DIVISION 5: STORMWATER MANAGEMENT

5.1 DESIGN CRITERIA

A. APPLICABILITY

1. These Design Standards are intended for use by project engineers as a general design guideline for all storm drainage facilities within Dundee City limits.
2. This section supplements OSSC Standard Specifications
3. These Design Standards shall govern all construction and upgrading of all public and private drainage facilities in the City of Dundee and applicable work within its service areas. This standard shall apply to all drainage facilities which impact any public storm drain system, public right-of-way or easement dedicated to or located within the City of Dundee, any water course or natural drainage way located within the City of Dundee and within all off-street parking and loading areas.
4. Conditions not covered by these Design Standards are to be specifically reviewed and approved by the City.

B. GENERAL REQUIREMENTS

1. All stormwater runoff shall be conveyed to a public storm drain or natural drainage channel having adequate capacity to carry the flow without overflowing or otherwise causing damage to public and private property. In the case of private development, the developer shall pay all costs associated with designing and constructing the facilities necessary to meet this requirement.
2. Site stormwater discharge shall not be permitted to increase from conditions existing prior to any development except where the applicant can demonstrate that there is no adverse impact to downstream properties, according to the criteria contained in these Design Standards and the judgment of the City Engineer.
3. A project is exempt from performing an offsite analysis if all of the following conditions apply unless otherwise required by the City Engineer:

    a. The project:

    i. Adds less than 2,000 square feet of new impervious surface; and
    ii. Adds less than 35,000 square feet of new pervious surface; and
    iii. Does not construct or modify a drainage pipe/ditch that is 12 inches or more in size/depth or that receives runoff from a drainage pipe/ditch that is 12 inches or more in size/depth; and
    iv. Does not contain or lie adjacent to a landslide, steep slope, or erosion hazard area; and
    v. Does not change the rate, volume, duration, or location of discharges to and from the project site (e.g., where existing impervious surface is replaced with other impervious surface having similar runoff-generating characteristics or where pipe/ditch modifications do not change existing discharge characteristics).

4. The offsite analysis shall extend downstream for the entire flow path, from the development site to the receiving water or up to one (1) mile, whichever is less.
5. The existing conditions and potential impacts to be evaluated in the offsite analysis shall include, at a minimum, but not be limited to:
    a. Excessive sedimentation.
    b. Upland erosion impacts, including landslide hazards.
    c. Stream channel erosion at the outfall location.
    d. Stream bank erosion.
    e. Conveyance system capacity.
    f. Localized flooding.
    g. Violations of surface water quality standards as identified in a basin plan or a total maximum daily load (TMDL); or violations of groundwater standards in a wellhead protection area.
    h. Spills and discharges of priority pollutants, as defined by the federal clean water act.
    i. Existing offsite impacts that are not affected by the project site do not require mitigation. However, in cases where the project site was the cause of the existing impact, it is the responsibility of the applicant to mitigate for those impacts.
6. The design of a storm drainage system shall include provisions to convey all stormwater runoff to an approved point of disposal, as defined by these Design Standards.
7. All drainage systems are to be designed to provide a minimum practical design life of not less than 50 years.
8. Surface drainage entering a development shall be received at the naturally occurring locations and surface water exiting the development shall be discharged at the naturally occurring locations with adequate energy dissipaters to minimize erosion and other damage.
9. All public and private storm drainage systems shall discharge by gravity into the downstream drainage system without the use of pumps or other mechanical means.
10. The point of disposal for all stormwater may be a piped system, curb, or open channel as approved. Direct outfalls to infiltration systems, detention ponds, or waterways shall be approved on a case-by-case basis. Acceptance of suggested disposal points will depend upon the site conditions, capacity of existing downstream facilities, potential for erosion, and feasibility of alternate designs.
11. When an approved point of disposal is located on adjacent private property, the property owner shall be responsible to acquire an approved drainage easement and record it with Yamhill County at the owner's expense.
12. Design calculations shall be submitted for all drainage facilities. These drainage calculations shall be included on the site plan drawings and shall be stamped by a professional engineer licensed in the State of Oregon.
13. Surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume or location materially different from that

which existed before development occurred, but shall be collected and conveyed to a point of disposal as approved.

14. Permanent stormwater management facilities shall be provided for all developments within the City of Dundee in accordance with these Design Standards.

C. STORMWATER QUALITY

1. GENERAL

    a. Owners of new development and other activities which create new impervious surfaces, alters existing impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site are required to construct or fund permanent water quality facilities to reduce contaminants entering the storm and surface water system.

2. CRITERIA FOR REQUIRING CONSTRUCTION OF A WATER QUALITY FACILITY

    a. A water quality facility shall be constructed on-site unless, in the judgment of the City Engineer, any of the following conditions exist:

    i. The site topography or soils makes it impractical, or ineffective to construct an on-site facility;
    ii. There is a more efficient and effective regional site within the sub-basin that was designed to incorporate the development or is in the near vicinity with the capacity to treat the site.
    iii. The development is for the construction of one or two family (duplex) dwellings on an existing lot of record.

