligned, and backfilled.

328.0.00 FIRE HYDRANT ASSEMBLIES

328.1.00 General

328.1.01 Scope

This section covers the work necessary for furnishing, installing or relocating fire hydrant assemblies.

328.2.00 Materials

328.2.01 Excavation and Backfill

Trench excavation and backfill shall conform to requirements of Section 320, Trench Excavation and Backfill.

328.2.02 Pipe

Pipe shall conform to Section 326, Water Pipe and Fittings.

328.2.03 Hydrants

Fire hydrants shall be Waterous Pacer WB-67 (with 16" standpipe), Clow F-2500, Mueller Centurion, or M & H Valve 929 Reliant, all conforming to AWWA Standard C502 for dry barrel fire hydrants. Each hydrant shall be equipped with one 4-1/2" steamer nozzle, 5-3/4" O.D. with 4 threads per inch; two 2-1/2" hose nozzles, 3-1/16" O.D. with 7-1/2 threads per inch; operating nut shall be pentagon 1-1/2" point to flat, counter clockwise to open 5-1/4" valve; shoe 6" mechanical joint; all painted Miller, Bright Red # 2530 High Gloss Oil Spar Enamel.

328.2.04 Base Block

Solid precast concrete pier block having nominal dimensions of 12" x 8" x 6".

328.2.05 Drainage Rock

3/4 - 1/4" open graded crushed rock, or graded river gravel free of organic matter, sand, loam, clay, and other small particles that will tend to restrict water flow through the gravel.

328.2.06 Gate Valve and Valve Box

Gate valves for fire hydrant assemblies shall be 6-inch size as shown on the Plans. Valve and valve box shall conform to Section 327, Water Valves and Related Equipment.

328.2.07 Main Tee

Main tee shall be ductile iron as specified in Section 215, Water Pipe and Fittings. Side outlet of main tee shall be 6 inch flanged.

328.2.08 Tapping Tee and Valve

Shall be as specified in Section 327, Water Valves and Related Equipment. Side outlet of tapping tee shall be 6-inch flanged.

328.3.00 Workmanship

328.3.01 General

Hydrants shall be set-up as shown on Standard Drawing 610, and installation shall conform to Sections 3.7 and 3.8 of AWWA C600, except as otherwise specified.

328.3.02 Location and Position

Locate as shown or directed so as to provide complete accessibility and minimize possibility of damage from vehicles or injury to pedestrians. Improperly located hydrants shall be disconnected and relocated.

Set hydrant plumb and steamer nozzle at right angles and facing the street. Set hydrants so that the mid-point of the safety flange is 3 inches above finished grade.

328.3.03 Excavation

Over-excavated areas shall be filled with gravel, and hand tamped to provide firm foundation. Backfill around hydrant shall be similar to adjacent pipeline as specified in Section 320, Trench Excavation and Backfill.

328.3.04 Base Rock

Place on firm, uniform and level grade.

328.3.05 Hydrant

Prior to connecting hydrant, adjust position of base block to assure that weight of hydrant will bear on base block and not on the tee or valve. Approved mechanical joint retainer glands shall be used between the gate valve and hydrant. Test hydrant assembly with main line pressure.

328.3.06 Drainage Rock

Place drainage rock around hydrant shoe and base block up to the hydrant drain opening, after hydrant is in place. Top of gravel shall extend not less than 3 inches above hydrant drain opening.

328.3.07 Abandoned 6-Inch Service Line

After removing a fire hydrant, the Contractor shall if relevant, plug the existing 6-inch gate valve. Do not place backfill until the City Engineer has inspected the installation of the plug.

328.3.08 Location Markers

After installing the final lift of paving, the Contractor shall install a blue bi-directional Type Ia reflective pavement marker. Marker shall be located 18 inches from centerline in the direction of and perpendicular to the hydrant and shall conform to OSHD specification 02840.60.

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329.0.00 WATER METERS AND BOXES

329.1.00 General

329.1.01 Scope

This section covers the work necessary water meters including meter boxes, meters, service connection piping, fittings and other incidental work as required for complete installation.

329.1.02 Pipe Zone

The area of the pipe zone extends for the full width of the trench from the bottom of the pipe to 4 inches above the outside top of the pipe.

329.2.00 Materials

329.2.01 Excavation

Excavation shall conform to the requirements of Section 320, Trench Excavation and Backfill.

329.2.02 Backfill

Backfill within the pipe zone shall be 3/4-inch minus crushed rock. Backfill above the pipe zone below the street structural section shall be crushed rock as stipulated in Section 320, Trench Excavation and Backfill. Backfill above the pipe zone in areas outside the back of curb/sidewalk shall be native material excavated from the trench.

329.2.03 Copper Tube

Copper tubing shall conform to ASTM B 88, with Type K soft, used on services 1-inch and smaller, and Type K hard on sizes larger to 2-inch.

329.2.04 Fittings

Fittings shall conform to AWWA C 800, designed for connection to the service line by compression.

329.2.05 Meters

The City Operations Department will install meters up to 2" in size. Meters larger than 2" shall be installed by the Permittee, and shall be as shown on the appropriate standard drawings.

329.3.00 Workmanship

329.3.01 Preparation of Trench

Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid. The trench bottom shall form a continuous and uniform bearing support for the pipe. Provide and maintain ample means to remove water entering the trench during the laying operation to the extent required to properly grade the bottom of the trench and allow for proper compaction of the backfill above the pipe zone. Do not lay pipe in water. Trench excavation and backfill shall conform to applicable portions of Section 320, Trench Excavation and Backfill.

329.3.02 Copper Tubing

The copper tubing shall be cut with square ends, reamed, cleaned, and made up tightly. Care shall be taken to prevent the tube from kinking or buckling on short radius bends. Kinked or buckled section of copper tube shall be cut out and the tube spliced with the proper brass fittings at the Contractor's expense.

329.3.03 Installation of Meter Boxes

Meters and meter boxes or vaults shall be installed in a workmanlike manner. Finish grade of completed meter enclosure shall be flush with the top of curb and/or back of sidewalk. Meter boxes or vaults shall be set or constructed plumb, with the top set to conform to the slope of the finish grade. Lightly compacted pipe zone material shall be placed inside of the meter boxes, from the pipe zone above the pipe to the base of the meter. Prior to connection of the meter, the angle meter key valve shall be opened and the service line flushed clean of all foreign materials.