SECTION 3 - STREETS AND RELATED WORK

3-1 GENERAL REQUIREMENTS

All work performed in the design, preparation of plans and in the construction or improvement of city streets and all appurtenances, whether public or private shall be the responsibility of the developer or contractor and done to the satisfaction of the City Engineer and in accordance with the plans and specifications approved by the city for the work.

It is emphasized that no permits will be issued to start work until plans for that work are approved. Any revisions to the plans shall be approved by the City Engineer before being implemented. A set of "as-built" drawings will be required at the completion of the project and prior to final acceptance of the work. See individual utility sections for more specific "as-built" requirements.

City Ordinances and Standards establish policy for the installation of street improvements. Specific application will be determined at the time of permit application and/or issuance.

3-2 ROADWAY TYPES AND GEOMETRICS

3-2.1 GENERAL

City of Everett roadways are classified functionally as indicated in Standard Drawing No. 300. Criteria for minimum right-of-way and roadway widths and other geometrics shall be as listed for given classifications.

Structural sections and roadway appurtenances shall be as shown on Standard Drawing Nos. 301 and 302. In certain cases permeable pavement may be required to meet stormwater criteria. See Section 4-4.3(4) for permeable pavement design standards.

The City Engineer may require the second lift asphalt to be bonded and delayed for up to one year.

Typical utility locations for design purposes are shown on Standard Drawing 330.

3-2.2 HORIZONTAL ALIGNMENT

3-2.2(1) CURB RETURN RADII

For the intersection of two local streets, the minimum allowable curb radius shall be 25 feet, which is to be measured from the radius point to the face of curb.

For the intersection of a local street with any collector or arterial, the minimum radius shall be 30 feet.

3-2.2(2) LOCAL STREETS

For the intersection of two local streets, the minimum allowable curb radius shall be 25 feet, which is to be measured from the radius point to the face of curb.

For the intersection of a local street with any collector or arterial, the minimum radius shall be 30 feet.

3-2.2(3) OTHER STREETS

On all other street intersections, the minimum allowable radii shall be 30 feet.

3-2.2(4) TRUCKS AND BUSES

Radii of 40 feet or more should be provided where large truck combinations and buses turn frequently. Larger radii are also desirable where speed reductions would cause problems.

3-2.3 INTERSECTIONS

Angle of Intersection	80° to 90°
Minimum Centerline Radius	N/A
Minimum Curb Radius	25 feet

3-2.4 STREET ENDS

Cul-de-sacs shall be provided at all permanent street ends, and on any temporary dead end location when the length of the street is more than 150 feet in length. Cul-de-sacs shall be per Standard Drawing 306.

On temporary dead ends, when the street is less than 200 feet in length, the required turnaround area may be a hammerhead type of design per Standard Drawing 331.

3-3 EASEMENTS

A nonexclusive easement shall be reserved for and granted to all utilities serving subject plat and their respective successors and assigns, over, under and upon the exterior 10 feet parallel with adjoining the street frontage of all lots and common areas in which to install, lay, construct, renew, operate and maintain underground conduits, cables, pipes, and wires; together with other necessary facilities and equipment, for the purpose of serving this subdivision and other property with utility service, together with the right to enter upon the lots at all times for the purposes herein stated.

3-4 FIRE DEPARTMENT ACCESS

As required by the fire chief, every building constructed shall be accessible to the Fire Department, both during and after construction, by way of access roadways approved by the Fire Department. The roadway shall have at least 20 feet of unobstructed width, shall have adequate roadway turning radius, and be capable of supporting the imposed loads of fire apparatus. The minimum allowable vertical clearance shall be 13 feet 6 inches. All required fire access roads must be in service prior to commencement of construction.

When access roads cannot be installed due to topography, waterways, nonnegotiable grades or other similar conditions, the chief is authorized to require additional fire protection as specified in Section 10.501(b) of the Uniform Fire Code. Such devices or appliances may consist of automatic fire alarm systems, automatic sprinkler or water spray systems, standpipe and hose, fixed or portable fire extinguishers, suitable fire blankets, breathing apparatus, manual or automatic covers, carbon dioxide, foam, halogenated or dry chemical or other special fire-extinguishing systems. Where such systems are provided, they shall be designed and installed in accordance with the applicable Uniform Fire Code Standards.

The following definitions shall apply:

A. **Fire Lane:** That portion of the Fire Department access to areas or structures which is required by the provisions of Chapter 46.44 of the Everett Municipal Code. Generally, this access is in larger complexes and constitute continuous loops around buildings or complexes.

B. **Fire Access Road:** That portion of the Fire Department access to areas or structures which is required by the provisions of Section 10.207 of the Uniform Fire Code, 1991 edition or subsequent revision. This type of access may be provided to almost any type of property.

C. **Access Easement:** That portion of a "fire access road" as defined above which is provided by the granting of a permanent easement over one or more properties in order to provide permanent access to other projects.

D. **Short Plat Access:** That portion of Fire Department access into short plats regulated by Title 18 of the Everett Municipal Code.

Temporary access roads in use during building construction shall be constructed for all weather driving conditions. At no time during the construction of the project should the roadway surface consist primarily of dirt, mud, sand, or other material that, in the opinion of the Fire Chief, may impair firefighting or rescue operations. The required 20 foot width must be maintained so that the driving surface is recognizable day or night.

The required width of any fire apparatus access road shall not be obstructed in any manner, including parking of vehicles. Minimum required widths and clearances established under this section shall be maintained at all times. The required cul-de-sac turnaround for fire apparatus shall be per Standard Drawing No. 306.

3-5 PARKING LOTS

3-5.1 GENERAL

Off street parking lots shall be constructed in conformance with the requirements for number of stalls and landscaping as noted in the Zoning Code. Additionally, if all of the following are met, a maximum of 15% of the required number of stalls may be sized for compact cars, as shown on Standard Drawing 340. Aisle widths may be required to be widened if multiple utility lines are located within the aisle corridor.

A. The parking lot contains 20 or more parking spaces.

B. The parking area is defined as long term parking, i.e., more than 3-4 hours and does not involve packages. For example, a shopping center could not meet this criterion, but an apartment complex could.

C. The compact stalls are located together and are not intermixed with the standard parking stalls.

3-5.2 CONSTRUCTION

All parking lot construction shall be inspected by the Public Works Department for conformance to plans for size, layout, drainage control and structural section. The minimum acceptable structural section for parking lots shall be 2 inches compacted depth HMA Class ½" PG 64-22 asphalt pavement placed over 4 inches of Crushed Surfacing Base Course, unless otherwise approved by the City Engineer. In certain cases permeable pavement may be required to meet stormwater criteria. See Section 4-4.3(4) for permeable pavement design standards. Prior to placing any surfacing material on the roadway, it will be the responsibility of the developer/contractor to provide density test reports certified by a professional engineer registered in the State of Washington.

Crushed Surfacing Base Course shall be compacted to 95% maximum density. Density testing for asphalt pavement including the necessity and frequency of core samples will be determined by the engineer on a case by case basis.

5. The following Tables should be provided in the study:

Table A

LEVELS OF SERVICE (LOS)				
Intersection	**Existing**	**1998 w/project**	**1998 w/o projects**	**1998 w/mitigations**

Table B

VOLUME					
Roadway Section Intersection	**Project a.m. p.m.** (1)	**Existing a.m. p.m.** (2)	**1998 a.m. p.m.** (3)	**Proj. Vol. as % of Diff. 1/(302)**	**Proj. Vol. as % of Total 1/3**

NOTE: The horizon year is normally 5 years from the date of project application. A horizon year of 1998 is used here for illustrative purposes only.

6. Traffic Accidents:

   Traffic accident information may be required for affected street corridors and intersections. The study period will normally be 3 years. Information is available from the city.

   Estimates of increased or decreased accident potential must be evaluated for the development, particularly if the proposed development might impact existing traffic safety problems in the study area. Safety mitigation measures must be included where necessary.

7. Recommendations:

   In the event that analysis indicates unacceptable Levels of Service (LOS) in the study area, a description and cost estimate of the proposed improvements to return intersection to an acceptable LOS is required. The cost estimates should be all inclusive and include any additional right-or-way as required.

8. The Study shall also analyze the interface of entrances and exits with the city street system. The study shall also make recommendations regarding site circulation for both vehicles and pedestrians including handicap access.

3-9 UNDERGROUND UTILITIES

3-9.1 GENERAL

1. The WSDOT/APWA Standard Specifications shall apply unless otherwise stated below.

2. When trenching through existing pavement, the open cut shall be a neat line made by either saw cutting or jackhammering a continuous line. Saw cutting will be required unless the cut is made prior to reconstruction or an overlay.

3. Temporary pavement patch shall be accomplished by using cold mix (MC 250), ATB or steel plates.
4. Permanent pavement patch shall be as specified on Standard Drawing No. 326.

3-10 SURVEYING AND MONUMENTATION

3-10.1 DESCRIPTION

This work shall consist of all the surveying and monumentation required to construct the project as described in the plans and these Specifications.

It shall be the responsibility of the developer/contractor to furnish materials and install monuments and castings in accordance with the drawings and where directed by the engineer. All survey work shall be performed by or under the direct supervision, of a Professional Land Surveyor (PLS) licensed in the State of Washington. Monument and monument case and cover shall be supplied and installed per Standard Drawing 323 or 324.

Surveying, as required to construct a given project per the approved plans, shall be furnished by the developer at no expense to the city. It is required that survey stakes be set for new curb and gutter construction, for both horizontal and vertical control. Additionally, any water, storm drain, or sanitary sewer mains which are to be constructed in easements are to have survey offset stakes set prior to starting that work, and any deviation from that staked line must be left uncovered and resurveyed to realign easement as required and for corrected as-built information.

3-10.2 MATERIALS

Materials for monumentation shall be Class 3000 concrete or commercial concrete per Section 6-12 of the WSDOT/APWA Standard Specifications and the monument case and covers shall be gray iron castings conforming to the requirements of AASHTO M 105, Class 30B. The cover and seat shall be machined so as to have perfect contact around the entire circumference and full width of bearing surface.

3-10.3 CONSTRUCTION REQUIREMENTS

Monuments shall be located at all centerline intersections of intersecting streets. Curved streets shall be monumented at centerline PI's (point of intersection), if it falls within the street pavement, otherwise the PC (point of curvature) and PT (point of tangency) of the curve shall be monumented.

It shall be the developer's/contractor's responsibility to provide the surveying required to establish or perpetuate land corner monumentation as may be required on the project.

All land corner surveying shall conform to the requirements of RCW 58.09. If the developer's or contractor's surveyor replaces or restores an existing or obliterated "General Land Office" (GLO) corner(s), it shall be their responsibility to file "Land Corner Records" for these monuments with the Snohomish County Auditor's Office.

When all land corners have been established, replaced or restored and monumented as described herein, the surveyor shall certify this information with a letter to the City Engineer. This certification letter shall include the location of the monumented corner(s) and that all land corner(s) have been monumented as described herein.

The city reserves the right to check survey points and/or the correct locations and elevations of new construction. These spot-checks will not change the requirements for normal checking and testing as described elsewhere, and do not relieve the contractor of the responsibility of producing a finished product that is in accordance with the contract. If unacceptable errors are found due to errors or omissions by the contractor's survey activities, then the contractor shall correct these errors including removing and replacing improvements and pay all expenses incurred by the city including the re-survey.

3-11 STREET ILLUMINATION

Street lights shall be provided in plats and for commercial developments. Street light poles shall be aluminum with a concrete base. Special ornamental poles may be installed with approval of the City Traffic Engineer. The luminaires may be supplied and maintained by Snohomish County PUD. Special luminaires, which are not supplied by the PUD, must be approved by the City Traffic Engineer. All street light wiring, conduit and service connections shall be located underground.

Street light locations must be approved by the City Traffic Engineer.

The installation of special luminaires, not provided by the PUD, shall be the responsibility of the developer. The luminaires shall be full cut –off type and street light locations shall attempt to minimize illumination of salmonid streams to reduce the risk of predation.

3-12 GUARDRAILS

Unenclosed floor and roof openings, open and glazed sides of stairways, landings and ramps, balconies or porches, which are more than 30 inches above grade or floor below, and roofs used for other than service of the building shall be protected by a guardrail. See Sections 1712 and 3306 of the latest edition of the Uniform Building Code for specific requirements.

For Safety Rail see Section 3-16 of these Standards and Standard Drawings 333 and 334.
Roadway guardrails shall conform to WSDOT/APWA Standard Plan C-1, Beam Guardrail Type 1. Guardrail anchors shall conform to WSDOT/APWA Standard Plan C-6, Guardrail Anchor Type 1. For local streets, end treatment shall conform to WSDOT/APWA Standard Plan C-6, Guardrail Anchor Type 1. For Principal arterials, Minor arterials, collector arterials, or other locations where the end of the guardrail is subject to head-on impacts, a crash tested guardrail terminal shall conform to WSDOT/APWA Standard Plan C-4b and C-4e. All concrete barrier and bridge rails shall have guardrail transition sections with appropriate end treatments. Redirectional landforms are not allowed for permanent installations.

3-13 MAILBOXES

New residential developments shall have mailboxes installed similar to Standard Drawing 328, or mailbox cluster supplied by the U.S. Postal Service similar to Standard Drawing 329.

A. When mailboxes are located adjacent to the sidewalk, the sidewalk shall be widened to provide a clear width of not less than 5 feet from back of curb to any portion of the mailbox structure, per Standard Drawing 329.

B. In the case of new road construction or reconstruction requiring mailboxes to be moved back or rearranged, the builder shall coordinate with the U.S. Postal Service through the Everett Postmaster in the main Post Office in Everett, for acceptable box locations and to ensure uninterrupted mail service. Approved locations for mailboxes shall be shown on street construction plans.

ASTM D1556	(sand cone method)
ASTM D2167	(rubber balloon method)
ASTM D2922	(nuclear method)

3-14.7(2) CEMENT CONCRETE PAVEMENT

After the Crushed Surfacing Top Course subgrade for the pavement has been constructed and compacted to line and grade, the cement concrete pavement patch shall be placed and struck off to a thickness of 1 inch greater than the existing pavement or 8 inch minimum, whoever is greater. All work shall be in accordance with Section 5-05 of the WSDOT/APWA Standard Specifications, except as modified by these Specifications and Standard Drawings 315, 316, or 317.

Through joints and dummy joints shall be placed to match existing or as directed by the engineer. The surface of the concrete patch shall be finished and brushed with a fiber brush. Approved curing compound shall be placed on the finished concrete immediately after finishing.

3-15 ROCKERIES AND ROCK WALLS

3-15.1 DESCRIPTION

This work shall consist of constructing rockeries with rock facing height of 8’ or less used for erosion control or the containment of cuts and embankments. Work shall be performed in accordance with these Specifications and Standard Drawing 332. Rockeries over 8’ in height must be designed by a civil engineer licensed in the State of Washington.

3-15.2 MATERIALS

All rock shall be sound, angular ledge rock that is resistant to weathering. The longest dimension of any individual rock should not exceed three times its shortest dimension. Acceptability of rock will be determined by laboratory tests as hereinafter specified, geologic examination and historical usage records.

All rock delivered to and incorporated in the project shall meet the following minimum specifications:

a. Absorption ASTM C127 AASHTO T085	*Not more than 2.0% for igneous and metamorphic rock types and 3.0% for sedimentary rock types.*
b. Accelerated Expansion (15 days) CRD-C-148*1, *2	*Not more than 15% breakdown.*
c. Soundness (MgS04 at 5 cycles) ASTM C88 or CRD-C-137	*Not greater than 5% loss.*
d. Unconfined Compressive Strength ASTM D 2938	*Intact strength of 6,000 psi, or greater.*
e. Bulk Specific Gravity (155pcf) ASTM C127 or AASHTO T-85	*Greater than 2.48.*

*1. The test sample will be prepared and tested in accordance with Corps of Engineers Testing Procedure CRD-C 148, “Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol.”

*2. Accelerated expansion tests should also include analyses of the fractures and veins found in the rock.

of a rock wall, they shall be visually examined to determine if contact between the rocks exists within the thickness of the rock wall. If there is no rock contact within the rock wall thickness, the void shall be chinked with a smaller piece of rock.

A rock drainage filter shall be installed between the rear face of the rock wall and the soil face being protected. This drain rock layer shall be at least twelve (12) inches thick. For rock walls eight (8) feet in height or higher, it shall be at least eighteen (18) inches thick. The material for the drainage filter shall be Quarry Rock, as specified in Section 3-20.7 of these Specifications.

3-16 METAL HAND RAILINGS

3-16.1 DESCRIPTION

This section applies to providing and building metal hand railings that meet the requirements of the Plans, these Specifications and the City Engineer.

3-16.2 MATERIALS

Materials shall meet the requirements of the following:

Ornamental Pedestrian Guard

Ornamental Pedestrian Guard shall be constructed in accordance with Standard Drawing 334 and these Specifications. Horizontal rails and vertical support posts shall be 1 ½ inches by 1 ½ inches by 1/8 inch tubular steel conforming to ASTM A120. Balusters shall be ½ inch by ½ inch and the horizontal bottom rail 1-1/2 inches by ½ inch by 1/8 inch channel steel (ASTM A120). Vertical support posts shall be a maximum 8 feet on center and balusters a maximum 4 inches per space. The center of the bottom rail shall be a maximum of 4 inches above finished grade. Finished height of the railing shall be 42 inches above the pedestrian walking surface. Provide slip joints at stairway expansion joints and at 24 feet on center maximum.

