CHAPTER 200

DESIGN REQUIREMENT SPECIFICATIONS

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201 GENERAL PROVISIONS

201.1.01 Scope

This chapter covers the standards for the design of public works facilities, water quality facilities, Public Utilities, and the preparation and submittal of construction plans. Except as provided otherwise in a specific section, these standards and regulations apply to all public works and water quality construction within the City.

Design and construct all public works facilities in accordance with the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG).

Section 202, Construction Plans, does not apply to Public Utilities.

201.2.00 Design Engineer

The Design Engineer is the person responsible for preparation of the Plans and Special specifications for proposed public works construction. Designs submitted shall be stamped by a registered Professional Engineer licensed to practice in the State of Oregon.

201.3.00 Predesign Conference

The City Engineer will, if requested or warranted, hold a predesign conference with the Permittee and/or Design Engineer before formal plan preparation to review the project approvals, special site conditions, construction methods, outside jurisdictions, and any other matters that may affect the project. This meeting will allow discussion on the specific matters of the proposed project prior to starting on the preparation of formal plans and specifications.

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202 CONSTRUCTION PLANS

202.1.00 Design Plan Format

1) The plans shall be submitted on sheets 24" x 36".

2) Vicinity maps shall be located on the first sheet of all plans and shall show the location of the project in respect to the nearest major street intersection. Additionally, a sheet index shall be located on the first sheet of all plans.

3) A north arrow shall be shown on each plan view sheet of the plans and adjacent to any other drawing which is not oriented the same as other plan review on the sheet. North shall generally be orientated to the top or left of the page.

4) The scale shall be 1"=2', 4', 5', or 10' vertically and 1"=10', 20', 40', 50', or 100' horizontally for all drawings except structural or detail drawings and they are exempt. The scale shall be shown on all drawings.

5) Letter size shall not be smaller than 0.10 of an inch high.

6) The location and elevation of a National Geodetic Survey, United States Geological Survey, State Highway, or County bench-mark must be shown. Use Oregon Coordinate Reference System (OCRS) Portland Zone, NAD 83 (2011) Epoch 2010 for horizontal and North American Vertical Datum of 1988 (NAVD 88). Per FEMA Flood Insurance Study (FIS) add 3.52 feet to convert a Northern Geodetic Vertical Datum 1929 (NGVD 29) to NAVD 88. Request approval from the City Engineer prior to use of alternate datums. Temporary bench-marks must be shown.

7) Existing survey monuments shall be shown with a note to protect them.

8) A title block shall appear on each sheet of the plan set and shall be placed in the lower right hand corner of the sheet, across the bottom edge of the sheet or across the right hand edge of the sheet. The title block shall include the names of the project, the engineering firm, the owner, and the sheet title.

9) The seal and signature of the Registered Professional Engineer responsible for preparation of the plans shall appear on each sheet.

10) The description and date of all revisions to the plans shall be shown on each sheet affected, and shall be approved and dated by a Registered Professional Engineer as evidenced by signature or initial.

11) Each set of plans shall include a sheet containing a composite plan of the street layout and all public utilities.

12) Each set of plans shall include a sheet containing the drainage calculations.

202.2.00 Plan View

Plan views must show the following:

1) Right-of-way, property lines, tract, permanent and temporary easement lines.

2) Subdivision name, lot numbers, street names, and other identifying labels. Street names are subject to the approval of the City.

3) Location and stationing of existing and proposed street centerlines and curb faces at a minimum of 100-foot intervals.

4) Horizontal alignment and curve data of street centerline and curb returns.

5) Public utilities and trees (8" in diameter and larger) in conflict with the construction or operation of the street and drainage facilities.

6) Location, stationing, and size of drainage and water quality facilities. Facility stationing must be located in relationship to the street stationing. Show drainage facilities both upstream and downstream of the project. Direction of drainage flows must be shown with arrows.

7) Match lines with sheet number references.

8) Top of curb elevations along curb returns and cul-de-sacs at quarter-points, PC and TL points, and at 100-foot stations.

9) Location of the low points of street grades and curb returns.

10) Curb ramp locations and designs including slopes, elevations and other dimensions necessary to construct curb ramps in accordance with PROWAG.

11) Crown lines along portions of streets transitioning from one typical section to another.

12) Traffic control plan, including temporary and permanent striping and signing.

13) Centerline stationing of all intersecting streets.

14) Location and description of existing survey monuments including, but not limited to, property corners, section corners, quarter corners, and donation land claim corners.

15) Legend.

16) Permittee and developer's name, address, and phone number (including emergency after hours number).

17) Size, location, material type, grade or slope of all existing utilities including, but not limited to, sanitary sewer, domestic water, storm water, electric, telephone, gas, and cable tv, and size, location, material type, elevation, and proposed scope of the proposed utility.

18) Location of existing buildings, wells, septic tanks, drain fields, fuel tanks, other buried structures, driveways, mailboxes, signs, and any other existing facilities.

19) The total square footage of new impervious area for projects other than single family residences and duplexes. This determination needs to be differentiated into public (within rights-of-way) and private jurisdictions.

20) FEMA designated 100-year floodplains and floodways, or areas of flooding during a 100-year storm event.

21) Wetland, greenway, water quality facilities, and associated buffer strips or undisturbed corridors, or significant natural resource areas.

22) An erosion control plan must be provided and must include the following:
    a. The topography of the site (existing and proposed).
    b. Graveled access points (dimensioned).
    c. Sediment fences, as proposed.
    d. Post construction sediment fences, as proposed.
    e. Filtration control for existing inlets, as proposed.
    f. Clearing limits.
    g. Details corresponding to each control measure.
    h. The total square footage of this site.
    i. Other proposed measures, i.e. detention ponds.
    j. Landscaping (existing and proposed).

23) Detail sheets must be provided, as proposed.

24) Any other information deemed necessary by the City Engineer to clarify and show details of the project.

202.3.00 Profile View

Profile view shall show the following:

1) Stationing, elevations, vertical curve data and slopes for centerline of streets or top of curbs. For offset or superelevation cross sections, both curbs shall be profiled. Where curbs are not to be constructed, centerline of street and ditch inverts shall be shown.

2) Original ground along the centerline and, if necessary, at the edges of the right-of-way if grade differences are significant.

3) Centerline of existing streets for a distance of at least three hundred (300) feet each way at intersections with proposed streets or project boundaries. Show original ground beyond existing streets for like distances.

4) Extension of the profile of streets that will be extended in the future (stub streets). The extended profile shall be at least two hundred (200) feet for local and minor streets and as required for streets with higher classifications and be designed to be compatible with the restraints of the terrain.

5) The top of curb elevation for all cul-de-sacs, eyebrows, and intersection curb returns.

6) All proposed and existing utilities, their types, all invert and top elevations, slopes, materials, bedding, and backfill.

7) Existing drainage and water quality facilities, including off-site facilities, upstream and downstream that affect the design (e.g. downstream restrictions that back water onto project site).

8) Profiles for ditch and creek flow lines shall extend a minimum of two hundred (200) feet beyond the project, both upstream and downstream. Typical cross sections at fifty (50) foot intervals shall also be submitted.

9) All existing and proposed sanitary, storm, water, gas, telephone, cable television, or other lines crossing the profile.

10) Anything else deemed necessary by the City Engineer.

202.4.00 Site Grading Plan

A site grading plan shall be submitted showing existing and proposed elevations. Grading contours (existing and proposed) shall be at no more than two (2) foot intervals and shall extend off-site a minimum of 50 feet. Structural fill areas shall be "shaded".

202.5.00 Drainage Calculations

Drainage calculations shall be presented in a clear, concise, and complete manner. These calculations shall address all runoff into the drainage system; areas contributing flow to each inlet must be computed separately and each inlet with contributing area shall be designated and shown on an accompanying contour map worksheet.

Initial time of concentration with assumptions listed and charts or nomographs used shall be included with drainage calculations.

Refer to Section206, Storm Sewer Design, for specific requirements.

Concentrated surface runoff shall not be allowed to flow over driveways, sidewalks, accessways, bicycle or pedestrian paths.

202.6.00 Other Requirements

Other information to be shown on the construction drawings or other submittals may include if requested by the City Engineer:

1) The design assumptions for each street (ex: traffic coefficient, R-value).

2) The design elements, such as:
   a. Street classification
   b. Design speed
   c. Superelevation
   d. Average Daily Traffic (ADT) or Design Hourly Volume (DHV)

3) Structural construction plans and the necessary calculations shall be submitted for proposed structures (ex: walls, box culverts, bridges).

4) Any additional information that the City Engineer deems necessary to review the plans and assure compliance with design standards.

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203 STREET DESIGN

203.1.00 General

203.1.01 Scope

This section covers the classification, design, and construction of publicly-owned street facilities within the City.

The functional classification of existing and proposed roads shall be defined by the Tualatin Development Code (TDC). Where the functional classification of a road is not defined by the TDC, the existing land use and existing operational characteristics shall be used by the City to determine the functional classification of the road in question.

The TDC defines the following road classifications (TDC abbreviation in parenthesis):

1) Expressway (F)
2) Arterials
   - Major arterials (Ei, Eb&t)
   - Minor arterial (Db&t)
3) Collectors
   - Major collector (Cb&t)
   - Minor collectors (Cb&p, Cb, Cs&p, Cs&2p, Cr)
4) Local Residential Streets (B)
5) Local Commercial Industrial Streets (B-CI)

203.1.02 Design Standards

The location, width and grade of streets shall be considered in relation to existing and planned streets, topographical conditions, public convenience and safety, and the proposed use of the land to be served by the streets. Where location is not shown in the development plan, the arrangement of streets shall:

Provide for the continuation of existing streets.

Conform to a plan for the neighborhood, approved or adopted by the City Council, to meet a particular situation where topographical or other conditions make the extension to existing streets impractical.

203.2.00 Design Criteria

203.2.01 Design Speed

The minimum design speed for each road classification is the posted speed or as directed by the City Engineer, in accordance with Oregon Revised Statutes (ORS) 810.180.

203.2.02 Sight Distance

The most recent AASHTO Guidelines as outlined in “A Policy on Geometric Design of Highways and Streets” must be used to develop safe streets, with particular emphasis on the four types of controls that apply to at-grade intersections:

1) No control, but allowing vehicles to adjust speed.

2) Yield control where vehicles on the minor intersecting roadway must yield to vehicles on the major intersecting roadway.

3) Stop control where traffic on the minor roadway must stop prior to entering the major roadway.

4) Signal control where all legs of the intersecting roadways are required to stop by either a stop sign or where the intersection is controlled by traffic signals.

203.2.03 Tapers

Street width transitions from a narrower width to a wider width shall be designed with a 10:1 minimum taper. Pavement markers and markings, as approved by the Engineer and in accordance with the applicable sections of this chapter, shall be installed to define the configuration.

