CHAPTER 4

STORM DRAINAGE DESIGN STANDARDS

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CHAPTER 4

STORM DRAINAGE DESIGN STANDARDS

4.00 Objective

Permanent storm drainage, grading, detention basin, and related infrastructure improvements shall be provided on all development projects, public and private infrastructure improvements, and related infrastructure improvements. The City of Keizer Department of Public Works shall review all storm drainage improvement plans. Applicability of the requirements stated herein shall be determined in accordance with Chapter 1 of these Design Standards as interpreted by the City.

All storm water runoff shall be conveyed to a public storm sewer or natural drainage channel. Receiving waters, including underground storm drainage systems, shall have adequate capacity to carry necessary flow without overflowing or causing damage to public property or welfare. The cost for the approved system shall be wholly borne upon the developer or other party creating the impact, including any off site system that may be required.

These standards have the objective of developing a storm water distribution and management system that will:

a. Meet all current Federal, State, and Local storm water runoff regulations;

b. Comply with Keizer's NPDES Storm Water Discharge Permit and Storm Water Management Plan;

c. Be of adequate design to safely manage all volumes of storm water generated upstream and on the site to an approved point of disposal;

d. Provide points of disposal for storm water generated by future upstream development;

e. Minimize the impact of development activity upon downstream floodplains by designing detention facilities to a higher standard in critical drainage basins;

f. Prevent the uncontrolled or irresponsible discharge of storm water onto adjoining public or private property;

g. Prevent the capacity of downstream channels and storm drainage facilities from being exceeded;

h. Have sufficient structural strength to resist erosion and all external loads which may be imposed;

i. Maintain the runoff characteristics of the original undeveloped drainage basin, where feasible, as determined by the City;

j. Maximize efficient use of the City's natural drainage system of streams, lakes, and wetlands;

k. Maintain the City's existing high level of overall storm water quality;

l. Be designed in a manner to allow economical future maintenance; and

m. Be designed using materials to insure a minimum practical design life of storm drainage facilities of 50 years; and

n. Be consistent with the requirements of City of Keizer Standard Construction Specifications and Standard Plans.

Alternate materials and methods relating to storm drainage improvements will be considered for approval on the basis of these objectives.

4.01 Applicability

In addition to those standards stated in Chapter 1, these Storm Water Design Standards shall be utilized for:

a. Public or private developments, general improvements, or any work in the City of Keizer which in any way impacts, alters, destroys, changes, or modifies existing drainage conditions or facilities.

b. Developments entailing construction which would change the point of discharge of surface waters, the quantity of discharge, or discharge surface waters at a higher velocity than that of the existing or pre-construction discharge rate, or add to pollution of surface waters;

c. Construction or reconstruction of public roadways and temporary detours;

d. Developments entailing construction in or adjacent to any existing stream or surface watercourse including intermittent streams; and

e. Developments requiring construction in or adjacent to the 100-year floodplain of any stream.

4.02 Additional Referenced Standards

Design of storm drainage, storm water quality facilities, and related improvements shall conform to these Design Standards, City of Keizer Standard Construction Specifications, and certain sections (as required by the City Engineer) of the current edition of the following referenced standards or documents:

a. "Hydraulics Manual"
Oregon Department of Transportation (ODOT)

b. "Surface Water Design Manual"
King County, Washington Surface Water Management Division

c. "Appendix B: Water Quality & Quantity Facility Design"
Clean Water Services of Washington County, Oregon (formerly Unified Sewage Agency (USA))

d. Oregon Plumbing Specialty Code
International Association of Plumbing and Mechanical Officials (IAPMO)

e. City of Keizer Flood Insurance Rate Map (FIRM), current adopted
Federal Emergency Management Agency (FEMA)

4.03 General Design Requirements

Storm drainage design must include provisions to adequately control runoff from all public and private streets and the roof, footing, and area drains of residential, multifamily, commercial, or industrial buildings, and insure future extension of the drainage system to the entire drainage basin in conformance with the City of Keizer Storm Drain Master Plan. These storm drainage provisions shall include:

a. Surface or subsurface drainage, caused or affected by changing the natural grade of the ground or removal of natural ground cover or placement of impervious surfaces, shall not be allowed to 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 in an approved manner to an Approved Point of Discharge (APD).

b. Surface water entering the subject property shall be received at the naturally occurring locations and surface water exiting the subject property shall be discharged at natural locations with adequate energy dissipaters within the subject property to minimize downstream damage and with no diversion at any of these points.

c. An Approved Point of Discharge (APD) is required for all storm drainage and associated systems. The APD for all storm water may be a storm drain, existing open channel, creek, detention, or retention pond approved by the City. Determination of the APD shall be based upon prevailing site conditions, and the capacity of existing downstream drainage facilities.

d. When off site private or public property (including public rights-of-way) must be crossed in order to reach an APD, it shall be the applicant's responsibility to acquire a drainage easement (of dimensions in accordance with those included in Section 4.25 from the property owner meeting the approval of the City. The drainage facility installed may be an

open drainage ditch, or a perforated or watertight closed conduit system. Drainage ditch facilities must be engineered to contain the storm water without causing erosion or other adverse effects to the property.

a. The design storm peak discharge from the subject property may not be increased from conditions existing prior to the proposed development except where it can be satisfactorily demonstrated by the applicant, and accepted by the City, that there is no adverse impact.

b. Retention/detention (R/D) facilities or a combination of both shall be provided in order to maintain surface water discharge rates at or below the existing design storm peak discharge except where it can be demonstrated by the applicant, and accepted by the City, that no adverse impact will result from not providing said facilities. R/D facilities will not be maintained by the City of Keizer.