3. WATER QUALITY FACILITIES

    a. As Design Standards for stormwater quality, the City Engineer will accept stormwater quality facilities designed pursuant to the policies and procedures of the City of Portland Bureau of Environmental Services (BES) in its stormwater management manual. However, the City Engineer may impose additional requirements or require changes to those standards as deemed appropriate for the City of Dundee.
    b. The standards for BES can be found online at:

    i. BES: http://www.Portlandonline.com/bes/

    c. Runoff volumes and flow rates shall be determined in accordance with the hydrologic calculation methods contained in Section 5.1d - Stormwater Quantity of these Design Standards.
    d. As required in Section 5.1d to use another analytical method acceptable to the City Engineer (e.g., the Santa Barbara Urban Hydrograph Method, XP-SWMM and SCS 1A storm, etc.), the water quality design storm event shall be 0.83-inches per 24-hour period.
    e. All areas subject to vehicular use must be routed to an approved water quality facility.

D. STORMWATER QUANTITY

1. The storm drainage system shall ensure that the 25 year storm shall show free flowing conditions through the existing and proposed stormwater conveyance system, including the water quality and detention facilities from the development site to the receiving water or up to one (1) mile, whichever is less.
2. The stormwater conveyance system (piped flow) shall be designed to meet the design storm frequency as shown on Table 5.1.
3. The use of a low impact development design is encouraged in order to minimize runoff and the overall stormwater quantities required to be detained, infiltrated or conveyed.

Table 5.1 - Design Storm Frequency

Area	Design Storm Frequency
Residential Areas	10-Year Storm
Commercial And High Value Districts	10-Year Storm
Trunk Lines (18" Pipe And Larger)	25-Year Storm
Minor Creeks And Drainage Ways (Not Shown As A Flood Plain On The Flood Insurance Rate Map (Firm))	50-Year Storm
Major Creeks (Shown As A Flood Plain On The Firm)	100-Year Storm

4. RUNOFF CALCULATIONS

a. Drainage Areas

i. All designs shall identify drainage areas within and upstream of the development. In undeveloped drainage areas, drainage calculations shall separately consider existing drainage patterns and post-developed drainage patterns.

b. Analytical Methods

i. The Design Engineer is not limited to any one method for calculating runoff. Drainage Basins less than 25 acres in size may be analyzed using the rational method. Basins larger than 25 acres and systems with ponds, swales or any other volume sensitive system, including all detention and water quality facilities, must use an analytical method acceptable to the City Engineer.

ii. If use of a Santa Barbara Urban Hydrograph (SBUH) based computer program is proposed for use in sizing storm drain pipes for peak discharge, all cn parameters shall be as or more conservative than the equivalent runoff coefficients listed in these Design Standards.

iii. The City Engineer reserves the right to verify all calculations using any method, and require larger pipe sizes if the those calculations result in higher flows than the utilized methodology.

5. RATIONAL METHOD

a. The rational method calculation shall be made as follows:

Q = CIA
Q = peak flow (cubic feet/second)
C = runoff coefficient
I = rainfall intensity (inches/hour)
A = drainage area (acres)

b. Runoff Coefficient "C"

The runoff coefficient is difficult to estimate because it represents the interaction of many complex factors including surface ponding, infiltration, antecedent moisture, ground cover conditions, ground slopes, and soil type. The actual runoff coefficient for a given drainage basin can best be approximated by calculating a weighted average of all distinct surface types:

$$Cav = \frac{\sum Cxax}{Atotal}$$

Table 5.2: Average Runoff Coefficient "C" Values			
	Flat 0% To 2%	Rolling 2% To 10%	Hilly Over 10%
Developed Surface Types:			
Impervious Areas	.9	.9	.9
Gravel Pavement	.5	.55	.6
Landscape Areas (Except Lawns)	.3	.35	.4
Lawns	.17	.22	.35
Undeveloped Surface Types:			
Meadow, Pasture, Or Farm	.25	.3	.35
Mixed	.15	.2	.25
Woodland And Forest	.1	.15	.2
Development Types:			
Commercial Development	.8	.85	.9
Industrial Development, Heavy	.7	.8	.9
Dense Residential (Over 6 Units/Acre)	.7	.75	.8
Industrial Development, Light	.6	.7	.8
Normal Residential (3 To 6 Units/Acre)	.5	.55	.6
Light Residential (1 To 3 Units/Acre)	.35	.4	.45
Parks	.15	.2	.25

c. Rainfall Intensity "I"

The cumulative rainfall intensity shall be derived from Figure 5.1. The design storm interval is typically based on the longest time of concentration for the drainage area.