Street width transitions from a wider width to a narrower width, the length of transition taper shall be determined as follows:

Type of Taper	Taper Length
Merging taper	L minimum
Shifting taper	1/2 L minimum

Formulas for L

Speed limit	Formula
40 mph or less	$L = \frac{W \times S^2}{60}$
45 mph or greater	$L = S \times W$

Where:

L = Minimum length of taper (feet)
S = Design speed (mph)
W = width of offset (feet)

Pavement markers and markings, as approved by the City Engineer and in accordance with the applicable sections of this chapter shall be installed to define the configuration. Maximum spacing of markers shall be the numerical value of the design speed, in feet [i.e., thirty-five (35) foot spacing for thirty-five (35) MPH].

203.2.04 Superelevation

Where superelevation is required as indicated by AASHTO guidelines, street curves should be designed for a maximum superelevation of 0.06 with appropriate transitions per AASHTO standards. Wherever possible, street design must conform to the standard street cross section.

Where superelevations coincide with crosswalks or pedestrian crossings, limit roadway cross section to 5% max counter slope for 4 feet approaching curb ramp.

203.2.05 Horizontal Alignment

Alignments shall meet the following requirements:

A. Streets shall be aligned horizontally to match existing street improvements and possible future street extensions.

B. Horizontal curves in alignments shall meet the minimum centerline radius requirements of the most current edition of AASHTO based on the design speeds set forth in 203.2.01.

203.2.06 Vertical Alignment

Alignments shall meet the following requirements:

A. Minimum tangent street gradients shall be one-half (0.5) percent along curb and gutter.

B. Grades shall not exceed 12% on collector or arterial streets, or up to 15% on any other street.

C. Streets intersecting with a minor collector or greater functional classification street shall provide a landing averaging two (2) percent or less. Landings are that portion of the street within twenty (20) feet of the curb line of the intersecting street at full improvement.

D. Grade changes of more than one percent shall be accomplished with vertical curves.

E. Street grades, intersections and superelevation transitions shall be designed to not allow concentrations of stormwater to flow across the street.

F. Off-set crowns shall be a minimum of 10.5-feet in width as measured from face of gutter.

G. Streets not constructed to full urban standards shall be designed to match both the present and future vertical and horizontal alignments of any street which may be intersected. The requirements of this chapter shall be met for both present and future conditions.

H. Vertical curves shall conform to the requirements of the most current edition of AASHTO.

I. Slope easements shall be granted or obtained for the purposes of grading outside of the rights-of-way.

J. Streets shall be aligned vertically to match existing street improvements and the topography of adjacent parcels for possible future street extensions.

203.2.07 Slope Design

All slopes shall be stable. Side slopes, both cut and fill, generally shall be no steeper than 3 (horizontal) : 1 (vertical). The City Engineer may approve steeper slopes where dictated by site constraints and allowed by geotechnical data and sound engineering practice.

203.2.08 Intersections

The following are the minimum requirements for intersections:

A. The interior angle at intersecting streets must be kept as near to ninety (90)

degrees as possible and in no case will it be less than seventy-five (75) degrees.

B. Minimum intersection spacing must be at least 100 ft., measured centerline to centerline.

C. Curb ramps must be provided at all corners of all intersections, regardless of curb type, and must conform to the Standard Drawings and Section 203.2.15.

D. Curb radii at intersections must be as shown in Table 203-1 for the various function classifications. The right-of-way radii at intersections must be sufficient to maintain at least the same right-of-way to curb spacing as the lower classified street.

TABLE 203-1

Curb Radii (feet)
Edge of Pavement/Curb - Minimum

Street Classification	Arterial Street	Major Collector Street	Minor Collector Street	Local Commercial Industrial	Local Residential Street
Expressway	55	40	30	35	25
Arterial	55	40	40	35	25
Major Collector	40	40	30	35	25
Minor Collector	30	30	30	35	25
Local Commercial Industrial	35	35	35	35	25
Local Residential	25	25	25	25	25

203.2.09 Cul-de-Sacs, Eyebrows, Turnarounds

The following specifies the minimum requirements for cul-de-sacs, eyebrows, and turnaround areas. Other turnaround geometrics may be used when conditions warrant and the City Engineer approves the design and application of its use.

A. Cul-de-sacs, eyebrows and turnaround areas shall be allowed only on local residential and local commercial/industrial streets.

B. Cul-de-sacs shall not be more than six hundred (600) feet in length. The length of a cul-de-sac shall be measured along the centerline of the roadway from the near side right-of-way of the nearest through traffic intersecting street to the radius point of the cul-de-sac bulb.

C. The minimum curb radius for cul-de-sac bulbs shall be forty-five (45) feet

and the right-of-way radius shall be sufficient to maintain the same right-of-way to curb spacing as the tangent section of street.

D. Cul-de-sacs, eyebrows and turnaround areas shall have a six (6) foot public utility easement extending outside the right-of-way around the cul-de-sac.

E. The minimum curb radius for transitions into cul-de-sac bulbs shall be twenty-five (25) feet and the right-of-way radius shall be sufficient to maintain the same right-of-way to curb spacing as in the adjacent portion of the road.

F. Cul-de-sacs and eyebrows shall have a maximum longitudinal slope of six (6) percent from the radius point to curb.

203.2.10 Stub/Dead End Streets

Stub streets or dead end streets for future extension shall not exceed 250 feet in length without an approved temporary vehicular turnaround.

Stub streets or dead end streets for future extension shall be constructed to the property line, and shall be designed such that the vertical grade of the street matches the existing topography of the adjacent property. Where vertical design standards preclude matching the existing topography, a proposed street extension alignment and profile showing potential grading impacts to the adjacent property shall be provided to the City Engineer for review and approval.

If the street cannot be constructed to the property line without requiring access/easements onto adjacent properties and the adjacent property owner is unwilling to grant the access/easement, the street shall be stopped short of the property line at a location determined by the City Engineer.

Barricades per Standard Drawing Nos. 510 and 511 shall be installed at the end of all stub streets or dead end streets.

203.2.11 Bike and Pedestrian Facilities

203.2.11A Bike Paths

The following standards shall be used when designing bike paths:

1. The standard bike path width shall be 12-feet. A minimum 10-foot, or maximum 14-foot bike path may be approved by the City Engineer.

2. The standard side graded area width shall be 3-feet. No obstructions other than ground vegetation for erosion control shall be allowed within the side graded area.

3. Where bike paths are separated from vehicular traffic, the minimum separation between a bike path and the edge of pavement of an adjacent roadway is 5-feet. When this is not possible a suitable physical divider may be constructed. The divider shall be designed with a minimum height of 4.5-feet and shall be approved by the City Engineer.

4. The standard vertical clearance to obstructions is 10-feet measured from the bike path and from the side graded area. When this standard is not practical, the City Engineer may approve a minimum of 8-feet vertical clearance with proper warning signage.

5. The maximum desirable grade of bike paths is 5%. Grades in excess of 5%, but no greater than 10%, may be acceptable where terrain dictates, where sight distance is adequate and as approved by the City Engineer. Where grades exceed 5%, the design speed and width shall be modified according to AASHTO “Guide for the Development of Bicycle Facilities”.

6. Superelevation of bike paths shall be a minimum of 2% and a maximum of 5%.

7. Horizontal alignment and the minimum curve radius shall meet the design criteria in the AASHTO “Guide for the Development of Bicycle Facilities”.

8. Portland Cement Concrete (PCC) is required for construction of bike paths.

9. Where illumination of bike paths is specified by the City, lighting shall be in conformance with the AASHTO “Guide for Development of Bicycle Facilities”.

10. Electrical conduit with 2-inch diameter, and pull lines, shall be installed with maximum spacing of 200-feet between pull boxes or as otherwise specified by the City Engineer.

11. Sight distance shall meet the design criteria in the AASHTO “Guide for the Development of Bicycle Facilities”.

12. Bike paths shall be separated from industrial areas or areas that present a hazard to bicyclists by means of fencing or impenetrable landscaping as may be specified by the City Engineer.

13. Any design requirement not specified above shall be governed by the City's interpretation of the AASHTO “Guide for the Development of Bicycle

Facilities" and "Oregon Bicycle and Pedestrian Plan".

14. A suitable storm drainage system for removal of surface water shall be provided.

15. Landscaping and vegetation shall comply with TDC 72.060(2)(f) for bike paths within greenways and TDC 73.230 through 73.290, inclusive, for all other bike paths. TDC 71.064(2)(d) shall apply for areas in the Wetland Protection District.

203.2.11B Bike Lanes

1. Bike lanes shall be separated from a motor vehicle travel lane by an 8-inch wide white stripe. The common edge of the bike lane/travel lane shall also be the centerline for the 8-inch wide bike lane stripe.

2. Bike lanes shall be signed and marked as described in the most recent *Oregon Bicycle and Pedestrian Plan* and in the *Manual of Uniform Traffic Control Devices, with Oregon Supplement*, with final approval by the City Engineer.

3. Illumination of bike lanes shall be consistent with AASHTO's most recent *An Informational Guide for Roadway Lighting*.

4. Any design requirement not specified above shall be governed by the City's interpretation of the most recent AASHTO *Guide for the Development of Bicycle Facilities* and *Oregon Bicycle and Pedestrian Plan*.

203.2.11C Accessways

The following standards must be used when designing and constructing public accessways:

1. Public accessways must be designed and constructed in accordance with the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG)

2. Public accessways must be designed to comply with the TDC.

3. Accessways must be constructed of Portland Cement Concrete.

4. Materials and workmanship in the construction of accessways must conform to the standards used in construction of public sidewalks.

5. An accessway must be 8-feet in width inside an 8-foot wide tract dedicated to the City.

203.2.11D Pedestrian Path Standards

The following standards shall be used when designing pedestrian paths:

1. The width of soft surface recreation trails should be 6-feet.

2. A minimum one foot zone on both sides of the path shall be maintained to provide horizontal clearance from trees, poles, fences, or other lateral obstructions.

3. Trees, vines and shrubs should be trimmed along the path to provide a minimum vertical clearance of eight feet.

4. Pedestrian paths shall meet the "Accessibility Standards" listed in Tables 203-2A and 203-2B.

5. Trail construction should entail use of geotextile filter fabric, topped with a 5-inch base of 3/4-inch minus rock and a 3-inch surface layer of 1/4-inch minus crushed rock. Refer to the Greenway Development Plan for a concept drawing of this trail. Note: Other materials may also be used to achieve a stable and firm surface. Departures from the crushed rock standard by the use of other materials, designs, or technologies may be considered by the Parks and Recreation Department where it can be demonstrated that they will provide adequate access and durability given soil conditions and expected use.

6. Portland Cement Concrete shall be used for outdoor recreation access routes in high use areas, as determined through development approval.