Note: Historically, R/D facilities have been used primarily for control of stormwater quantity. R/D involves the temporary collection and storage of stormwater. Detention facilities are designed with a restricted outflow rate; retention facilities are not designed for a measurable outflow. R/D can provide a combined benefit by controlling both stormwater quality and quantity.

R/D control measures include aboveground facilities (i.e., wet ponds, constructed wetlands, presettling basins, or extended detention [dry] ponds) and belowground facilities (i.e., wet vaults or tanks and catchment basins).

c. Detention facilities will be required so that release rates downstream of the development do not exceed the 5-year frequency design storm flows for existing land use conditions up to the specified rainfall event. These release rates cannot increase the flooding conditions downstream. Detention facilities may be either off-line, as a separate facility or in-line, designed as part of a swale system.

d. Minimum width of an access easement from an existing public road to a R/D facility shall be 15-feet. Access easements shall be provided with a drivable surface as approved by the City.

e. Drainage from roofs, may drain through a closed conduit system to a street through the curb under the following circumstances:

1) The building pad ground elevation or finished floor shall be established so that the closed conduit system meets Oregon Plumbing Specialty Code Requirements.

2) The existing street is not a shed roof or tilt section that will permit runoff to flow across the street. This requirement will be waived if Type A curb and gutter is existing or installed.

j. Vegetation shall be established on areas disturbed by or on areas of construction as necessary to control and minimize erosion, in accordance with these Design Standards.

4.04 Storm Drainage Construction Plans

a. Cover Sheet

The Cover Sheet shall be prepared in accordance with the requirements of Chapter 1 of these Design Standards.

b. Conformance with the Preliminary Site Drainage and Grading Plan

The Preliminary Site Drainage and Grading Plan as required in Chapter 1 of these Design Standards shall be included in the Construction Drawings submitted for review by the City.

c. Plan And Profiles

Plan view of storm drain lines shall be to a scale of not greater than 1"=50' and shall contain the following information:

1. Adjacent street curbs and property lines, right-of-way and utility easements referenced to property corners, street intersections, or section lines. Adequate 1-foot contour lines or property corner and curb elevations to help determine the points of disposal for building storm drains.

2. The location of each manhole and catch basin shall be numbered and stationed to facilitate checking the plans with the profiles. The stationing shall be tied to existing property corners and/or street monuments with the relationship of each manhole and catch basin shown to the property corners (minimum two directions). Each line with a separate designation shall be stationed continuously up grade from Station 0+00 at its point of connection to another line.

3. Location of watercourses, railroad crossings, culverts, and sanitary sewers that cross the alignment within 250-feet of the proposed extension. All watercourse channels must show the 100-year flood plain and floodway channel for the design storm as specified in these standards.

4. Location of water mains, valves, pump stations, blowoffs, services, gas mains, underground power, and other utilities that either cross the alignment within 250-feet of the terminus of the proposed extension or are adjacent to the proposed extension within the public right-of-way or within 10-feet of the easement line. The

intent is to prevent grade conflicts along future extensions.

5. The location and elevation of the benchmark used as the basis of vertical control in the design shall be shown on the plans and referenced to property corners and/or street monuments.

6. The location of all potable drinking water wells, existing or abandoned, public and private, within 500-feet of an Underground Injection Control (UIC) System.

Profiles for individual storm drain lines and open channels shall be to the same horizontal scale on the same sheet and drawn immediately below the corresponding plan view to a vertical scale of 1"=5' reading from 0+00 left to right (where conditions warrant, right to left may be approved as well as a smaller vertical scale), and shall contain at least the following information in addition to the above:

1. Location of catch basins, manholes, and other appurtenances with each manhole and catch basin numbered and stationed as in item 2 of Plan above.

2. Profile of the existing and proposed ground and/or pavement surface, storm drain inverts, and backwater curves for the design storm.

3. Size, slope, length, and type of material of the line between consecutive catch basins or manholes (type of pipe may be designated by abbreviations listed under Section 4.18), type of pipe bedding and backfill material.

4. Elevation of original ground, finished grade, proposed rim elevation, and storm drain inverts at each catch basin or manhole (Mean Sea Level Datum, U.S.G.S.).

5. Railroad crossings, ditch, or creek channels with elevations of the ditch or creek bed and the 100-year flood elevation profile. See Section 4.26 for additional requirements.

6. Utility crossings that conflict with the proposed storm drain installation.

7. All existing facilities upon which work is to be performed, i.e., installation, repair, or removal.

SPECIAL NOTE: The design engineer shall field locate and verify the alignment, depth, and inverts of all existing facilities shown on the plans that will be crossed by proposed facilities and shall certify them with a note on the plans. City as-builts are only to be used as an aid to the design engineer when field verifying the existing facilities.