Pedestrian Guard (Galvanized Steel and Aluminum)

Galvanized Steel and Aluminum pedestrian guard shall be constructed in accordance with Standard Drawing 333 and these Specifications. Horizontal rails and vertical support posts shall be 1-1/2 inch diameter Schedule 40 Standard pipe and balusters shall be ¾ inch diameter Schedule 40 Standard Pipe. Vertical support posts shall be on 8 foot centers and balusters on 4 inches clear space. Finished height of the railing shall be 42 inches above the pedestrian walking surface. Provide slip joints at stairway expansion joints and at 24 feet on center maximum.

3-16.3 FABRICATION

Before fabricating the railing, the contractor shall submit 6 copies of the shop plans for the engineer's approval. The contractor may substitute other rail connection details for those shown in the plans if details of these changes show in the shop plans and if the engineer approves. In approving shop plans, the engineer indicates only that they are adequate and complete enough. Approval does not indicate a check on dimensions.

Welding shall conform to the requirements of the "Structural Welding Code" AWS D1.1 for steel, and to the requirements of the "Specifications for Aluminum Structures" of the Aluminum Association, for aluminum alloys. All exposed welds shall be ground flush with adjacent surfaces.

Railing panels shall be straight and true to dimensions. Adjacent railing panels shall align with each other with a variation not to exceed 1/16 inch. Joints shall be matchmarked.

For structures on curves, either horizontal or vertical, the railing shall conform closely to the curvature of the structure by means of series of short chords. The lengths of the chords shall be the distance center to center of rail posts.

Steel railing units shall be galvanized after fabrication. Zinc used for galvanizing shall be grade Prime Western conforming to ASTM B6 with a minimum 2 ounces per square foot.

Completed aluminum railing units shall be anodized after fabrication conforming to the requirements of the Aluminum Class 1 Anodic Coating, AA-C22-A41.

Ornamental railing shall be painted with a rust proof metal primer and one coat of black ornamental iron metal paint.

3-16.4 INSTALLATION

The railing shall be erected in accordance with the plans on anchor bolts, or in holes formed by inserts provided in the concrete railing base to receive the railing posts. Sheet metal inserts shall be removed before the erection of the railing.

No railing shall be erected on the structure until the sidewalk to which it is to be attached is completed and all falsework supporting the system is released.

The railing shall be carefully erected, true to line and grade. Posts and balusters shall be vertical with the direction from the vertical for the full height of the panel not exceeding 1/8 inch.

Slip joints shall be as shown on Standard Drawings 333, 334. Railing installed without slip joints will be rejected and the contractor shall install new railing at his own expense.

3-17 CEMENT CONCRETE SIDEWALKS

3-17.1 DESCRIPTION

This work shall consist of constructing cement concrete sidewalks, thickened edge for sidewalks, curb ramps, and bus shelter pads, including excavation for the depth of the sidewalk and subgrade preparation, in accordance with these Specifications, the WSDOT/APWA Standard Specifications and Standard Drawings 307, 312, 313, and 315-322.

3-17.2 MATERIALS

Materials shall meet the requirements of the following section of the WSDOT/APWA Standard Specifications:

Cement Concrete Class 3000	6-02
Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04
Concrete Curing Materials and Admixtures	9-23

Slump of concrete mix shall not exceed 3-1/2 inches. Lamp black coloring agent for matching the color of newly constructed cement concrete sidewalks to the color of adjacent existing cement concrete sidewalks

angles to the line of the sidewalk and be normal to and flush with the surface. Where the sidewalk will be contiguous with the curb, it shall be constructed with a thickened edge as shown on Standard Drawings 312 and 313.

After the concrete has been thoroughly compacted and leveled, it shall be floated with wood floats and finished at the proper time with a metal float.

The surface shall be brushed with a fiber hair brush of an approved type in a transverse direction except that at driveway and alley crossings it shall be brushed longitudinally. The placing and finishing of all sidewalk shall be performed under the control of the engineer, and the tools used shall meet with his approval. After brush finish, the edges of the sidewalk and all joints shall be lightly edged again with an edging tool to give it a finished appearance.

The surface finish and joint pattern may vary at the direction of the engineer in order to match existing sidewalk.

3-17.3(4) CURING AND PROTECTION

The curing materials and procedures specified in Section 5-05.3(13) of the WSDOT/APWA Standard Specifications shall prevail, except that white pigment curing compounds shall not be used on sidewalks.

The contractor shall have readily available sufficient protective covering, such as waterproof paper or plastic membrane, to cover the pour of an entire day in event of rain or other unsuitable weather.

The sidewalk shall be protected against damage or defacement of any kind until it has been accepted by the engineer. Sidewalk which is not acceptable to the engineer because of damage or defacement, shall be removed and replaced by the contractor.

3-17.3(5) CURING AND HOT WEATHER

In periods of low humidity, drying winds, or high temperatures, a fog spray shall be applied to concrete as soon after placement as conditions warrant in order to prevent the formation of shrinkage cracks. The spray shall be continued until conditions permit the application of a liquid curing membrane or other during media. The engineer shall make the decision when the use of a fog spray is necessary.

3-17.3(6) COLD WEATHER WORK

When the air temperature is expected to reach the freezing point during the day or night, the concrete shall be protected from freezing. The contractor shall provide a sufficient supply of straw, hay, grass, earth, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. The contractor shall be responsible for the quality and strength of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the contractor's expense in accordance with these Specifications.

3-17.3(7) THROUGH AND CONTRACTION JOINTS

Standard locations for through joints for sidewalks are:

a) At street margins produced and at 30 foot intervals.

b) To separate concrete driveway, stairways, curb ramps and their landings from sidewalks.

c) Around the vertical barrel of fire hydrants, around utility poles and large diameter underground utility cover castings when located in the sidewalk area.

d) Longitudinally between concrete walks, curbs, paved planting strips and solid masonry or concrete walls where they abut.

e) To match as nearly as possible, the through joints in the adjacent pavement and curb when sidewalk abuts to curb.

Transverse contractions joints (dummy joints) shall be constructed with premolded material 3/8 inch wide by 2 inches depth, and set at 15 foot intervals, or as decided by the engineer. At no time will dummy joint spacing exceed 15 feet.

Transverse and longitudinal through joints as shown on Standard Drawings 312, and 315 through 317 shall be 3/8 inch thickness premolded non-extruding joint material, cut to a width equal to the full depth of the concrete where located, plus ½ inch. When installed, they shall be placed with top edge 1/8 inch below the finished surface of the concrete, in a perpendicular plane to the surface and with the bottom edge embedded in the subgrade. All joints shall be in straight alignment, except where placed in curved locations.

Construction joints for sidewalks shall conform to the applicable requirements for through joints. The top edge shall be 1/8 inch below the finished surface of the sidewalk. At no time will joint spacing exceed 15 feet.

3-17.3(8) CURB RAMPS

In accordance with State law, curb ramps shall be provided at all pedestrian crossing with curb sections. It is required that when a ramp is constructed giving handicap access to the roadway area, the corresponding ramp at the opposite side of the roadway will also be required. Exact locations at each curb return will be approved in the field during construction.

Curb ramps shall be constructed in accordance with the Standard Drawings 318 through 322. Curb ramps shall be constructed where shown on the plans or as described by the engineer. This work shall include curb ramps installed in new sidewalks and curb ramps to be installed in existing sidewalks. Existing sidewalks shall be neatly saw-cut full depth prior to construction of curb ramps.

Curb ramps shall be constructed separately from the sidewalk to produce a definite break line between the ramp and the sidewalk. A 3/8 inch non-extruded through joint material shall be installed between the curb ramp and the sidewalk with edging.

Ramp texturing is to be done with an expanded metal grate placed and removed from wet concrete to leave a diamond pattern as shown. The long axis of the diamond pattern shall be perpendicular to the curb. Grooves shall be 1/8 inch deep and ¼ inch wide.

SECTION 4 - STORM AND SURFACE WATER

4-1 GENERAL

This section of the Standards provides criteria for the design of storm and surface water drainage systems, including stormwater conveyance pipes, culverts, and catch basins, on-site stormwater management, flow control, and water quality treatment facilities. Each of the sections in this chapter contains the design criteria and reference standard drawings for the various systems or facilities.

Drainage control and stormwater treatment shall be provided for all property improvements within the City of Everett per these Standards, the City of Everett Stormwater Management Manual, Everett Municipal Code Sections 14.28 and 14.56, the City's Surface Water Comprehensive Plan, and the City's Zoning Code.

The City of Everett Stormwater Management Manual (Stormwater Management Manual) shall be the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington*, current edition, unless otherwise determined by the City Engineer. All requirements of the manual shall be the City of Everett's requirements, except as augmented herein. Where conflicts exist between the Stormwater Management Manual and the requirements herein the requirements herein shall take precedence. The combined requirements will apply to all new and redevelopment projects and activities within the City of Everett unless one of the following applies:

- The project site is legally served by a combined storm and sanitary sewer system, in which case the stormwater standards shall be as set in Section 6-10.

- The project type or activity is included in the list of exempt practices included in the City of Everett Stormwater Management Manual

- The activity is covered under the WSDOT Stormwater General Permit and is designed in accordance with the WSDOT Highway Runoff Manual, provided that any more restrictive City of Everett requirements are met.

- Public agency funded roadway and transportation related projects may use technical design elements of the WSDOT Highway Runoff Manual provided that any more restrictive City of Everett requirements are met. Determination of project requirements must be in accordance with the Stormwater Management Manual.

- Drainage facilities conceived, designed, or constructed by or through an agent of the City shall be exempted from the submittal and permitting requirements of the City of Everett Stormwater Management Manual. The City shall meet the intent and specific requirements of the Stormwater Management Manual on all projects relative to drainage or incorporating drainage components and shall maintain records adequate to reflect such compliance. These records shall be available upon request per the State Public Disclosure of Information Act, RCW 42.17.

4-2 STORM DRAINAGE CONVEYANCE SYSTEM DESIGN CRITERIA

4-2.1 OVERVIEW

For the purposes of this section, the conveyance system includes all portions of the surface water system that transport storm and surface water runoff, either natural or man-made, except those features protected as environmentally sensitive areas under the City's zoning code. Environmentally sensitive areas may only be modified as allowed under the City of Everett Zoning Code. Stormwater must generally be treated and detained prior to discharge to an environmentally sensitive area, including those features created for mitigation.

This section covers the following components of the conveyance system:

Pipe systems
Culverts
Outfalls
Open Channels

4-2.2 DESIGN FLOW AND ROUTE REQUIREMENTS

4-2.2 (1) DESIGN FLOW

The method used to determine the design flow will depend on the characteristics of the drainage area and the type of conveyance. Refer to Section 4-3.1 for appropriate methods for calculating design flows.

The design flow for each conveyance system category is as follows:

- Private Property –
    - The project's internal drainage system shall be designed for a 25-year recurrence interval peak flow rate from the contributing drainage area under fully developed conditions.

- Public Roads and other Public Rights of Way
    - All conveyances within public roads or other public rights of way shall be designed to pass a 25-year recurrence interval peak flow rate from the contributing drainage area under fully developed conditions.
- Culverts and Bridges –
    - Culverts for and bridges over natural channels shall be designed to safely convey the 100-year recurrence interval peak flow rate from the contributing drainage area under fully developed conditions.
    - Culverts and bridges shall also be designed to meet fish passage requirements, where applicable.

A backwater analysis (see Section 4-2.2(3)) may be required for a proposed or existing pipe system if the ability of the pipe system to convey the peak rate of runoff from the 25-year design storm event may be affected by tailwater conditions (outlet control) anywhere in the pipe system, or as otherwise determined by the City.

4-2.2 (2) CONVEYANCE SYSTEM LOCATION

New conveyance system alignments that are not in dedicated tracts or right-of-way shall be located in drainage easements that are adjacent and parallel to property lines. The width of the permanent easement must be completely within a single parcel or tract and not split between adjacent properties. Topography and existing conditions are the only conditions under which a drainage easement may be placed that is not adjacent and parallel to a property line.

1. A drainage easement with a minimum width of 15 feet shall be provided for publicly maintained open channels, closed drainage systems, and from established city streets to a stormwater facility.
2. Pipes installed in public easements shall be constructed in the center of the easement, as nearly as possible, but in no case shall the pipe be within five feet of any structure or property line.
3. No structures shall be erected within any public drainage easement. Construction of a fence across a public easement is allowed provided a 15-foot wide access gate is provided.
4. All public easements, except for special circumstances, shall be located to run within single lots rather than being split by a lot line.
5. All drainage facilities such as detention or retention ponds or infiltration systems to be maintained by the City shall be located in separate tracts dedicated to the City. Conveyance systems for these facilities may be in easements or as part of the drainage facility tract.
6. Drainage facilities that are designed to function as multi-use recreational facilities shall be located in separate tracts or in designated open space and shall be privately maintained and owned, unless dedicated to and accepted by the City.
7. Any new conveyance system located on private property designed to convey stormwater runoff from other private properties must be located in a private drainage easement granted to the contributors of stormwater to the systems to convey surface and stormwater and to permit access for maintenance or replacement in the case of failure. The easement shall be a minimum of 15 feet in width.
8. All pipes and channels must be located within the easement so that each pipe face or top edge of channel is no closer than 5 feet from its adjacent easement boundary.
9. Pipes greater than 5 feet in diameter and channels with top widths greater than 5 feet shall be placed in easements adjusted accordingly so as to meet the required dimensions from the easement boundaries.

4-2.2 (3) PIPE SYSTEM DESIGN CRITERIA

Two methods of hydraulic analysis using Manning's Equation are used for the analysis of pipe systems. The first method is the Uniform Flow Analysis Method, commonly referred to as the Manning's Equation, and is used for the design of new pipe systems and analysis of existing pipe systems.

The second method is the Backwater Analysis Method. If the City determines that, as a result of the project, runoff for any event up to and including the 100-year peak frequency flow would cause damage or interrupt vital services, a backwater (pressure sewer) analysis shall be required. A backwater analysis shall also be used when the outlet of the pipe system being analyzed is fully or partially submerged or can be expected to be so during the design storm event. Examples of where this may be encountered include discharge to a river, tidally influenced water body, stormwater pond or a low gradient open channel conveyance system.

When a backwater calculation is required, the design engineer shall analyze the 25- and 100-year peak flows and demonstrate compliance with the requirements in section 4-2.2(1):

- For the 25-year recurrence peak flow rate, there shall be a minimum of one-half a foot of freeboard between the water surface and the top of any manhole or catch basin.

- For the 100-year recurrence peak flow rate:
    - Overtopping of the pipe conveyance system may occur; however, the additional flow shall not extend beyond half the lane width of the outside lane of the traveled way and shall not exceed 4 inches in depth at its deepest point.
    - Off-channel storage on private property is allowed with recording of the proper easements. The additional flow shall be analyzed by open channel flow methods.

Results of the backwater analysis shall be provided to the City in tabular and graphic format showing hydraulic and energy gradient.

Outfall to a Natural System

Where a pipe system outfalls to a natural water body such as a stream, river, or bay the assumed tail water at the outlet shall be in accordance with Table 4.2.2(3)A. The water surface elevation used shall be dependent on the purpose of the analysis. Design of water quality treatment facilities shall be based on commonly occurring water surface elevations in receiving water to ensure that the treatment facility will function as designed under normal operating circumstances. Conveyance system designs shall be based on the highest anticipated water level in the receiving water to ensure that conveyance systems function correctly during extreme weather.

Table 4.2.2(3)A Design Water Surface Elevations for Natural Systems

	Assumed Tailwater Elevation at Outlet For Water Quality Analysis	**Assumed Tailwater Elevation at Outlet For Conveyance System Analysis**
Stream	Ordinary High Water Mark	Ordinary High Water Mark
River	Ordinary High Water Mark	FEMA Base Flood Elevation
Tidal waters such as Port Gardner Bay and associated tidelands	Mean Higher High Water	Mean Higher High Water +2 feet
Tidally influenced fresh water waterbodies such as the Snohomish River or Union Slough	Whichever is greater, Mean Higher High Tide or Ordinary High Water Mark	Whichever is greater, Mean Higher High Water +2 feet or FEMA Base Flood Elevation

When using the Manning's Equation for design, each pipe within the system shall be sized and sloped such that its barrel capacity at normal full flow is equal to or greater than the design flow rate.

Table 4-2.2(3) provides the recommended Manning's “n” values for preliminary design for pipe systems. (Note: The “n” values for this method are 15 percent higher in order to account for entrance, exit, junction, and bend head losses.)

Manning’s “n” values used for final pipe design must be documented in the Stormwater Site Plan.

Nomographs may also be used for sizing the pipes. For pipes flowing partially full, the actual

velocity may be estimated from engineering nomographs by calculating Q_{full} and V_{full} and using the ratio of Q_{design}/Q_{full} to find V and d (depth of flow). Refer to the most current version of WSDOT's Hydraulics Manual for nomographs and additional guidance on the design of pipe systems.