7. Use elevated boardwalks for paths through wetland areas. Boardwalks should be constructed of pressure treated Douglas fir or cedar. Planks must run perpendicular to the direction of travel and joints must be no more than 1/2-inch. Planks must be securely fastened so they do not warp and should be treated with an appropriate preservative to avoid decay and drying. Boardwalks shall be designed by a registered professional engineer. Refer to Greenway Development Plan for concept drawings of these structures.

8. Minimize impact on natural areas. Balance cut and fill where possible along cross slopes to create a level trail surface.

9. Provide a 10-foot setback between the path and edge of wetland and creeks, unless otherwise approved by the City Engineer.

TABLE 203-2A

Outdoor Recreation Access Routes

The following table summarizes design parameters for outdoor recreation access routes in urban/rural and more natural settings. All trails within the Tualatin Greenway system should attempt to meet the "Easier" standard. However, unusual site constraints may justify shifting to the "Moderate" or "Difficult" standard. Design of the facility shall be in accordance with the standard designated by the Greenway Development Plan, or as part of development approval.

Summary of Design Standards for Recreation Access Routes:

Level of Development:

	Urban/Rural Easier	Roaded/Nat. Moderate	Semi-Primitive Difficult
Clear width (minimum):	48 inches	36 inches	36 inches
Sustained running grade (maximum): *	5 percent	5 percent	8.3 percent
Max. grade allowed: *	8.3 percent	10 percent	10 percent
For max. distance of:	30 feet	50 feet	50 feet
Cross slope (max.): **	3 percent	3 percent	3 percent
Passing space interval (maximum):	200 feet	300 feet	400 feet
Rest area interval (maximum):	400 feet	900 feet	1200 feet
Small level changes (maximum):	1/2 inch	1/2 inch	1 inch

* No more than 20% of the total length of the outdoor recreation access route shall exceed the maximum sustained running grade.

** The measurement of a maximum grade and cross slope should be made over a 30" measurement interval to correspond to the footprint of a wheelchair operating in that environment.

TABLE 203-2B

Outdoor Recreation Trails

The following chart summarizes design parameters for outdoor recreation trails in urban/rural and more natural settings. All trails within the Tualatin Greenway system should attempt to meet the "Easier" standard. However, unusual site constraints may justify shifting to the "Moderate" or "Difficult" standard. Design of the facility shall be in accordance with the standard designated by the Greenway Development Plan, or as part of development approval.

Summary of Design Standards for Recreation Trails:

Level of Development:

	Urban/Rural Easier	Roaded Nat. Moderate	Semi-Primitive Difficult
Clear width (minimum):	48 inches	36 inches	28 inches
Sustained running slope* (maximum)	5 percent	8.3 percent	12.5 percent
Max. grade allowed**	10 percent	14 percent	20 percent
For a max. distance of:	30 feet	50 feet	50 feet
Cross slope (maximum.):**	3 percent	5 percent	8.3 percent
Passing space interval (maximum):	200 feet	300 feet	400 feet
Rest area interval (maximum):	400 feet	900 feet	1200 feet
Small level changes (maximum):	1/2-inch	2-inch	3-inch

* No more than 20% of the total trail length shall exceed the sustained running grade.

** The measurement of maximum grade and cross slope should be made over a 30" measurement interval to correspond to the footprint of a wheelchair operating in that environment.

203.2.11E Exceptions

The following exceptions are allowed to Tables 203-2A and 203-2B are allowed:

1. Where the City Engineer determines that compliance with any of the standards would have such significant environmental impacts as to threaten or destroy the unique environmental, natural, geologic, cultural or religious character of the site, then the specific standard in question, and only that standard may be modified to meet the highest level of access practicable and feasible.

2. When it is determined in accordance with the procedures in ADAAG 4.1.7(2) that compliance with any of the standards would threaten or destroy the historic significance of a site, then the specific standard(s) in questions, and only that standard(s) may be modified to meet the highest level of access practicable.

3. When a trail is developed for a specific purpose, such as a challenging or rugged hike, and compliance with any of the standards would change the fundamental nature of that experience, then the specific standard(s) in question, and only that standard(s), may be modified to meet the highest level of access practicable and feasible.

Requests for exceptions shall include documented evidence that people with disabilities or their representatives were involved in the design process.

203.2.12 Private Streets

Private streets are not subject to the requirements in this document.

203.2.13 Driveways

The following specifies the minimum requirements for driveways:

A. Driveways shall not be permitted on streets with existing or proposed non-access reserve strips or as set forth in the Tualatin Development Code.

B. The widths and spacing requirements shall conform to the requirements of the Tualatin Development Code, Section 73.400 and Standard Drawings 440-446.

203.2.14 Sidewalks

The following specifies the requirements for sidewalks:

A. Sidewalks must be designed and constructed in accordance with the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG).

B. The location and width of the sidewalks must conform to the requirements of City's Transportation System Plan Street Design Standards in Table 3 and Figure 2 (pages 17 through 24), or as otherwise provided by the City Engineer. Location and width are relative to the centerline.

C. Where existing clustered mailboxes, utility poles, fire hydrants, or other objects are within a sidewalk, the sidewalk must be widened or meandered to provide clearance equal to the required sidewalk width. Easements in the name of the City are required for sidewalks outside of the right-of-way.

D. Where it is required to install sidewalks and a permanent sidewalk cannot be constructed, a temporary walkway may be constructed. The temporary walkway may consist of an asphaltic concrete or Portland Cement concrete to a width, location and structure approved by the City Engineer and meeting requirements of the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG).

E. In the Town Center, the sidewalks must be 10-feet wide and, rather than a planter strip, must have tree wells. These wells must have a grate per Standard Drawing 514. These grates must be installed per manufacturers recommended specifications and additional details as identified by the Project Engineer.

203.2.15 Curb Ramps

Curb ramps must be designed and constructed in accordance with Standard Drawings 460-464. Design and construct curb ramps in accordance with the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG). The City Engineer may approve engineered curb ramp designs provided they meet all requirements of the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) may be used.

203.2.16 Right-of-Way and Grading

Grading outside the improved areas shall be as follows:

A. All streets functional classifications shall have a two (2) percent upward grading from back of curb through the right-of-way line, and within the public utility easement.

B. Retaining walls shall be used if slopes are greater than the requirements in paragraph A. above. Retaining walls shall be constructed to a height where the slope is no more than one and one-half (1-1/2) horizontal to one (1) vertical. Retaining wall design shall be prepared by a registered engineer in the State of Oregon and approved by the City Engineer. Due consideration shall be given to ground water pressures in any retaining wall design. Retaining wall shall be located outside of the right-of-way unless otherwise approved by the City Engineer.

C. Cross-slope of the street section shall be no less than two (2) percent and no greater than five (5) percent. Whenever possible, the crown of

D. A root control system, such as Biobarrier or approved equal, shall be installed at both sides of the planter strip. It shall be installed vertically 12” deep from finished grade per manufacturers recommendation.

203.2.17 Subsurface Drainage

Subgrade drainage shall be provided for the purposes of collecting and conveying subsurface water only. The flow volume shall not be considered part of the storm drainage system for storm drain pipe sizing purposes unless the volume collected and conveyed is significant to warrant consideration during a design storm event.

Subgrade drains shall be provided:

1. On uphill sides of road cuts.
2. Transverse to the road centerline at the low point of sag vertical curves and at 300-foot intervals uphill thereafter.
3. At naturally occurring springs or other wet areas.

Subgrade drains shall be sloped to and connect into the storm drainage system at catch basins, manholes, roadside ditches or other suitable point of discharge. Storm water shall not be allowed to back up into the subgrade drains during design storm events.

203.2.18 Raised Medians

Where raised medians are constructed, the following criteria must be met:

A. The raised median shall be set back at least two (2) feet from the travel lane on both sides.

B. Street lighting, painting, and reflective markers shall be sufficient to provide illumination and delineation of the raised median.

C. Objects, such as trees, shrubs, signs, light poles, etc., shall not physically or visually interfere with vehicle or pedestrian traffic.

D. The style and design of the raised median shall be site specific. The raised median shall be safe for the design speed, and shall be approved by the City Engineer.

E. Landscape islands are not permitted in residential local streets.

203.2.19 Structural Section

Streets must be constructed of:

A. Asphaltic concrete with crushed rock base or treated bases. The minimum asphalt concrete and crushed rock sections shall be a follows:

Street Classification	Min. Section
Local	6" A.C. over, 2" 3/4"-0 rock over, 6" 1-1/2"-0 rock.
Downtown Core and Commercial/Industrial Connectors	8" A.C. over, 2" 3/4"-0 rock over, 8" 1-1/2"-0 rock.
Major and Minor Collectors	8" A.C. over, 2" 3/4"-0 rock over 10" 1-1/2"-0 rock, or as designed.
Major and Minor Arterials	Per asphalt pavement design for anticipated traffic loading.

All Classifications	3/4”-0 rock may be used for full rock section in place of 1-1/2”-0 rock.

B. Portland cement concrete with cushion course of crushed rock or on a base of crushed rock or treated base.

Design the road structural section based upon soil analysis. Applicants must submit a geotechnically engineered pavement design for City Engineer approval.

Perform soil tests:

1. For each visually observed soil type, and
2. On samples of the materials expected to be within three (3) feet of the planned subgrade elevation, and
3. A minimum of two (2) tests are needed for each site, and
4. A minimum of every five hundred (500) linear feet of roadway.

Specify compaction moisture content at optimum to slightly over optimum. Address subgrade drainage and ground water considerations for year round conditions. Recommend both summer and winter construction. A licensed geotechnical engineer registered in the State of Oregon must prepare the soils report.

203.2.20 Asphalt Pavement Design

Design, construct, and test Asphalt Concrete Pavements in accordance with the most current ODOT Pavement Design Guide and Oregon Standard Specifications for Construction Sections 744 and 745, except where modified by City requirements.

Asphalt concrete (A.C.) streets must be Level 3 for arterials, collectors, and commercial/industrial connector streets, and Level 2 for local streets. The maximum lift thickness must be three (3) inches.

Asphalt pavement must be designed using ODOT, AASHTO, or another nationally recognized procedure. Traffic loading must be as approved by the City Engineer. Use a 30-year design period.

203.2.21 Portland Cement Concrete Pavement Design

203.2.21A 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 close conformity to the lines, grades, thicknesses and cross sections shown on the plans or established by the City Engineer.

203.2.22 Portland Cement Concrete Structure Design

The Design Engineer shall design Portland Cement Concrete streets using the guidelines and requirements of the Portland Cement Association (PCA) design procedures.

The Design Engineer shall test the subgrade and determine the Modulus of Subgrade Reaction, k, to design the street structure. Correlations of R-value and CBR to k may be made using Figure 2, Thickness Designs for Concrete Highway and Street Pavements.

Minimum thickness of Portland Cement concrete shall be six (6) inches. The maximum thickness of untreated aggregate base shall be four (4) inches. Design modulus of rupture (MR) shall be six hundred fifty (600) psi.

A higher value of modulus of rupture shall be allowed if adequately supported test data is submitted and approved by the City Engineer.