4.05 Preliminary Site Drainage and Grading Plan

A Preliminary Site Drainage and Grading Plan, the requirements for which are set for in Chapter 1 of these Design Standards, is required for most construction activities in the City of Keizer.

A copy of the Approved Preliminary Site Drainage and Grading plan, including additions or corrections required as conditions of development, shall be included in the Project Engineer's Construction Drawings submitted for review by the City.

4.06 Final Site Drainage and Grading Plan

A Final Site Drainage and Grading Plan incorporating the final site grading for the subject area and adjoining areas within 100 ft. of the perimeter of the subject property is required to be submitted in accordance with these requirements and the City of Keizer Development Code for review with the Construction Drawings.

The Final Site Drainage and Grading Plan be prepared by a Professional Civil Engineer registered in the State of Oregon, and shall be approved by the City Engineer.

These provisions shall also apply to any cut or fill on a property, which may impact the velocity, volume, or quality of surface water on adjacent properties, or may impact any permanent natural body of water.

The Final Site Drainage and Grading Plan shall incorporate all requirements of the Preliminary Site Drainage and Grading Plan, and indicate the following:

1. **Elevations**. Proposed finished lot corner and finished street elevations. Include cross sections for all proposed swales and ditches. The plan shall identify control for Minimum Floor Elevations, and shall be enforced in conjunction with Building Permits issued by the City.

2. **Proposed contours**. Proposed finished grade contours in 1-foot intervals, or less if required by the City Engineer. The contours shall clearly identify elevations, dimensions and location, extent, and slopes of all grading work proposed to be done.

3. **Run-off**. The methods to be used to minimize the amount of runoff other than into an Approved Point of Discharge, siltation, and pollution created from the development both during and after construction. The plan shall clearly identify the boundaries of all areas that will be paved or otherwise altered in a manner that will increase surface water runoff and boundaries

of all areas to remain in an existing or natural condition.

4. **Facilities**. Overall plan for the construction of storm sewers, open drainage channels, and other facilities that depict line sizes, profiles, construction specifications, detention/retention facilities, and other drainage features. Indicate the location of proposed drainage facilities that transport surface water across, or from the site, including natural watercourses, artificial channels, underground drainpipes, and culverts.

5. **Engineering Calculations**. Calculations used by the Project Engineer in sizing storm drainage facilities. These shall include the following calculations:

   a. Background computations for sizing drainage facilities including, tributary upstream and downstream drainage basins, surface and subsurface water entering the subject property, and existing and proposed discharges and release rates.
   b. Calculations for sizing of facilities that will be utilized to handle, transmit, store, and discharge storm runoff to the Approved Point of Discharge in accordance with applicable sections of these Design Standards.
   c. Pipe network and or drainage ditch network analyses and cross sections identifying water surface profiles for the required design storm.

6. **Perimeter Drainage.** Construction drawings shall identify perimeter drainage facilities and private drainage easements that will control runoff to and from project sites.

7. **Identify** cut and fill areas, desilting facilities, interceptor ditches (channels), velocity check dams, soils, topography, vegetation, and areas of proposed re-vegetation.

4.07 Erosion and Pollution Control

An Erosion Control Plan, with an associated Department of Environmental Quality NPDES 1200C Permit, if required, shall be prepared for all projects which may impact the velocity, volume, or quality of surface water on adjacent properties, or which may impact any permanent natural body of water. The City will require erosion control measures, using current acceptable BMPs, on all projects at its own discretion, and will determine which projects will be required to have and Erosion Control Plan. All erosion control measures shown on the approved Erosion Control Plan will be enforced by the City against the permit holder until build-out of a subdivision or partition, or 100% completion of a project.

The Erosion Control Plan shall address the following requirements:

a. Proposed measures for controlling runoff during all three phases of construction:

   1. Prior to excavation or construction.

   2. During excavation and construction.

   3. After construction until the site is stabilized.

b. For subdivision plats this shall include temporary erosion control measures to be utilized by the applicant during installation of plat improvement and by subsequent builders during construction of dwellings and other lot improvements.

c. Prior to the initial clearing and grading, provisions shall be made for the interception of all potential silt-laden runoff that could result from said clearing and grading. Said interception shall preclude any silt-laden runoff from discharging from the proposed land development to downstream properties. Said interception shall cause all silt-laden runoff to be conveyed by open ditch or other means to whatever temporary facility is necessary to remove silt prior to discharge to downstream properties.

d. Prior to initial clearing and grading, an evaluation of the following factors must be carried out:

   1. **Soil Erodibility.** Soil erodibility should be identified using Soil Conservation Service erodibility ratings. Erosion control techniques shall be designed accordingly.

   2. **Slope and Runoff.** Cleared areas will require protection from erosion.

   3. **Cover.** Erosion protection will be required for all disturbed areas.

e. Temporary and permanent hydroseeding or acceptable seeding and mulching must be provided whenever perennial cover cannot be established on sites which will be exposed for 60-days or more.

f. Erosion Control Plans are reviewed and approved by the City in conjunction with Flood Plain Development Permits and Right-of-way Permits.