Figure 5.1: ODOT Zone 8 IDF Curve

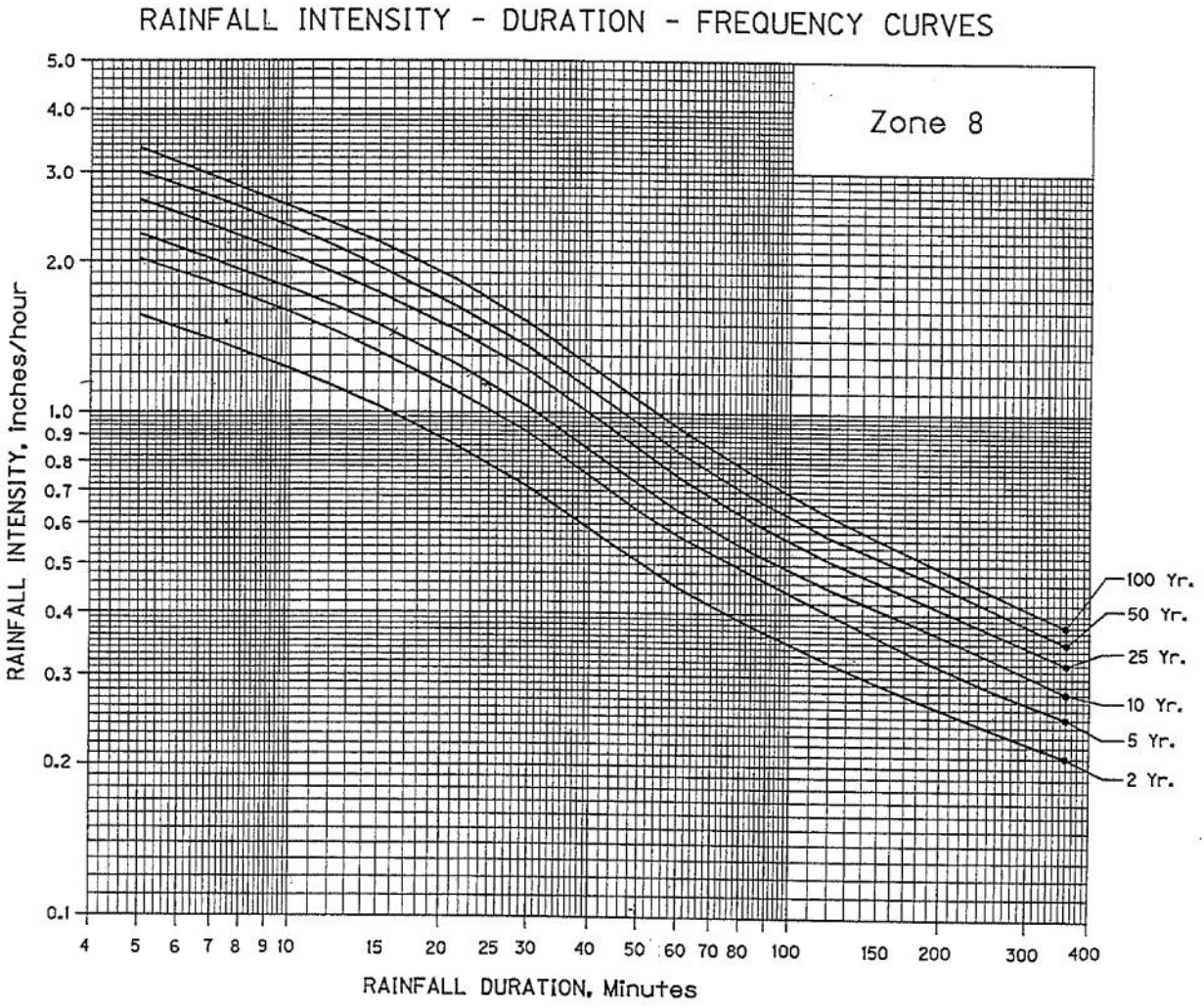

Table 5.3: ODOT Zone 8 IDF Curve Data

Rainfall Duration (Min)	Rainfall Intensity, inches/hour				
	5 year Storm	10 year Storm	25 year Storm	50 year Storm	100 year Storm
5	2.01	2.25	2.63	3.00	3.35
6	1.90	2.12	2.50	2.81	3.12
7	1.81	2.01	2.35	2.68	2.95
8	1.71	1.91	2.24	2.55	2.80
9	1.65	1.83	2.14	2.43	2.69
10	1.60	1.78	2.07	2.33	2.58
11	1.51	1.70	1.98	2.25	2.48
12	1.48	1.65	1.90	2.18	2.40
13	1.41	1.60	1.85	2.10	2.31
14	1.38	1.55	1.79	2.01	2.24
15	1.32	1.50	1.72	1.95	2.19
20	1.13	1.30	1.50	1.69	1.90
25	1.00	1.14	1.35	1.50	1.69
30	0.91	1.02	1.21	1.36	1.51
35	0.82	0.92	1.10	1.21	1.38
40	0.75	0.84	0.98	1.11	1.24
45	0.69	0.78	0.92	1.02	1.15
50	0.64	0.73	0.85	0.95	1.08
55	0.60	0.68	0.80	0.89	1.00
60	0.57	0.64	0.75	0.84	0.94
70	0.53	0.59	0.68	0.76	0.85
80	0.49	0.54	0.63	0.70	0.78
90	0.46	0.52	0.59	0.66	0.74
100	0.44	0.49	0.56	0.62	0.69
110	0.42	0.47	0.53	0.60	0.66
120	0.40	0.45	0.51	0.57	0.63
130	0.385	0.44	0.49	0.55	0.60
140	0.37	0.42	0.48	0.53	0.58
150	0.36	0.41	0.46	0.52	0.56
160	0.35	0.40	0.45	0.50	0.54
170	0.34	0.39	0.44	0.49	0.53
180	0.33	0.38	0.43	0.48	0.52

6. TIME OF CONCENTRATION "TC"

a. Calculations for time of concentration should be divided into two segments: sheet flow and controlled flow. For the first 300 feet of overland flow, the sheet flow time of concentration can be calculated with the kinematic wave equation:

Tc = 0.93 l0.6n0.6/i0.4s0.3

Tc = flow time (minutes)
L = overland flow length (feet)
N = manning's roughness coefficient (see table 5.4)
I = rainfall intensity (inches/hour) (see figure 5.1)
S = average slope of overland area (foot/foot)

