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SECTION 3 – STORMWATER DESIGN & CONSTRUCTION STANDARDS

3.1 ENGINEERING

3.1.1 Introduction

This section outlines design and construction requirements for stormwater and surface water management. The provisions and technical specifications herein set forth the requirements of the City of Independence for constructing stormwater and surface water improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the City Engineer. Refer to Section 1 of these standards for general provisions and requirements.

Design guidelines established here are consistent with the City of Independence Stormwater Master Plan and the city's DEQ Total Maximum Daily Load requirements for suspended solids and mercury and as a stormwater Designated Management Agency (DMA). These provisions are intended to prevent or reduce adverse impacts to the drainage system and water resources of the Willamette River Basin. In combination with other federal, state, and local laws and ordinances, these requirements are intended to protect the beneficial uses of waters in the Willamette River Basin and inside the Independence city limits.

3.1.2 Purpose

A. The purpose of these Standards is to ensure the development of a stormwater management system which will:
   1. Provide on-site stormwater management through the use of Low Impact Development (LID) principles.
   2. Be of adequate design to safely manage all volumes of water generated upstream and on the site to an approved point of disposal.
   3. Provide points of disposal for stormwater generated by existing upstream properties and future upstream developments.
   4. Prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.
   5. Prevent the capacity of downstream channels and storm drainage facilities from being exceeded, unless downstream improvements to increase capacity are provided as part of the project.
   6. Have sufficient structural strength to resist erosion and all external loads which may be imposed.
   7. Maximize the use of the City's natural drainage system.
   8. Be designed in a manner to allow economical future maintenance.
   9. Require the use of design and materials to provide a system with a minimum practical design life of not less than 75 years.
   10. Shall not negatively impact existing water quality.

   Alternate materials and methods may be considered for approval on the basis of these objectives.

B. These standards cannot provide for all situations. They are intended to assist but not substitute for competent work by professional design engineers.

3.1.3 Alternative Design and Construction Standards

A. Any alternative design not explicitly approved herein will be considered for approval on the basis of the objectives set forth in Subsection "Purpose". Persons seeking such approval shall make application in writing to the City Engineer. Approval of any major deviation from these Standards shall be in written form. Approval of minor matters will be made in writing,

if requested. Any and all such requests shall be submitted in writing to the City Engineer prior to City approval of the design drawings.

B. The design of the following items are considered special items and are not covered in detail in these Standards:
   1. Stormwater pump stations and force mains
   2. Siphons
   3. Energy dissipators
   4. Flow measurement devices
   5. Bore Crossings
   6. Concrete box culverts

C. Review and approval of the above special items by the City Engineer shall be required. When requested by the City, full design calculations shall be submitted for review prior to approval by the City.

3.1.4 Extension of Public Storm Sewer Systems

Public storm sewer systems shall be extended to the most distant upstream parcel boundary or boundaries to accommodate current and future storm flows entering the property, unless otherwise approved by the City Engineer. Except as otherwise provided, the extension or upsizing of the public stormwater systems to serve any parcel or tract of land shall be done by, and at the expense of, the property owner or permit applicant. The City Engineer may require a storm pipeline that serves or may serve more than one property to be a public system.

3.1.5 Drainage Plans

A. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines in these standards.

B. All elevation on design plans and record drawings shall be based on the NAVD 1988 datum.

C. All engineering drainage plans shall be stamped by a Professional Engineer registered in the State of Oregon. The drainage plan shall contain the following:
   1. At least one sheet showing a plan view of the entire project site. If the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.
   2. A topographic map showing existing conditions for the site, including:
      a) Existing topography for the site.
      b) Adjacent streets, including street names.
      c) Existing utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert elevations.
      d) Existing sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).
   3. Plans for proposed drainage improvements shall include the following:
      a) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations.
      b) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscaped areas, etc.
      c) Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed drainage system.

d) Applicable detail drawings.
e) Existing and proposed easements.
f) Setbacks from environmentally sensitive areas or protected resource areas. There shall be a 25' greenway setback along the banks of Ash Creek. The 25' shall begin at the top of the bank or at the high-water mark, whichever is higher.
g) Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc.
h) Plan and profile of drainage conveyance facilities, including the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure (e.g., 48-inch diameter manhole), location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included for referencing details, cross-sections, profiles, etc.
i) Any proposed phasing of construction. (Note: water quality and quantity facilities must be constructed before completion of any phased construction)

4. A detailed grading plan shall be provided for all open stormwater quantity or quality control facilities. The plan shall include the following:
   a) Existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.
   b) Location of top and toe of slope.
   c) Limits of embankment designed to impound water.
   d) Location of all drainage structures as well as any other piped utilities in vicinity (0.1-foot detail).
   e) Flow route of the secondary/emergency overflow system (0.1-foot detail).
   f) Maintenance access, as applicable (see Subsection "Access Road Design").
5. A detailed landscape plan shall be provided for open stormwater quantity or quality control facilities. The plan shall include the following:
   a) Final ground contours at a minimum 1-foot contour interval.
   b) Location of top and toe of slope.
   c) Maximum water surface elevations.
   d) Location of all drainage structures as well as any other piped utilities in vicinity (screened) (0.1-foot detail).
   e) Limits of areas to receive amended topsoil.
   f) Irrigation plan to achieve the required plant survival rate.
   g) Planting species, locations, and densities in accordance with the landscape requirements in Section 8, "Landscape Requirements: Stormwater Quality and Quantity Facilities".
6. Cross sections shall be provided for at least the following:
   a) Detention/retention ponds, wet ponds, and sediment ponds. Cross-sections shall graphically illustrate the following:
      1) Design maximum water surface for the 2-year, 10-year, and 50-year design storms.
      2) Proposed dead storage water surface (as applicable).
      3) Pavement section or amended soil section, as applicable.
   b) Proposed ditches and swales, including vegetated swales.