4.08 Storm Water Quantity Calculations

Design calculations performed and stamped by a Civil Engineer registered in the State of Oregon shall be included with all plan submittals. Peak design flows may be calculated using the Rational Formula, (Q = CiA) for basins with a **total area under 20 acres**. *Alternate methods or programs including King County, SCS, TR-20, SWMM, or others as approved by the City Engineer may be used for drainage basins with a total area greater than 20 acres.*

Design of storm drainage and related facilities shall incorporate both quantity standards utilizing the required frequency rainfall event, and storm water quality provisions as required in these Design Standards.

Project Engineer shall submit a certified set of detailed drainage calculations identifying drainage basins, estimated quantities of runoff for the existing and developed conditions, and detention/retention systems as required in these Design Standards.

The following guidelines shall be used in analyzing storm water runoff and sizing storm drainage facilities:

a. **Design Rainfall Event**

The following guidelines shall apply for selecting a design rainfall event. Design rainfall events shall be the 5, 10, 25, 50, and 100-year events. Analyses shall be provided showing no increase in runoff for all storm events up to, and including, the design frequency event.

Development Type	Design Frequency
Residential and commercial development	10-Year
Critical facilities, sag inlets, and minor drainage ways	25-Year
Critical drainage basins (As determined by the City)	100-Year
Major drainage ways or waterways having a delineated floodplain boundary as shown on the FIRM.	100-Year
Drainage ways or waterways not having a delineated floodplain boundary on the FIRM. (These shall be delineated by the Developer's Engineer and included on the final PLAT.)	100-Year

b. **Rainfall Intensity Duration Frequency Curve**

Rainfall intensities for projects in drainage basins with a total tributary basin area of less than 20-acres utilizing the Rational Method shall be obtained from the ODOT Zone 7 Intensity-Duration-Frequency (IDF) Curves.

RUNOFF COEFFICIENTS

LAND USE	SLOPE		
	2% or Less	2% to 7%	7% or More
Unimproved Areas	.10	.20	.30
Meadows & Pasture Land	.25	.30	.35
Woodland & Forests	.10	.15	.20
Impervious Surfaces (Pavement, Roofs, Driveways, Gravel, etc.)	.92	.92	.92
Agricultural	.15	.20	.25
Parks & Cemeteries	.15	.20	.25
Lawns	.17	.22	.35
Playgrounds	.20	.25	.30
Low Density Residential (1 to 3 units per acre)	.45	.50	.55
Medium Density Residential (3 to 6 units per acre)	.55	.60	.65
High Density Residential (6 to 15 units per acre)	.75	.80	.85
Commercial & City Business Areas	.85	.85	.85
Light Industrial	.65	.70	.80
Heavy Industrial	.75	.80	.90
Parks and Open Spaces	.10	.15	.20
Mobile Home Parks	.60	.65	.70

c. **Time of Concentration**

Time of Concentration shall be calculated using the Soil Conservation Service, or other approved method.

After a maximum of 300-feet, sheet flow typically becomes shallow concentrated flow. Open channel flow is assumed to begin where surveyed cross-section information has been obtained where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on Unites States Geological Survey (USGS) quadrangle sheets.

The minimum time of concentration shall be 10 minutes for a residential development.

4.09 Storm Water Detention

Development of areas within the City must provide runoff controls to limit the developed condition's peak rates of runoff to the pre-development runoff rate. Detention is the collection and temporary storage of surface water with the outflow rate restricted usually to the pre-developed flow rate. Required detention storage is equal to the difference in volume of excess runoff from the design storm event with post-development conditions and the 5-year storm with pre-development conditions.

a. Storm water detention is required for all developments, except where otherwise approved by the City Engineer.

b. Control orifices and structures shall be sized using approved engineering methods. To prevent plugging, the minimum diameter of the orifice shall be 2-inches. The detention facility shall have an overflow system with the capacity to past the 50-year storm event to an accessible drainage feature.

c. Detention shall be supplied either by subsurface storage in conduits and structures, or a pond. Temporary parking lot ponding may be utilized as storage volume with approval of the City.

d. Detention storage and release rates shall be calculated for all specified rainfall events up to and including the design rainfall event. *Example. A Detention requirement is for a 100-year rainfall event. Calculations shall include detention calculations for the 5-year, 10-year, 25-year, 50-year, and 100-year rainfall events with associated allowable release rates and orifice plates.*

4.10 Storm Drainage Design

The following physical design requirements shall be utilized by engineers for the design of public storm drainage facilities in the City. *These design requirements may be used for private systems when plumbing code requirements cannot be met, provided a professional civil engineer designs the system.*

a. Hydraulic Considerations

The minimum design velocity for storm drainage conduits shall be 3.0-feet per second. Pipe slopes of 20% or greater, require anchor walls at approved intervals. Manning's "n" value of 0.013 shall be used for flow and velocity calculations. Manning's equation shall be used for design of piped systems where practicable.

1. When pipe depths exceed 10-feet, calculations for pipe loading and strength shall be submitted.

2. Subsurface storm drains crossing private property shall have a minimum easement width of 10-feet, provided cover depth does not exceed 5-feet. Greater depths may require wider easements.

3. All storm drains shall be sized to accommodate undetained storm flows under the design rainfall event for the type of facility. Minor surcharging may be allowed under certain conditions when approved by the City Engineer.