Table 4.2.2(3)B Recommended Manning's "n" Values for Preliminary Pipe Design

Type of Pipe Material	Analysis Method	
	Backwater Flow	Manning's Equation Flow
A. Concrete pipe and CPEP-smooth interior pipe	0.012	0.014
B. Annular Corrugated Metal Pipe or Pipe Arch:		
1. 2⅔ x ½ inch corrugation (riveted)		
a. plain or fully coated	0.024	0.028
b. paved invert (40% of circumference paved):		
(1) flow full depth	0.018	0.021
(2) flow 0.8 depth	0.016	0.018
(3) flow 0.6 depth	0.013	0.015
c. treatment 5	0.013	0.015
2. 2.3 x 1-inch corrugation	0.027	0.031
3. 3.6 x 2-inch corrugation (field bolted)	0.030	0.035
C. Helical 2⅔ x ½-inch corrugation and CPEP-single wall	0.024	0.028
D. Spiral rib metal pipe and PVC pipe	0.011	0.013
E. Ductile iron pipe cement lined	0.012	0.014
F. High density polyethylene pipe (butt fused only)	0.009	0.009

4-2.3 PIPE SYSTEMS

Pipe systems are networks of stormwater conveyance pipes, catch basins, manholes, inlets, and outfalls designed and constructed to convey surface and stormwater runoff. The hydraulic analysis of flow in stormwater conveyance pipes is typically limited to "gravity flow". The following subsections give design criteria for different components and aspects of pipe systems.

4-2.3(1) PIPE MATERIALS

1. Pipe material, joints, and protective treatment shall conform to the requirements set forth in Section 9-05 of the WSDOT/APWA Standard Specifications.

   The following pipe materials are allowed for use in pipe systems in the City of Everett; other pipe materials may be approved on a case-by-case basis:

   a) Plain concrete pipe (12 inches in diameter, used only for driveway culvert)
   b) Reinforced concrete pipe
   c) Ductile iron pipe
   d) Galvanized or aluminized corrugated iron or steel pipe, treatment 1 through 6 (not to be used in city maintained systems unless approved in advance by the City Engineer)
   e) Aluminum Storm Sewer Pipe (not to be used in city maintained systems unless approved in advance by the City Engineer)
   f) PVC pipe (SDR35, ASTM D3034 with 3 feet of cover, minimum)
   g) Corrugated polyethylene storm sewer pipe, with smooth interior
   h) High-Density Polyethylene (HDPE) pipe

2. Coupling bands shall be of the same material as the pipe.

3. Materials for concrete, rubber gaskets, metal castings, reinforcing steel, and masonry units shall meet the requirements of the appropriate sections of the WSDOT/APWA Standard Specifications.

4. Galvanized or aluminized pipe are not permitted in marine environments or where salt water may occur, even infrequently through backwater events.

5. HDPE pipe systems longer than 100 feet must be secured at the upstream end and the downstream end must be placed in a 4 foot section of the next larger pipe size. The sliding sleeve connection accounts for the high thermal expansion/contraction coefficient of this pipe material.

6. Stormwater pipe trenches shall be backfilled in accordance with Standard Drawing 614.

4-2.3(2) PIPE SIZES, SLOPES, AND VELOCITIES

1. No stormwater conveyance pipe between catch basins or manholes in the public right-of-way shall be less than 12 inches in diameter, with the exception that 8-inch pipe may be used between inlets and catch basins in runs of 50 feet or less. Private storm drain pipes receiving surface runoff shall be a minimum of 8 inches in diameter

2. The minimum velocity in any pipe or culvert carrying the design storm flow shall be 2 feet per second, unless otherwise approved.

3. The maximum allowable velocity in any pipe shall be 30 feet per second, except that continuously fused HDPE pipe may exceed 30 feet per second if the pipe is designed to accommodate higher velocities.

4. Changes of pipe size are allowed only at junctions, and structures must be located at all junctions.

5. Downstream decrease in pipe size is not a recommended practice and will only be allowed under special conditions, where approved by the City Engineer.

6. Stormwater conveyance pipe used for private roof/footing/under-drain systems may be less than 8-inch diameter and sized according to the application.

4-2.3(3) STRUCTURES

1. Manholes, catch basins, and inlets shall be constructed of pre-cast units in accordance with the following Standard Drawings:

Item	Section
Manholes	605 through 607
Catch Basins	402 through 405
Inlets	401
Steps and Ladder	608, 609
Frames and Grates	406 through 412
Clean-out	421

2. Catch basin (or manhole) diameter shall be determined by pipe size and orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if necessary) must ensure a minimum solid concrete wall distance between pope openings of 8 inches for 48 inch and 54 inch catch basins and 12 inches for 72 inch and 96 inch catch basins.

3. Catch basin evaluation of structural integrity for H-20 loading may be required for multiple junction catch basins and other structures.

4. Catch basins shall be provided within 50 feet of the entrance to a pipe system to provide for silt and debris removal.

5. Catch basins on a continuous pipe run shall be spaced no further apart than 400 feet to facilitate pipe cleaning.

6. The maximum slope of the ground surface for a radius of 5 feet around a catch basin grate shall be 3:1.

7. A Type II catch basin or a manhole shall be required when the depth to the lowest pipe invert exceeds 5.5 feet, regardless of the pipe size.

8. All Type II catch basins and all manholes shall be equipped with ladders per Standard Drawings 608 or 609.

9. A Type II catch basin shall be installed as the last collector in the public right-of-way prior to discharge to the combined sanitary sewer. A gas trap, in accordance with Standard Drawing 414 shall be installed.

10. Concrete inlets shall not be used where the discharge goes directly into the main storm drain system.

11. Area or yard drains consisting of plastic catch basins or pipe tees shall be allowed only in privately owned and maintained systems, shall be located only in non-traffic areas and only drain catchments consisting primarily of landscape or otherwise vegetated areas. Area or yard drains may also be used as overflow structures in rain gardens and bioretention facilities as allowed in the Stormwater Management Manual. Multiple area or yard drains may be used in succession. However, area or yard drains may not be located downstream of standard catch basins or inlets on the same system. Yard drain grates must be sized appropriately for their catchment area and shall be a minimum of 12 inches x 12 inches unless specifically approved otherwise.
12. The City may, at the discretion of the public works department, require a floatable materials separator in the last catch basin in a drainage system prior to discharge to a public storm drainage main or natural water body. The floatable materials separator shall be constructed in accordance with Standard Drawing 413 or 414. Flow control restrictors may also be used to meet this requirement.

4-2.3(4) PIPE ALIGNMENT/CONNECTIONS/CROSSINGS

1. Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction, except for HDPE and ductile iron with flanged restrained mechanical joint bends (not greater than 30 degrees) on steep slopes. Tracer wire shall be applied to all HDPE pipe which deviates from a straight line and grade.

2. A catch basin or manhole will be required at all changes in storm drain diameter and changes in grade or alignment.

3. Connections to a pipe system shall be made only at catch basins or manholes. No wyes or tees are allowed except on roof, footing, or yard drain systems on pipes 8 inches in diameter or less, with clean-outs upstream of each wye or tee.

4. 6 inches minimum vertical and 3 feet minimum horizontal clearance (between outside surfaces) shall be provided between storm drain pipes and other utility pipes and conduits.

5. Closed storm drainage system collecting runoff from paved areas in the public right-of-way or private property may be required to provide for floatable material separation, per Standard Drawings 413 and 414, prior to discharge to the main storm drainage system in the public right-of-way, at the discretion of the City Engineer.

6. All PVC connections to catch basins or manholes shall be made by grouting in an approved manhole adapter into which the PVC pipe is inserted.

7. Activities such as trench excavation, tunneling or boring, pipe embedment, backfilling, compaction, safety and pavement patching, whether for public or private utilities, shall conform to the requirements set forth in other Sections of these Standards. For all the above, except pavement patching, see Section 3-9 Underground Utilities and Standard Drawings 614. For pavement patching see Section 3-14 and Standard Drawing 326.

4-2.3(5) FRAMES/LIDS/GRATES/COVERS

1. In general, frames and grates shall be furnished and installed per Standard Drawings 406 through 412.

2. The cover or grating of a manhole or catch basin shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the City inspector to grout the cover or grating in place.

3. Lids, grates, and covers shall be seated properly to prevent rocking.

4. All catch basins and manholes in unpaved areas shall be equipped with locking frames and lids or grates per Standard Drawings 406 through 411 or 611.

5. Vaned grates, in accordance with Standard Drawing 411, shall be provided for all inlets and catch basins within the public right of way, except that solid covers shall be used where the structure is not intended to collect surface flow. Bi-directional vaned grates in accordance with Standard Drawing 411 shall be provided in sag vertical curves where gutter line flow approaches from both directions.

6. Herringbone grates may be used only on private systems. Herringbone grates are best suited to uses where surface flow approaches from multiple directions, such as in a parking lot. Vaned grates are recommended for use adjacent to curb lines and any other situation where flow generally approaches the grate from a single direction.

7. All Type II catch basins and all manholes with catches shall be supplied with locking lids or grates.

8. Type II catch basins and manholes functioning exclusively as access structures shall be equipped with round 24 inch covers and framed per Standard Drawing 611.

9. Round lids on all storm drain structures shall have “Drain” cast into the lid.

10. In conditions when the effectiveness of a normal grate installation would be limited, an open curb face frame and grate shall be furnished and installed per Standard Drawing 412. These conditions include high likelihood of clogging from leaf fall, especially in sag vertical curves; when the inlet is a surface drainage end point, such as a cul-de-sac; and when normal inlet grates may be passed over due to the road grade. The use of open curb face frame and grates must be approved by the City Engineer.

4-2.3(6) RESTRICTOR DEVICES

1. The minimum orifice size diameter allowed for use in the City of Everett is one half inch.
2. The minimum width of a notch allowed for use in the City of Everett is one quarter inch.

3. Restrictor devices shall be constructed and installed in accordance with Standard Drawing 415 and 416.

4. Proprietary flow restricting devices may be considered on a case by case basis. Proprietary devices must demonstrate that their use is acceptable to the Washington Department of Ecology prior to use within the City of Everett. Detailed calculation shall be provided demonstrating that the proprietary device is designed and modeled correctly for the proposed application.

4-2.3(7) FLOW SPLITTER DEVICES

1. Flow splitter devices shall be designed in accordance with Section 4.5 of Volume V of the Stormwater Management Manual.
2. Flow splitters/Bypass Structures shall be constructed and installed in accordance with Standard Drawings 422 through 424. Other flow splitter designs may be used if they are designed based on demonstrable sound hydraulic principles and are consistent with the material requirements herein.
3. The maximum head shall be minimized for flow in excess of the water quality design flow. Specifically, flow to the water quality facility shall not increase above the design water quality flow by more than 10 percent when the water level in the flow splitter is at a 100-year level. Flow splitters designed for uses other than bypassing water quality facilities may be designed to proportionately distribute high flows or other criteria as appropriate to the use.
4. Materials used in flow splitter construction shall comply with the requirements for Restrictor Devices as defined in Section 4-2.3(6). Risers and other appurtenances within the splitter shall be manufactured from aluminum, stainless steel, or plastic materials. Steel (except stainless) materials will not be accepted.
5. Flow splitter designs which incorporate a baffle wall shall ensure access to each side of the baffle wall. If the baffle wall exceeds 36 inches in height, or if the separation between the top of baffle and underside of the structure lid is insufficient to allow maintenance access, two separate access points shall be provided.

4-2.3(8) DEBRIS BARRIERS

Debris barriers (trash racks) are required on all pipes entering or leaving a closed pipe system, including pipes entering or leaving a control/restrictor manhole or catch basin from a surface-type BMP (detention pond, infiltration basin, wetpond, biofiltration swale, etc.). See Standard Drawings 434 and 435 for debris barrier fabrication requirements.

4-2.3(9) PAVEMENT DRAINAGE

Stormwater collection systems shall be designed to prevent flooding of driving surfaces which inhibits safe travel and loss of function during heavy rainfall events. Drainage collection systems for public roadways, including new roadways to be dedicated to the City, shall be designed to limit gutter flow widths to the limits given in Table 4-2.3(9)A. Gutter flow shall be calculated using Manning's Equation for flows generated at the design frequencies noted in the table. Refer to Chapter 5 of the current version of the WSDOT Hydraulics Manual for more detail on the design and analysis of pavement drainage systems.

Table 4-2.3(9)A

Road Classification		Design Frequency	Design Spread (Zd)
Principal, Minor Arterial, or Divided	< 45 mph	10-year	Shoulder+2 ft [1] or ½ of the Outside Driving Lane if No Shoulder Exists
	≥ 45 mph	10-year	Shoulder
	Sag Pt.	50-year	Shoulder+2 ft [1]
Collector and Local Streets	≤ 45 mph	10-year	Shoulder+½ Driving Lane[2]
	Sag Pt.	50-year	½ Driving Lane[2]

1 The travel way shall have at least 10 ft that is free of water.

2 In addition to the design spread requirement, the depth of flow shall not exceed 0.12 ft at the edge of shoulder.

In addition to the requirements above, areas where a superelevation transition or topography causes a crossover of gutter flow, the amount of flow calculated at the point of zero superelevation shall be limited to 0.10 cfs. The designer will find, by the time the roadway approaches the zero point, the flow spread

becomes very wide. The flow width criteria will be exceeded at the crossover point even when the flow is less than 0.10 cfs.

In lieu of preparing calculations described above, catch basins on continuous grade roadways may be determined based on the following minimum spacing requirements.

Table 4-2.3(9)B Catch Basin Spacing Requirements

Minimum Catch Basin Spacing on Continuous Grade Roads (LF)*				
Longitudinal Road Slope (%)	Contributing Width (ft)**			
	0-12	>12-24	>24-36	>36-48
0-1<	400	220	150	100
1-2<	550	300	200	150
2-5<	600	400	250	200
5-8<	600	425	250	210
8+	600	400	***	***

* Table may not be used when significant runon from adjacent property is anticipated.

** Road width draining to gutter line. Typically the width from roadway crown to curb line or back of sidewalk if present

*** Calculations must be prepared demonstrating compliance with Table 4-2.3(9)A

Note that the restrictions on pipe lengths between structures must also be met and may reduce catch basin spacing. See Section 4-2.3(3)

Collection systems on private property shall be designed such that ponding depths do not exceed 4 inches in depth in the 25 year storm event in areas subject to vehicular traffic. Ponding depths should be further reduced in areas commonly subject to pedestrian traffic. Grate inlets in parking areas should generally be modeled as broad crested weirs. Calculate the length of the weir as the perimeter length of the weir divided by 2 to account for debris plugging.

4-2.3(10) STORMWATER PUMPS

Stormwater pumps are generally not accepted as part of a stormwater system. However, in certain circumstances stormwater pumps may be the only viable way to convey stormwater. In these cases pump systems may be approved on a case by case basis, subject to the following requirements:

1. Stormwater Pumps must be privately owned, operated, and maintained and must be located on private property unless otherwise approved by the City Engineer.
2. Stormwater pumps will only be approved when no gravity-based alternative is available.
3. A gravity overflow must be provided which will ensure that flooding will not occur if the pumps fail.
4. Backup power must be provided with sufficient capacity to run the pumps at max flow.
5. Pump systems should be designed in a duplex configuration or otherwise provided with sufficient redundancy to continue to operate in case of a single pump's failure.
6. Appropriate alarms must be provided to ensure that a failing system is quickly identified. In general, an audible alarm will be required.

7. Site discharge rates must comply with stormwater standards. Pumping upstream of detention is preferred versus pumping out of the detention system.

4-2.4 CULVERT DESIGN CRITERIA

Culverts shall be designed in accordance with the following criteria:

1. Minimum Culvert Velocity shall be 2 feet per second and a maximum culvert velocity shall be 15 feet per second at the design flow rate. Thirty feet per second may be used with an engineered outlet protection design. Velocity requirements will not be applied to culverts on natural systems designed to meet fish passage standards.
2. No maximum velocity for ductile iron or HDPE pipe shall be established but outlet protection shall be provided.
3. All CPEP and PVC culverts and pipe systems shall have concrete or rock headwalls at exposed pipe ends.
4. Bends are not permitted in culvert pipes.
5. The following minimum cover shall be provided over culverts:
   2 feet under roads.

   1 foot under roadside applications and on private property, exclusive of roads.

6. If the minimum cover cannot be provided on a flat site, use ductile iron pipe and analyze for loadings.
7. Maximum culvert length = 250 feet
8. Minimum separation from other pipes:
   6 inches vertical (with bedding) and in accord with the City Sewer Utility Design criteria.
   3 feet horizontal.

Trench backfill shall be bank run gravel or suitable native material compacted to 95 percent Modified Proctor test to a depth of 2 feet; 90 percent below 2 feet compacted in 8 inch to 12 inch lifts.

All driveway culverts shall be of sufficient length to provide a minimum 3:1 slope from the edge of the driveway to the bottom of the ditch. Culverts shall have beveled end sections to match the side slope.

4-2.4(1) HEADWATER

1. For new culverts 18 inches in diameter or less, the maximum allowable 25-year design storm headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter/arch culvert height used and shall be one foot or more below the road or parking lot subgrade.