Use a forty (40) year design period.

203.2.24 Traffic Signals

203.2.24A Design and Installation Requirements

Traffic signal installation must conform to the most current edition of the MUTCD.

203.2.24B Design Drawing Requirements

Traffic signal installation plans shall consist of the following separate sheets:

1. Construction plan (street), 1" = 20'

2. Signal wiring including electrical service, 1" = 20'
3. Underground detection plan, 1" = 20'
4. Sign and striping plan, 1" = 40'

203.2.24C Modification to General Specifications

Modification, or specific to general specifications are:

1. Specific micro processor prom program shall be the current version of W4IKS supplied with each controller, unless otherwise specified.
2. Approved fire preemption devices shall be installed on all approaches to signal.
3. Traffic detection shall consist of magnetometer or preformed (State specifications) loops, as directed by the City Engineer.
4. The traffic signal design and installation shall provide for interconnection to other area signals (existing and proposed future signals).
5. The traffic signal design and installation shall provide for transit preemption.

203.2.25 Traffic Signs

Traffic signs must be furnished and erected in conformance with the most current edition of the MUTCD and the Standard Specifications supplemented by the State of Oregon and/or modified as follows:

Category A
Regulatory signs are classified in the following groups:

1. Right-of-way series
2. Speed series
3. Movement series
4. Pedestrian series
5. Miscellaneous series

Category B
Warning signs that may warrant the use due to hazards and typical locations are:

1. Changes in horizontal alignment
2. Intersections
3. Advance warning of control devices
4. Converging traffic lanes
5. Narrow roadways
6. Changes in highway design
7. Grades Roadway surface conditions

8. Railroad crossings
9. Entrances and crossings
10. Miscellaneous

Category C
School Areas:

1. School advance sign
2. School crossing sign
3. School bus stop ahead sign
4. School speed limit signs

Category D
Guide signs and street name signs

203.2.26 Street Name Signs

In business districts and on major arterials, street name signs should be placed in diagonally opposite corners so that they will be on the right-hand side of the intersection for traffic on the minor street.

In residential districts, at least two street name signs will be mounted at each intersection.

On T-intersections, the street name signs will be designated at two locations. One street name sign being placed at the end of "T" intersection, and the second being placed at the right-hand corner of the intersecting street.

203.2.27 Traffic Marking

Traffic marking must be designed and installed in accordance with the most current edition of the MUTCD.

Paint is allowed for line striping only. All other pavement markings, including arrows, stop bars, bike lane symbols, railroad crossing legends, and word legends, must be pre-formed thermoplastic material.

203.2.28 Street Lights

Street lights shall be designed and installed in accordance with PGE (Option B) standards, and Table 203-3.

Street lighting plans shall be submitted to PGE for review and approval, with copies of the submittals provided to the City.

TABLE 203-3 **STREET LIGHT STANDARDS**

	LUMINAIRE	POLE	MAST ARM	MOUNTING HEIGHT	WATTS	SPACING	AVE FT. CNDLS
RESIDENTIAL :							
Standard Street	Early Amer. (black) (3-56-523)	Bronze (3-40-110)	N/A	16'	100W HPS 120/240V	135' 2' behind curb	0.4
Collector Street	Shoebox cutoff (3-56-537)	Bronze (3-40-125)	only if behind s/w 6' alum (SK-3-55-076)	25'	100W HPS 120/240V	135' 2' behind curb	0.59
Arterial Street	"	"	"	25'	100W HPS 120/240V	120' 2' behind curb	0.59
INDUSTRIAL / COMMERCIAL:							
Standard and Collector Streets	Semi-cutoff (3-56-564)	Non-davit alum. (3-40-060)	6' aluminum (SK 3-55-076)	30' 25'	200W HPS Type III 240V	155' 3' behind curb	1.21
	Semi-cutoff (3-56-574)		"	30' 25'	250W HPS 240V	170' 3' behind curb	1.21
	Semi-cutoff (3-56-584)	Dir. bury fiberglass (3-40-120)	"	30' 25'	400W HPS 240V	290' 3' behind curb	1.21
Arterial Street	Semi-cutoff (3-56-564)	Non-davit alum. (3-40-060)	"	30' 25'	200W HPS 240V	110' 3' behind curb	1.72
	Semi-cutoff (3-56-574)		"	30' 25'	250W HPS 240V	100' 3' behind curb	1.74
	Semi-cutoff (3-56-584)	Dir. bury fiberglass (3-40-120)	"	30' 25'	400W HPS 240V	205' 3' behind curb	1.74
Hazelfern Street Boones Ferry Rd-Warm Springs/Lower Boones Ferry Rd Lower Boones Fy Rd 72nd Avenue Bridgeport Rd Childs Rd	HADCO #S5980D		N/A	16'6"	165W QL	55' on both sides of street 2' behind curb	1.22

- All reference numbers in parentheses are from the PGE Overhead Construction Standards, dated Sept. 1991

203.2.29 Guardrails

The following specifies the minimum requirements for the location and type of guardrails:

- The decision of whether to install a guardrail or not shall be based on information found in AASHTO publication, Guide for Selecting, Locations, and Designing Traffic Barriers.

- Guardrails shall be designed and constructed per ODOT's Standard Drawings for Design and Construction.

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204 POTABLE WATER DESIGN

204.1.00 General

This section covers the design of public water supply distribution systems within the City, in combination with the guidelines of Chapter 12 of the Tualatin Development Code. The standards for the transmission system shall be applied by the City Engineer on a case by case basis.

The following guidelines and specifications are set forth as minimum standards for the planning, design, and construction of public water system improvements. In the event these guidelines and specifications do not address a specific situation, the City Engineer will, at their discretion, determine the appropriate course of action to be followed. The City Engineer may revise these requirements at any time without prior notification.

The City's current Water Master Plan includes a detailed discussion of service pressure requirements, pressure zone service elevations and overall system configuration.

The Design Engineer shall at an early stage meet with the City Engineer to discuss the service and distribution issues.

204.1.01 Design Criteria

The Design Engineer shall follow the requirements of the City Water Master Plan and Chapter 12 of the Tualatin Development Code.

204.2.00 System Design

204.2.01 Pipe Sizes

Pipe sizes shall be as shown in the Water System Master Plan. The following pipe sizes are accepted for use in the Tualatin water system: 8, 12, 16, 24 and 36-inch. Distribution water mains typically have a minimum 8-inch diameter.

Peak domestic demand combined with fire flow at full and future development, and possible external emergency demand, shall be accounted for when designing pipe sizes.

Fire systems shall be designed with a pressure based upon the lowest pressure that occurs in the summer during the peak-shaving period, rather than the higher winter pressures. The fire flow demand shall be as specified by the Fire Marshal as applicable for the location, land use type, proposed buildings, and occupancy hazard. The minimum acceptable pressure under fire flow conditions shall not be less than 25 psi.

204.2.02 Pipe Materials

Pipe shall be push-on joint ductile iron pipe, centrifugally cast of 60-42-10 iron and shall be minimum Class 52 thickness, conforming to the latest revision of ANSI/AWWA C151/A21.51. All pipe joints shall be restrained with an acceptable pipe/gasket restraint system per Section 326.2.03B.

Abnormal trench conditions, excessive depth of cover and/or live loads shall be checked as per AWWA C150 which may indicate a heavier special class is required. All thickness classes heavier than Class 52 shall be called out on the plans.

204.2.03 Location and Alignment

To allow for the logical extension of the overall system, completion of loops, and to minimize the impacts to existing improvements, water mains shall be located as determined by the City Engineer.

Wherever possible, distribution pipelines shall be located on public property. Where pipelines are required to pass through private property, easements shall be obtained from the property owner and shall be recorded with the county clerk. Mains shall be extended to the boundary of public property to facilitate future subdivisions or developments.

Wherever possible, dead-ends shall be eliminated by looping into existing lines for improved hydraulic performance and redundancy, and shall be allowed only after receiving prior approval of the City Engineer. A blowoff assembly will be required on all dead-end lines.

Where joint deflection is utilized in the pipeline design, maximum pipe deflection for any joint shall not exceed 75% of the manufacturer's stated joint deflection allowance. Locations of joint deflection shall be shown on the plans for all vertical and/or horizontal pipe deflection.

Sampling stations shall be installed where directed by the City Engineer.

204.2.04 Clearances from Other Utilities

All clearances listed below are measured from the edge of each pipe and/or utility. Water services and sewer laterals shall have a 5-foot minimum horizontal separation. Maintain minimum vertical and horizontal clearances. Crossing existing utilities at perpendicular angles whenever possible, and avoiding crossing angles less than 75 degrees.

Horizontal clearances from water piping and appurtenances:

Cable TV	5’
Natural Gas	5’
Electrical	5’
Storm Sewer	5’
Sanitary Sewer	10’ or as allowed by OAR 333-061-0050
Telephone, Fiber Optics	5’
Other (not specified)	5’ or as required by the City Engineer

Vertical clearances from water piping and appurtenances (for crossing only):

Cable TV	12”
Natural Gas	12”
Electrical	12”
Storm Sewer	12”
Sanitary Sewer	18” or as allowed by OAR 33-061-0050
Telephone Fiber Optics	12”
Other (not specified)	12” or as required by the City Engineer

All utilities shall cross under water piping and appurtenances unless otherwise authorized by the City Engineer. Where a water pipe crosses below a sanitary sewer line, one full length of water pipe shall be used with the pipe centered for maximum joint separation. Spacing and separation may be modified as allowed by OAR 333-061-0050 and approved by the City Engineer.

204.2.05 Valves

Generally, valves shall be located at water main intersections in groups of three (3) for tee applications and four (4) for cross applications. Sufficient valves should be provided to permit shutting down any section of line, not exceeding 800-feet, with valve operations at no more than three locations. Direct bury valves shall be MJ style and include restraints. Valve operator extensions are required on all valves with operating nuts more than 6 feet below finish grade.

A three-foot radius clear zone, free of obstructions, should be provided at all valve locations. Avoid installing valves and their associated valve operators and boxes in inaccessible areas or within areas of existing curb and gutter, driveways, sidewalks or ADA curb ramps.

Butterfly valves shall be installed on pipe sizes 12-inches and larger, and gate valves shall be installed on pipes sizes 4-inches to 10-inches.

Mains extended to the property line or subdivision boundary for future extension shall be terminated with a mainline valve and blowoff assembly. Where permanent dead ends are installed, or low points exist, a blowoff assembly of appropriate size shall be provided to allow a minimum flow of 4-feet/second in the main line.

Air release valve design shall be in accordance with the latest version of AWWA M51. Combination air valves must be located at high points to provide venting while the system is being filled and during normal operation, and for air inflow to provide vacuum protection while the pipe is draining. Pressure reducing/pressure sustaining valves complete with SCADA equipment shall be installed at pressure level interfaces.