4. Storm drains shall be designed for the specified storm rainfall event, however all designs shall provide for an overflow with capacity to accommodate the 50-year rainfall event.

b. Pipe Materials

Pipe materials shall be as allowed in City of Keizer Standard Construction Specifications. The City may approve alternate materials on a case-by-case basis.

Corrugated Metal Pipe (CMP) shall not be used.

Pipe load analysis calculations shall be submitted when requested by the City. Shallow cover (less than the minimum requirements stated in these Design Standards), excessive cover, or pipe material or method of manufacture may trigger the request.

Alternate materials may be reviewed on a case-by-case basis for approval.

c. Storm Drain Size

Main line and lateral storm drains shall not be less then 10-inches inside diameter and shall begin at a structure and shall terminate at an Approved Point of Discharge.

d. Minimum Grade of Storm Drains

All storm drains shall be laid on a grade which will produce a mean velocity (when flowing full) of at least 2.5-feet per second, based upon Manning's pipe friction formula using a roughness coefficient valued at not less than 0.013, or the pipe manufacturer's recommendations, whichever is greater. The minimum acceptable grades for various pipe sizes with an "n" value of 0.013 are listed in the table on the next page.

MINIMUM PIPE GRADE FOR 2.5 FT./SEC.

Inside Pipe Diameter (inches)	**Minimum Grade** (feet per 100 feet)
10	0.39
12	0.30
15	0.23
18	0.18
21	0.14
24	0.12
27	0.10
30 & larger	0.09

The minimum grade may be reduced from the above table to produce an absolute minimum velocity of 2.0-fps upon approval of the City. Cases requiring flatter grades than listed above shall be reviewed on a case-by-case basis by the City.

e. Alignment

Storm drains shall be laid on a straight alignment (horizontally and vertically) between catch basins and manholes.

f. Anchor Walls

Storm drains laid on slopes of 20 percent or greater shall be secured by anchor walls designed by the design engineer and approved by the City Engineer.

Where velocities greater than 15-feet per second are attained, special provisions shall be made to protect structures against erosion and displacement by shock.

g. Cover Requirements

All storm drains shall be laid at a depth sufficient to protect against damage by traffic and to drain building footings where practical. Sufficient depth shall mean the minimum cover from the top of the pipe to finish grade at the storm drain alignment.

Under normal conditions minimum cover shall be 30-inches above the top of the pipe in paved areas and 36-inches at all other locations. Cover requirements may be reduced if ductile iron pipe, control density backfill, or a concrete cap is incorporated into the design.

In areas of relatively flat terrain, the design engineer must show that sufficient depth is provided at the boundary of the development to properly drain the remainder of the upstream basin area tributary to the site.

h. Location

Where storm drains are being designed for installation parallel to other utility pipe or conduit lines, the vertical location shall be in such a manner that will permit future side connections of main or lateral storm drains and avoid conflicts with parallel utilities without abrupt changes in vertical grade of main or lateral storm drains.

When 2 parallel storm drains are installed adjacent to one another, e.g. at a culvert crossing, the minimum separation between the pipes shall be 1-foot or one-third the diameter, whichever is greater, as measured at the bell. This requirement may be waived if grouting or other approved method/substance fills the void between the pipes below the spring line.

4.11 Culverts

Culverts shall be designed to pass upstream tributary flows for a 50-year rainfall event.

Culvert design shall be performed using the Federal Highway Administration (FHWA) publication Hydraulic Design of Highway Culverts (Reference No. 10). Other methods may be used with approval of the City.

4.12 Storm Drain Appurtenances

Detailed drawings shall be included for all storm drain appurtenances including manholes, catch basins, culvert, head walls, orifice controls, detention diversion structures, etc. Appropriate references to Standard Details may be used in lieu of details actually shown on the plans, unless otherwise required by the City.

4.13 Manholes

Manholes shall be installed at the following locations in a storm drainage system unless otherwise allowed by the City:

a. All changes in horizontal or vertical alignment.

b. All junctions, changes in pipe size, and private/public interfaces.

c. At a maximum spacing of 500-feet.

Manhole diameter shall be determined by pipe size as follows:

Pipe Diameter	Required Manhole Diameter	Wall Thickness
Pipe diameter < 21”	48” Diameter Manhole	5”
Pipe Diameter 24” – 30”	60” Diameter Manhole	6”
Pipe Diameter 36” – 42”	72” Diameter Manhole	7”
Pipe Diameter 48” – 54”	84” Diameter Manhole	8”

4.14 Catch Basins and Inlets

In general, catch basins and inlets shall be constructed at all low points in streets, at intersections to prevent gutter drainage across handicap ramps, at points where changes in the street configuration will direct flow across the street, at intervals on continuous grades to limit the width of gutter flow, and at field or ditch inlets on perimeter drainage systems.