3.1.6 Storm Systems and Fish Passage

For pipe systems that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. All box

culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria*, or latest edition, unless exempted by ODFW and the City.

3.1.7 Surveying

A. The design engineer shall be responsible for establishing the location of the sewer using reference stakes offset along the sewer. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.
B. Stakes shall locate all public tees, cleanouts, manholes, catch basins, area drains, water quality stations, and pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts or fills to all invert elevations and rim grades. The design engineer shall also be responsible for identifying easements during construction.

3.2 HYDRAULIC ANALYSIS

3.2.1 General

The method of hydraulic calculations shall be subject to approval from the City Engineer and shall be consistent with Subsection "Hydrology and Hydraulics."

3.2.2 Hydraulic Design

A. Detention/retention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report. Acceptable analysis programs include:
    1. HYD – King County, Washington
    2. HEC-1 – U.S. Army Corps of Engineers
    3. HEC-HMS – U.S. Army Corps of Engineers
    4. SWMM – U.S. Environmental Protection Agency
    5. HYDROCAD – HydroCAD Software Solutions
    6. Others, as approved
B. Peak runoff rates shall not exceed predevelopment rates for the specific range of storms. Exemptions to the on-site detention requirements may be considered for situations in which properties discharge directly to the Willamette River or to open bodies of water that have no capacity limitations, or areas where detention in downstream reaches could increase peak stormwater flow rates, and other areas or unique circumstances as identified by the Public Works Director.
C. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway.
D. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment.

3.2.3 Design Criteria

A. The facility can be a combined water quality/quantity facility, provided that it meets all relevant criteria.
B. Interior side slopes up to the maximum water surface = 4H:1V.
C. Maximum exterior side slopes = 2H:1V, unless analyzed for stability by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.
D. If slopes need to be mowed, maximum side slope = 4H:1V
E. Walls in Water Quality/Quantity Facilities

1. Retaining walls may serve as pond walls if the design is prepared and stamped by a Professional Engineer registered in the State of Oregon and a 4-foot-tall black vinyl chain link fence is provided along the top of the wall. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.
2. Walls that are 4 feet or higher must meet all of the following criteria:
    a) Be designed by a Professional Engineer registered in the State of Oregon whose area of expertise is structural or geotechnical engineering.
    b) The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water quantity tract or easement shall be clearly documented in the City's Permanent Access Easement & Stormwater Detention System Easement & Detention System Maintenance Agreement.

F. Over excavated by a minimum of 20% to allow for sediment deposition.
G. Minimum freeboard = 1 foot from 50-year design water surface elevation.
H. Maximum water storage depth in water quality/quantity facilities for the 50-year storm event shall not exceed 4 feet in depth, unless otherwise approved by the City Engineer. Where design depth exceeds 4 feet, the facility shall be constructed in conformance with public safety considerations (see Section "Detention/Retention Facility Protection").
I. Provide approved outlet structure(s) for all flows up to the 100-year storm event.

3.2.4 System Design Criteria

Site development improvement projects shall address on-site and off-site drainage concerns, both upstream and downstream of a project, including but not limited to the following:

A. Modifications to the existing on-site storm drainage facilities shall not restrict flows creating backwater onto off-site property.
B. Storm drainage facilities shall be designed and constructed to accommodate all future full build out flows generated by the proposed development or improvement and all upstream property based on the most recent approved comprehensive land-use plan.
C. The design of storm drainage facilities shall analyze the impact of restrictions downstream of the project site, in accordance with Subsection "Review of Downstream System." Downstream restrictions that create on-site backwater may be required to be removed by the applicant, at the discretion of the City Engineer, or the on-site backwater shall be addressed in the design of the development's storm system. The removal of downstream obstructions shall not be allowed if removal would create downstream capacity problems.
D. If the projected increase in the surface water runoff from a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition before development, or the applicant shall construct an on-site detention/retention facility.

3.2.5 Review of Downstream System

A. The design engineer for each development that establishes or increases the impervious surface area by more than 1 acre shall submit documentation for review and approval by the City Engineer, of the downstream capacity of any existing storm facilities impacted by the proposed development.
    1. The analysis shall extend downstream to a point in the drainage system where the additional flow from the proposed development site constitutes 10% or less of the total tributary drainage flow (for example, the analysis point for a 10-acre site would be analyzed to the nearest downstream point with a drainage area of 100 acres).

2. When the additional flow from the proposed development drops to less than 10% of the total tributary drainage flow, the analysis will continue for the lesser of the following:
    a) One-quarter of a mile; or
    b) Until the additional flow constitutes less than 5% of the total tributary drainage flow.

B. When the downstream analysis does not continue for at least ¼ mile, the design engineer shall provide a stamped Certification of Investigation stating that he/she has visually investigated the downstream system for at least ¼ mile and is aware of no observable downstream impacts to structures.