Valves shall be pressure rated to a minimum of 150 psi, or 1.5 times the working pressure, whichever is greater.

Related Standard Drawings: 600, 601, 602, 603, 605, 606

204.2.06 Fire Hydrant

Fire hydrants shall be located so that no part of any single-family residential building is greater than 400-feet from a hydrant, and such that no part of any commercial, industrial, or multiple-family building is greater than 250-feet from a hydrant, both as measured along the most practicably accessible route by fire-fighting equipment. Where hydrants are not required for protection of surrounding structures or other fire concerns, fire hydrants shall be provided at a spacing not exceeding 1,000 feet, for transportation hazards and watermain flushing water quality.

Insofar as practical, all fire hydrants shall be located at street intersections to facilitate hose deployment by fire-fighting equipment. When placed at mid-block locations, fire hydrants are to be installed at a common property line. All efforts shall be made to place fire hydrants outside of new, existing or future sidewalk and 5-foot minimum to driveways or other vehicle accesses.

No fire hydrant shall be connected to mains less than 6-inches in diameter. Mains supplying water to two or more fire hydrants shall be at least 8-inches in diameter.

Fire hydrant location shall be subject to City Engineer and Fire District approval, and shall be analyzed for minimum fire flow requirements at design peak flow demand.

Related Standard Drawings: 610

204.3.00 Water Meters and Services

204.3.01 Size

Water services shall be sized for maximum demand, and meter size shall match the service line or be a maximum of one diameter size less than the service line, as approved by the City Engineer.

204.3.02 Vaults

Vaults shall be sized to meet the minimum requirements of the Standard Drawings.

All vaults shall be watertight, precast, reinforced, air-entrained concrete structures manufactured to conform to ASTM C913 and designed to carry anticipated soil pressures and traffic loading conforming to ASTM C890-A16 and AASHTO HS20 live loading. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil. All precast concrete vaults shall be as manufactured by Oldcastle Infrastructure, or approved equal.

All vaults shall be designed to resist static lateral loading equal to 105 pounds multiplied by Depth of Fill per square foot (psf) triangular equivalent fluid pressure plus a surcharge of an additional 3 feet of soil depth in areas subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise). Lateral loading due to seismic acceleration shall be analyzed per UBC Zone 3 requirements (I = 1.25) where I = importance factor, I = 1.25, but not less than 0.20 grams (g) acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.

Concrete for the manufacturing of vaults shall conform to ACI-318 and have a minimum 28-day compressive strength of 3,000 pounds per square inch (psi). All pipe penetrations shall be pre-formed or core-drilled at the required locations. Knockouts shall not be cast into vault walls.

Vault rebar shall conform to ASTM A615 Grade 60 and wire mesh shall conform to ASTM A185 Grade 65.

Shop Drawings for Precast Concrete Valve Vaults shall be submitted for approval by the City Engineer, and include the following:

1) Indicate Plan, location and inverts of connecting piping.

2) All interior and exterior dimensions.

3) Location and type of lifting inserts, connection embeds, and joints.

4) Details of reinforcement.

5) Covers or hatches.

6) Ladders and grating.

7) Design calculations for all loading conditions described herein.

All vaults shall be located within the public right-of-way or within an access easement approved by the City Engineer. Use ductile iron pipe through and 5-feet beyond vault on private side due to vault settlement. No pipe bell ends inside vault.

All vaults shall include the following:

1) Provide a sump pump with a diaphragm or vertical float switch and 2-inch PVC check valve with pipe discharge to daylight. Supply power through GFCI internal wall mount, 12-inches below ceiling.

2) In high ground water areas, anchors to prevent uplift or floatation that may result from the buoyant forces of the ground water.

3) Backfill around vault is to be per manufacturer's specifications.

4) Standard Bilco door with locking hasp, or equal.

5) An approved ladder if greater than 4'0" in depth, with entry through the vault chamber door.

6) A moisture-proof lighting fixture and wall mounted switch.

7) Installation on a compacted gravel base.

8) Ductile iron vault piping with 5-foot stub-out beyond outer vault wall on private side of improvements. Install cap, plug of blind flange on end of pipe prior to backfill.

9) Locate meter vault in locations that minimize or avoid areas where routine traffic loading will occur.

Additionally, the following requirements shall apply:

1) No device shall be installed higher than 3' above the floor or slab.

2) The device assembly shall be adequately supported from the floor and suitably restrained from movements. Supports shall consist of adjustable manufactured steel and shall be bolted to the floor.

3) Horizontal vault joints shall be sealed with a butyl resin sealant.

Related Standard Drawings: 630, 631, 632, 633, 634

204.3.03 Domestic Meters

Meters for domestic use shall be disc-type or compound meters. 5/8" through 2” meters shall be purchased by the applicant, and installed by the City.

204.3.04 Gate Valves

Meter installations larger than 2-inch shall include a suitable gate valve on each side of the meter and fittings external to the vault, for repair, maintenance or replacement.

204.3.05 Meter Location

All meter installations, including those for fire protection service, shall be located within the public right-of-way, or within an access easement in a suitable meter box per the applicable standard drawing. Standard meter installation shall be located at the back face of curb, at the property line in unimproved areas, or as directed by the City Engineer.

204.3.06 Backflow Prevention Device Assembly for Fire Service Line

204.3.06A Device Requirement

Approved backflow prevention devices shall be provided per the requirements of City Ordinance No. 839-91 and Oregon Administrative Rules (OAR) 333-061-0070 and 0071.

204.3.06B Location

Install the device in a vault on private property at the property line. Provide a public utility easement around the vault, extending from the vault to the right-of-way, with a utility easement minimum width of 10-feet, centered on the service line. The City Engineer may approve building installation or vault installation on the project site when installation at the property line is impractical or not feasible.

204.3.06C Testing

The water service shall not be turned on until all required backflow prevention devices have been installed, inspected, tested, approved, and registered with the city.

204.3.06D Control Valves

The Permittee shall install valves on both sides of the backflow device within the vault or box for ease of maintenance.

204.3.06E Non-Residential Building Installation of Backflow Prevention Devices

No part of the backflow prevention device shall be submerged in water or installed in a location subject to flooding. If installed in a vault or chamber, adequate drainage shall be provided and test cocks shall be plugged. The plug shall not be of dissimilar metal.

The device assembly must be protected from freezing and other severe weather conditions.

Only 4-inch and smaller device assemblies previously approved for vertical installation may be installed vertically. Device assemblies larger than 4-inches will not be accepted in a vertical installation.

The device assembly shall be readily accessible with adequate room for maintenance and testing. Devices 2-inches and smaller shall have at least a 12-inch clearance below and on both sides of the device assembly. If located in a vault, the top of the device assembly shall be between 18- and 24-inches below grade.

All device assemblies larger than 2-inches shall have a 12-inch clearance on the back side, a 24-inch clearance on the test cock side, and 12-inches below the device assemblies. Adequate clearance (3-inch minimum) must be maintained above outside screw and yoke flanged (OSY) gate valve stems. Access to the device shall remain clear at all times.

Only approved Post Indicating Valves are allowed on all fire line device assemblies.

Only approved double-check detector assemblies are to be used for system containment on fire line services in the city. The meter on the bypass assembly shall read in cubic feet.

The remote reader shall be installed and rigidly mounted on an outside building wall, enclosed in a metal box with a slot opening which allows reading the remote without opening the box. The box shall be installed at an elevation of five (5) feet to six (6) feet above ground level.

The remote reader shall have the same number of dials to read as the metering device itself, and read in cubic feet. All wires to the remote reader shall be enclosed in a heavy plastic or metal conduit. All wiring shall be in conformance with the appropriate sections of the National Electric Code.

204.3.06F Vault and Chamber Installation

See Section 204.3.02.

204.3.07 Corrosion Protection

Soil resistivity testing is required for waterline installations that exceed 1,000-lineal feet in total length, with a minimum of one soil resistivity test per 1,000-lineal feet of water main. Soil sampling and resistivity testing needs to be conducted by either a NACE Certified Corrosion Specialist or an Oregon Licensed Geotechnical Engineer. Soil resistivity data results of less than 5,000 ohm-cm (considered corrosive to extremely corrosive) may require cathodic protection measures be included with the water main design. Corrosion protection may also be required where water systems are near utility infrastructure carrying high voltage electrical current (electrical transmission lines) or where active cathodic protection is installed to protect other utility's buried infrastructure.

The City Engineer will determine the extent of required cathodic protection measures based on the soil resistivity data and nearby sources of electrical stray current. Protection measures may include minimum separation requirements, application of protective coverings and coatings, pipe joint bonding, and installation of dielectric isolation and galvanic anodes. Cathodic protection (CP) test stations will typically be required in combination with corrosive soil and stray current mitigation methods to evaluate and monitor corrosion protection effectiveness.

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205 SANITARY SEWER DESIGN

205.1.00 General

205.1.01 Scope

This section covers the design of public sanitary sewer systems within the City. The provisions of this chapter shall apply to all public sanitary sewers within the City jurisdiction. Interpretations of such provisions and their application in specific circumstances shall be made by the City Engineer.

205.2.00 Design Criteria

205.2.01 General

The Design Engineer shall submit to the City construction plans and design calculations for sizing the proposed sanitary sewer system. The proposed sanitary sewer system shall be sized to carry the ultimate flow for the tributary basin as illustrated in the City of Tualatin Sanitary Sewer Master Plan, Tualatin Development Code (Chapter 13), and any applicable amendments and updates thereto.

Public sanitary sewer extension shall be extended to adjacent parcel boundaries to facilitate future extension or to serve adjacent properties unless otherwise required by the City Engineer.

Sanitary lines that serve more than one property shall be a public system.

Sanitary sewers should be designed to remove the domestic sewage and basement floor drainage from houses, business buildings, and other public and private establishments, but not street or roof drainage. Storm water, including street or roof drainage, shall be removed by a system of storm sewers or by some other method separate from the sanitary sewer system. Unpolluted cooling waters and swimming pool drains should be kept out of sanitary sewers wherever possible.

The Design Engineer shall verify that the proposed connection will not create or worsen a surcharge condition. In the event the connection will create or worsen a surcharge condition, the applicant shall mitigate the downstream pipe system to provide adequate capacity and eliminate surcharge condition.

205.2.02 Tributary Basin

Sanitary sewer lines shall be installed to serve each property in accordance with the TDC. If there are undeveloped properties adjacent to the proposed development site which can be served by the gravity sewer system on the proposed development site, the applicant shall extend sanitary sewer lines to the common boundary line with these properties. The lines shall be sized to convey flows to include all future

development from all upstream tributary areas that can be expected to drain through the lines on the site, in accordance with the City's Sanitary Sewer System Master Plan.

A reference map showing the tributary area in which the project is located shall be provided by the design engineer. This map shall show the basin that is consistent with the City of Tualatin Master Plan, and any applicable amendments and updates thereto.