Following are additional design guidelines for the design and location of catch basins and storm drain inlets:

a. Minimum lateral diameter for connection to an inlet or catch basin shall be 10-inches.

b. Maximum diameter storm drain connection to a catch basin shall be 15-inches.

c. Catch basins shall be designed to completely intercept the 10- year design storm gutter flow. Water from all low areas must be collected and conveyed to the storm drainage system.

d. Quantity of gutter flow is determined using the Rational Method. Inlet design flows shall exceed gutter design flows. The width of gutter flow on residential streets shall not exceed 5-feet in a 10-year design storm at any point along the street.

e. The maximum total length of curb that may drain to a catch basin is 800 feet (400-feet each side). The maximum length of continuous sloping curb that may drain to a catch basin is 400-feet.

f. Catch basins shall be installed where the improvement ends on all streets terminating on a descending grade, and piped to an Approved Point of Discharge.

g. Catch basin laterals 30-feet or less in length and 10-inches in diameter or more may tie into the main line with a 90º "T", provided the connection is located not more than 100-feet from a manhole or cleanout and the main line connected to is 15-inches in diameter or greater. Flow through catch basins are prohibited

h. Water quality provisions shall be installed in all catch basins and/or manholes as directed by the City.

i. Type 2 side inlet catch basins, shall be used at all locations in streets where other construction (e.g., driveways, pedestrian ramps, etc.) or facilities do not prohibit. *Exceptions will be considered on a case-by-case basis.*

j. Type 3 field inlets shall be used to convey drainage from perimeter drainage systems, ditches, and similar inlets not associated with street drainage.

4.15 Storm Drain Location in Right-of-way

Under normal conditions, storm drains shall be located in the street right-of-way no closer than 5 feet from the curb line and preferably on the low side of the street. All exceptions shall be reviewed and approved by the City.

4.16 Surface Pond Design Requirements

Surface Ponds shall incorporate water quality provisions in accordance with these Design Standards where required by the City.

a. Interior slopes on surface ponds shall not exceed 3-feet horizontal to 1-foot vertical (3H:1V) for all storm detention and retention ponds. Exterior pond slopes shall not exceed two horizontal to one vertical (2H:1V).

b. The minimum bottom width of all ponds less than 3-feet deep shall be 6-feet. The minimum bottom width of all ponds 3-feet or more deep shall be 15-feet. The maximum design water depth in all detention ponds other than those in parking lots shall be 5-feet.

c. Ponds suited to multiple uses are encouraged. Examples of multiple uses are sport courts, play areas, neighborhood parks, and picnic areas. Such ponds may be designed with engineered walls (with slopes exceeding three to one) as approved by the City on a case-by-case basis.

d. All ponds shall be landscaped so as to provide slope stability and pleasant appearance by utilizing sodding, seeding, and planting of trees and shrubbery. Under no circumstances shall the use of floating or eroding materials (such as “bark dust”) be permitted in pond interiors.

e. Maintenance of surface ponds shall generally be the responsibility of a single property owner, homeowners association, or similar entity stipulated on a plat or in a similar recorded document. Failure to maintain a weed abatement program will be cause for the City to perform the work and bill the property owner. The City will maintain surface Pond inlet and outlet works, including the control structure.

f. When embankments, regardless of size, are constructed to form R/D facilities, the following requirements with regard to soils shall be designed, tested, and certified by a licensed geotechnical engineer. The licensed geotechnical engineer shall state, “The R/D facility embankments are stable and safe for their intended use.” in his certification/test report. A note of this requirement shall be indicated on the plans.

1. Embankment soils shall be compacted in 6-inch lifts.

2. Embankment soil permeability (k) shall be no greater than $3x10^{-5}$ cm/sec.

3. Vegetation on embankment soils shall be limited to shallow rooted varieties placed in topsoil above or adjacent to the engineered embankment soils.

g. Any embankment for a R/D facility in excess of 3-feet in height must be designed by a qualified geotechnical engineer and approved by the City. The minimum top width of this berm shall be 15-feet, unless designed, inspected, and certified by a licensed geotechnical engineer and approved by the City.

h. All City maintained detention pond control structures not abutting a public right-of-way shall be accessible to the City for maintenance and operation. A minimum 15-foot wide Access Easement with a 12-foot all weather drivable surface shall be provided in all such situations. Control structures shall be designed to operate automatically as much as possible.

i. Where required by the City, a vehicular access must be provided to the bottom of the surface pond. The access grade into the surface pond shall be no steeper than 5-feet horizontal to 1-foot vertical (5H:1V).

j. All detention ponds other than those in parking lots shall have a minimum of 1-foot of freeboard above the maximum design water surface.

k. Any embankment less than 3-feet, including 1-foot of freeboard, in depth forming one or more sides of a R/D facility shall have a minimum 6-foot wide top of berm with an exterior slope not to exceed 2-feet horizontal to 1-foot vertical (2H:1V).

l. The bottom of all constructed and graded R/D facility shall be sloped no flatter than 1% towards the outlet for drainage. *Exceptions to this requirement are natural ponds utilized for* R/D facilities.

m. The use of "flow through" detention ponds shall be encouraged by the City to allow for the installation and promote the use of water quality facilities. All "flow through" detention ponds shall have a well-defined low flow channel to contain runoff of lesser storms. Any low flow channel shall be designed so as to enhance the pond landscaping and overall pond appearance.

n. Outlets of all detention ponds shall be provided with suitable debris barriers and water quality controls designed to protect the outlet from blockage or plugging.

o. The design volume of the detention pond shall be shown on the plan and the pond volume inspected prior to landscaping (a note to this effect shall be shown on the plans).