3.2.6 Conveyance System Hydraulic Standards

A. The conveyance system shall be designed to convey and contain at least the peak runoff for the design storm events in **Table 3.1** below using the Rational Method.
B. The Santa Barbara Urban Hydrograph (SBUH) based computer program may be used in sizing storm drain pipes. A 50-year, 24-hour design storm event must be used in lieu Rational Method storm events identified in **Table 3.1**.
C. Structures for proposed pipe systems must be demonstrated to provide a minimum of 1 foot of freeboard between the hydraulic grade line and the top of the structure or finish grade above pipe for the identified post-development peak rate of runoff.
D. Design surcharge in new pipe systems shall not be allowed if it will cause flooding in a habitable structure, including below-floor crawl spaces.
E. The design storm events shall be supplemented with an overland conveyance component demonstrating how a 100-year event will be accommodated. The overland component shall not be allowed to flow through or inundate an existing building.
F. Flows in streets during the 25-year event shall not run deeper than 4 inches against the curb or extend more than 2 feet into the travel lane.
G. Open channel systems shall be designed for minimum 1-foot freeboard from bank full, provided that no structures are impacted by the design water surface elevation.

Table 3.1.

Rational Method – DESIGN STORM EVENTS	
AREA or Road Classification	**24-HOUR DESIGN STORM**
Tributary Basin ≤ 15 acres	10-year
Tributary Basin > 15 acres	25-year
Local Roads	10-year
Collector or Higher	25-year

3.2.7 Catch Basin System Standards

Design of catch basins and drain inlets shall follow the specifications provided in Subsection "Drain Inlet Design Standards."

A. **Standard Catch Basin System:** All catch basins shall be sumped. The main storm line shall not pass through any catch basins or sumped manholes unless approved by the City Engineer. No more than three catch basins may be connected in a series before connecting to the main storm line. A ditch inlet or field inlet may be connected directly to the end of the main storm line.
B. **Series Catch Basin System:** No more than three catch basins may be constructed in series. No ditch inlet or field inlet may be part of a series of catch basins.
C. **Flow-through Catch Basin System:** This system is allowed within an arterial or collector road, provided that the mainline storm pipe has a design velocity of at least 3 feet per

second. Unsumped catch basins, ditch inlets, and field inlets are allowed to connect directly to the main storm line. An adequately sized water quality manhole is required at the downstream end of the flow-through system.

D. Grates shall be identified with a pavement marking in bike lanes, as indicated by the MUTCD, Part 9, or latest edition. Drainage grate inlets shall be bicycle-safe (as required by ORS 810.150) and hydraulically efficient.

3.3 HYDROLOGY & HYDRAULICS

3.3.1 Hydrologic Analysis

This section describes acceptable methods of estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods shall be used to analyze existing and to design proposed drainage systems and related facilities.

3.3.2 Rational Method

The rational method for analyzing small drainage basins is allowed, with the following limitations:

A. Use it only in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.

B. Drainage sub-basin area cannot exceed 25 acres for a single calculation without approval from the City Engineer.

C. The time of concentration shall be five minutes when computed to be less than five minutes.

D. Rainfall intensities shall be from **Table 3.2,** or an alternative approved by the Public Works Department is the ODOT Zone 8 IDF Curve.

E. Rational formula:

$$Q=C*I*A$$

Where: Q = Flow in cubic feet per second.
C = Runoff coefficient (0.9 for paved surfaces).
I = Intensity.
A = Area in acres

Table 3.2. RAINFALL DISTRIBUTION

Time of Concentration (minutes)	Storm Event (year and probability)				
	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
5	2.01	2.25	2.63	3.00	3.35
10	1.60	1.78	2.07	2.33	2.58
15	1.32	1.50	1.72	1.95	2.90
20	1.13	1.30	1.50	1.69	2.19
30	0.91	1.02	1.21	1.36	1.51
40	0.75	0.84	0.98	1.11	1.24
50	0.64	0.73	0.85	1.15	1.08
70	0.53	0.59	0.68	0.95	0.85
100	0.44	0.49	0.56	0.62	0.69
180 or more	0.33	0.38	0.43	0.48	0.52

Data from City of Independence Public Works Design Standards, January 2023

3.3.3 Unit Hydrograph Method

A. **Hydrograph Analysis:** To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the City Engineer. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume, and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.
The HYD computer program, developed by King County, Washington, in its "Surface Water Design Manual," January 1990, uses these methods to generate, add, and route hydrographs. The City Engineer may check all hydrologic calculations using the King County HYD program.

B. **Design Storm:** Return frequency and duration specify the design storm event. The design storms shall be based on total rainfall (depth in inches).

C. **Design Storm Distribution: The** total depth of rainfall for storms of 24-hour duration is shown in **Table 3.3** The rainfall distribution to be used in the City is the design storm of 24-hour duration based on the standard National Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), type 1A rainfall distribution.