Table 5.4: Manning's Roughness Coefficients For Overland Sheet Flow	
Surface Types:	N
Impervious Areas	0.014
Gravel Pavement	0.02
Developed: Landscape Areas (Except Lawns)	0.08
Undeveloped: Meadow, Pasture, Or Farm	0.15
Developed: Lawns	0.24
Undeveloped: Mixed	0.30
Undeveloped: Woodland And Forest	0.40
Development Types:	N
Commercial Development	0.015
Industrial Development, Heavy	0.04
Industrial Development, Light	0.05
Dense Residential (Over 6 Units/Acre)	0.08
Normal Residential (3 To 6 Units/Acre)	0.20
Light Residential (1 To 3 Units/Acre)	0.30
Parks	0.40

b. For overland flow distances greater than 300 feet, sheet flow typically becomes shallow concentrated flow. The average velocity for this flow can be determined from Figure 5.2 (source: 1972 Soil Conservation Service Handbook), in which the average velocity is a function of watercourse slope and surface type. For open channels, Manning's Equation should be used to estimate average flow velocity. Once velocity is calculated, time of concentration can be calculated as follows:

Tc = L/V

Tc = Flow Time (Seconds)
V = Flow Velocity (Feet/Second)
L = Flow Length (Feet)

c. For land in pre-development condition, the minimum time of concentration shall be 10 minutes.
d. For developed residential and commercial/industrial property, the maximum time of concentration will be 10 minutes unless calculations by an acceptable method show the time to be longer.

E. DETENTION

1. GENERAL REQUIREMENTS

a. All stormwater runoff originating from and/or draining to any proposed development shall be detained, controlled, and/or conveyed in accordance with these Design Standards. When existing conditions make stormwater detention impractical for all or a portion of a proposed development, the City Engineer may permit compensatory storage volume to be provided in another location within the drainage basin. The total runoff within the drainage basin shall not exceed the allowable release rate.
b. Detention requirements may be modified in the following situations at the discretion of the City Engineer:

i. Developments in critical drainage basins with history of flooding or other drainage problems.
ii. Developments which require an orifice size less than 2-inches in diameter.
iii. Projects for which detention may increase peak flows of the downstream storm system such as direct outflow to a major waterway.
iv. Drainage basins with adequate regional detention facilities.
v. Other special conditions that the City Engineer deems necessary to warrant an increase or reduction in detention capacity or allowable release rate.
vi. Single family residences.

c. Detention facilities shall be open basins or ponds located outside the public right-of-way. Other configurations, such as underground pipes, vaults, or gravel-filled trenches, shall be approved by the City Engineer on a case-by-case basis. Infiltration systems may be subject to the Underground Injection Control (UIC) program and registration requirements administered by DEQ.
d. Stormwater runoff should not flow through the detention system, but instead should flow through the conveyance system. Stormwater runoff should enter the detention system only as redirected by the flow restriction device. When flow through a detention system is approved by the City Engineer, a well-defined low flow channel shall be required.
e. All aspects of public health, safety, maintenance, nuisance abatement, and vector control must be carefully reviewed in every drainage control system plan. Protective measures are often necessary and shall be required whenever appropriate. The protective measures themselves shall not constitute hazards or nuisances as defined in other applicable codes or standards.
f. The impact of a 100 year event system failure should be analyzed for effects to the proposed development, adjacent properties, elements of on-site and off-site private storm systems, and elements of the public drainage system.

g. Detention system designs shall minimize frequency, difficulty, and expense of future maintenance. Control structures shall be designed to operate automatically, minimizing operation and maintenance requirements. Maintenance of closed private detention or conveyance systems such as underground pipes, gravel-filled trenches, and both underground and surface vaults shall be the responsibility of the property owner or owner's association. The City may require evidence of a legal and enforceable funding mechanism for operation, maintenance, repair, and replacement of closed private detention systems.

h. Multiple-use detention facilities (i.e., parks, playgrounds, tennis courts, basketball courts, parking lots) are encouraged if such a design complies with all other requirements in these Design Standards.

2. DETENTION VOLUME CALCULATIONS

a. Allowable Outfall

i. The total outflow from a development shall not exceed the historic, pre-developed 5 year design storm runoff from the development area. The City Engineer may further modify the allowable outflow in critical drainage areas. Regardless of the existing pre-developed surface condition, the runoff characteristics for calculating allowable outflow shall typically equal "undeveloped, mixed" as shown in table 5.2 and table 5.4 and "fallow or minimum tillage cultivation" as shown in figure 5.2.

ii. Often, small drainage areas within a site are not practical to detain and must flow undetained from the site. Impervious areas of undetained runoff shall be calculated and subtracted from the allowable total outflow through the orifice or other flow-control structure.