4.17 Underground R/D Storage Facilities

Underground detention storage facilities are permitted in the City of Keizer. An approved drainage easement shall be required for all underground detention systems using the criteria set forth in Section 4.20

4.18 Storm Water Quality

Point source water quality facilities shall be provided where required by the City. Catch basins shall be outfitted with approved "turndowns" and sumps for oil/water separation and sedimentation control. Storm water quality manholes shall be installed in all proposed storm drains discharging into existing drainage facilities.

Storm Water Quality manholes shall be approved on a case-by-case basis by the City.

Biofiltration swales, wet detention basins, treatment wetlands, and other related storm water quality Best Management Practices (BMP's) shall be incorporated into project drainage design where required by the City. Only BMPs listed by an agency with a program in place to evaluate the BMP effectiveness will be considered for approval.

4.19 Easements for Storm Drains & Watercourses

a. When it is necessary to locate storm drains in easements, the storm drain shall be centered in the easement. *Exception: When the storm drain is 12-inches or less in diameter and the easement is centered on a property line, the storm drain shall be offset 18-inches from property line (distances being measured property line to center line of pipe) to allow for fencing.*

b. All storm drain easements shall be exclusive and shall not be used for any purpose that would interfere with the unrestricted use of the storm drain line. *The City will review exceptions such as a utility corridor in a new subdivision on a case-by-case basis.*

c. Easements for storm drain lines 18-inches or less in diameter with a depth less than 10 feet shall have a minimum width of 10-feet. Pipelines 18 to 36-inches in diameter with a depth less than 10-feet shall have a minimum

width of 15-feet. All pipelines greater than 36-inches in diameter shall have a minimum width of 20-feet. Pipelines greater than 10-feet in depth shall have an easement width equal to twice the depth of the pipe.

d. Open channels shall have easements sufficient in width to cover the 100-year Floodplain Boundary identified on the current adopted Flood Insurance Rate Map or in accordance with the best available information when a 100-year design storm is required, or 15-feet from the waterway centerline, or 10-feet from the top of the recognized bank, whichever is greater. A 15-foot wide access easement shall be provided on both sides of the channel for channel widths greater than 14-feet at the top of the recognized bank.

e. Easement locations for public storm drains serving a PUD, apartment complex, or commercial/industrial development shall be in parking lots, private drives, or similar open areas which will permit an unobstructed vehicle access for maintenance by City forces. Easements in these situations will be provided with a minimum 12-foot drivable surface.

f. All easements must be furnished to the City for review and approval prior to recording.

4.20 Easements for Surface R/D Facilities

a. Surface R/D facilities in subdivisions or partitions may be required to be located in separate tracts dedicated to the City with access easements for maintenance where required.

b. Where a detention pond is located within the boundaries of a residential lot and not in a separate dedicated tract, the peak design discharge water surface plain shall be shown as an easement on the final plat. Restrictions shall be added to the final plat and appear on the face of the plat.

c. A written restriction shall be added to the final plat to the affect that approval shall be obtained from the City before any structures, fill, or obstructions (including fences) are located within any drainage easement or delineated 100-year flood plain area.

d. An access gate for access roads may be required and shall be structurally and aesthetically acceptable for the use and location proposed, or an acceptable alternative to control traffic must be provided.

e. All publicly maintained storm water drainage systems including collection, conveyance, and flow restrictors not located in right-of-way shall be located in drainage easements.

f. Permanent access and drainage easements shall be granted to the City for all storm water retention/detention facilities, and for access easements to that facility. The owner in fee simple and contract purchaser of the property upon which the access road and facility are to be located shall execute the said easement. The minimum access easement width shall be 15-feet.

4.21 Storm Discharge into Creeks And Drainage Channels

Storm drain lines shall enter a creek or drainage channel at 90º or less to the direction of flow. The outlet shall have a head wall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of pipe or channel being entered will govern which protective measures are required.

Discharges shall be fitted with an approved backflow prevention device.

4.22 Slope Intercept Drainage

Slope intercept drains shall be provided at the following locations and shall be designed in accordance with all applicable sections of these Design Standards:

a. Along the upper boundaries of a development where the natural ground slope exceeds 10% to intercept drainage from the tributary area above the site.

b. Along the lower boundary of a development where the natural ground slope exceeds 10% to prevent drainage onto a lower tributary area other than by means of an Approved Point of Discharge.

c. Along the top of all cuts which exceed 2-feet where the area above the cut is tributary to the cut bank.

4.23 Subsurface Drainage

Where required, subsurface drainage shall begin at a cleanout and terminate at an Approved Point of Discharge. Open jointed storm drain lines are prohibited.

Subsurface drains shall be provided at the following locations:

a. On all cut and fill slopes in excess of 2-feet for stability except when a soils report submitted by a registered professional engineer experienced in soils certifies they are not required.

b. For all existing springs or springs intercepted during construction activity for other facilities, i.e., sewer, water mains, or street excavations.

c. Where high ground water exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or under floor flooding of buildings.