Table 3.3. RAINFALL DISTRIBUTION

Recurrence Interval (years)	Total Precipitation Depth (inches)
2	3.00
5	3.60
10	4.20
25	4.60
50	5.20
100	5.70

D. Runoff Parameters: The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.
   1. Area
      a) To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use in a given basin must be addressed by dividing the basin area into sub-basin areas of similar land use or runoff characteristics. Hydrographs shall be computed for each sub-basin area and superimposed to form the total runoff hydrograph for the basin.
      b) All pervious and impervious areas within a given basin or sub-basin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately, the cumulative errors associated with averaging these areas are avoided, and the true shape of the runoff hydrograph is better approximated.
   2. Selection of Curve Number
      a) The NRCS has developed CN values based on soil type and land use. The combination of these two factors is called the "soil-cover complex."
      b) Soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil hydrologic groups may be found in Table 14, *Soil Survey of Polk County, Oregon* (SCS, November 1982).
         1) Many factors can affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
         2) CN values can be area-weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas shall not be combined with low CN areas (unless the low CN areas are less than 15% of the sub-basin).
         3) Antecedent soil moisture values shall be considered. Soil shall be considered to be saturated before the start of a precipitation event.
   3. NRCS Curve Number Equations:
      a) Time of Concentration: Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of T_c. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph.
         1) Sheet Flow: Sheet flow is flows over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute T_t:

            $T_t = (0.93L^{0.6} \times n^{0.3}) / (I^{0.4} \times S^{0.3})$

            Where: T_t = travel time (minutes).
            n = Manning's effective roughness coefficient for sheet flow.
            L = flow length (feet).
            I = rainfall intensity (inches per hour).
            S = slope of hydraulic grade line (feet per foot [ft./ft.])

            Sheet flow shall not be used for distances over 300 feet.
         2) Shallow Concentrated Flow: For slopes less than 0.005 ft./ft. (0.5%), the following equations can be used:
            (a) For unpaved surfaces: $V=16.1345\ (S)^{0.5}$

(b) For paved surfaces: $V=20.3282\ (S)^{0.5}$

Where: V = velocity (feet per second).

S = slope (ft./ft.).

3) Channel Flow: A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$V = (1.486 / n) \times R^{0.6} \times S^{0.5}$

Where: V = velocity (ft./s).

n = Manning's roughness coefficient.

S = slope of flow path (ft./ft.).

R = area/perimeter.

3.3.4 Water Quality Flow

The water quality storm is the storm required by regulations to be treated. The storm defines the rate of runoff. The Water Quality Storm Event is the total precipitation of 1.50 inches falling in 24 hours.

3.3.5 Hydraulics

Catch Basins and inlets collect water from an adjacent ditch, gutter line, or pavement and convey the water to a storm sewer or box culvert. The inlet systems are to be designed in accordance with the following criteria:

A. Subsection "Drain Inlet Design Standards."
B. The following sources shall be used to locate catch basins and inlets:
   1. ODOT's "Hydraulics Manual."
   2. Hydraulic Engineering Circular 12 (Federal Highway Administration, FHWA-84-202), "Drainage of Highway Pavements."

3.3.6 Area Drains

The maximum acceptable intake flow rate for Type II area drains and ditch inlets is shown in **Table 3.4**.

Table 3.4. INTAKE FLOW RATE, GRATE ANGLE 30 DEGREES

Hydraulic Head (ft.)[1]	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Flow Rate (cfs)[2]	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

[1]Measure from bottom of grate to headwater.

[2]Cubic feet per second.

3.3.7 Channel Protection

Open channels shall be designed to prevent long-term scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6-inch-thick gravel base. **Table 3.5** provides additional design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.5. CHANNEL PROTECTION, NEW CHANNEL CONSTRUCTION

Velocity at Design Flow (feet per second)		Required Protection	Thickness (feet)	Minimum Height Above Design Water Surface (feet)
Greater Than	Less Than or Equal to			
0	5	Vegetation lining	N/A	0.5
5	8	Bioengineered lining[1] or ODOT Class 50 riprap[2]	N/A 1.5	1
8	12	ODOT Class 200 riprap[2]	2.5	2
12	20	Slope mattress, etc.[3]	Varies	2

[1]Bioengineered lining allowed for flows between 5 and 8 feet per second.
[2]ODOT riprap class in English units
[3]For high-velocity channels, engineering calculations are to be submitted to the City Engineer for review and approval.

3.3.8 Outfall Protection

Stormwater outfalls shall be designed to prevent scouring at, or in association with, the outfall discharge and provide velocity reduction before discharge to the receiving channel. Engineered energy-dissipaters shall be required for outfalls with design flow discharge velocities greater than 3 feet per second (fps). **Table 3.6** provides design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

Table 3.6. ROCK PROTECTION

Discharge Velocity at Design Flow (fps)	Required Protection (Minimum Dimension)				
	Type	Thickness[2]	Width	Length	Height
0 to 5	ODOT Class 50 riprap[1]	1.5 ft.	Diameter + 6 ft.	8 ft. or 4 x diameter, whichever greater	Crown + 1 ft.
5 to 10	ODOT Class 200 riprap[1]	2.5 ft.	Diameter + 6 ft. or 3 x diameter, whichever greater	12 ft. or 4 x diameter, whichever greater	Crown + 1 ft.
Greater than 10	Designed system[3]	As required	As required	As required	Crown + 1 ft.

[1]ODOT riprap class in English units.
[2]Riprap shall be grouted in place.
[3]For high-velocity outfalls, engineering calculations are to be submitted to the City Engineer for review and approval.

3.3.9 Detention/Retention Facility Protection

A. Stormwater quantity detention/retention facilities and stormwater quality facilities shall be designed to prevent scouring at the inflow structure(s) by using an engineered energy-dissipating device such as a swale inflow spreader or other method approved by the City Engineer.
B. The nearest upstream manhole from a stormwater quantity detention/retention pond or swale shall be a stormwater pretreatment manhole conforming to these standards.