2. For new culverts larger than 18 inches in diameter, the maximum 25-year design storm headwater elevation for the new culvert shall be one foot or more below the road or parking lot subgrade.

3. No Culvert shall have a headwater elevation which overtops the roadway in the 100-year design storm.

4. For bottomless culverts the maximum 25-year design storm headwater shall not exceed the top of the culvert.

4-2.4(2) INLET

1. For culverts 18 inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by rock lining or riprap as specified in Table 4-2.1, except the length shall be a minimum of five feet (upstream of the culvert) and the height shall be at the design headwater elevation.

2. Trash racks/debris barriers are required on culverts that are over 60 feet in length and that are 12 inches to 36 inches in diameter. Exceptions are culverts on fish-bearing streams.

3. In order to maintain the stability of roadway embankments, concrete headwalls, wing walls, or tapered inlets and outlets may be required if right-of-way and/or easement constraints prohibit the culvert from extending to the toe of the embankment slope. Normally, concrete inlet structures/headwalls installed in or near roadway embankments must be flush with and conform to the slope of the embankment.

4-2.4(3) OUTLETS

The receiving channel at the outlet shall be protected from erosion by rock lining, as specified in Table 4-2.1, except the height shall be one foot above the maximum tailwater elevation or one foot above the crown of the pipe, whichever is higher.

4-2.4(4) MINIMUM CULVERT SIZE

Minimum culvert diameters are as follows:

For cross culverts under public roadways – minimum 18 inches, 12 inches if grade and cover do not allow for 18 inches.

For roadside culverts, including driveway culverts, minimum 12 inches.

For culverts on private property, minimum 8 inches.

4-2.4(5) FISH PASSAGE

Guidance for designing culverts for fish passage must be obtained from the Washington State Department of Fish and Wildlife.

4-2.4(6)ADDITIONAL REQUIREMENT FOR CULVERTS OVER 20 FEET

Culverts exceeding 20 feet in width are defined as bridges and must be designed to bridge design standards. The federal definition of a bridge is a structure, including supports, erected over a depression or obstruction, such as water, highway, or railway, and having a track or passage way for carrying traffic or other moving loads with a clear span as measured along the center line of the roadway equal to or greater than 20’. The interior cell walls of a multiple box are ignored as well as the distance between the multiple pipes if the distance between pipes is less than D/2 (i.e. a 16’ culvert on a 45 degree skew is a bridge, a 10’ culvert on a 60 degree skew is a bridge, three 6’ pipes two feet apart is a bridge).

Culverts which qualify as bridges must be designed in accordance with applicable sections of the most current edition of the *AASHTO LRFD Bridge Design Specifications*. The two primary types of hydraulic analysis performed on bridges are backwater and scour.

4-2.5 OUTFALL DESIGN CRITERIA

4-2.5(1) GENERAL

1. All outfalls (at a minimum) shall be provided with rock protection per Table 4-2.1 or flow dispersal trench. For outfalls with a velocity at the design flow greater than 10 fps, a gabion dissipater or engineered energy dissipater shall be required.

2. Flow dispersal trenches shall only be used at outfalls when both criteria below are met:

   - An Outfall is necessary to disperse concentrated flows across uplands where no conveyance system exists and the Natural (existing) discharge is unconcentrated.
   - The 100 year peak flow is less than 0.75 CFS calculated using the rational method or a continuous simulation method using a 15 minute time step.

   Flow dispersal trenches shall be designed in accordance with the Stormwater Management Manual

3. Mechanisms which reduce velocity prior to discharge from an outfall are encouraged.

4. Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 20 fps.

5. Inlet control will usually dictate outfall pipe system capacity. The inlet conditions should be carefully examined, as well as the consequences should the inlet to the pipe system become plugged or capacity exceeded.

6. All Outfall's shall be designed for the 100-year peak flow rate.

Table 4-2.1 Outlet Protection

Design Flow Discharge Velocity	REQUIRED PROTECTION (Minimum Dimensions)				
(fps)	Type	Thickness	Width	Length	Height
0 – 5	Riprap*	1 ft	Diameter + 6 ft	8 ft or 4x diameter, whichever is greater	Crown + 1 ft
>5 – 10	Riprap**	1 ft	Diameter + 6 ft or 3x diameter, whichever is greater	12 ft or 3X diameter, whichever is greater	Crown + 1 ft
>10 - 20	Gabion	1 ft	As required	As required	Crown + 1 ft
20+	Engineered Energy				

	Dissipater Required				

Note: The stone for riprap shall be hard, sound, and durable and free of rock fines, soil, or other extraneous material. It shall also be free of segregation, seams, cracks, and other defects which would tend to destroy its resistance to weather.

* Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100% passing an 8 inch square sieve (maximum stone size = 8 inches)
40 – 60% passing a 6 inch square sieve (median stone size = 6 inches)
0 – 10% passing a 2 inch square sieve (minimum stone size = 2 inches)

** Riprap for these velocities shall be reasonably well-graded with rock gradation as follows:

100% passing a 24 inch square sieve (maximum stone size = 24 inches)
40 – 60% passing a 16 inch square sieve (median stone size = 16 inches)
0 – 10% passing a 4 inch square sieve (minimum stone size = 4 inches)

Note: Filter blankets designed in accordance with Section 4-2.6(2) shall be provided beneath riprap pads and gabion structures

4-2.5(2) OUTFALL SYSTEMS TRAVERSING STEEP SLOPES

1. Outfall systems constructed of pipe segments which are banded and/or gasketed are not acceptable for traversing steep slopes. Failure of the system will result from leaks which develop at the joints.

2. Continuously fused, welded or flange bolted mechanical joint pipe systems (such as high density polyethylene pipe (HDPEP) or ductile iron pipe with flange-bolted mechanical joints) with proper anchoring shall be used for outfall systems traversing steep slopes.

3. In general, outfall pipes systems shall be installed in trenches with standard bedding on slopes up to 20 percent. On slopes greater than 20 percent, outfall pipe systems shall be placed on the ground surface with proper pipe anchored.

4. HDPEP outfall systems must be designed to address the material limitations as specified by the manufacturer, in particular thermal expansion/contraction and pressure design. Sliding sleeve connections to address thermal expansion and contraction shall be used. These sleeve connections consist of a section of the appropriate length of the next larger size diameter of pipe into which the outfall pipe is fitted. These sleeve connections must be located as close to the discharge end of the outfall as is practical.

5. Flows of very high energy will require a specifically engineered energy dissipation structure, as described above.

4-2.6 OPEN CHANNEL DESIGN CRITERIA

Open channels, either natural or artificial, may be used to convey stormwater on and from a site. In general, however, natural channels are protected as environmentally sensitive areas under the City's zoning code

and may not be used to convey untreated, undetained stormwater. Alteration of these channels, including bank stabilization projects, requires special permits.

Artificial channels are those constructed from upland areas specifically to convey storm and surface water. Artificial channels include roadside ditches, grass lined swales, and rock lined channels. Where space and topography permit, open conveyances are the preferred means of collecting and conveying stormwater.

When constructing artificial channels, vegetation-lined channels are preferred when properly designed and constructed. Rock-lining may be necessary along the length of channels or at specific locations (such as bends and outfalls) when a vegetative lining will not provide adequate protection from erosive velocities.

4-2.6(1) ARTIFICIAL CHANNELS

1. Channel section geometry shall be trapezoidal. Side slopes shall not be steeper than 3H:1V for vegetation-lined channels and 2H:1V for rock-lined channels, unless the channel is engineered specifically for steeper slopes. Channel side slopes adjacent to roads shall not exceed 4:1 and will meet all other AASHTO and City road standards.
2. All constructed channels shall be compacted to a minimum 95 percent compaction as verified by a Modified Proctor test, except that compaction requirements for bio-retention swales and bio-filtration swales shall be in accordance with the requirements of the City of Everett Stormwater Management Manual.
3. Channels shall be designed with a minimum freeboard of one-half-foot when the design flow is 10 cubic feet per second or less and 1 foot when the design discharge is greater than 10 cubic feet per second.
4. Velocities must be low enough to prevent channel erosion based on the native soil characteristics or the compacted fill material. For velocities above 5 feet per second channel linings shall be designed using a shear stress analysis.
5. Water quality shall not be degraded due to passage through an open conveyance.
6. Vegetation-lined channels shall have bottom slope gradients of five percent or less and a maximum average velocity at the design flow of five 5 feet per second.
7. Rock-lined channels shall be used when design flow velocities exceed 5 feet per second. Rock lining shall be in accordance with Table 4-2.2.
8. Check dams for erosion and sedimentation control may be used for stepping down channels being used for biofiltration.
9. A maintenance access easement 15-ft-wide (minimum) is required along all publicly maintained constructed channels located on private property. However, required easement widths and building setback lines may vary with channel top width. A minimum 15-foot-wide setback must be provided between any structures and the top of the bank of the channel.

4-2.6(2) CHANNEL LINING

4-2.6(2)A Shear Stress Analysis

Channels which exceed velocities of 5 feet per second or slopes greater than 5 percent shall be analyzed to determine channel stability and the need for protection using a channel lining. In most cases a flexible channel lining is appropriate while extremely high shear stresses may require hard armoring. In order to determine the need for a channel lining the maximum shear stress in a channel shall be calculated using the methodology below. A liner with a permissible shear stress exceeding the channel's maximum shear stress can then be selected from Table 4-2.6(2).

The maximum shear stress in a straight channel is given by:

$$\tau_d = \gamma d S_o$$

where,

τ_d = shear stress in channel at maximum depth, lb/ft^2

γ = unit weight of water, lb/ft^3

d = depth of flow in channel, ft (determined using Manning's Equation)

S_o = channel bottom slope, ft/ft

A more detailed discussion of the shear stress analysis, including compound liners and complex geometry can be found in the Federal Highway Administration's *Hydraulic Engineering Circular No. 15 - Design of Roadside Channels with Flexible Linings* (http://www.fhwa.dot.gov/engineering/hydraulics/pubs/05114/05114.pdf.)

Stability in Bends

Flow around a bend creates secondary currents, which impose higher shear stresses on the channel sides and bottom compared to a straight reach. At the beginning of the bend, the maximum shear stress is near the inside and moves toward the outside as the flow leaves the bend. The increased shear stress caused by a bend persists downstream of the bend.

The maximum shear stress in a bend is given by:

$$\tau_b = K_b \tau_d$$

where,

τ_b = side shear stress on the channel, lb/ft^2

K_b = ratio of channel bend to bottom shear stress

τ_d = shear stress in channel at maximum depth, lb/ft^2

The maximum shear stress in a bend is a function of the ratio of channel curvature to the top (water surface) width, R_C/T. As R_C/T decreases, that is as the bend becomes sharper, the maximum shear stress in the bend tends to increase. Kb can be determined from the following equation:

$$K_b = 2.00 \qquad R_C/T \leq 2$$

$$K_b = 2.38 - 0.206\left(\frac{R_c}{T}\right) + .0073\left(\frac{R_c}{T}\right)^2 \qquad 2 < R_C/T < 10$$

$$K_b = 1.05 \qquad 10 \leq R_C/T$$

where,

R_c = radius of curvature of the bend to the channel

T = channel top (water surface) width, ft

Table 4-2.6(2) Open Conveyance Protection.

Shear Stress at Design Flow (lb/ft^2)				
Greater Than	**Less Than or Equal To**	**Protection**	**Thickness**	**Min. Height Required Above Design Water Surface**
0	2	Grass Lining	N/A	0.5 ft.
0	2	Temporary Erosion Control Blanket[5]	N/A	0.5 ft.
2	4	Riprap[1,2,4]	1 ft.	2 ft.
3	6	Riprap[3]	2 ft.	2 ft.
4	8	Permanent Erosion Control Blankets and Turf Reinforcement[5]	NA	0.5 ft.
6	8	Slope mattress, gabion, etc.	Varies	1 ft.
10	20	Fabric formed or cast in place Concrete	Varies	1 ft.

1. Riprap shall be in accordance with Section 9-13.1 of the WSDOT/APWA standard specifications.
2. Riprap shall be a reasonably well graded assortment of rock with the following gradation:
   Maximum stone size 12"
   Median stone size 8"
   Minimum stone size 2"
3. Riprap shall be reasonably well graded assortment of rock with the following gradation:
   Maximum stone size 24"
   Median stone size 16"
   Minimum stone size 4"
   Note: Riprap sizing governed by side slopes on channel, assumed ~3.1.
4. Bioengineered lining allowed for design flow up to 8 fps.
5. Provide Manufacturer's certification of blanket product's allowable shear strength.

4-2.6(2) RIPRAP FILTERS

Riprap shall be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the natural or artificial channel from being washed through the voids in the riprap. Likewise, the filter material shall be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well graded sand and gravel material with $D_{15}<5d_{85}$, where d_{85} refers to the sieve opening through which 85 percent of the material being protected will pass and D_{15} has the same interpretation for the filter material. A filter with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used it is sometimes necessary to use two filter layers between the material being protected and the riprap.

4-2.7 REQUIRED NOTES FOR STORM DRAINAGE PLANS

1. No part of the drainage system shall be covered, concealed, or put into use until it has been inspected, tested, and accepted by the City of Everett.

2. All work and material shall conform to the City of Everett Design and Construction Standards and Specifications and the WSDOT/APWA Standard Specifications for Road, Bridge, and Municipal Construction (Current Edition).

3. Approximate locations of existing utilities have been obtained from available records and are shown for convenience. The contractor shall be responsible for verification of locations and to avoid damage to any additional utilities shown. If conflicts with existing utilities arise during construction, the contractor shall notify the Public Works Inspector and any changes required shall be approved by the City Engineer prior to commencement of related construction on the project.

4. All storm systems within the public right-of-way or in easements must be staked by survey for line and grade prior to starting construction.

5. All catch basin grates must be stenciled or stamped **"Dump No Waste, Drains to Stream, Lake, River, Puget Sound, or Wetland."** Choose appropriate feature for the project

4-3 STORMWATER ANALYSIS

4-3.1 HYDROLOGIC ANALYSIS AND DESIGN STANDARDS

The minimum computational standards for designing stormwater systems depend on the type of information required and the size of the drainage area to be analyzed.

A calibrated continuous simulation hydrologic model based on the U.S. Environmental Protection Agency's (U.S. EPA) Hydrological Simulation Program-Fortran (HSPF) program, or the most current major revision of an approved equivalent model (e.g., the Western Washington Hydrology Model [WWHM] or MGSFlood), must be used to calculate runoff and determine design flow rates and volumes for the purpose of designing stormwater facility BMPs in the City. Certain volume based BMPs may alternately be sized using the Soil Conservation Service Unit Hydrograph (SCSUH) or Santa Barbara Unit Hydrograph (SBUH) methodology as allowed in the Stormwater Management Manual.

For the purpose of designing conveyance systems in the City, the method depends upon the size of the basin. For sites in the City with a developed time of concentration less than or equal to 60 minutes, the rational method must be used to determine design flows. For sites in the City with a developed time of concentration of greater than 60 minutes, the designer must use an approved continuous simulation runoff model. The city also allows the use of dynamic hydraulic models such as the Storm Water Management Model (SWMM) available from the US EPA, and its derivatives for basins of any size. Dynamic models must use a rainfall time series developed by the City of Everett unless otherwise approved by the City Engineer.

Table 4-3.1 summarizes the required standards for each type of stormwater analysis. Each analysis method is described in more detail in the following sections. See Section 4-2 for requirements for hydraulic analysis including pipe capacity and channel erosion calculations.
Table 4-3.1 Summary of Stormwater Analysis Standards

1. Many Onsite Stormwater Management BMPs for small projects do not require modeling for proper design.

Application	Applicable Design Methodology
Flow Control Facility Sizing	Continuous Runoff Model (WWHM, MGSFlood, or approved equal)
Water Quality Facility Design	Continuous Runoff Model (WWHM, MGSFlood, or approved equal). Single Event Modeling may be used in limited circumstances as allowed in the Surface Water Manual
Onsite Stormwater Management/Low Impact Development Facility Design[1]	Continuous Runoff Model (WWHM, MGSFlood, or approved equal)
Conveyance System Design (time of concentration less than 1 hour)	Rational Method or dynamic modeling using the 14 Storm Series
Conveyance System Design (time of concentration greater than 1 hour)	Continuous Runoff Model (WWHM, MGSFlood, or approved equal) or dynamic modeling using the 14 Storm Series

4-3.1 (1) RATIONAL METHOD

The formula for the rational method is as follows:

$$Q = C\ i\ A$$

where:

Q = runoff in cubic feet per second

C = runoff coefficient (unitless)

i = average rainfall intensity, in inches per hour, for a particular storm duration

A = drainage area in acres

The rainfall intensity is found using the following equation, with contributing basin's time of concentration used as the storm duration:

$$i = m/T_c^{\,n}$$

where

T_c = time of concentration

m,n = dimensionless coefficients (see Table 4-3.1(1)-1)

Table 4-3.1(1)-1 Rainfall Coefficients

coefficient	Mean Recurrence Interval (MRI)					
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
m	3.69	5.20	6.31	7.83	8.96	10.07
n	0.556	0.570	0.575	0.582	0.585	0.586

The runoff coefficient represents the portion of rainfall that becomes runoff. Table 4-3.1(1)-2

gives runoff coefficient values to be used for storm conveyance calculations in the City of Everett.