205.2.03 Planning District and Population Saturation Density

The planning district and population saturation densities shall be from information obtained from the planning department. If these figures vary from those of the City Master Plan estimates, this difference must be noted in the design calculation.

205.2.04 Flow Variations and Peaking Factor

205.2.04A Domestic Flows

Domestic flows are based on the waste generated from all residential properties. Land uses and densities for residential properties are figured based on data contained in Chapter 5 of the Tualatin Community Plan and the Land Use Map shown in Chapter 9. Only populations at saturation densities are projected for design purposes. Average domestic flow is assumed to be 90 gpcd.

Residential	DU/Acre	Persons/DU
RL Low Density	5.36 - 6.7	3
RML Medium-Low Density	8 - 10	2.4
RMH Medium-High Density	12 - 15	1.9
High Density	20 - 25	1.4
RH/HR High Density/High Rise	24 - 30	1.2

205.2.04B Nondomestic Flows

Nondomestic flows include waste loads from commercial and industrial lands as shown on the previously referenced land use map. A minimum population density of 11.5 people per acre shall be applied to net acreage of industrial and commercial lands to arrive at a population equivalent. The average per capita flow of 90 gpcd shall be applied to this figure to obtain a peak nondomestic flow. Existing and proposed peak point source flows shall be added at the appropriate locations.

205.2.04C Peaking

The peaking factor of 3 shall be used unless, an acceptable figure based on other studies and equal to the peaking factor for water demand. However, for basin populations of greater than 7,000, the peaking factor shall be reduced to $2.7/X^{0.23}$ where X is the average sanitary flow in mgd.

205.2.05 Infiltration and Inflow

Infiltration and inflow must be included in flow calculations in the design of the sanitary system. The parameters used to determine the infiltration and inflow shall be 500 gallons per acre, per day for commercial and industrial zones; and 900 gallons per acre, per day for residential zones.

205.2.06 Sewage Flows

The Manning's coefficient value ("n") to be used in calculating sewage flows shall be 0.013 for ductile iron and PVC (concrete pipe is not allowed). Sewers of sizes which are obviously larger than are necessary for satisfactory carrying capacity, but which are specified in order to meet grade requirements, are not allowed. Surcharging shall not be designed into the piping system. Maximum pipe capacity shall be calculated with the pipe flowing full.

205.2.07 Pipe Design

Install public sanitary sewer lines that are minimum 8 inches in diameter unless otherwise approved by the City Engineer. Install sanitary sewer laterals that are six inches in diameter minimum unless otherwise approved by the City Engineer. Where site constraints exist, four-inch diameter pipe may be used as approved by the City Engineer. Concrete laterals are not allowed.

205.2.07A Location

Sanitary sewers, whenever possible, shall be installed within 5-feet of the centerline of the public right-of-way and in accordance with Section 102.7.00 if within easements unless otherwise approved by the City. All manholes out of the roadway will require access to provide for maintenance as required by the City. All portions of the line (including manholes) shall be within the 400-foot reach of cleaning equipment. In easements and/or maintenance access tracts, paved roadways meeting the following loading and turning requirements of the City's maintenance equipment are required:

Gross weight	42,000 lbs.
Width	12 feet
Length	32 feet
Turning radius	40 feet

205.2.07B Alignment

Sanitary sewer lines shall be laid on a straight alignment and uniform grade between manholes. Curves in sanitary sewers shall not be allowed.

205.2.07C Grade

Lay sanitary sewer mains on a grade which will produce a minimum velocity of two feet per second at design peak flow. For service laterals, use a minimum slope of three percent for six-inch pipe and two percent for four-inch pipe. Where flow velocities at design peak flow are greater than 15 ft/sec, use PVC pipe.

205.2.07D Steep Slopes

Ductile iron sanitary sewers on slopes in excess of 20 percent shall be secured through the use of concrete anchor walls and suitable pipe anchors to prevent pipe slippage. Spacing for anchors shall be as follows:

Minimum Anchor Spacing

Grade (%)	Center to Center
20-34	35 ft.
35-50	25 ft.
51 +	15 ft.

205.2.07E Pipe Cover

All sanitary sewer pipe shall have at least the cover specified in CWS Design and Construction Standards June 2007, 5.06.7. Where this requirement cannot be met, the City Engineer may approve a lesser amount of cover, with the use of appropriate pipe materials.

205.2.07F Spacing Requirements from Water Supplies

Meet requirements of Oregon Administrative Rule 33-061-0050(2), Construction Standards.

Construct public sanitary gravity sewers a minimum of 50-feet away from all wells, springs, or other sources of domestic water supply.

Construct public sanitary pressure sewers a minimum of 100-feet away from all wells, springs, or other sources of domestic water supply.

205.2.07G Water Line – Sewer Line Horizontal Separation

For parallel water and sanitary sewer lines, maintain a minimum horizontal separation of at least 10-feet. If approved by the City Engineer, the horizontal separation can be reduced down to one foot (as measured from the outside edge of the pipes), with the requirement that the bottom of the water line be 18-inches or more above the top of the sewer line.

Refer to OAR 333-061-0050(9) “Crossings-Sanitary sewers and water lines” for additional information regarding Oregon Health Authority Rules.

205.2.07H Water Line – Sewer Line Vertical Separation

Whenever it is necessary for sanitary sewer and water lines to cross, the crossing should be at an angle of approximately 90 degrees.

Whenever possible, the bottom of the water line will be 18 inches or more above the top of the sewer line and one full length of water pipe will be centered at the crossing. Where the water line crosses over the sewer line but with a clearance of less than 18-inches, the sewer pipe will be exposed to the sewer pipe joints on both sides of the crossing to permit examination of the sewer pipe by the City. If the sewer pipe is in good condition and there is no evidence of leakage from the sewer pipe, as determined by the City, then 18 inch separation may be reduced. If it is determined that the conditions are not favorable or there is evidence of leakage from the sewer line, replace the sewer line with a full length of pipe centered at the crossing point, of:

- PVC Pressure Pipe (ASTM D-2241, SDR 32.5);
- High-Density Polyethylene Pipe (HDPE);
- Ductile-Iron Class 50 (AWWA C-151);
- Other similar acceptable pipe;

Alternatively, the sewer can be encased in a reinforced concrete jacket for a distance of 10-feet on both sides of the crossing.

Where water lines cross under sewer lines, expose the sewer line and examine it as described above. If conditions are favorable and there is no evidence of leakage from the sewer line, the sewer line may be left in place. Take special precautions to ensure that the backfill material over the water line near the crossing is thoroughly tamped in order to prevent settlement that could result in the leakage of sewage. In this situation, center one length of the water line at the crossing. If the City determines that conditions are not favorable or finds evidence of leakage from the sewer line, replace sewer line as described above.

Refer to OAR 333-061-0050(9) “Crossings-Sanitary sewers and water lines” for additional information regarding Oregon Health Authority Rules.

205.2.08 Manholes

Manholes are mainly for the purpose of facilitating maintenance and access to the sewer line. Accordingly, manholes shall be located as follows unless otherwise approved by the City Engineer.

1) Every change in grade or alignment of sewer

2) Every point of change in size or elevation of sewer

3) Each intersection or junction of sewer

4) Upper end of all sewers, except as noted in Section 205.2.09

5) At intervals of 400-feet or less

6) 0.20-foot fall through manhole.

All manholes shall be a minimum of 48-inches in diameter and shall have a minimum 12-inch ledge in the base.

Location of steps and elevations of proposed inlets and outlets are required on the plan submittals.

All manholes located in the 100 year floodplain, creek areas, areas outside of the street right-of-way, and/or as directed by the City engineer, shall be equipped with water-tight covers and frames.

205.2.09 Cleanouts

Cleanouts are required for all sanitary sewer laterals. Install cleanouts for sanitary sewer laterals within the public utility easement, 12 to 18-inches from the right of way line or as directed by City Engineer.

Install cleanout no more than 150-feet from sanitary sewer main. The stand pipe must be the same material and size as the sanitary main.

Cleanouts may be temporarily installed within the right-of-way at the end of a stub street under the following conditions: (1) where the street is expected to be extended in the future; and (2) the design of the sewer system does not warrant a manhole be constructed at this location. The City Engineer will make the determination of when and where cleanouts will be allowed, or required.

Use a cast iron frame and bolt down cover embossed with the word “SEWER” for all sanitary cleanouts.

205.2.10 Fittings/Laterals

Tee or wye fittings shall be provided in the sewer main for side sewers. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. All fittings shall be of the same materials as the pipe unless otherwise approved. Material joining the fittings shall be of the same materials as the pipe unless otherwise approved. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface. All fittings shall be capped or plugged, and gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout plug. The plug shall be able to withstand all test pressures without leaking, and when later removed, shall permit continuation of piping with jointing similar to joints in the installed line.

Side sewers are allowed to be connected directly into a manhole providing that they are properly channelized.

All sanitary sewer laterals shall extend beyond the property line approximately 6-feet or as approved by the City Engineer.

In all subdivisions each lot shall be provided with a service.

Tee fittings shall be manufactured of the same material on gravity sewer pipes 18-inches or smaller.

Tee stubs on pipe larger than 18-inches may be field fabricated by cutting a neat hole and grouting with non-shrinking grout. Stubs shall not project into the sewer pipe.

205.5.11 Pump Stations and Force Mains

The design of pump stations and force mains shall be approved by Clean Water Services.

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206 STORM DRAINAGE DESIGN

206.1.00 General

Storm water conveyance systems shall be designed in conformance with master plans adopted by the City and the requirements of the Clean Water Services in accordance with Title II of Ordinance 846-91 of the Tualatin General Ordinance. All proposed development will be required to submit an engineered analysis of the storm water conveyance systems. The submitted analysis is to show that downstream systems are adequately sized to carry the added storm water from the proposed development, and that the increased runoff volume from the development will not cause or contribute to flooding problems. Projects proposing an infiltration system must be approved by the City Engineer.

206.1.02 Design Criteria

The Design Engineer shall submit to the City construction plans and design calculations for sizing the proposed storm drainage system. The proposed storm drainage system shall be sized to carry the ultimate flow for the tributary basin as illustrated in the City of Tualatin Storm Drain Master Plan, Tualatin Development Code (Chapter 13), and any applicable amendments and updates thereto.

Public storm drainage shall be extended to adjacent parcel boundaries to facilitate future extension or to serve adjacent properties unless otherwise required by the City Engineer.

The Design Engineer shall verify that the proposed connection will not create or worsen a surcharge condition. In the event the connection will create or worsen a surcharge condition, the applicant shall mitigate the downstream pipe system to provide adequate capacity and eliminate surcharge condition.

206.2.00 Hydrology

Rational Method

The rational method of run-off calculation will be used for all storm drainage design, unless otherwise approved by the City Engineer. The Rational Method (Q=CIA) is the standard method for calculations related to the peak discharge and other related hydrologic information. For reference to the concepts and theories of the Rational Method see "The American Society of Civil Engineers," Design and Construction of Sanitary and Storm Sewers or others. If other hydrologic methods are proposed, calibration or comparison to the Rational Method is required from the Design Engineer prior to acceptance by the City.