C. Safety
    1. Stormwater facilities shall include a vegetated buffer or a safety bench.
    2. Side slopes in stormwater facilities shall not exceed 4H:1V up to the maximum design water elevation.
    3. Stormwater facilities shall be posted with warning signs that prohibit swimming or wading.
    4. Where fencing is required by federal, state, and local laws and ordinances for public safety considerations or security reasons, the fencing shall be 4-feet in height, black vinyl coated chain link fence. No barbed wire fencing shall be used.

3.3.10 Drainage Report

A. The drainage report shall be on 8½ x 11 paper. Maps shall be folded to 8½ x 11 size unless another format is approved before the report is submitted.
B. The drainage report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:
    1. Cover sheet, including the project name, applicant's name, address, and telephone number, design engineer's name, and date of submittal.
    2. Table of contents, with page numbers for each section of the report, including exhibits, appendices, and attachments.
    3. Vicinity Map.
    4. Project description, specifying type of permit(s) for which the applicant is applying, size and location of the project site, address or parcel number, and property zoning. Also describe other permits required (e.g., Corps of Engineers 404 fill permit). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.
    5. Existing Conditions
        a) Describe existing site conditions and relevant hydrological conditions, including but not limited to the following:
            1) Project site topography.
            2) Land cover and land use.
            3) Abutting property land cover, land use, and ownership information.
            4) Off-site drainage to the property.
            5) Natural and constructed channels.
            6) Wetlands, creeks, ravines, gullies, steep slopes, springs, and other sensitive areas on or adjacent to the project site.
        b) General soil conditions in the project site, using SCS soil designations.
        c) Points of discharge for existing drainage from the project site.
        d) References to relevant reports, such as basin plans, flood studies, groundwater studies, wetland designations, watershed plans, sub-basin master plans, sensitive area designation, environmental assessments, water quality reports, or other relevant documents. Where such reports impose additional conditions on the applicant, those conditions shall be included in the report.
        e) Soils report(s), where applicable.
        f) Hydrologic analysis, pursuant to Subsection "Hydrologic Analysis."
        g) Basin maps showing boundaries of project, any off-site contributing drainage basins, on-site drainage basins, approximate locations of all major drainage structures in the basins, and depicting the course of stormwater originating from the subject property and extending to the closest receiving body of water. Reference the source

of the topographic base map (e.g., USGS), the scale of the map, and include a north arrow.

h) Description of drainage basin(s) to which the project site contributes runoff, and identification of the receiving waters for each basin.

6. Developed Conditions
   1) Developed site drainage conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposed methods for collection and conveyance of runoff from the project site, for the control of any increase in stormwater quantity resulting from the development, and for maintaining stormwater quality.
   2) Description of upstream and downstream basins, identifying any sources of runoff to the project site. Description shall be based on field investigation. Any existing drainage or erosion issues upstream that may affect the proposed development shall be noted.
   3) Downstream analysis.
   4) Hydraulic design computations, supporting the design of all proposed stormwater conveyance, quantity, and quality control facilities, and verifying the capacity of existing and proposed drainage facilities. These computations may include capacity and backwater analysis required either as part of the proposed drainage design or as part of the downstream drainage investigation, and flood routing computations required for the design of detention/retention storage facilities, for wetland impact analysis, or for floodplain analysis. Include a description of how the stormwater system will function during the water quality storm, ½ of the 2-year, 10-year and 50-year, 24-hour return storm.
   5) Operation and maintenance manual required for privately owned and maintained stormwater quantity and quality control facilities. The manual will be an attachment to the City's Permanent Access Easement & Stormwater Detention System Easement & Detention System Maintenance Agreement.
   6) Appendices shall include necessary technical information.

3.4 WATER QUANTITY FACILITY DESIGN

3.4.1 Mitigation Requirement for Quantity

Each new development is responsible for mitigating its impacts on the public stormwater system. The City Engineer shall determine which of the following techniques may be used to satisfy this requirement. Mitigation requirements shall meet applicable federal, state, and local standards and regulations.

A. Construction of permanent on-site stormwater quantity detention/retention facilities, designed in accordance with these standards.
B. Enlargement or improvement of the downstream conveyance system shall be done in accordance with these standards.

3.4.2 Criteria for Requiring On-Site Detention/Retention

On-site facilities shall be constructed when any of the following conditions exist:

A. The proposed development establishes or increases the impervious surface area by more than 10,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
B. There is an identified downstream deficiency, and detention/retention rather than conveyance system enlargement is determined to be the more effective solution.

C. There is an identified regional detention/retention site within the boundary of the development.
D. A site within the boundary of the development would qualify as a regional detention/retention site under the criteria or capital plan adopted by the City.
E. Water quantity facilities are required by City-adopted stormwater master plans or adopted sub-basin master plans and TMDL requirements.