Table 4-3.1(1)-2

GENERAL LAND COVER			
LAND COVER	C	LAND COVER	C
Dense Forest	0.10	Playgrounds	0.30
Light Forest	0.15	Gravel Areas	0.80
Pasture	0.20	Pavement and Roofs	0.90
Lawns	0.25	Open Water	1.00
SINGLE FAMILY RESIDENTIAL AREAS (Density is in dwelling units per gross acre)			
DENSITY	C	DENSITY	C
0.20	0.17	3.00	0.42
0.40	0.20	3.50	0.45
0.80	0.27	4.00	0.48
1.00	0.30	4.50	0.51
1.50	0.33	5.00	0.54
2.00	0.36	5.50	0.57
2.50	0.39	6.00	0.60

4-3.1 (2) CONTINUOUS RUNOFF MODELS

Ecology has developed the HSPF-based WWHM, which has been created for the specific purpose of sizing stormwater control facilities for new developments and redevelopments in western Washington. WWHM can be used for a range of conditions and developments; however, certain limitations are inherent in this software. A detailed description for the use of WWHM can be found in Section III-2.2 of the Stormwater Management Manual.

One other HSPF-based continuous runoff model that has been approved by Ecology and may be used in the City is MGSFlood:

http://www.mgsengr.com/mgsfloodhome2.html

Use of other continuous simulation runoff models must receive prior concurrence from the City before being used for facility design.

All stormwater facilities including Flow Control, Water Quality Treatment and Onsite Stormwater Management BMPs must be designed using an approved continuous runoff model, unless alternate sizing methods are provided in the Stormwater Management Manual.

Conveyance systems designed using continuous runoff models must be designed using a maximum 15 minute time-step to determine peak flow rates.

4-3.1 (3) DYNAMIC HYDRAULIC MODELS

Dynamic hydraulic models allow the designer to account for the storage within a conveyance system and more accurately represent the function of some conveyance systems versus an analysis performed using the rational method. However, the use of dynamic modes requires substantial computational resources and an experience stormwater modeler to complete a design. As such it is expected that the approach will generally only be used on larger projects and more complex designs. There are many dynamic modeling software packages available, both in the public domain and for purchase. The City will accept the EPA's SWMM model and its proprietary derivatives as approved for use. Other software packages will be reviewed and approved on a case by case basis.

The City has prepared a rainfall record which shall be used for all dynamic modeling. The record is derived from calibrated rainfall data from 24 years of rainfall monitoring and is highly specific to the City of Everett. The record consists of the 14 storm events most likely to cause failure in a conveyance system. The data is provided in 5-minute increments in order to capture the high intensity-short duration storm events which are often responsible for conveyance system failure. A conveyance analysis which demonstrates that runoff from the entire 14 storm record can be routed without overtopping is equivalent to meeting the 25 year conveyance standard defined in section 4-2.

The 14-storm record is available upon request from the City of Everett Public Works Department as a text file suitable for import into most dynamic modeling software.

4-3.1 (4) SINGLE EVENT HYDROLOGY METHOD

Single Event Hydrology is usable as an alternate method for designing some stormwater BMPs (wetpool type) as allowed in the Stormwater Management Manual. In addition it is useful for some other types of analysis where no minimum computation standards apply, such as preliminary analysis and concept generation. Two examples of single-event hydrograph methodology are the Soil Conservation Service Unit Hydrograph (SCSUH) and the Santa Barbara Unit Hydrograph (SBUH). These methods are discussed in Volume III, Section 2.3 of the Stormwater Management Manual, which shall be used as a basis for designing using the single event hydrology method. However, there are two adjustments to the information contained in the Stormwater Management Manual when the method is used in the City of Everett. The Hydrologic Soils Group classifications presented in Section 4-3.3 must be used in place of those contained in the Stormwater Management Manual. In addition, the total precipitation depths presented in Table 4-3.1D shall be used in place of determining rainfall depths from the hyetographs published in the Stormwater Management Manual.

All storm event hydrograph methods require the input of a design storm hyetograph, which is a plot of rainfall depth versus time for a given design storm frequency and duration. The design storm hyetograph is constructed by multiplying a dimensionless hyetograph (which plots the percent of total rainfall depth versus time) by the total rainfall depth for the design storm. The design storm hyetograph to be used in the City of Everett is a SCS Type 1A rainfall distribution resolved to 10-minute time intervals.

Table 5.4 gives the total precipitation for the 6 month, 2-year, 10-year, and 100-year, 24-hour duration storms in Everett:

Table 4-3.1(D) Design Storm Hyetograph 24-hour Design Storm Totals

Return Frequency	Total Precipitation (inches)
6 month	1.12
2 year	1.55
10 year	2.25
25 year	2.60
100 year	3.25

4-3.2 TIME OF CONCENTRATION AND TRAVEL TIME

The following discussion is based on the methods described in Chapter 3, SCS TR-55(5). The time of concentration (T_c) is the time it takes for runoff to travel from the hydraulically most distant point of the watershed to the watershed outlet. The T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. The T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases the T_c, which increases peak discharge.
Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these types of flow. The type of flow that occurs is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = L/(60V)$$

where:

T_t = travel time (minutes)

L = flow length (feet)

V = average velocity (feet/sec)

60 = conversion factor from seconds to minutes

The Tc is the sum of Tt values for the various consecutive flow segments.

$$T_c = T_t1 + T_t2 + \ldots T_tm$$

where:

T_c = time of concentration (minutes) and

m = number of flow segments

Sheet Flow: Sheet flow is flow over plane surfaces. It usually occurs in the headwater areas of streams. With sheet flow, the friction value n_S is used. The n_S values are for very shallow flow depths of about 0.1

foot and are only used for travel lengths up to 300 feet. Table 5.7 gives Manning's n_s values for sheet flow for various surface conditions.

Manning's kinematic solution is used to directly compute T_t:

$$T_t = 0.42(n_s L)^{0.8}/((P_2)^{0.527}(S_o)^{0.4})$$

where:

Tt = travel time (min),

Ns = sheet flow Manning's effective roughness coefficient

L = flow length (ft),

P2 = 2-year, 24-hour rainfall (in), and

S_o = slope of hydraulic grade line (land slope, ft/ft)

Shallow Concentrated Flow: After a maximum of 300 feet, sheet flow is assumed to become shallow concentrated flow. The average velocity for this flow can be calculated as a function of watercourse slope and type of channel. After computing the average velocity using the velocity equation below, the travel time (T_t) for the shallow concentrated flow segment can be computed using the travel time equation described above.

Velocity Equation: The following equation is commonly used for computing average flow velocity, once it has measurable depth:

$$V = k(s_o)1/2$$

where:

V = velocity (ft/s)

K = time of concentration velocity factor (ft/s)

s_o = slope of flow path (ft/ft)

"k" is computed for various land covers and channel characteristics with assumptions made for hydraulic radius. Values of k can be selected from Table 4-3.2.

Table 4-3.2 "n" and "k" Values Used in Time Calculations for Hydrographs

Sheet Flow (initial 300 feet of travel) Surface	 n
Smooth surfaces (concrete, asphalt, gravel, compacted soil)	0.011
Fallow fields or loose soil	0.05
Short prairie grass and lawns	0.17
Dense grasses	0.15
Bermuda grass	0.24
Range (natural)	0.41
Woods or forest with light underbrush	0.13
Woods or forest with dense underbrush	0.40
Shallow Concentrated Flow (After the initial 300 feet of sheet flow; R = 0.1) Surface	 k
Forest with heavy ground litter and meadows (n = 0.10)	3
Brushy ground with some trees (n = 0.060)	5
Fallow or minimum tillage cultivation (n = 0.040)	8
High grass (n = 0.035)	9
Short grass, pasture and lawns (n = 0.030)	11
Nearly bare ground (n = 0.25)	13
Paved and gravel areas (n = 0.012)	27
Intermittent Channel Flow (At the beginning of visible channels, R = 0.2) Channel Type	 k
Forested swale with heavy ground litter (n = 0.10)	5
Forested drainage course/ravine with defined channel bed (n = 0.050)	10
Rock-lined waterway (n = 0.035)	15
Grassed waterway (n = 0.030)	17
Earth-lined waterway (n = 0.025)	20
CMP pipe (n = 0.024)	21
Concrete pipe (n = 0.012)	42
Other waterways and pipe	0.508/n
Continuous Stream Channel Flow (R = 0.4) Channel Type	 k
Meandering stream with some pools (n = 0.040)	20
Rock-lined stream (n = 0.035)	23
Grass-lined stream (n = 0.030)	27
Other streams, man-made channels, and pipe	0.807/n

Open Channel Flow: Open channels are assumed to begin where surveyed cross-sectional information has been obtained, where flows enter piped systems, where channels are visible on aerial photographs or in the field, or where lines indicating streams appear (in blue) on United States Geological Survey (USGS) quadrangle sheets. The velocity equation above or water surface profile information can be used to estimate average flow velocity. The variable k used in the velocity equation can be taken from Table 4-3.2 or calculated using the following derivation of Manning's equation:

$$k = (1.49(R)^{0.667})/n \qquad \text{(See Table 4-3.2)}$$

where:

R = an assumed hydraulic radius

n = Manning's roughness coefficient for open channel flow

Average flow velocity is usually determined for bank full conditions. After average velocity is computed, the travel time (Tt) for the channel segment can be computed using the travel time equation above.

Lakes or Wetlands: Sometimes it is necessary to estimate the velocity of flow through a lake or wetland at the outlet of a watershed. This travel time is normally very small and can be assumed to be zero. Where significant attenuation may occur due to storage effects, the flows should be routed using the "level pool routing" technique described in Chapter 5.4.4.

Limitations: The following limitations apply in estimating travel time (Tt).

1. Manning's kinematic solution not be used for sheet flow longer than 300 feet.
2. In watersheds with storm drains, the appropriate hydraulic flow path must be carefully identified to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels to the outlet by streets, lawns, etc.
3. A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. Other methods shall be applied to determine the outflow from a reservoir.

4-4 STORMWATER FACILITIES

4-4.1 GENERAL STORMWATER FACILITY REQUIREMENTS

Stormwater facilities constructed in the City shall be designed, constructed, and maintained in accordance with the requirements of the Stormwater Management Manual as augmented herein. In addition, the facilities shall comply with the following requirements:

4-4.1 (1) OWNERSHIP

The City of Everett assumes ownership and maintenance of facilities designed and constructed as common stormwater facilities serving multiple lots within single family residential projects. All other facilities (for multi-family, commercial, or industrial projects) remain privately owned and operated. Facilities to be maintained by the city must meet the additional design criteria in Section 4-4.1(2) as well as the requirements of Section 4-4.2(5) Element 4.

The City of Everett will not generally accept ownership of some types of BMPs without prior approval by the City Engineer. BMPs that require prior approval include:

- Detention Tanks or Pipes constructed from steel pipe materials
- Sand Filter Vaults or Devices
- Proprietary Treatment Devices which require replacement of filter media or plant materials. Devices which can be maintained with conventional methods, such as vortex separators, will generally be accepted.
- Rain Gardens and small site bio-retention facilities.
- Low Impact Development BMPs intended to serve individual lots.
- Permeable pavement
- Underground infiltration facilities and underground injection control (UIC) wells

4-4.1 (2) PROJECTS WITH PUBLIC MAINTENANCE OF THE STORMWATER FACILITIES

Storm facilities in rights-of-way, public easements, and those associated with residential subdivisions or any other development where the City will undertake maintenance of the facility may have special restrictions regarding materials used and/or design criteria for open-air systems. Specific restrictions/criteria applying to this type of development include, but may not be limited to, the following:

1. Corrugated metal pipe may not be used in storm drainage conveyance systems, unless otherwise approved by the City Engineer.

2. All stormwater detention and deep dead storage (deeper than 2.5 feet) shall be provided in underground, covered systems unless otherwise approved by the City Engineer. Only shallow vegetated storage, infiltration basins, bioretention facilities and sand filter basins shall generally be allowed as open-air systems. Retaining walls associated with these open-air facilities shall not exceed three feet in height and side slopes shall not exceed 3:1 (H:V).
3. Open-air stormwater facilities (such as wetponds, infiltration basins, and sand filter basins) providing runoff control for residential subdivisions or any other development where the City will undertake maintenance of the facilities shall be dedicated in a separate tract to the City of Everett. The tract dedicated shall include, at a minimum, all area within the high water mark, and may be required to include any required access roads or paths associated with the facilities.
4. The City may require an area 10 feet wide, as measured from the high water mark, to be provided around the perimeter of an open-air runoff control facility and included in a tract held in common ownership, with an easement granted to the City. The City strongly encourages landscaping of this area by the developer to provide screening for the pond and an aesthetically pleasing appearance. Maintenance and irrigation of the landscaping shall be provided as necessary to ensure successful plant establishment.
5. At a minimum, an area five feet wide must be available to the City for maintenance of any fencing associated with stormwater management facilities. This area must be provided around the perimeter of the fence, on both sides. If this area is not contained within the dedicated drainage tract, then an easement must be granted to the City.
6. The developer shall establish appropriate vegetation in the entire dedicated right-of-way. Vegetation shall be selected which will not inhibit the function or maintenance of the stormwater facility.

4-4.1 (3) SETBACKS

1. All wet pool, detention and infiltrating facilities which are open on the surface shall maintain minimum setback distances as follows. All setbacks shall be horizontal unless otherwise specified:
    a. 1 foot positive vertical clearance from any open water maximum surface elevation to structures within 25 feet.
    b. 10 feet from the open water maximum surface elevation or edge of the stormwater facility to property lines and on-site structures.
    c. 50 feet from top of slopes greater than 20 percent and greater than 10 feet high. A geotechnical analysis and report must be prepared addressing the potential impact of the facility on the slope. The geotechnical report may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
    d. 10 feet from open water maximum surface elevation or edge of stormwater facility to a sanitary sewer main or service.
    e. 50 feet from any septic tank, holding tank, containment vessel, pump chamber, and distribution box.

2. Infiltrating facilities, including permeable pavement and bio-infiltration facilities, and unlined wetponds and detention ponds shall comply with the setbacks in Item 1 and shall also maintain the following additional setbacks:
    a. 100 feet from the edge of a septic tank, drain field and drain field reserve area.
    b. 100 feet from drinking water wells and 200 feet from springs used for public drinking water supplies. Infiltration facilities up-gradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Health Department requirements (Washington Wellhead Protection Program, DOH, 12/93).
    c. 50 feet from slopes greater than 20 percent and greater than 10 feet in height.
    d. 10 feet from any other infiltration facility.
    e. Additional requirements for infiltration facilities are contained in the Stormwater Management Manual.
    f. 100 feet from retaining walls unless the entire infiltration facility is located at a lower elevation than the base of the wall. This setback may be reduced if an appropriate barrier is constructed to prevent groundwater movement toward the wall or if the wall is designed to retain groundwater. Setback reduction will require analysis by an appropriately qualified soils professional.

3. All underground stormwater facilities shall be setback from any structure or property line a distance equal to the depth of the ground disturbed in setting the structure.
4. A geotechnical analysis and report must be prepared for work located within 200 feet of the top of landslide or erosion hazard areas (as defined in Title 19, Chapter 37 of the Everett Municipal Code), or where there is reasonable concern of impact to landslide or erosion hazard areas. The scope of the geotechnical report shall include an assessment of impoundment seepage on the stability of the hazard area.
5. The City Engineer may increase the setbacks based on concerns about site specific soil conditions and proposed construction.

4-4.1 (4) SITES CONTAINING OR ADJACENT TO CRITICAL AREAS

Environmentally sensitive areas shall be protected and impacts mitigated in accordance with the City's Zoning Code requirements, the Stormwater Management Manual, and the conditions of final SEPA approval.

4-4.2 STORMWATER FACILITY ACCESS

Adequate access for maintenance and operation activities must be provided for all stormwater facilities constructed in the City. Access shall be designed in accordance with the Stormwater Manual, except as augmented below.

4-4.2 (1) GENERAL ACCESS REQUIREMENTS

1. An access road is required to all stormwater facility inlet pipes, control structures, risers and at least one point of each cell or compartment of a stormwater facility.
2. Access roads shall have a minimum width of 15 feet throughout.
3. Access roads shall have an all-weather surface of crushed rock or better.
4. Manhole and catch basin lids must be in, or at the edge of, the access road and at least 5 feet from a property line.
5. When the length of an access road exceeds 75 feet, a vehicle turn-around must be provided, and designed to accommodate vehicles having a maximum length of 31 feet and having an inside wheel path radius of 40 feet. The vehicle turn around requirement may be waived if a completely paved perimeter road is provided and can be used in a continuous drive back to the entrance with no turnarounds.
6. Stormwater facility access roads shall be located in the same tract as facilities, when the facilities themselves are in tracts. When facilities are located in designated open space areas, access roads may be located in the designated open space also, provided that they are constructed so as to be aesthetically compatible with the open space use.
7. Ongoing maintenance of access roads will be required to ensure safe access by City inspectors, owner's representatives and maintenance personnel.