4.24 Surface Drainage

For purposes of these Standards, surface drainage routes will be classified according to two general categories: Artificial Watercourses, and Natural Rivers and Creeks.

a. Plan requirements for surface drainage courses shall include the requirements previously specified in these Design Standards and the following supporting data and calculations:

1. Plan drawn to a scale of not less than 1" = l00' with north arrow and vicinity map. Topography with 1-foot contours. If in a floodplain shown on the Flood Insurance Rate Map (FIRM), show the 100-year floodway contour.

2. Profile of the channel showing the existing flow line and top of bank, proposed flow line and top of bank and design storm water surface profile (backwater curve).

3. A minimum of three cross-sections of the existing channel adjoining or crossing the property taken at the upstream, midsection, and downstream boundaries of the property. More sections may be required depending on the length of the reach and existing channel alignment.

4. Calculations for arriving at the design flow rate. The City will furnish the flow rate when records are available. Analyze the proposed system and show that the channel cross section after improvement will pass the design storm with one (1) foot of freeboard to the top of bank. For channels shown on the FIRM maps, show that the channel cross-section after improvement will pass the base flood at or below the 100-year flood elevation shown on the FIRM.

4.25 Artificial Watercourse Requirements

a. Artificial watercourses shall be designed with a "natural" curved alignment with a variable side slope not to exceed a slope of 4-horizontal to 1- vertical (4H:1V), except that in tight spots created by existing natural features, e.g., boulders, large trees, etc., then the slope can be 3-horizontal to 1-vertical (3H:1V) until the natural feature is bypassed or where steeper slopes are needed and do not impair the hydraulic efficiency of the waterway.

The bank shall be designed with 1-foot of free board above the design storm with a minimum top of bank width of 6-feet. A larger width shall be provided when required by the City for maintenance purposes. The exterior slope of the bank shall not exceed 2 horizontal to 1 vertical (2:1).

The existing ground adjacent to the toe of the bank exterior slope shall be graded to slope away at 2 percent to prevent water ponding at the exterior slope's toe.

b. Design shall be curvilinear with a 100-foot minimum radius. Tighter curves may be used if the City determines that sufficient erosion control has been incorporated into the design to maintain stable bank conditions following development.

c. A low flow channel shall be designed to carry a two-year design storm or the normal low water flow of a year-round creek whichever is greater. Low flow channel slopes shall not exceed two to one and shall be stabilized to the satisfaction of the City. In general, bank stabilization will be required in any channel with a design flow velocity in excess of 3-feet per second. The invert shall be paved with concrete if the velocity is less than 3-feet per second and to prevent local ponding for mosquito abatement purposes.

d. Roadside ditch construction adjacent to public streets in new developments is not normally permitted. *Exceptions to this requirement will be reviewed on a case-by-case basis.*

e. Capacity of channels shall be determined by the Manning Formula. The value for "n" shall be 0.033 for maintained grass-lined swales. The value for "n" shall be 0.035 for channels with rock-lined bottoms.

f. Existing ditches approved for the Approved Point of Discharge for storm drains and culverts shall be provided with rock-lined bottoms and side slopes at the discharge point of storm drain or culvert. The rock shall extend for a minimum distance of 8-feet downstream from the end of the storm drain or culvert.

g. All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following construction. Bank stabilization measures shall be consistent with applicable sections of these Design Standards.

h. Approved Points of Discharge from culverts and storm drains into ditches and swales 15% or greater in grade shall be rock-lined with boulders with one face a minimum of 24" in dimension. Said rock lining shall extend for a distance of 10-feet minimum from the point of culvert or storm drain discharge and shall have a width 3-feet in excess of the diameter of the culvert or storm, drain. Special energy dissipaters may be substituted for boulders at the discretion of the City.

4.26 Natural Rivers & Creeks

Creek Classification: Creeks shall be classified as salmon-producing creeks or other creeks. No in-stream work will be allowed in salmon producing creeks during the months of June through October or as specified by Oregon's Division of State Lands (DSL). The intent is to minimize sediment production in these creeks during critical salmon spawning season. The following rivers and creeks shall be included in the salmon-producing classification:

Willamette River
Claggett Creek
Labish Creek

A permit must be obtained from the Division of State Lands and the Department of Fish and Wildlife for all in stream work (bank to bank).

4.27 Other Natural Creek Requirements

a. Natural creeks shall be preserved and all work in and adjacent to creeks shall incorporate both temporary and permanent erosion control measures in accordance with Section 4.07 of these Standards. No alteration will be permitted that reduces the overall creek capacity.

b. Creek channel design and construction practices shall be such that the cumulative incremental effects of creek work considered alone or together with existing or similar projects in the vicinity will not result in substantial damage to existing waterways and surface waters by erosion, siltation or sedimentation, significant changes in water quality, increased downstream water velocity, significant harmful deterioration of groundwater drainage, or significant deterioration of aquatic wildlife habitat as determined by the City.

c. Creek construction, relocation, and/or reconstruction may be approved if the City determines that such a proposal will result in an overall benefit to or maintenance of a surface water system of equal quality in terms of water quantity and quality control.

d. All stream work shall be consistent with floodplain management policies and regulations.

e. All stream work shall be consistent with storm water management policies and regulations.