3.4.3 Water Quantity Facility Design Standards

A. When required, stormwater quantity on-site detention/retention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the predeveloped runoff rates, based on a ½ of the 2-year, 10-year and 50-year, 24-hour return storm. Specifically, the post-development runoff rates shall not exceed their respective predevelopment runoff rates, unless other criteria are identified in an adopted stormwater master plan or sub-basin master plan.
B. Water quantity facilities shall be designed to include inlet energy dissipation and a sediment forebay. The sediment forebay shall consist of an area in which heavier sediments can accumulate and receive periodic maintenance to remove these sediments. The forebay size shall be engineered with respect to the anticipated flow rate, and have a durable surface, such as concrete or rock, suitable for periodic maintenance. A minimum size of 20 square feet of water area is anticipated. Some type of barrier shall separate the forebay area from the main area of the water quantity facility. The invert of the incoming storm drain pipe shall be set at or above the top of the forebay barrier elevation and shall consider the pipe wall thickness. Pond inlets with a drainage area of less than one-third acre (⅓ AC) may not require a sediment forebay.
C. Water quantity facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection “Sediment Management/Pollutant Control”
D. When required because of an identified downstream deficiency, stormwater quantity on-site detention/retention facilities shall be designed so the peak runoff rates will not exceed predevelopment rates for the range of storms that cause the downstream deficiency.
E. The average, wet-season groundwater elevation shall be determined for the proposed stormwater quantity facility. Groundwater elevation may be established through measurements at existing wells, installation of piezometer(s), or other methods approved by the City Engineer. The facility shall be designed to exclude detention/retention capacity below the established wet-season groundwater elevation.
F. Water quantity facilities in which water is in direct contact with the soil must be lined with either a low permeability liner or a treatment liner when the soil does not have properties which reduce the risk of groundwater contamination from stormwater runoff that may infiltrate in the facility. Liners shall be designed in accordance with Section 11, “Water Quality Facility Liners.”
G. Construction of on-site detention/retention facility shall not be allowed as an option if such a facility would have an adverse effect on receiving waters in the basin or sub-basin in the event of flooding or would increase the chance or severity of flooding problems downstream of the site.
H. No water quantity facility shall be built in a public easement or right-of-way unless approved by the City Engineer or be located in an area designed or used for vehicular parking.
I. Vegetation shall be planted in accordance with Section 8, “Landscape Requirements for Stormwater Facilities.”
J. Water Quantity Facilities shall be constructed in conformance with Subsection “Design Criteria.”

K. Water Quantity Facilities shall be constructed in conformance with public safety considerations in "Safety" in Subsection "Detention/Retention Facility Protection."
L. Stormwater quantity facilities shall be protected in conformance with Subsection "Detention/Retention Facility Protection."
M. Access roads to stormwater facilities shall be in conformance with Subsection "Access Road Design."

3.4.4 Access Road Design

Access roads are for maintenance and inspection purposes. All-weather access shall be provided for the entire perimeter of the stormwater facility, unless otherwise approved by the City Engineer. At a minimum, access shall be provided for maintenance and inspection of the inflow and outflow structures of the facility. The following criteria are the minimum City requirements:

A. Three inches of Class C AC; over 8 inches of 1"-0"compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.

   Or

   The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.
B. The plan shall include the design of strengthened sidewalk sections where maintenance vehicles will cross.
C. Maximum grade: 15% with a maximum 3% cross-slope.
D. Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.
E. A 2-foot-wide gravel shoulder shall be provided on the facility side of the access road.
F. Access shall extend to within 10 feet of all control structures, unless otherwise approved by the City Engineer.
G. If fencing is required for public safety or security reasons, the fence shall include a 12-foot-wide lockable gate for maintenance access.

3.4.5 Flood Management Design Standards

A. Purpose: The purpose of these standards is to reduce the risk of flooding, prevent or reduce the risk to human life and property, and maintain the functions and values of floodplains, such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems.
B. Flood Management Areas Defined: Flood management areas shall include, but are not limited to, the following:
   1. Land identified within the 100-year floodplain and floodway, as shown on the Federal Emergency Management Agency (FEMA) flood insurance maps.
   2. Land identified in updated flood studies or any other authoritative data documenting flood elevations, as approved by the City. The design engineer shall use the most recent and technically accurate information available to determine flood areas.
C. Flood Plain Delineation: In areas of the City where the 100-yr flood plain has not been defined as per this section, the City Engineer may require a study to delineate the 100-yr flood plain prior to development of a site to access the potential impact to upstream or downstream properties.
D. Design Criteria: Design and construction of improvements within the 100-yr flood plain shall be in conformance with these Standards, all flood plain requirements of the Independence City Code, and all applicable federal, state, and local statutes and rules governing flood plains and flood hazard areas.