Drainage Basin Areas (A)

The drainage area used in the design or analysis of storm drainage facilities shall include all areas that are or will be tributary (both on and off the project site) to the location under consideration.

Runoff Coefficients (C)

The runoff coefficients used in the design or analysis of storm drainage facilities shall depend on the maximum expected impervious area of all tributary areas to the basin under consideration. Existing storm runoff conditions shall be considered and interim storm designs may be required. Table 206-1 shows minimum acceptable values for the coefficients. The composite runoff coefficients shall be the acceptable form and standard for this parameter.

The use of individual characteristic runoff coefficients is more appropriate than composite coefficients, when preparing the storm drainage calculations for the project. Project-specific composite coefficients can be calculated from an area-weighted-average basis using characteristic coefficients. Table 206-2 shows minimum acceptable values for the coefficients.

Rainfall Intensity (I)

The rainfall intensity used in the design and analysis of storm drainage facilities will vary depending on the time of concentration for the drainage basin that is tributary to the location under consideration. Table 206-3 shows a tabular representation of the rainfall intensities for the 2, 5, 10, 25, 50, and 100 year storm events as a function of time of concentration. Interpolate for values not shown.

The time of concentration shall be calculated as the time required for all portions of the drainage basin to contribute to the location under consideration assuming the maximum potential zoning. This time is the addition of the travel time for overland flow from the most remote part of the drainage basin to the point under consideration, and the time for pipe flow. For drainage basins not yet fully developed, the anticipated conveyance system must be incorporated to generate the shortest possible time of concentration.

Table 206-4 shows the acceptable values for the overland flow travel time. For residential developments use the nominal travel time of five (5) minutes, or use Table 206-4; whichever is less.

The travel time in a conveyance system shall be based on the actual velocity of the conveyance facilities.

The benefits of upstream detention systems shall not be accounted for in determining the time of concentration for any storm drain system.

TABLE 206-1

COMPOSITE RUNOFF COEFFICIENT CHART

Values of coefficient, C

Existing Land Use or Maximum Potential Zoning		Average Gradient of Terrain		
		Less than 2%	2% - 7%	More than 7%
USE	ZONE*			
Commercial or Industrial	4	0.70	0.80	0.90
Multiple Family	3	0.60	0.65	0.70
Duplexes, Single Family	2	0.50	0.55	0.60
Single Family & Schools	1	0.40	0.45	0.50
Parks, golf courses, Agricultural or undeveloped	5	0.20	0.25	0.30

* These are to be used as a guide in evaluating undeveloped land based on current zoning and where no information is available defining a proposed development.

ZONE	PRIMARY LAND USE DISTRICT
1	RL (Residential 5 units per acre)
2	RML (Residential 6-10 units per acre)
3	RMH (Residential 11-15 units per acre)
3	RH (Residential 16-25 units per acre)
3	RH/HR (Residential 25 units per acres)
4	CN Neighborhood Commercial
4	CR Recreational Commercial
4	CG General Commercial
4	CO Office Commercial
4	CC Central Commercial
4	ML Light Manufacturing
4	MG General Manufacturing
4	MP Manufacturing Park

TABLE 206-2

CHARACTERISTIC RUNOFF COEFFICIENT CHART

	Values of coefficient, C		
	Average Gradient of Terrain		
Land Characteristic	Less than 2%	2%-7%	More than 7%
Asphalt or concrete	0.85	0.90	0.95
Roofing	0.85	0.90	0.95
Grassy surface	0.20	0.25	0.30
Bare soil	0.30	0.35	0.40

TABLE 206-3

RAINFALL INTENSITY, DURATION, AND FREQUENCY

Intensity (inches/hr)

Duration (Mins.)	Frequency 2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5	1.92	2.50	3.20	3.88	4.53	4.95
10	1.38	1.79	2.30	2.79	3.26	3.56
15	1.11	1.45	1.86	2.24	2.62	2.86
20	0.95	1.23	1.58	1.92	2.24	2.45
30	0.75	0.97	1.25	1.51	1.77	1.94
40	0.62	0.80	1.03	1.25	1.46	1.60
50	0.54	0.70	0.90	1.09	1.28	1.39
60	0.49	0.64	0.82	0.99	1.16	1.26
90	0.40	0.51	0.65	0.81	0.95	1.03
120	0.34	0.44	0.55	0.68	0.79	0.85
150	0.30	0.39	0.50	0.62	0.71	0.77
180	0.278	0.35	0.45	0.55	0.64	0.70

TABLE 206-4

OVERLAND FLOW TRAVEL TIME OF CONCENTRATION (MIN)

Length of Overland Flow (Ft.)	AVERAGE GRADIENT OF TERRAIN														
	2% or less			2%			4%			7%			10% or more		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
50	11	6.5	4	10	5.5	3	8.5	4	2	7.5	3.5	2	7	3	2
100	15	8.5	5	13	7.5	4	11.5	6.5	3	10	5.5	2	9	5	2
200	20	11	6	17	9.5	5	15	8.5	4	13	7.5	3	12.5	7	2
300	23	13	7	20	11.5	6	18	10	5	16	9	4	14	8	3
400	26	15	8	22	12.5	6.5	20	11	6	18	10	5	16	9	4
500	28	16	9	24	14	7	22	12.5	6.5	19	11	6	18	10	5
700	33	18	10	28	16	8	25	14	7.5	22	12	6.5	20	11	6

This table is to be used for Sheet Flow conditions only.

SURFACE TYPE: A Grassy
B Bare Soil
C Rooftop/Paved

206.3.00 Hydraulics (Storm)

206.3.01 General

The following specifies the minimum requirements for various hydraulic criteria necessary for the design and construction of all storm drains under City jurisdiction.

1) All appurtenances (inlets, catch basins, and the like) shall be designed to accept a 25-year storm event. The grates to these appurtenances shall, as far as practical, be designed to be self-cleaning to avoid failure due to accumulation of debris such as leaves.

2) The conveyance system (pipe, culverts, channels, ditch inlets, ditches, curb inlets, manholes, etc.) shall be designed to provide a level of protection from

flooding during a 25-year storm event. The design shall be supplemented with an overland component demonstrating how up to a 100-year event will be accommodated. The overland flow component shall not be allowed to flow through or inundate an existing building. "A level of protection during a design storm event from all damage due to flooding" also means that all surface run-off waters must pass through a conveyance system and overland component without flooding public and private property and other items of value not normally acceptable to be flooded. The hydraulic grade line for the 25-year storm event shall remain below finished grade for conveyance facilities. Surcharge in below-ground facilities during a 25-year storm event shall not be allowed.

206.3.02 Impact Considerations

Each new development is responsible for mitigating the impacts of that development upon the public conveyance system. The specific requirements of the City's Surface Water Management Ordinance (Ordinance No. 846-91) shall be met.

206.3.03 Flow Capacities

The following describes the detailed procedures required for the calculation of flow capacities of drainage facilities. This section also specifies the capacities for most common hydraulic components. If hydraulic components other than those discussed in this section are proposed or encountered, the method of hydraulic calculations shall be subject to City approval. If other methods of hydraulic calculations are used for components discussed in this section, calibration or comparison to the methods in this section is required prior to acceptance by the City.

1) The maximum acceptable intake flow rate for catch basins, curb inlets and gutter inlets shall be as shown in Table 206-6.

2) The maximum acceptable intake flow rate for area drains shall be as shown in Table 206-7.

3) Pipes and Culverts. Design shall be in conformance with Chapter 4 of the Oregon Department of Transportation (ODOT) Hydraulics Manual. For various improved entrances, the ODOT Hydraulics Manual is acceptable for capacity determinations.

For outlet control, Manning's Formula with proper consideration for entrance, exit and other minor losses shall be the accepted method of calculation. See Table 206-8 for the acceptable values of Manning's "n" and minor loss coefficients.

The Manning's coefficient value ("n") to be used in calculating storm water flows shall be as shown on Table 206-8. Surcharging shall not be designed into the piping system. Maximum pipe capacity shall be calculated with the pipe flowing full.

TABLE 206-6

CATCH BASIN AND CURB INLET CAPACITIES

Maximum Allowable Intake Flow Rate (cfs)

Structure Style	Centerline Street Gradient (%) 0 (SAG)	Less than 6	6 or more
Oversize catch basin w/pavement taper	8.0	4.5	N/A
Standard curb inlet w/pavement taper	N/A	3.5	2.5
Oversize curb inlet w/pavement taper	8.0	5.0	3.5
Gutter inlet 2 1/2A w/pavement taper 2-1/2"	4.2	N/A	N/A
Gutter inlet 4A w/pavement taper 2-1/2"	6.7	N/A	N/A

N/A: Not allowed in this situation.

TABLE 206-7

AREA DRAIN, TYPE II CAPACITIES

(in cfs)

	Grate Angle 30 degrees									
Hydraulic head (ft.) *	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Flow rates C	2.0	5.6	10.3	11.91	113.3	14.5	16.8	18.8	22.3	26.6

***** Measured as depth of flow from bottom of grate to water surface.

TABLE 206-8

FRICTION AND MINOR LOSS COEFFICIENTS

Friction Coefficients

Conveyance Facility	Manning's n (FT1/6)
Concrete Pipe	0.013
Polyvinyl Chloride (PVC) pipe	0.009
Corrugated outer wall, smooth inner wall Polyethylene (N12) pipe	0.010
Aluminum Spiral rib	0.011
Ductile or cast iron	0.013
Corrugated aluminum or steel pipe	
Annular (2-2/3" x 1/2")	0.025
Helical (2-2/3" x 1/2") not full flow	0.025
10", 12" flowing full	0.013
18" flowing full	0.015
24" flowing full	0.017
36" flowing full	0.019
48" flowing full	0.021
54" flowing full	0.022
Annular (3" x 1")	0.025
Helical (3" x 1") not full flow	0.025
36" flowing full	0.020
48" flowing full	0.020
54" flowing full	0.021
60" flowing full	0.021
66" flowing full	0.021
72" flowing full	0.022
Fully paved	0.012
Earth ditches; straight, uniform, clean	0.025
Earth ditches; rough, grass	0.035
Stream channels; fine gravel, straight, grass	0.030
Stream channels; course gravel, straight, clean banks	0.035
Stream channels; fine gravel, slightly winding, grass	0.045
Stream channels; fine gravel, slightly winding, weeds	0.048
Stream channels; fine gravel, slightly winding, obstructions	0.055
Stream channels; obstructed, very winding	0.080

For overbanks flow and other characteristics refer to Ven Te Chow's, Open-Channel Hydraulics

206.4.00 Pipe Design

A) Size. Install the following minimum pipe diameters for all storm sewer pipes installed in the public rights of way or public easements:

1. 10-inches between catch basin and main line.