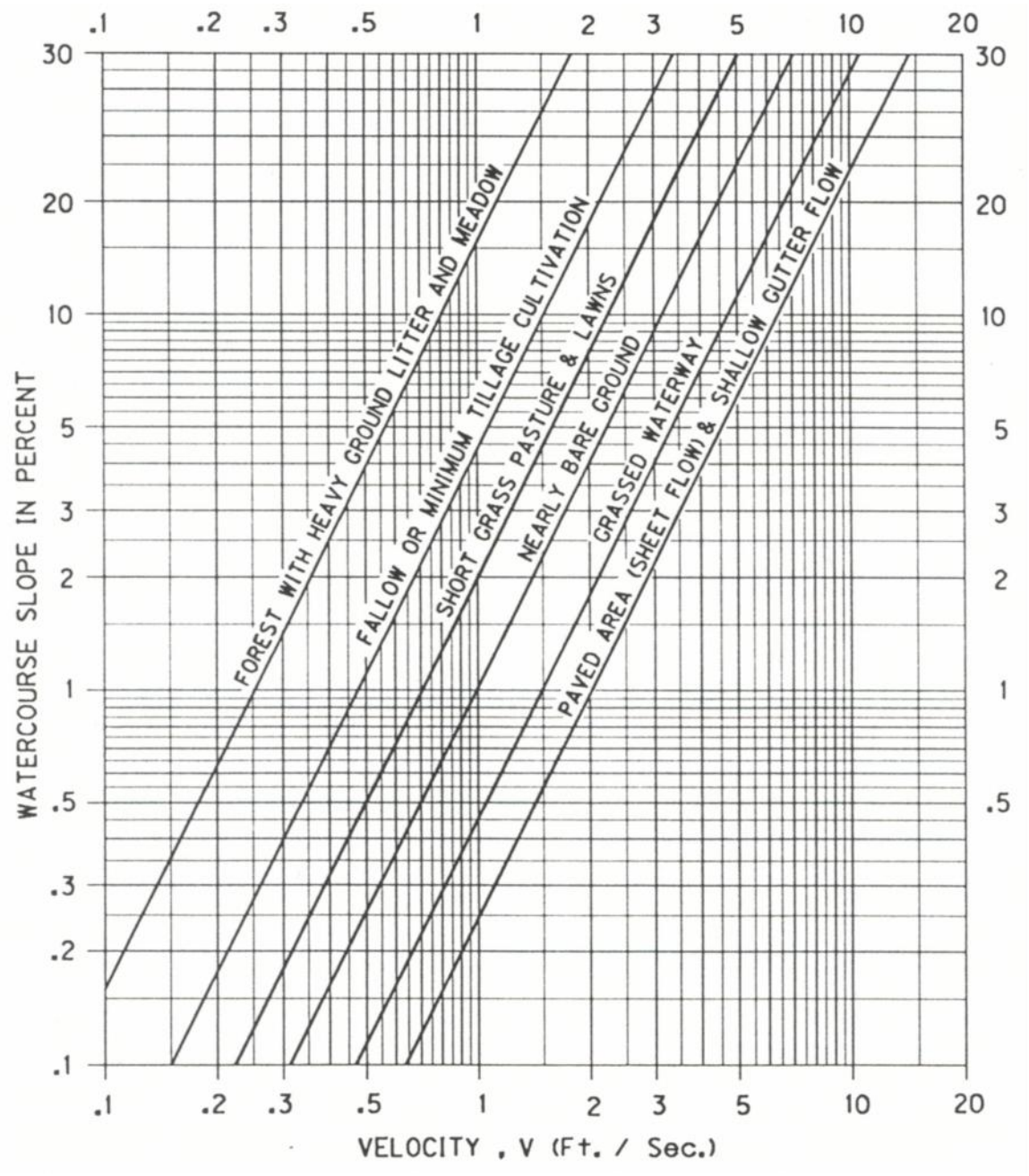

Figure 5.2: Average Velocity of Shallow Concentrated Flow

b. Outlet Control

i. Outflow is typically restricted through an orifice, usually located within a manhole or other junction structure. Orifices shall be a minimum of 2-inches on public systems and 1-inch on private systems unless otherwise approved or required by the City Engineer. The orifice diameter shall always be greater than the thickness of the orifice plate.

ii. Multiple orifices may be necessary to meet the flood control design storm performance for a detention system. However, extremely low flow rates may result in orifices that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures may be used to the maximum extent possible to meet flow control requirements. Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

iii. Orifice sizes shall be established based on the following equation:

$$D = 6.073 \sqrt{\frac{Q}{\sqrt{H}}}$$

D = Orifice Diameter (Inches)

Q = Allowable Outflow (CFS)

H = Maximum Head (Feet). The Vertical Distance From The maximum water surface elevation to the outlet pipe invert (or to the ten-year water surface elevation at the outlet if above the pipe invert).

c. Detention Volume

i. The detention volume shall be sufficient to detain a 50-year design storm of any duration without overflow. The required detention volume is determined from the storm duration with the greatest difference between total cumulative runoff and allowable cumulative outflow.

F. STORMWATER CONVEYANCE

1. GENERAL CONDITIONS

a. Conveyance systems shall be designed and constructed in compliance with requirements of all applicable Federal, State, and local agencies. Written authorization of approval from other jurisdictions may be required at the City Engineer's discretion.

2. STORMWATER DISPOSAL

a. Surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume or location materially different from that which existed before development occurred, but shall be collected and conveyed to a point of disposal as approved.
b. The point of disposal for all stormwater within a development may be a storm drain pipe, open channel, curb and gutter, or other approved facility. The City Engineer shall approve all points of disposal. Infiltration systems may be subject to the UIC program and registration requirements administered by DEQ.
c. When private property must be crossed in order to reach an approved point of disposal, it shall be the developer's responsibility to acquire a recorded drainage easement from the private property owner meeting the approval of the City Engineer. The drainage facility installed must be a closed conduit system. Temporary drainage facilities, when approved, must be engineered to contain the stormwater without causing erosion or other adverse effects to the private property.
d. As a condition of development, all developments will be required to provide public storm drainage systems to serve adjacent upstream parcels. This shall include the extension of storm drain lines in easements across the property to adjoining properties and across the street frontage of the property to adjoining properties when the storm drain system is located in the street right-of-way. This shall include extension to the far side of streets fronting or adjacent to the development as required to avoid work within or under these streets in the future. This shall include storm drains which are oversized to provide capacity for upstream development.
e. Direct outfalls greater than 6 inches in diameter to open channel waterways shall typically be designed by a professional engineer licensed in the state of Oregon. Outfalls shall be constructed to minimize the potential for erosion and other potential damage to the waterway banks. Outfall designs shall address erosion and scouring within the waterway upstream and downstream of the outfall structure.