1. All fill placed in a flood plain shall be balanced with an equal amount of removed soil material and shall not decrease the flood plain storage capacity at any stage of a flood. No net fill in any floodplain is allowed except when all of the following conditions are met:
    a) When an area has received special protection from floodplain improvement projects that lower the floodplain or otherwise protect affected properties.
    b) Where the exceptions comply with adopted master plans, watershed management plans, or sub-basin plans, if any.
    c) When all required permits and approvals have been obtained in compliance with FEMA rules and other local, state, and federal laws regarding fill in floodplains.
2. Large areas may not be excavated to gain a small amount of fill in a floodplain. Excavation areas shall not exceed the fill areas by more than 50% of the square footage, unless approved by the City Engineer.
3. Any excavation dug below the winter low-water elevation shall not count toward compensating for fill, because those areas would be full of water in the winter and not available to hold stormwater after a rain. Winter low-water elevation is defined as the water surface elevation during the winter when it has not rained for at least three days, and the flows resulting from storms have receded. The elevation can be determined from records, studies, or field observation. Any fill placed above the 100-year floodplain will not count toward the fill volume.
4. The excavated area must be designed to drain if it is an area identified to be dry in the summer, e.g., if it is used for a park or mowed in the summer. Excavated areas identified to remain wet in the summer, such as a constructed wetland, shall be designed not to drain. For areas that are to drain, the lowest elevation shall be at least 6 inches above the winter low-water elevation and sloped to drain. Slopes of 1% will be allowed in areas of less than 1,000 square feet.
5. Excavation to balance a fill shall be on the same parcel as the fill unless it is not reasonable or practicable to do so. In such cases, the excavation shall be in the same drainage basin, within points of constriction on the conveyance system, if any, as near as practical to the fill site, and shall be constructed as a part of the same development project.
6. Temporary fills permitted during construction shall be removed at the completion of construction and before the closure of the in-stream work window, as defined by the ODFW or federal, state, or other local authority.
7. Excavation and fill required for the construction of detention/retention facilities or other facilities, such as levees, shall be specifically designed to reduce or mitigate flood impacts. Levees shall not be used to create vacant buildable land.
8. Excavation and fill required to restore or enhance floodplains, riparian areas, wetlands, uplands, and streams, including but not limited to the planting of vegetation and daylighting of existing storm pipes, shall be permitted as long as the design complies with applicable federal, state, and local standards.
9. The floodplain may not be modified to increase water velocities such that stream bank erosion will be increased.
10. Uncontained areas of hazardous materials, as defined by the Oregon DEQ, are prohibited in flood management areas.
11. Any proposed work within, or modification to, a floodway must be certified by a Professional Engineer registered in the State of Oregon as to how it conforms to these standards and FEMA regulations.
12. For streams, creeks, rivers, and other watercourses where the floodway has not been identified, the entire floodplain shall be treated as a floodway unless a study has been

prepared by a Professional Engineer registered in the State of Oregon and approved by the City Engineer to define the floodway limits for a stream section.

3.5 WATER QUALITY FACILITY DESIGN

This section describes methods of designing water quality facilities. Water quality facilities are designed to remove pollutants from stormwater runoff. The pollutants of concern include, but are not limited to, sand, silt, and other suspended solids; metals such as mercury, copper, lead, and zinc; nutrients such as nitrogen and phosphorus; certain bacteria and viruses; and organics such as oil, grease, petroleum hydrocarbons, and pesticides. Methods of removing pollutants include sedimentation or settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum shall be removed with separators.

3.5.1 Water Quality Facility Design Standards

A. Purpose: New development and other activities that create new 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 stormwater and surface water system. Water quality volume and flow shall be determined as described in Subsection 3.3.4, “Water Flow.”

B. Criteria for requiring construction of water quality facility: A water quality facility shall be constructed on site unless, in the judgment of the City Engineer, any of the following conditions exist:
   1. The site location, size, gradient, topography, soils, or presence of a significant resource make it impractical or ineffective to construct an on-site facility.
   2. The sub-basin has a more effective, existing regional site designed to incorporate the development or which has the capacity to treat the site stormwater.
   3. The development is for construction of single-family or two-family (duplex) dwellings on existing lots of record which will establish or create less than 10,000 square feet of impervious surface.

C. Design standards
   1. Stormwater quality facilities shall be designed to capture and treat 80% of the average annual runoff volume, to the maximum extent possible, with the goal of 70% total suspended solids (TSS) removal. Impervious surfaces shall include pavement, gravel roads, buildings, public and private roadways, and all other surfaces with similar runoff characteristics.
   2. The removal efficiency standard for TSS specifies only the design requirements. It is not intended as a basis for performance evaluation or compliance determination of a stormwater quality control facility installed or constructed pursuant to this section.
   3. If an on-site water quality facility cannot be constructed to treat the runoff from the development’s impervious surface, then with the approval of the City Engineer, an on- or off-site water quality facility may be designed to treat runoff from an equivalent area of adjacent untreated impervious surfaces. The water quality facility shall meet all applicable requirements of these standards.
   4. Water quality facilities shall be designed for a total precipitation of 1.50 inches falling in 24 hours.
   5. Water quality facilities shall be sized for impervious area, as outlined below in “Impervious Area Used in Design.”
   6. Water quality facilities shall be designed to include inlet energy dissipation and a sediment forebay in conformance to Subsection “Water Quantity Facility Design Standards.”

7. Water quality facilities shall be designed to allow for proper functioning with full sediment accumulation as allowed in Subsection "Sediment Management/Pollutant Control."
8. Water quality facilities shall be constructed as part of the development's public improvements.
9. Other design options for meeting the requirements of this section may be considered by the City Engineer for approval, as referenced in Subsection "Alternative Design and Construction Standards."
10. Water quality facilities in which water is in direct contact with the soil must be lined with either a low permeability liner or a treatment liner when the soil does not have properties which reduce the risk of groundwater contamination from stormwater runoff that may infiltrate in the facility. Liners shall be designed in accordance with Section 11, "Stormwater Quality Facility Liners."
11. Water Quantity Facilities shall be constructed in conformance with Subsection "Design Criteria."
12. Stormwater quality facilities shall be protected in conformance with Subsection "Detention/Retention Facility Protection."

D. Impervious Area Used in Design
1. Water quality facilities are required when proposed development establishes or increases the impervious surface area by more than 10,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.
2. For single-family and duplex residential subdivisions, water quality facilities shall be sized for all impervious areas created by the subdivision, including all residences on individual lots at the current rate of 2,750 square feet of impervious surface area per dwelling unit.
3. For all developments other than single-family and duplex dwellings, including row-houses and condominiums, the sizing of water quality facilities shall be based on the impervious area to be created by the development, including structures and all roads and impervious areas. Impervious surfaces shall be based on building permits, construction plans, or other appropriate methods of measurement deemed reliable by the City Engineer.
4. The City encourages design initiatives that reduce the effective impervious area. For developments other than single-family and duplex dwellings, a smaller water quality facility may be possible.