2. 12-inches for main line pipe.

3. Use the following minimum pipe sizes for service laterals:

Commercial, Industrial, Multi-Family	10-inch
Single Family Residential	6-inch

Single family residential service laterals may be 4-inch diameter where site constraints exist, if approved by the City Engineer. Size pipe to meet the minimums specified above or to meet the requirements of Section 206.3.00, whichever is larger.

B) Location. When storm pipes are located within a public street right-of-way, locate the storm pipe between the curbs, but not closer than 5-feet to a curb unless approved by the City Engineer. Storm pipes may not be located under sidewalks on arterial streets. When in easements, locate the storm pipe on the centerline of the easement unless otherwise approved by the City Engineer. Do not place the centerline of a storm pipe closer than five feet to an easement side line.

C) Pipe length between structures:

10-inch pipe: 250-feet
12-inch pipe: 400-feet

D) Alignment. Install public storm pipes on a straight alignment and uniform grade, except as provided in Section 206.4.00 (E).

E) Curved Storm Pipe. Install all non-metallic pipe with a locating wire. To determine the minimum radius of the curve of concrete pipe use the following formula:

Where:
R = minimum radius of curvature (feet)
D = outside pipe diameter (feet)
L = length of individual pipe sections (feet)

$$R = 32DL$$

F) Grade. Design storm pipe mains with sufficient slope to maintain a minimum velocity of three feet per second when at design flow, but not less than 0.5%. For service laterals, use a minimum slope of three percent for six-inch pipe and two percent for four-inch pipe. Do not allow flow velocity in concrete storm pipes to exceed ten feet per second. If the slope is such that the velocity exceeds 10-feet per second, use PVC pipe.

G) Pipe Cover. Install storm pipes per CWS Design and Construction Standards Section 5.06.7, Pipe Cover. Where this requirement cannot be met, the City Engineer may approve a lesser amount of cover, with the use of properly designed pipe material.

H) Headwalls. When headwalls are required, design according to the ODOT Hydraulics Manual standards.

I) Access. Provide manholes as specified in Section 206.6.00, Manhole.

J) Rip rap. Where rip rap is required, submit a design of the rip rap outfall area per CWS Table 5-5 to be approved by the City Engineer. Place suitable geotextile fabric under and around the sides of riprap.

K) Pipe Material. Concrete, PVC, ductile iron, and HDPE pipe materials are acceptable for the construction of public storm pipe systems. Design all systems to resist permanent and construction loading. Polymer type protective coatings may be required if the pipe is to be installed in possible aggressive soils or where cathodic protection is present.

206.5.00 Catch Basins

A) The catch basins for use within the City are the oversized gutter and curb inlet catch basin. The curb inlet catch basin (oversize) with alternate top (manhole frame and cover) shall be used in roadways with bike lanes.

B) All catch basins shall be constructed with an 18-inch minimum sump unless a part of a series catch basin system. A series catch basin system exists when a maximum of three unsumped catch basins are constructed in a row, a pollution control manhole, Standard Drawing No. 060, shall be installed at the point where three unsumped catch basins connect to a main storm line. Unsumped catch basins are not to be part of a main storm line. No ditch inlet may be part of a series catch basin system.

C) A main storm line shall not pass through a sumped catch basin or pollution control manhole.

D) The spacing between catch basins shall be as required hydraulically. Gutter flow shall not exceed 4" depth at the curb during a 25-year storm. Catch basins and gutter inlets shall be of sufficient size and number to accept the inflows without backing up water on the street during the 25-year storm event.

E) Catch basins shall be provided on the tangent just prior to curb returns on streets and outside of the handicap ramp.

F) Catch basins shall be installed at the low point of all sag vertical curves in streets.

G) Catch basins may connect to a main storm line with a tee connection when the main storm line is at least one size larger than the catch basin line. When the catch basin line is the same size as the main storm line, the connection shall be made at a manhole. The maximum length of pipe line between the catch basin and the main line shall be 60-feet.

H) Pavement tapers shall be required for all catch basins.

206.6.00 Manhole

A) Manholes shall be provided at least every 400-feet (or as required for maintenance purposes), at every change in alignment, at every change in pipe size or material, and at every grade change unless otherwise approved by the City Engineer. A manhole shall be located at the upstream end of the pipe. Manholes shall not be closer than 5-feet to a curb line and not in a wheel path.

B) All manholes shall be a minimum of 48-inches in diameter. All manholes shall have a minimum 12-inch ledge in the base. Minimum wall distance between connecting pipes shall be 8-inches.

C) Elevations of the inlets and outlets will be required on the plan submittals.

D) Lateral storm sewers are allowed to be connected directly into the manhole base providing that they are properly channelized and approved by the City Engineer.

206.7.00 Pipe Stubouts/Adaptors

Install storm drainage laterals and adaptors to a maximum of one 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.

206.8.00 Surface Water Quality / Detention Facilities

The Surface Water Management (SWM) Ordinance requires new development projects to construct permanent water quality facilities to remove 65% of the phosphorus from the storm water runoff from 100% of the newly constructed impervious surfaces. The facilities shall be designed to meet the removal efficiency for a mean summertime storm event totaling 0.36 inches of precipitation falling in four hours with an average return period of 96 hours.

The design of water quality and detention facilities shall conform to the standards set forth in Clean Water Services “Design and Construction Standards for Sanitary Sewer and Surface Water Management”, June 2007.

The applicant's design engineer shall submit a complete design of the proposed water quality and/or storm water detention facility along with supporting calculations and reference material used to design the facility.

The applicant will be required to provide a maintenance assurance for the landscape portion of a public water quality and/or detention facility per the requirements of Section 106.16.01.

All water quality and/or detention facilities shall meet the following standards:

1. Swale-type facilities shall have side slopes no steeper than4:1.

2. Where a facility is designed to be used for both water quality and storm water detention, the facility volume used for water quality purposes shall not be included as part of the required storm water detention volume.

3. Landscaping approved by the City Engineer appropriate for the particular facility shall be installed. Plantings selected for the facility shall be as set forth in CWS's Design and Construction Standards, June 2007 Additional screening plants shall be installed around the perimeter of the facility. These plants shall be a combination of Alder and Ash. All plantings shall be installed prior to paving.

4. An irrigation system shall be provided to the facility to allow for adequate maintenance of the facility landscaping.

Additionally, public water quality facilities shall meet these standards:

1. A 4' or 6' high vinyl-coated chain-link fence, with a 16' wide locking gate, shall be installed around the tract area. This measure will ensure the safety of the public, particularly small children that can fall into a facility. The height of the fence will be determined by the Operations Department.

2. A 12' wide Portland Cement concrete access road shall be constructed from the public street to the facility in such a manner that a maintenance vehicle can completely exit the street right-of-way and park in front of any structure within the facility. The access road shall be designed to handle a 60,000 pound vehicle and shall not exceed 15% maximum gradient. This measure ensures that the City will be able to adequately access the facility for maintenance.

3. City-approved information signs are required to be placed so that at least one is clearly visible and legible from all adjacent streets, sidewalks or paths. During the 2-year maintenance period these signs should identify the responsible party. The applicant shall pay the City a fee equal to the manufacture and installation costs of the permanent signs. The City will obtain and install the permanent information signs.

4. If a berm or other above grade structure is a part of the facility, a site specific soil evaluation will be required. The issues to be addressed include:
   - saturation of soils under berms,
   - leaking of water through the berm, etc.

206.9.00 Outfalls

Outfalls shall be designed to discharge at a level to eliminate or minimize erosion as approved by the City Engineer.

All outfalls shall be provided with approved erosion control protection measures. Rock protection at outfalls shall be designed in accordance with CWS Table 5-5 except as approved by the City Engineer. Mechanisms which reduce velocity prior to discharge from an outfall are encouraged. Examples are drop manholes and rapid expansion into pipes of much larger size. For outfalls with a velocity at design flow greater than 6-feet per second, an engineered energy dissipater shall be required.

Where engineered energy dissipaters such as stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required, these structures shall be designed using published references such as Hydraulic Design of Energy Dissipaters for Culverts and Channels published by the Federal Highway Administration of the United States Department of Transportation, and others. Design reference shall be included on the construction plan submittal.

206.10.00 Cleanouts at the Right-of-Way

Install cleanouts for storm pipe service laterals within the public utility easement, 12 to 18-inches from the right of way line or as directed by City Engineer. Use a cast iron frame and bolt down cover embossed with the word “STORM” for all storm cleanouts.

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207 PUBLIC UTILITY DESIGN

207.1.00 Scope

Public Utilities that have a current Franchise Agreement or a Rights-of-Way License with the City may construct Public Utilities in the City of Tualatin public Rights-of-Way or in publicly controlled easements in strict conformance with City of Tualatin standards and specifications and the requirements stipulated in City of Tualatin Municipal Code Chapter 03-06, Utility Facilities in the Rights-of-Way. Before starting construction of work in the public Rights-of-Way or publicly controlled easements, obtain a Public Utility Permit. Public Utilities may also be constructed with a Public Works Construction Permit.

207.2.00 Construction Plans

Show the location of all existing and proposed Rights-of-Way, easements, public utilities, and public works facilities including curb and gutter, edge of pavement and sidewalk. Label identifying features including street names and site addresses. Provide a north arrow and a scale.

On construction plans, clearly show the location and construction methods of all proposed work. When public works facilities are potentially affected or as directed by the City Engineer, include all applicable City of Tualatin standard drawings with the construction plan submittal.

207.3.00 Location of Proposed Public Utilities

Place Public Utilities in the Public Utility Easement (PUE) or as approved by the City Engineer. Place Public Utilities parallel to the Right-of-Way, except when crossing a street. Install public utility street crossings perpendicular to the Right-of-Way.

When an underground Public Utility is not completely installed before construction of the road subgrade, place the appropriate utilities conduits in all areas to be paved to allow future completion of the utility. Extend conduit termini beyond the edge of Right-of-Way a minimum of 5 feet or as directed by the City Engineer. Seal and mark the ends of the conduit in accordance with the requirements of the affected utility.

All installations of Public Utilities are subject to the inspection and approval of the affected utility and the City of Tualatin.

207.4.00 Minimum Depth

Place Public Utilities a minimum of 36 inches below finished grade.

207.5.00 Minimum Vertical Separation

Provide a minimum of 12 inches vertical separation from all City owned utilities, except as approved by the City Engineer. Locate public utilities below water lines when crossing. The City Engineer may require Public Utilities to be placed deeper to avoid the possibility of conflict. Sanitary sewer and water lines must comply with Section 205.2.07H, Water Line – Sewer Line Vertical Separation.

207.6.00 Minimum Horizontal Separation

Provide a minimum horizontal separation of ten feet from all parallel City utilities, except as approved by the City Engineer.

For sanitary sewer or water lines, conform to Section 205.2.07G, Water Line – Sewer Line Horizontal Separation.