3. STORM LINE REQUIREMENTS

a. The minimum pipe size shall be no less than 12 inches for storm systems within the public right-of-way, unless approved otherwise by the City Engineer.
b. The minimum pipe size shall be no less than 10 inches for storm laterals serving a single catch basin.
c. When two parallel pipes are installed in lieu of a box culvert, the minimum separation between the pipes shall be one (1) foot or 1/3 the diameter, whichever is greater. This requirement may be waived if the void between the pipes below the spring line is filled by grouting or other approved method.
d. Maximum joint deflection shall be per manufacturer's recommendation.

4. STORM LATERAL REQUIREMENTS

    a. Storm laterals from private drains to inlets may be a minimum of 6 inches, and shall have a cleanout installed at the easement or property line.
    b. For new mainline and lateral construction, catch basin laterals of 10 feet or less in length and 10 inches in diameter or less may connect to the main line with a shop-fabricated 90 degree tee, provided the connection is located not more than 100 feet from a manhole or cleanout on the main line and the main line is a minimum of 12-inches or larger in diameter.
    c. Laterals draining private property may be connected directly to an existing main line provided the lateral diameter is 8-inches or less and is no more than half the diameter of the main line. The hole in the main line shall be made with a drill designed for cutting the mainline pipe material. The connection shall be properly grouted or otherwise connected to provide a strong, leak-proof joint. The lateral shall not project inside the main line. For new construction the connection shall be made with a manufactured fitting.
    d. Construction of the storm service laterals shall be of the same quality and meet the same requirements as the public storm drain with regard to materials, water-tightness, and location. These storm drains shall conform to the current Oregon Specialty Plumbing Code and local plumbing codes and restrictions.
    e. Storm drain laterals shall be provided as required to prevent roof and surface drainage from flowing across pedestrian access routes.
    f. Additional laterals must be stubbed into the property lines sufficient to serve all residential parcels where such service or future partition would require new streets be cut to install such services.

5. SLOPE REQUIREMENTS

    a. Mean Velocity

    i. Storm drains shall be at a grade which produces a minimum mean velocity of 2 ½ feet per second (fps) when flowing full, based upon manning's pipe friction formula using a roughness coefficient of not less than 0.013 for smooth wall pipe and 0.024 for corrugated wall pipe, or the pipe manufacturer's recommendations, whichever is greater.
    ii. An absolute minimum mean velocity of 2.0 fps may be used upon the approval of the City Engineer.
    iii. Where mean velocities greater than 10 fps are attained, the pipe material shall be ductile iron and measures must be taken to protect structures against erosion and displacement. In addition, energy dissipaters may be required.

    b. Storm drains shall be laid with uniform slope between structures.
    c. A maximum grade of 20% should be used in the design of storm line systems, unless approved by the City Engineer.
    d. Design Engineers are cautioned not to specify storm drains of sizes which are obviously larger than is necessary for satisfactory carrying capacity but which are specified in order to meet grade requirements, i.e., a 12-inch pipe for a 10-inch pipe to acquire a decrease in slope.

6. PIPE ALIGNMENT AND LOCATION

    a. Alignment within the street right-of-way shall conform to Appendix A, Standard Details.
    b. Storm lines shall be laid on a straight alignment between junctions. All changes of direction shall be made at a manhole or other approved structure.
    c. Lines 15 inches in diameter and smaller may be laid on horizontal curves conforming to the street curvature provided the radius of the horizontal curve is not less than 200 feet. Variance for horizontal curves shall be reviewed by the City Engineer on a case-by-case basis.
    d. Storm system alignments shall accommodate future planned projects. Where storm drains are parallel to other utilities, their vertical and horizontal alignment shall allow for future side connections to main and lateral storm drains while avoiding conflicts with parallel utilities and abrupt changes in vertical grade.
    e. Installation of private utilities in a common trench with storm drain lines shall be prohibited.

7. STORM DRAIN COVER AND UTILITY CROSSINGS

    a. Storm drain lines shall have a minimum cover of 30 inches from the top of the pipe to the finish surface. Pipes designed with less than 30 inches of cover shall be approved by the City Engineer on a case-by-case basis and may require special bedding and/or backfill, load calculations, manufacturer's specifications, specific pipe materials, or other additional requirements.
    b. Where storm lines cross other utilities, the crossing should be made as close to 90 degrees as possible. Utility crossings with less than 6 inches of vertical separation shall be backfilled with controlled density backfill or other approved material. Utility crossings with 6 inches or greater vertical separation may require granular or other special backfill as specified by the City Engineer.
    c. Separation of utilities must meet Oregon DEQ and OHA DPH requirements.

8. UNDERGROUND WARNING TAPE

    a. Detectable or non-detectable acid and alkali resistant safety warning tape shall be provided along the full length of all service laterals and all mainlines not located under sidewalks or paved portions of public streets.
    b. Underground warning tape shall be placed a minimum of 12 inches and a maximum of 18 inches below the finish ground surface, and shall be continuous the entire length of the service laterals installed from the mainline to the back of the public utility easement. Where required for mainlines not located under sidewalks or paved portions of public streets, the warning tape shall be continuous between manholes or cleanouts.