4-4.2 (2) ACCESS TO OPEN AIR FACILITIES

1. Vehicle access to open-air facilities shall be limited to maintenance and operation personnel.
2. Access roads in accordance with Standard Drawing 429 shall be provided to the bottom of all cells or compartments of open-air facilities unless all of the following conditions apply:
    a. cell or compartment bottoms are accessible or reachable by track hoes from an access road along the side of the facility; and
    b. a truck can be loaded without the truck accessing the bottom of the cell or compartment
    c. no point in the bottom of the cell or compartment is more than 20 feet from the center of the access road.
3. Access road surfacing shall be extended across the entire length of the bottom of the cell when an access road is extended to the bottom of a cell.
4. An access ramp shall be provided to the bottom of all vertical walled ponds, regardless of size.
5. A perimeter access road may be required by the City for large open-air stormwater facilities in order to provide complete vehicular access to all points of the facility requiring regular maintenance.
6. Perimeter roads may be 12 feet in width where the road is not accessing a structure or being used for a circular loop road in lieu of turn around.
7. A minimum of one locking access road gate shall be provided to fenced open-air facilities. Gates must meet WSDOT State Standard Plan L30.10 and may be 14, 16, 18, or 20 feet in width.
8. Access to unfenced open-air facilities shall be limited by removable bollards. Bollards shall consist of two fixed bollards on the outside of the access road and two removable bollards equally spaced between the fixed bollards (or all four removable if placed in the traveled way). Bollards shall be separated by a minimum of 4 feet clear and no more than 6 feet. Fixed bollards shall be set a minimum of 15 feet apart with removable bollards between. Add or remove bollards from the standard configuration to meet separation standards.

9. Access gates and bollards must be set 20 feet back from the property line when the access road is connecting to a road that is posted at 35 mph or greater.

4-4.2 (3) ACCESS TO UNDERGROUND FACILITIES

Access to underground stormwater facilities, including vaults, tanks, and proprietary stormwater treatment units, shall be provided in accordance with the Stormwater Manual and the following criteria:

1. Access openings shall be provided over all inlet pipes and outlet structures. Pipe inlet and outlet structures shall be visible from the rim of the access opening.
2. Ladders and hand-holds shall be provided at the outlet structure and inlet pipes and as needed to meet OSHA confined space requirements.
3. Access roads shall be provided to all access points to underground facilities. Access roads shall be as required for open air facilities, or better.
4. Access lids larger than the standard manhole lids defined herein shall be hinged and shall be capable of being opened and held open by a single individual, unless otherwise approved by the City Engineer.
5. All Access lids shall be equipped with a pick hole capable of being opened with a standard grate hook or handles. Grates or lids requiring specialized equipment to open will not be accepted unless approved by the City Engineer.

4-4.2 (4) STORMWATER FACILITY FENCING

Fencing shall be provided for stormwater facilities in accordance with the Stormwater Manual, except as augmented below:

1. Surface ponds and infiltration basins with a maximum depth of three feet or less do not require fencing provided the maximum associated interior side slope of the pond does not exceed 3H:1V (including baffle side slopes).
2. All ponds and basins with a maximum design depth of water greater than three feet will require a six foot high perimeter fence unless one of the following conditions is met:
    a. The facility is designed and constructed with a 10 foot wide safety bench for every three feet of depth, and no more than 10% of the interior side slopes are greater than 3H:1V (including baffle side slopes); or
    b. The facility is designed and constructed so that the maximum water depth of the facility does not exceed three feet during a 2 year recurrence interval event, nor exceed three feet during a 25 year recurrence interval event, and no more than 10% of the interior side slopes exceed 3H:1V (including baffle side slopes); or
    c. The City Council reviews a proposed facility designed and approved by a licensed engineer or architect which meets neither the requirements of a or b herein and exercising its discretion makes a policy determination that either no fencing will be required or fencing less than six feet in height will be required. Issues considered by the Council when making this determination include but are not limited to: (1) reasons why the proponent does not want to construct a fence six feet in height; (2) purpose(s) the facility is to serve; (3) design considerations of the facility; (4) safety considerations of the facility without the fencing or with fencing reduced in height; and (5) such additional issues as the Council feels are appropriate.
3. When fencing is required around a facility to be dedicated to and/or maintained by the City, the fence shall be a chain link fence, unless otherwise approved by the City Engineer. The chain link fabric shall be galvanized steel core wire and, when the facility is in a visible location, shall be coated with bonded polyvinyl. The polyvinyl coating shall not be subject to fading, cracking, peeling, or shrinkage and shall be brown, black, or some shade of natural green (such as pine, forest,

or olive). The fence manufacturer shall provide a 10 year (minimum) warranty on polyvinyl coating. All posts, cross bars, rails, fasteners, and gates shall be powder-coated the same color as the chain link fence fabric.

4. Fencing slats will be allowed, subject to the same color restrictions as the polyvinyl coating, if the slats proposed are non-brittle, crack-resistant, "locked in place" in a bottom retaining channel, and non-fading.
5. The chain link fence shall meet all other applicable specifications for Type I or Type 3 chain link fence as set forth in the most current edition of the Standard Specifications for Road, Bridge, and Municipal Construction (Washington State Department of Transportation, American Public Works Association), except that line posts for Type 3 fence shall be set in concrete.
6. Fencing of tracts within the clear zone of roads with design speeds of 35 mph or higher shall use WSDOT Type 3 chain link fence.
7. Other regulations such as the International Building Code (IBC) may require fencing of vertical walls.
8. For metal baluster fences, IBC standards apply.

4-4.2 (5) STORMWATER FACILITY MAINTENANCE REQUIREMENTS

1. Adequate provisions to facilitate maintenance operations must be included in the design of all stormwater facilities. Provisions must be made for regular and perpetual maintenance of the facility, including replacement and/or reconstruction of any media that are relied upon for treatment purposes. The maintenance checklists in Appendix V-A of the Stormwater Management Manual, manufacturer's guidelines, and the Washington Department of Ecology's 2013 Western Washington Low Impact Development (LID) Operation and Maintenance (O&M) Guidance Document shall be used to identify required maintenance for specific BMPS. Additional maintenance requirements may be imposed by the City Engineer.
2. Any standing water removed during maintenance operations must be disposed of to an approved discharge location. Discharge to a sanitary sewer at an approved discharge location may be an option. The City of Everett must be contacted prior to any discharge. Residuals must be disposed of in accordance with state and local solid waste regulations (see Minimum Functional Standards for Solid Waste Handling, Chapter 173-304 WAC).
3. The maintenance of drainage facilities associated with commercial, industrial, planned residential development, and multi-family development is the responsibility of the owner(s) of the development. The owner(s) shall inspect and maintain stormwater facilities in accordance with the approved maintenance plan. A log of inspections and maintenance activities shall be maintained by the owner(s) and shall be made available to City inspectors upon request.
4. The City generally assumes the operation and maintenance of drainage facilities constructed in connection with residential subdivision of land in the City, after the expiration of a two-year operation and maintenance period, if the following conditions have been met:
    a. All of the requirements of Section 14.28.090 of the Everett Municipal Code have been fully complied with; and
    b. The facilities have been inspected and accepted by the utility division of the Public Works department after two years of operation and maintenance in accordance with City maintenance standards; and
    c. All deeds conveying drainage tracts and necessary easements entitling the City to properly maintain the facilities have been conveyed to the City and recorded with the Snohomish County auditor; and
    d. The warranty bond required in subsection D of Section 14.28.090 of the Everett Municipal Code has been extended for one year, covering the City's first year of operation and maintenance; and

e. The developer has supplied to the City an accounting of capital construction, operation and maintenance expenses, or other items, for the drainage facilities to the end of the two-year period.
f. The facility is not of a type listed as not accepted by the City in Section 4-4.1(1).

5. A Maintenance Covenant, of a form acceptable to the City, shall be recorded for all stormwater facilities to be maintained by the owner(s). The covenant shall ensure the responsibility of the owner to maintain the stormwater facility in accordance with the approved Operation and Maintenance Manual or standards and shall grant the City the right to inspect the stormwater facility, including right of entry. The covenant shall be recorded to all properties responsible for maintenance of the stormwater facility and shall be transferable to all subsequent owners of the property.

4-4.3 ONSITE STORMWATER MANAGEMENT AND LOW IMPACT DEVELOPMENT

Projects subject to Minimum Requirement #5 shall implement onsite stormwater BMPs in accordance with the Stormwater Management Manual. Additional requirements and restrictions specific to the City are included in the following subsections.

Onsite stormwater management facilities which are also credited toward the requirements of Minimum Requirements #6, #7, or 8 shall comply with the requirements for water quality treatment and flow control facilities in regards to the owner's responsibilities for maintenance and ongoing operation. The City shall retain the same rights to access and inspect onsite facilities used to meet other requirements as it would for water quality treatment flow control facilities. Documentation requirements, including asbuilt drawing requirements, will also be the same.

4-4.3 (1) APPLICABILITY AND INFEASIBILITY CRITERIA

Onsite Stormwater Management BMPs shall be selected based on the selection methods outlined in Minimum Requirement #5 and the infeasibility criteria associated with each BMP. In order to facilitate selection of BMPs the City maintains an Infiltration Infeasibility Map identifying areas known to be incompatible with infiltration. Projects which fall within the areas identified as infeasible need not provide any other documentation that infiltration BMPs such as Roof Downspout Infiltration Systems, Rain Gardens, Bioretention and Permeable Pavements are infeasible.

All projects subject to Minimum Requirement #5 must comply with BMP T5.13 – Post Construction Soil Quality and Depth, except where existing vegetation will be retained on steep slopes.

4-4.3 (2) ROOF DOWNSPOUT INFILTRATION SYSTEMS

Downspout infiltration systems are trench or drywell designs intended only for use in infiltrating runoff from roof downspout controls. Downspout infiltration systems shall be designed in accordance with Section 3.1 of Volume 3 of the Stormwater Management Manual and the following criteria:

1. Roof downspout infiltration systems shall be not be constructed in areas indicated as infeasible in the Infiltration Infeasibility Map unless specifically approved by the City Engineer.
2. The same infeasibility criteria applied to bioretention systems and raingardens in BMP T7.30 in the Stormwater Management Manual shall also be applied to roof downspout infiltration systems.
3. Stormwater facilities which infiltrate stormwater by means of an underground facility such as an infiltration trench or vault may need to be registered as an underground injection control well (UIC) with the Washington Department of Ecology's UIC Program.

4-4.3 (3) RAIN GARDENS

Rain gardens are non-engineered, shallow, landscaped depressions with amended soils and adapted plants. Rain gardens may be used to meet onsite stormwater management requirements and in voluntary retrofit installations for residential and small commercial sites. Rain gardens shall be designed and constructed in accordance with Chapter V-11 of the Stormwater Management Manual, Standard Drawings 426 and 427, and the following criteria:

1. Rain gardens shall not be constructed in areas indicated as infeasible in the Infiltration Infeasibility Map unless specifically approved by the City Engineer. This requirement does not apply to rain gardens with an impermeable liner.
2. A rain garden information sign shall be placed in all new rain gardens associated with new construction, and is encouraged in retrofit and voluntary rain garden installations. Signs are available from the permit counter at a nominal expense.
3. A maintenance agreement shall be recorded for each new privately owned rain garden to ensure ongoing maintenance by the property owner. Details of the maintenance agreement are available from Permit Services.
4. Mulch shall be applied to all rain gardens. Mulch below the design water surface shall consist of coarse compost in accordance with Section 9-14.4(8) of the WSDOT/APWA Standard Specifications. Mulch above the design water surface shall consist of mixture of 35%-50% bark or wood chips and 50% to 65% fine compost in accordance with Section 9-14.4(8) of the WSDOT/APWA Standard Specifications.
5. Rain gardens shall be planted with appropriate plant material for the location within the rain garden. Consult the Rain Garden Handbook for Western Washington (2013) for guidance on plant selection. Plantings shall comply with applicable city vegetation standards for plant types and maintenance.
6. Where permits require a landscape plan the rain garden plantings shall be incorporated into the site landscape plan.

4-4.3 (4) BIORETENTION

Bioretention facilities shall be designed in accordance with the requirements of the Stormwater Management manual. Bioretention facilities may be used to meet the requirements of Minimum requirements #5, #6, #7 and #8 as defined in the Stormwater Management Manual.

1. Bioretention facilities may not be constructed in areas indicated as infeasible in the Infiltration Infeasibility Map unless specifically approved by the City Engineer, except that bioretention facilities with an impermeable liner may be used in most circumstances. Bioretention facilities with impermeable liners do not meet the requirements of Minimum Requirement #5 but may be applicable to Minimum Requirements #6 and #7 Lined bioretention facilities must meet the same steep slope setback requirements as lined facilities.
2. A maintenance agreement shall be recorded for each new privately owned bio-retention facility which serves a single lot or property to ensure ongoing maintenance of by the property owner. Details of the maintenance agreement are available form Permit Services.
3. A separate tract shall be provided for bioretention facilities which serve multiple lots or parcels.

4-4.3 (5) PERMEABLE PAVEMENT

Permeable Pavement shall be installed where required by Minimum Requirement #5 when feasible. Permeable pavement may also be used to meet the requirements of Minimum Requirement #6 and/or #7 when designed as outlined in the Stormwater Management Manual. In addition, permeable pavement installations shall meet the following criteria:

1. Permeable pavement shall not be constructed in areas indicated as infeasible in the Infiltration Infeasibility Map unless specifically approved by the City Engineer.
2. Permeable Pavement shall be constructed in accordance with Standard Drawings 430 and 431.
3. Permeable pavement installations in the public right of way shall be designed by a licensed civil engineer familiar with the design of permeable pavement and shall be designed using the process outlined in the AASHTO Guide for Design of Pavement Structures.
4. All materials and construction methods for permeable pavement shall comply with the most current APWA GSPs for permeable pavements. GSPs include the following:

Subgrade for Permeable Pavements	APWA GSP 2-06.3(3)
Subgrade for Permeable Pavements	APWA GSP 2-06.5
Permeable Ballast	APWA GSP 4-04.2 and 9-03.9(2)
Crushed Surfacing Choker Course	APWA GSP 4-04.2 and 9-03.9 (2)
Aggregates for Permeable Base	APWA GSP 4-04.2 and 9-03.9(2)
Shaping and Compaction	APWA GSP 4-04.3(5)
Asphalt Treated Base (ATB)	APWA GSP 4.SA1
Asphalt Treated Permeable Base (ATPB)	
Aggregates for Porous Hot Mix Asphalt/	APWA GSP 4-SA2
Porous Warm Mix Asphalt (PHMA/PWMA)	APWA GSP 5-04.1 and 9-03.8
Porous Asphalt Construction Requirements	APWA GSP 5-04.3
Porous Asphalt Mix Design	APWA GSP 5-04.3(7)
Porous Concrete	APWA GSP 5-04.3(8)
Spreading and Finishing Porous Concrete	APWA GSP 5-04.3(9)
General Porous Concrete Requirements	APWA GSP 5-04.3(10)
Pervious Concrete	
Aggregates for Asphalt Treated Base	APWA GSP 9-03.6

5. Underdrains shall be provided at the lowest end of all permeable pavement installations, and prior to a transition from privately maintained to publicly maintained pavements, in accordance with Standard Drawing 431. Underdrains shall be Perforated Corrugated Polyethylene Underdrain Pipe, 6 inch diameter minimum, in accordance with Section 9-05.2(7) of the WSDOT/APWA Standard Specifications. Underdrains shall be connected to a storm drainage system or day lighted in a manner which ensures that stormwater will not back up into the pavement base course material. This requirement may be waived for permeable pavement driveways serving single family residences.
6. When required, subgrade check dams shall be installed in accordance with Standard Drawing 431. Check dams shall extend the full span of the permeable pavement installation and tie into native soils in a manner which prevents short circuiting around the ends of the check dam.
7. Where native soils do not meet the treatment soil suitability criteria a 6 inch layer of media shall be placed below pollution generating permeable pavement section. The media shall meet the soil suitability criteria or the sand filter specifications contained in the Stormwater Management Manual. The hydraulic conductivity of the filter layer shall exceed that of the native soils.
8. Drainage collection systems in permeable pavement installations shall be designed as if conventional pavement is being used. Catch basins, or other appropriate collections methods, shall be placed at all low points and as required in Section 4-2.3(9).

9. Permeable pavement installations shall be treated as stormwater facilities and shall be maintained per the requirements of the Stormwater Management Manual. Maintenance requirements shall be defined in the project stormwater site plan and shall be provided to the property owner in conjunction with other site maintenance documents.
10. Measures shall be taken to prevent infiltrated water from moving along utility trenches located beneath permeable pavement sections. Install trench dams per Standard Drawing 436 in utility trenches or provide equivalent protection measures.

4-4.4 FLOW CONTROL

Projects which are required to meet Minimum Requirement #7 shall provide flow control facilities in full compliance with the requirements of the Surface Water Management Manual. Flow control BMP design is described in detail in the Stormwater Management Manual. Additional requirements for specific types of BMPs are included in the following subsections.