9. JUNCTIONS

a. General

i. Manholes, catch basins or junction boxes shall be required at the following locations or as determined by the City Engineer:
ii. All changes in horizontal or vertical alignment, all pipe junctions with present or future storm drains, and all changes in pipe size.
iii. Junctions shall be spaced no greater than four-hundred (400) feet apart.

b. Catch Basins

i. General

1) All Catch basins shall conform to the latest requirements of the OSSC.
2) Catch basins may be used for the junction of pipes 15-inches in diameter or less where the depth from rim to invert is less than 4 feet.
3) Catch basins shall be designed to completely intercept the 5 year design storm gutter flow.
4) All catch basins shall be stamped “dump no pollutants, outfalls to stream”
5) Catch basins shall have a sump at least fifteen (15) inches below the lowest invert to collect sediment and debris.

ii. Location

1) The maximum length of curb and gutter which may be drained by a catch basin is 500 feet.
2) The maximum impervious area which may be drained by a catch basin is 20,000 square feet.
3) Catch basins shall be installed where the improvement ends on all streets terminating on a descending grade, and piped to an approved point of disposal.
4) Catch basins on corners shall not be located in front of handicap access ramps.

c. Manholes

i. Manholes location, sizing, vertical drop and rim elevations shall conform to the requirements outlined under Section 3, Sanitary Sewers.

10. OPEN CHANNELS

a. Bank slopes shall be 3H: 1V or flatter unless otherwise required by the City Engineer.
b. The maximum allowable design velocity shall be 7 fps.
c. The minimum allowable design velocity shall be 2 fps.

d. All piped discharges to open channels shall be mitered to match the channel side slope and include a reinforced concrete collar of 6 inch minimum thickness to prevent settling or erosion of the pipe trench at the discharge location and to protect the end of the pipe. Unless otherwise approved by the City Engineer, the concrete collar shall extend from the channel bottom to the top of the bank.
e. Grates shall be provided on all inlets or outlets 18 inches or larger unless otherwise specifically approved by the City Engineer, as well as at any locations required by the Public Works Supervisor to accommodate maintenance or mowing requirements.
f. Bank stabilization shall not reduce the carrying capacity of the water course. Bank stabilization designs shall consider the 10-year flow velocities of pipe outlets and 25-year flow velocities of open channel waterways. Where stones are placed within existing bank slopes, the bank shall typically be excavated a minimum of 18 inches or 1.5 times the size of the largest stone being used, whichever is greater.
g. Flow from the outfall structure shall be directed downstream, typically no less than 30 degrees from perpendicular to the waterway flow. The outfall invert shall typically be located at the normal low water level of the waterway. Outfalls to waterways shall be consolidated and otherwise minimized as determined by the City Engineer.

11. EASEMENTS

a. Storm drains shall be located within the public right-of-way. Storm drains in easements will only be allowed by written approval of the City Engineer.
b. Minimum storm drain easement widths shall be according to table 5.7 below, unless authorized by the City Engineer. Easements shall be a constant width between manholes or other in-line structures and be based on the deepest portion of the line between such structures.

Table 5.7: Minimum Storm Drain Easement Width

Minimum Width		
Pipe Diameter	Depth To Invert	
	≤ 6 Feet	> 6 Feet
10-15 Inches	12 Feet	12 Feet Plus 2 Feet For Each Foot (Or Fraction Thereof) Deeper Than 6 Feet To Invert
18-24 Inches	16 Feet	16 Feet Plus 2 Feet For Each Foot (Or Fraction Thereof) Deeper Than 6 Feet To Invert
>24 Inches	20 Feet	20 Feet Plus 2 Feet For Each Foot (Or Fraction Thereof) Deeper Than 6 Feet To Invert

c. The conditions of the easement shall be such that the easement shall not be used for any purpose which would interfere with the unrestricted use for storm drain purposes. Under no circumstances shall a building or structure, tree or fence be placed over a storm drain pipe or easement. This shall include overhanging structures with footings located outside the easement.

d. Easement locations for public storm lines shall allow unobstructed vehicle access for City maintenance. Junction and inlet structures in easements shall be accessible for City maintenance at all times.
e. Common easements may be permitted, subject to the approval of the City Engineer.
f. Open channels located outside of public right-of-ways shall be provided with an easement width as follows:

i. For channel width less than 14 feet at top of banks: channel width plus 12 feet on one side and 2 feet on the other
ii. For channel width greater than 14 feet at top of bank: channel width plus 12 feet on both sides.

g. Any easement on a side slope may be required to be wider by the City Engineer than the minimum specified.
h. All easements must be furnished to the City for review and approval prior to recording. All recording costs shall be borne by the developer.

5.2 MATERIALS

A. GENERAL

1. Unless otherwise approved by the City Engineer, materials used for the construction of public stormwater facilities shall conform to the current OSSC, the minimum requirements outlined herein and as shown on the Standard Details. This listing is not intended to be complete nor designed to replace the City's Construction Standards (DCS).
2. In the case of conflicts between the provisions of these Design Standards and the DCS, the more stringent as determined by the City Engineer shall apply. Acceptable materials shall be as outlined in these Design Standards.
3. It is not intended that materials listed herein are to be considered acceptable for all applications. The Design Engineer shall determine the materials suitable for the project to the satisfaction of the City Engineer.