In accordance with Section 14.28 of the City of Everett Municipal Code the TDA Thresholds requirements contained in Section I-3.4.7 of the Stormwater Management Manual are replaced with the following:

Each TDA within a project that requires Minimum Requirement #7 (as detailed in I-3.3 Applicability of the Minimum Requirements) must be reviewed to determine if Flow Control BMPs are required for the TDA to be in compliance with Minimum Requirement #7.

Note that it is possible for a project that requires Minimum Requirement #7 with multiple TDAs to not need Flow Control BMP(s) in one or more individual TDAs. If a TDA does not trigger the TDA thresholds for Flow Control BMPs, then the designer must document the areas within the TDA used to determine that the TDA thresholds were not met. This documentation will demonstrate compliance with Minimum Requirement #7 for the TDA.

When assessing a TDA against the following thresholds, only consider the types of surfaces (e.g. new hard surfaces, replaced hard surfaces, converted vegetation areas) that are subject to Minimum Requirement #7, per the Project Thresholds in I-3.3 Applicability of the Minimum Requirements.

The following TDAs require construction of Flow Control BMPs to achieve the Flow Control Performance Standard. If a TDA meets any of the following thresholds, Flow Control BMPs are required. The project proponent must demonstrate that the TDA does not meet any of the following thresholds for Flow Control BMPs to not be required for that TDA.

- *Projects in which the total of effective impervious surfaces is <u>5,000</u> square feet or more in a threshold discharge area, or*
- *Projects that convert ¾ acres or more of vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site, or*
- *Projects that through a combination of effective hard surfaces and converted vegetation areas cause a 0.15 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model using 15-minute time steps. <u>The determination of the amount of increase in flow shall be based on the site conditions at the time of application and the anticipated runoff at the completion of the proposed improvements.</u>*

All other requirements of Section I-3.4.7 of the Stormwater Management Manual are applied as given.

When downstream drainage courses are inadequate or systems are undersized, or when, in the opinion of the City, property or properties may be adversely affected by the existing and/or proposed stormwater release rates, additional stormwater flow control measures may be required. Such determination by the City may be based upon existing information indicating problem areas or based upon current or past litigation regarding drainage problems within the vicinity of the project. If additional stormwater flow control measures are required by the City, the applicant may have the option to correct and/or improve downstream drainage conditions so that the proposed stormwater release rate does not have to be further restricted. Any offsite improvements will require the applicant to obtain easements from the owners of any property where work is to take place.

4-4.4 (1) DETENTION PONDS

Detention ponds shall be designed in accordance with Section V-12 of the Stormwater Management Manual and Standard Drawing 429. Detention ponds shall also comply with the access requirements in Section 4-4.2(2) and the following requirements:

1. Drainage facilities should be made attractive features of the urban environment. To this end, engineers are encouraged to be creative in shaping and landscaping facilities and to consider aesthetics when choosing alternatives for parking lot paving, conveyance systems, detention facilities, weirs, structures, etc.
2. An overflow route must be identified for stormwater flows that overtop the facility when facility capacity is exceeded or the facility becomes plugged and fails. The overflow route must be able to convey the 100-year recurrence interval developed peak flow to the downstream conveyance system or other acceptable discharge point without posing a health or safety risk or causing property damage.
3. No trees may be planted on berms that impound water either permanently or temporarily during storms. This restriction does not apply to cut slopes that form pond banks, only to berms *Note: The internal berm in a wet pond is not subject to this planting restriction since the failure of an internal berm would be unlikely to create a safety problem.*

4-4.4 (2) DETENTION TANKS

Detention tanks shall be designed in accordance with Section V-12 of the Stormwater Management Manual and Standard Drawing 418, Detention tanks shall also comply with the following requirements:

1. Tanks larger than 48 inches in diameter may be connected to each adjoining structure with a short section (2-foot maximum length) of 48-inch minimum diameter pipe.
2. Tanks shall not be located under the travel way in public rights of way. For single-family plans and planned urban developments (PUDs), planned residential developments, or planning and development districts, detention tanks shall be located in separate tracts.
3. No steel pipe shall be used in tanks. Tank materials shall be constructed of materials indicated in Standard Drawing 418 unless otherwise approved.
4. Tanks shall be designed to meet the structural requirements for overburden, vactor truck loads, and where appropriate traffic loadings. At a minimum tank materials shall meet the requirements for storm sewer pipe in the current version of the WSDOT/APWA Standard Specifications. End plates shall be of the same material as the tank pipe, but of an appropriate thickness to meet structural requirements.

4-4.4 (3) DETENTION VAULTS

Detention vaults shall be designed in accordance with Section V-12 of the Stormwater Management Manual and shall also comply with the following requirements:

1. Vaults shall not be located under the travel way in public rights of way, unless approved by the City Engineer. For single-family plans and planned urban developments (PUDs), planned residential developments, or planning and development districts, detention tanks shall be located in separate tracts.
2. Vaults shall be designed to meet the structural requirements for overburden, vactor truck loads, and where appropriate traffic loadings.
3. Vaults within a traveled way which exceed 20 feet in length along the direction of travel shall be designed to meet bridge structural standards in accordance with the current version of AASHTO LRFD Bridge Design Specifications. Vaults meeting these criteria shall be designed by a structural engineer licensed in the State of Washington.
4. Vaults may be designed as back-up systems if they are preceded by runoff treatment facilities designed in accordance with Volume V of the Stormwater Management Manual
5. Vault bottoms shall slope laterally a minimum of 5 percent from each side towards the center forming a broad "V" to facilitate sediment removal. More than one "V" may be used on wide vaults to minimize vault depths. Alternate slope configurations may be acceptable if they enhance maintenance. In all cases an access point must be provided at each end of the "V" to facilitate sediment removal.

   The city may allow the vault bottom to be flat if removable panels are provided over the entire vault. Removable panels shall be at grade, have stainless steel lifting eyes, and weigh no more than 5 tons per panel.

4-4.5 RUNOFF TREATMENT

Projects which are required to meet Minimum Requirement # 6 shall provide runoff treatment BMPs in full compliance with the requirements of the Stormwater Management Manual. The selection and design of Water Quality Treatment BMPs is described in detail in the Stormwater Management Manual. Additional requirements specific to the City of Everett are included in the following subsections.

4-4.5 (1) TREATMENT BMP SELECTION

Runoff treatment BMPs shall be selected and designed in accordance with the Stormwater Management Manual, except that the following BMPs listed in the Stormwater Management Manual will not be accepted for use in the City of Everett:

Treatment BMPs Not Accepted by the City of Everett

- Basic Biofiltration Swale (BMP T9.10)
- Wet Biofiltration Swale (BMP T9.20)
- Continuous Inflow Biofiltration Swale (BMP T9.30)
- Wet vault (BMP T10.20) except as noted below
- Wet Tanks (No BMP # Designation)
- API type Oil Water Separators (BMP T11.10) for contributing areas less than 2 acres.

Wet vaults are generally not allowed for the primary treatment of runoff in the City - the only exception is single family residential subdivisions creating less than 10,000 square feet of effective impervious area.

However, wet vaults may be used for sediment removal upstream of sediment sensitive treatment facilities, or as the first/presettling cell of a wet pond design.

Combined detention and wet vaults are allowed; see BMP 10.40.

If a wet vault/tank is designed to provide runoff treatment but not runoff quantity control, it must be located off-line from the primary conveyance/detention system. Flows above the peak flow for the water quality design storm must bypass the facility in a separate conveyance to the point of discharge. A mechanism shall also be provided at the bypass point to isolate the facility for maintenance purposes.

4-4.5 (2) EMERGING TECHNOLOGIES

The City will accept stormwater treatment BMPs not included in the Stormwater Management Manual only if they have been reviewed and received a designation under the Washington Department of Ecology's Technology Assessment Protocol- Ecology (TAPE) program. Use of TAPE designated BMPs shall be accepted subject to the following conditions:

1. Technologies used to comply with Minimum Requirements associated with development must have a current General Use Level Designation (GULD) from Ecology
2. Technologies of any designation may be used on voluntary retrofit projects which are not required to meet Minimum Requirements #5 or #6. Treatment technologies which will be maintained by the City must be approved by the City Engineer prior to use.
3. BMPs must be designed and maintained in accordance with the TAPE designation documentation.
4. The City Engineer also has the authority to add additional requirements or conditions to these technologies, beyond those required by Ecology.
5. Access to underground facilities shall comply with the requirements of Section 4-4.2(3).
6. The facility owner shall inspect and maintain the facility in perpetuity in accordance with the manufacturer's recommended maintenance procedures and all applicable City requirements. The facility shall be maintained in a manner which ensures that it continues to provide the treatment level originally intended in the facility design. A record of inspection and maintenance activities shall be maintained and provided to the City upon request.

The following three tables provide local maintenance requirements in addition to Appendix V-A of the Surface Water Management Manual for stormwater facility maintenance requirements.

No. 23 Maintenance Checklist For Fencing/Shrubbery Screen/Other Landscaping

Drainage System Feature	Defect	Conditions When Maintenance Is Needed	Suggested Corrective Action	Results Expected When Maintenance Is Performed
General	Missing or broken parts/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Repair/replace fence. Replant vegetation with appropriately sized plants.	Fence is mended or shrubs replaced to form a solid barrier to entry.
	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Fill in opening with onsite soil if available or import soil. Permanently stabilize ground with seed or rock.	Replace soil under fence so that no opening exceeds 4 inches in height.
	Unruly vegetation	Shrubbery is growing out of control or is infested with weeds. See also the Snohomish County noxious weeds list at www1.co.snohomish.wa.us/ department/ Public_works/divisions/road _maintenance/ Noxious-weeds/weeds_list.htm.	Mow or trim overgrown shrubbery. Remove weeds, especially noxious weeds. Do not use chemicals.	Shrubbery is trimmed and weeded to provide appealing aesthetics.
Fences	Damaged parts	Posts out of plumb more than 6 inches.	Reset or replace posts	Posts plumb to within 1.5 inches of plumb.
		Top rails bent more than 6 inches.	Repair or replace rail	Top rail free of bends greater than 1 inch.
		Any part of fence (including posts, top rails and fabric) more than 1 foot out of design alignment.	Repair or replace fence element	Fence is aligned and meets design standards.
		Missing or loose tension wire.	Tighten or replace tension wire	Tension wire in place and holding fabric.
		Missing or loose barbed wire that is sagging more than 2.5 inches between posts.	Re-stretch barbed wire and secure appropriately.	Barbed wire in place with less than three-fourths inch.
		Extension arm missing, broken, or bent out of shape more than 1.5 inches.	Repair or replace extension arm.	Extension arm in place with no bends larger than three-fourths inch.
	Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Replace rusted fence elements. Paint or coat new elements appropriately.	Structurally adequate posts or parts with a uniform protective coating.
	Openings in fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	Replace fence fabric or patch with wire of same type and diameter as existing fence.	No openings in fabric.

No. 24 – Maintenance Checklist For Gates

Drainage System Feature	Defect	Conditions When Maintenance Is Needed	Suggested Corrective Action	Results Expected When Maintenance Is Performed
Access gates	Damaged or missing components	Gate is broken, jammed or missing	Repair or replace gate. Remove obstructions if foreign object is affecting gate function.	Pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoe. If a lock is used, make sure the city field staff have a key.
		Broken or missing hinges such that gate cannot be easily opened and closed by one maintenance person.	Repair or replace hinges.	Hinges intact and lubed. Gate swings freely.
		Missing stretcher bands and ties.	Replace stretcher bands or ties.	Stretcher bar, bands and ties in place.
	Misaligned gate	Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Repair hinges or straighten support posts. Replace gate if irreparably damaged.	Gate is aligned and vertical.
Bollards	Damaged or missing bollard	Bollard is missing or is damaged to an extent where it cannot prevent vehicle access or creates a safety concern.	Replace bollard per original design or current City standard	Bollard is in place and fully functional.
	Removable bollard cannot be removed	Removable bollard is stuck in place and cannot be removed by hand.	Remove bollard and clean bollard and sheath. Replace bollard if bent or otherwise damaged.	Bollard moves freely in its sleeve and can be moved by hand.
	Locking bollard not secured	Lockable bollard is missing lock or securing mechanism.	Provide lock or repair locking mechanism.	Bollard lock in place consistent with original design. City staff holds a copy of the key.

No. 25 Access Roads And General Stormwater Facility Access

Maintenance component	Defect	Conditions When Maintenance Is Needed	Suggested Corrective Action	Results Expected When Maintenance Is Performed
Access road	Trash and debris	Trash and debris are readily visible within the easement.	Remove Trash and Debris	Access road and easement are free of significant trash.
	Hazard debris	Access road contains debris or other materials which have the potential to damage maintenance equipment tires.	Remove Debris or relocate large obstructions out of access road	Access road is free of debris or materials which could damage tires.
	Overhanging obstructions	Vegetation or other materials overhang the access road restricting maintenance equipment access.	Remove vegetation or trim portions of vegetation which restrict access	Access road overhead is clear to 14 feet high.
	Horizontal obstructions	Vegetation or other materials obstruct vehicular use of access road.	Remove vegetation of trim back out of access road.	No obstructions present which reduce road width to less than the design width, or 12 feet, whichever is greater.
	Road surface	Maintenance vehicle access could be hampered by potholes or road surface failure.	Fill in potholes with road material or regrade gravel/dirt access road. Repair structural deficiencies.	Road surface smooth with no evidence of potholes, settlement, soft spots or ruts.
	Weeds in road	Weeds or vegetation is growing in the roadway.	Mow or remove weeds/vegetation	Road surface is free of weeds greater than 6 inches high.
	Shoulder erosion	Access road shoulder is eroded.	Fill in eroded areas and permanently stabilize soils with seeding or rock as appropriate	Road shoulder is free of erosion and adequately stabilized.
Access to Stormwater Control Elements	Flow Control Structure	Brush, weeds, or other vegetation prevent access to control structure for inspection and maintenance	Remove vegetation	Flow Control Structure is accessible
		Structure is buried by built up vegetation or sediment and cannot be located or opened	Remove vegetation or sediment and clean out access	Structure and be located and opened for construction and maintenance.
	Inlet/Outlet Pipes and Other Internal Components	Brush, weeds, or other vegetation prevent access to control structure for inspection and maintenance	Remove vegetation	Inlet/Outlet Pipes can be accessed for inspection and maintenance

No. 26 – Private Stormwater Pumps

Note: Stormwater pumps are allowed within the city on a very limited basis and only with special approval. The following maintenance standards are included to facilitate inspection of these systems where they exist. This table is not a substitute for manufacturer's operations and maintenance documentation.

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Suggested Corrective Action	Results Expected When Maintenance Is Performed
Wetwell	Trash and Debris	Sediment is 6 inches deep or reaches the bottom of the pump intake.	Remove pump wash out bottom of wet well	Wetwell is clean with no sediment.
		Accumulated floating trash or debris covers 50% of water surface.	Rake or pick out floating debris	No trash or debris in wetwell.
		Trash blocks or plugs pump intake or otherwise inhibits pump operation.	Lift pump inspect pump suction clean out debris	No trash or debris in wetwell.
	Physical Damage to Wetwell	Access frame and grate or hatch loose or damaged.	Replace / repair / reattach grate to hatch frame	Undamaged frame and grate secured to wetwell structure.
		Wetwell structure damaged, portions of structure missing, or rebar exposed.	Clean and patch/grout cracked and broken cement	Wetwell structure is repaired, all parts are present, no rebar is exposed.
		Groundwater flows into wetwell causing pumps to turn on even when there is no surface water flow.	Reseal / grout wet well leaks	Wetwell is sealed and no groundwater intrusion is observed.
	Overflow	Emergency overflow blocked/ not functional. Water fills past overflow point when pumps turned off.	Inspect overflow for debris/blockage/ collapse. Remove debris, repair pipe	Overflow repaired.
	Piping	Piping within the wetwell is broken or damaged, especially if leakage occurs when pumps are on.	Check flanges and fittings for tightness, replace broken or damaged piping	Piping is repaired or replaced to original specifications.
Pump	Pump(s) not functional	Pump has no power or does not turn on.	Check panel for power, check float operation, check power on pump side of contactor	Power is connected and pump operates as intended.
		Pump runs, but does not pump at intended flow rate.	Check pump suction and discharge for blockage, inspect pump and impeller for damage	Pump repaired/replaced and now meets design specs.
		Pump is excessively noisy to the point of reaching nuisance noise levels even when wet well is closed.	Check pump suction for debris, inspect impeller for damage or suction screen repair or replace	Pump is adjusted/repaired/replaced to eliminate nuisance noise condition.