B. UNDERGROUND WARNING TAPE

1. Underground warning tape shall be detectable or non-detectable acid and alkali resistant safety warning tape. The tape shall consist of a minimum 4.0 mil (0.004") thick, virgin low density polyethylene plastic film formulated for extended use underground. The tape shall be in accordance with the APWA national color code and shall be permanently imprinted in lead free black pigments suitable for direct burial.
2. The tape shall be safety green and shall be provided with the legend "Caution Buried Storm Drain Line Below" or approved equivalent printed continuously down the length of the tape.

C. BORE CASINGS AND ACCESSORIES

1. Carrier pipe used in bore casings shall be ductile iron or as otherwise specified herein.
2. Bore casing and carrier pipe design and installation shall conform to the requirements outlined under Section 2, Water.

D. PIPE SIZE AND MATERIALS

1. Unless otherwise approved by the City Engineer, storm drain pipe materials shall conform to the following:

    a. Ductile Iron (up to 30”)

    i. Ductile iron pipe shall be Class 52 pipe conforming to AWWA C-151, and cement-mortar lined and seal coated in accordance with AWWA C104.

    b. Non-Reinforced Concrete (CP) and Reinforced Concrete (RCP) Pipe (all sizes)

    i. Joints shall be bell and spigot with an O-ring as specified or shown on the drawings and conforming to the following:

        1) Bell and spigot joints shall be sealed with flexible watertight gaskets meeting or exceeding all requirements of Federal Specifications SS-S-06210 (GSA, FSS Washington, DC) "Sealing Compounds, Preformed Plastic for Pipe Joints," Type 1 ropeform. Such gaskets may be RAMNEK as manufactured by K.T.Snyder Co., Inc., of Houston, Texas; KENTSEAL No.2 joint sealant as manufactured by Hamilton Kent Mfg., Co., of Kent, Ohio, or approved equal.

        2) O-ring joints shall conform to ASTM c443. The gaskets shall conform to material requirements of ASTM c361.

    c. Polyvinyl Chloride (PVC) Pipe

    i. ASTM D3034 (up to 15”)

        1) Pipe and fittings shall conform to ASTM D3034, SDR 35.

        2) Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, sdr rating, and ASTM classification.

        3) The joints shall conform to ASTM d3212, joints for drain and sewer plastic pipes using flexible elastomeric seals.

    ii. ASTM F679 (18”-36”)

        4) Pipe and fittings shall conform to ASTM F679, SDR 35.

        5) Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, sdr rating, and ASTM classification.

        6) The joints shall conform to ASTM d3212, joints for drain and sewer plastic pipes using flexible elastomeric seals.

    iii. C900 (up to 12”)

        1) Pipe and fittings shall conform to AWWA C900, DR 25.

        2) Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, sdr rating, and ASTM classification.

3) The joins shall conform to ASTM D3139, joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

iv. A-2000 (up to 36")

1) Pipe and fittings shall conform to ASTM F949.

2) Pipe and fittings shall have integrally formed smooth interior pipe surface.

d. High Density Polyethylene (HDPE) Pipe

i. ADS Sanitite HP (12"-60")

1) Pipe and fittings shall have integrally formed smooth interior pipe surface.

e. Corrugated Metal (CMP) Pipe

i. Ultra Flow or Smooth Core (18" and up)

f. Pipe Joints

i. Except as otherwise specified, joints for pipe shall be watertight joints using elastomeric ring gaskets. The gaskets shall be securely fixed into place so that they cannot be dislodged during joint assembly.

ii. The gaskets shall be of a composition and texture which is resistant to common ingredients of drainage, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.

g. Pipe Accessories

i. Fittings shall be of the same material as the pipe, molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations as required.

ii. Manufactured fittings shall be used for all connections to existing or new storm drains.

2. Uniform pipe material shall be used on each pipe run between structures.
3. Special requirements for use of jointed HDPE pipe for slopes exceeding 6% for or cover depths greater than 10 feet may be required by the City Engineer.
4. Pipe cover shall be as specified by the current OSSC standard drawing by type of pipe.
5. Pipe materials shall be as specified in the current OSSC unless otherwise specified below.
6. Pipe materials and sizes other than listed above shall be determined on a case by case basis.

E. STORM DRAIN STRUCTURES

1. CATCH BASINS

    a. Catch basin construction and dimensions shall conform to Appendix A, Standard Details. Side inlet grated catch basins shall be required.
    b. Catch basin frame and grate shall conform to Standard Details, and shall be fabricated of structural steel, ASTM A7, A36 or A273.
    c. Solid lids on junction boxes shall be minimum ¾-inch steel plate, and shall be provided with at least one lifting hole. Junction boxes located in a travel lane shall have a manhole frame and cover.

2. MANHOLES

    a. Except as modified herein, precast concrete pipe manhole sections, transition sections, eccentric cones, flat slab tops, and adjusting rings shall conform to the requirements outlined under Division 4, Sanitary Sewers and as shown in the Standard Details.
    b. Steps shall not be required for manholes 4 feet or less in depth (rim to invert).
    c. Manhole castings for storm manholes shall have 16-hole lids.
    d. Pollution/flow control manholes shall be provided with a 30-inch diameter casting and lid.

3. CONCRETE (CAST-IN-PLACE)

    a. All concrete shall conform to the requirements of OSSC Section 00440, Commercial Grade Concrete, 3300 psi minimum.