No. 26 – Private Stormwater Pumps (Continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Suggested Corrective Action	Results Expected When Maintenance Is Performed
Pump	Float/ sensor malfunction	Pumps cycle on and off when no water is present.	Check control floats and contactors for proper operation.	Pumps cycle as designed, only when flow is present.
		Pump(s) do not turn on or shutoff when water levels reach design levels.	Trip floats check for proper electrical action, replace floats if not functioning	Floats/Sensors function as designed.
	Rails (if present)	Pump cannot be readily raised from the wetwell due to bent, corroded or otherwise non-functional rails.	Dismount top rail mounts remove pump and rails, inspect clean or replace rails.	Rails repaired or replaced so that pump can be removed with a reasonable amount of effort.
		Pump cannot be removed from disconnect flange or is difficult to disconnect from flange.	Clean and inspect rails and piping, dislodge flange to pump discharge piping	Pump can be easily separated from flange by lifting from above the wetwell.
		Pump does not re-connect to disconnect flange or leaks at flange after being pulled.	Clean and inspect mating surfaces and replace seal if damaged, check rails for bending	Pump slides easily back into connection when lowered into place and does not leak at flange.
Control Panel	Panel malfunction	No power to control panel or portions thereof.	Verify power from PUD, fuses and disconnects	Power is restored to entire panel.
		Error message or warning lights.	Consult O&M manual from panel manufacturer	Issues identified and resolved in accordance with operations manual and manufacturer's recommended procedures.
		Pump(s) do no cycle through on/off conditions when wetwell is filled.	Check for power and control wiring via O&M manual	System checked and functioning as designed.
	Enclosure damage	Enclosure is broken of otherwise damaged to the extent that rainwater or debris can enter.	Enclosure should have no moisture inside or exposed openings repair or replace as needed	Enclosure repaired.
	Alarms	Physical damage to auditory or visual alarms, or alarms are missing.	O&M manual should have instructions to test alert systems.	Alarms are repaired and operate as designed.
		Alarms don't trigger when wetwell filled past max water or drained below minimum water level.	Check float switch and wiring, lights or buzzers, repair/replace faulty components.	Alarms are triggered at design water surface levels.
		Telemetry system (where present) not communicating with appropriate recipient(s).	Consult O&M manual from panel manufacturer	Telemetry system fully functional and sending desired information to appropriate recipient(s).

No. 26 – Private Stormwater Pumps (Continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed		Results Expected When Maintenance Is Performed
Valve Vault	Backflow Valves	Excessive amounts of water flows back into wetwell when pump shuts off.	Check discharge check valve or duckbill at end of pipe for debris or damage clean or replace	Valve repaired or replaced so that only a small amount of water flows back into wetvault after pump shutoff.
	Shutoff Valves	Closing valve (s) does not stop flow when pumps are turned on.	Inspect valve for proper seat movement replace valve if defective	Valves are replaced and fully operational.
		Valve handle missing or inoperable.	Check valve stem condition replace handle or valve	Handle repaired or replaced.
	Pressure Gauges (if present)	Gauge is broken or missing.		Gauge is replaced and functional.
		Gauge does not register change in pressure after pump on, shutoff valve closure.	Remove valve open port to check for water pressure, check with known good gauge, replace if faulty	Gauge is repaired or replaced and registers pressure change with pump operation or valve shutoff.
Documentation	Operations Manual	Operations and maintenance manual is not on site or readily available, or materials are missing.	A copy of the manual should be available to maintenance and operation personnel	Operations and maintenance manual is onsite and readily available, and includes information on all components including catalog cuts, part numbers, manufacturer's recommended procedures, etc.
		Operations and maintenance manual does not reflect updates or changes to the system such as pump replacement or control panel modifications.	When equipment or operating procedures changes to manual should be updated in reasonable time	Operations and maintenance manual is up to date with information for equipment currently installed
	Control Panel	Wiring Schematic is not present in control panel.	An accurate copy of wiring should be available to maintenance and operation personnel	Wiring schematic is present in control panel.
		Pump operation labels missing or unreadable.	Replace illegible labels	Labels are present and readable.
		No information regarding contacts in case alarm is tripped during off hours.	Place personnel contact sheet in control documents.	Contact information is posted on exterior for 24 hour contact in case of alarm.

5-7 TRENCH EXCAVATION, BEDDING, AND BACKFILL FOR WATER MAINS

5-7.1 DESCRIPTION

This work shall consist of excavating, bedding, and backfilling for water mains and appurtenances, for both temporary and permanent installation under ordinary conditions.

5-7.2 GENERAL

Clearing and grubbing where required shall be performed within the easement or public right-of-way as permitted by the City and/or governing agencies. Debris resulting from the clearing and grubbing shall be disposed of by the owner or contractor in accordance with the terms of all applicable permits.

Material excavated from trenches and piled adjacent to the trench or in a roadway or public thoroughfare, shall be piled and maintained so that the toe of the slope of the material is at least 2 feet from the edge of the trench. It shall be piled in such a manner as will cause a minimum of inconvenience to public travel and so that there is a minimum risk of sediment erosion. Provisions shall be made for merging traffic where such is necessary. Free access shall be provided to fire hydrants, water valves, and meters, and clearance shall be left to enable free flow of storm water in gutters, other conduits, and natural watercourses. Free access shall be maintained to all other utility control valves, meters and vaults.

5-7.3 GRADE AND ALIGNMENT

Prior to any pavement cutting or removal, or excavation for pipe laying, the contractor shall verify, in the presence of the City Inspector, the locations and establish the depth of the existing water mains at the points where connections are to be made. The contractor shall verify the dimensions, type, and condition of the existing water main. The profile shall be adjusted so neither a high spot nor a low spot is created adjacent to the connection to the existing water mains.

The minimum cover for water mains less than 12 inches in diameter shall be 36 inches to the top of pipe. The minimum cover for water mains equal to or greater than 12 inches in diameter shall be 48 inches to the top of pipe. The maximum depth shall not be greater than 60 inches to the top of pipe.

All depths both minimum and maximum shall be from finish grades and shall be adhered to unless approved by Public Works Director or his designee in writing. The water line and hydrants shall be installed by line and grade information as supplied by a survey.

5-7.4 TRENCH EXCAVATION

5-7.4(1)GENERAL

The contractor shall perform all excavation of every description and of whatever materials encountered. All excavations shall be made by open cut unless otherwise provided for. The bottom of trenches shall be accurately graded to provide uniform bearing and support for each length of pipe on undisturbed or compacted soil at every point along its entire length, except at the joints.

In backfilling the trench, the contractor shall take all necessary precautions to protect the pipe from any damage or shifting. The contractor shall backfill from the side of the trench to a maximum uniform depth of 1 foot above the crown of the ductile iron pipe before starting mechanical compaction.

During all phases of the backfilling operations and testing as outlined herein, the contractor shall protect the pipe installation, protect adjacent utilities and structures, provide for the maintenance of traffic as may be necessary, and provide for the safety of property and persons.

5-7.4(7)COMPACTION OF BACKFILL

Trench backfill shall be spread in layers and be compacted by mechanical tampers of the impact type approved by the Public Works Director or his designee. Water settling will not be permitted. After the Pipe Zone backfill is placed the remaining backfill material shall be placed in successive layers not exceeding 1 foot in loose thickness, and each layer shall be compacted to the density specified in Standard Drawing 614.

See Section 3-9.4 for additional requirements on compaction.

5-8 CONSTRUCTION REQUIREMENTS

5-8.1 DEWATERING OF TRENCH

Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed, provisions are made to prevent floating of the pipe, and the trench has been properly backfilled and compacted in accordance with Section 5-7.4 of these standards. Trench water or other deleterious materials shall not be allowed to enter the pipe at any time. Trench water shall be discharged in accordance with Section 3-9.1 of these standards.

5-8.2 HANDLING OF PIPE

All types of pipe shall be transported, handled, stored, installed and backfilled in a manner that will prevent damage to the pipe, pipe lining or coating. Pipe and fittings shall be loaded and unloaded using hoists and slings in a manner to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled against other pipe. Damaged pipe will be rejected, and the contractor shall immediately place all damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.

Methods of handling shall be corrected by the contractor if the Public Works Department determines that these methods are damaging to the pipe.

All pipe to be purchased and installed as a part of the City of Everett water system shall be delivered to the job site or city yard with water tight pipe plugs. Furthermore, to comply with City of Everett Design and Construction Standards and AWWA Standards, these pipe plugs shall remain in place until the pipe is installed in the trench at which time one end plug would be removed for joining pipe ends.

The City shall reject any pipe not meeting AWWA Standards for water tight pipe plugs. Under special circumstances, the Public Works Department may reconsider the pipe after it has been swabbed out with chlorine solution and capped with water tight plugs meeting AWWA Standards.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations, and any pipe or fitting that has been installed with dirt or foreign material in it shall be

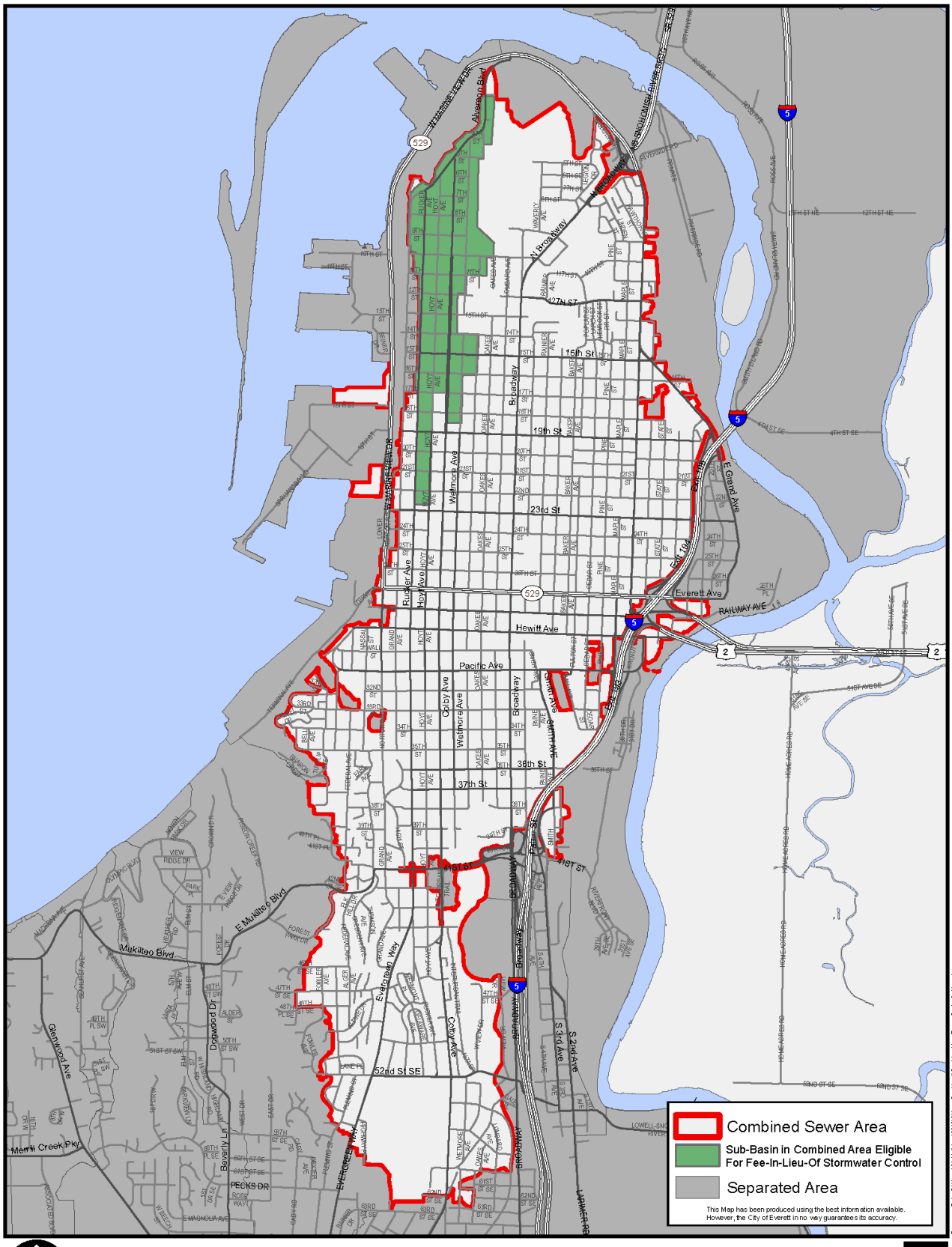
inspection costs are borne by the city. Follow-up reinspection after correction of any deficiencies is billed on a direct cost bases.

6-10 COMBINED SEWER SYSTEM

Portions of the City are served by a combined sewer system which collects both sanitary sewage and stormwater runoff. In these areas there is typically no separate storm drainage system and all stormwater runoff is collected in the combined system. As such, the combined sewer system must be designed and constructed to meet elements of both the sanitary sewer system, as described in the preceding sections of Chapter 6, and design standards more commonly associated with stormwater systems like those described in Chapter 4.

The following standards apply only within the Combined Sewer Area as shown in Figure 6-10.1 and Standard Drawing 109.

Figure 6-10.1 Limits of Combined Sewer Area



6-10.1 STORMWATER REQUIREMENTS FOR DEVELOPMENT IN THE COMBINED SEWER AREA

Development projects draining to the combined sewer system are not required to meet the same stormwater management standards as projects which drain to a separated stormwater system. Instead, projects must comply with the following requirements for design of stormwater systems associated with development. Public Infrastructure development/redevelopment (such as road and utility construction) within the Public Right of Way is exempt from these requirements. Projects need not meet the standards included in Section 4 of this DCSS or the adopted Stormwater Management Manual, although the following section draws from portions of both. Unless otherwise stated below stormwater facilities constructed to meet the combined sewer area requirements should be constructed and maintained in accordance with the requirements of Section 4 and the Stormwater Management Manual.

6-10.1(1) FLOW CONTROL

Projects shall employ Flow Control BMPs in accordance with the following thresholds, standards, and requirements to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions.

Thresholds

The following projects require construction of Flow Control BMPs to achieve the Flow Control Performance Standard. If a project meets any of the following thresholds, Flow Control BMPs are required. The project proponent must demonstrate that the project does not meet any of the following thresholds for Flow Control BMPs to not be required.

- Projects that have a total of 200 square feet or more of net new impervious surface, or
- Projects that convert ¼ acres or more of native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation to lawn or landscape.

Flow Control Performance Standard

The combined sewer collection system is designed to a goal of conveying the 25-year recurrence storm event without flooding. That analysis was based on the land cover in place at the time that the conveyance system was constructed. Any increases in runoff rates have the potential to cause or exacerbate flooding in the system. Therefore, projects which exceed the threshold for flow control shall comply with the following standard:

- Stormwater discharges shall match developed discharge durations to existing site durations for the range of existing discharge rates from the 10-year peak flow through the full 100-year peak flow.
- Peak runoff rates from the developed site shall not exceed existing site runoff rates in the 25-year and 100-year return intervals.

The existing condition to be matched shall be the site as it exists at the time of application. Calculations shall be performed using a continuous simulation modeling program approved by the Washington

Department of Ecology for stormwater facility design in Western Washington. Modeling shall be performed using a **5-minute** timestep.

Additional Requirement

Flow Control BMPs shall be selected, designed, and maintained in accordance with the City's adopted Stormwater Management Manual and Section 4 of the DCSS, except as noted in this Section. The Flow Control Performance Standard may be achieved through any combination of onsite stormwater management techniques, flow control BMPs and selective site design which can be demonstrated to achieve the standard.

6-10.1 (2) DESIGN DOCUMENTATION

Development applicants shall provide documentation of compliance with the Combined Sewer Area stormwater standards. Development applications shall include the following:

a. Stormwater Report which includes the following elements:
   - Narrative description of the proposed project, existing & proposed conditions, and proposed stormwater facilities to be implemented.
   - Existing and proposed site maps identifying land cover types used in the stormwater analysis
   - Numeric summary of existing and proposed surface areas within the site and contributing offsite areas
   - Determination of erosion control risks and proposed measures to control erosion and sedimentation.
   - Offsite analysis narrative description and figure describing upstream areas which contribute runoff to the site and the downstream system which will receive runoff from the site. Describe any identified issues which may affect or could be exacerbated by the project.
   - Flow control design and sizing calculations
   - Conveyance pipe sizing calculations
   - Other reports and data required to prepare the stormwater facility design
b. Construction plans for proposed stormwater facilities
c. Operations and maintenance manual for all proposed stormwater facilities.
d. Maintenance covenant for owner conducted maintenance of all stormwater facilities.

6-10.2 COMBINED SEWER CONVEYANCE SYSTEM

6-10.2 (1) MATERIALS AND CONSTRUCTION

Elements of the combined sewer system which convey only stormwater, such as catch basins and stormwater piping shall be constructed in accordance with the stormwater conveyance system requirements in Section 4-2.

Elements of the combined sewer system which convey only sanitary sewage, or a combination of stormwater runoff and sanitary sewage, shall be designed in accordance with Section 6-7 and 6-8.

The last drainage structure in a stormwater only system prior to connection to any facility which may contain sanitary sewage shall include a gas trap in accordance with Standard Drawing 413 or 414.

No connections of roof drains to side sewers or laterals shall be allowed without prior approval of the Director. Downspouts may be discharged to the ground surface, using splash blocks or other means.

Stormwater runoff shall not be connected directly to sanitary side sewers. Projects that discharge stormwater to the combined sewer system shall connect to the sewer main using a separate storm side sewer. Stormwater runoff shall be discharged to a floatable material separator with gas trap, per Standard Drawing 413 or 414, prior to the connection to the combined system sewer main.

6-10.2 (2) COMBINED SEWER CONVEYANCE SIZING

New combined sewer mains will be sized by Public Woks staff based on internal design standards and modeling methodologies.

Stormwater only elements of the combined sewer system shall be designed in accordance with Section 4-2.2