3.5.2 General Requirements

A. No water quality facility shall be built in a public easement or right-of-way, unless approved by the City Engineer.
B. Vegetation shall be planted in accordance with Section 8, "Landscape Requirements for Stormwater Facilities."
C. Safety of stormwater quality facilities shall be in conformance with Subsection "Detention/Retention Facility Protection."

3.5.3 Access Road

Access roads to stormwater quality facilities shall be in conformance with Subsection "Access Road Design."

3.5.4 Water Quality Treatment Methods

Methods used for water quality treatment facilities form several general categories:

A. Pretreatment Devices: Pretreatment often must be provided for filtration and infiltration facilities to protect them from clogging or to protect groundwater. Appropriate

pretreatment devices include a pre-settling basin, wet pond or vault, water quality manhole, or oil/water separator.

B. Filtration: Filtration entails capturing and temporarily storing stormwater and then passing it through a filter bed of sand, organic matter, soil, or other acceptable treatment media. Specific media such as activated carbon or zeolite can remove hydrocarbons and soluble metals.
C. Ponds: Ponds treat stormwater by settling particulates during quiescent conditions (sedimentation), by biological uptake, and by vegetative filtration. Ponds may be single-purpose facilities, providing only stormwater treatment, or they may be combined with a detention pond or vault to also control flow.
D. Wetlands: Constructed wetlands, like natural wetlands, remove pollutants through sedimentation, filtration, and biologic processes. Wetlands typically have shallower water than ponds. They may also incorporate small permanent pools and extended detention storage.
E. Infiltration: Infiltration refers to the use of the filtration, adsorption, and biological decomposition properties of soils to remove pollutants. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. Groundwater protection issues must be evaluated when considering infiltration facilities. The DEQ has identified drywells, sumps, and other infiltration-type facilities that inject untreated stormwater below the ground surface as Class V injection wells under the federal underground injection control program.

3.5.5 Pretreatment Devices – Water Quality Manholes

A. Hydraulic criteria
    1. Minimum design flow = water quality flow.
    2. An upstream flow splitter may be used to bypass conveyance flows in excess of the Water Quality flow.
B. Design criteria
    1. Shall be required immediately upstream of all detention/retention facilities, all water quality treatment facilities, or any release point to a natural drainage.
    2. Minimum manhole diameter shall be 60 inches.
    3. Sump depth shall be no deeper than 5 feet from invert to bottom of sump, unless approved by City Engineer.
    4. Volume of sump shall be 20 cubic feet per 1.0 cfs of flow into the water quality manhole, up to the 25-year flow. Flow calculations shall include the effect of an upstream flow splitter.
    5. Maintain a 3-foot clear access zone between the inside structure wall and the interior outlet structure.
    6. Orient access to structure in a clear zone.

3.5.6 Proprietary Pretreatment & Treatment Devices

A. Proprietary pretreatment devices are permitted with approval of the City Engineer. Contech Storm Filters are approved treatment devices.
B. The devices shall be sized in accordance with the manufacturer's recommendations. However, the minimum treatment flow must be the water quality flow.
C. Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, and maintenance requirements and schedule.

3.5.7 Filtration

A. Biofiltration Swale

Biofiltration swales are vegetated open channels that trap pollutants through filtration. General design requirements for biofiltration swales are given in **Table 3.7.** For more specific design criteria refer to Subsection "Biofiltration Swale."

Table 3.7. BIOFILTRATION SWALE CRITERIA

Parameter	Requirement
Area to be served	Less than 10 acres
Soils requirements (NRCS classification)	A, B, C, or D (A and B may require liners in certain circumstances)
Maximum ground slopes	10H:1V
Maximum maintained side slopes	4H:1V
Water application rate	Peak flow rate from water quality flow

B. Sand Filter

Sand filters are a layer of sand in a sedimentation chamber used to trap pollutants. The water runs into an under-drain system that conveys the filtered stormwater to the discharge point. General design requirements for sand filters are given in **Table 3.8.** For more specific design criteria refer Subsection "Sand Filter."

Table 3.8. SAND FILTER CRITERIA

Parameter	Requirement
Maximum area to be served	80 acres
Soils requirements (NRCS classification)	A, B, C, or D with limitations
Maximum ground slope	Not applicable
Maximum maintained side slope	4H:1V
Water application rate	2,000 sq. ft. of filter per cfs of design flow

3.5.8 Ponds

Inlet and outlet structures constructed in stormwater ponds shall follow the guidelines provided in Subsection "Inlets," and Subsection "Outlets." Ponds safety shall be in conformance with "Safety" in Subsection "Detention/Retention Facility Protection."

A. Wet Ponds

Wet ponds are constructed ponds with a permanent pool of water (called pool storage or dead storage). Pollutants are removed from stormwater by gravitational settling, biologic processes, and vegetative filtration. General design requirements for wet ponds are given in **Table 3.9.** For more specific design criteria refer to Subsection "Wet Ponds."

Table 3.9. WET POND CRITERIA

Parameter	Requirement
Area to be served	2 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	10H:1V
Maximum maintained side slopes	4H:1V

B. Extended Wet Pond
Extended wet ponds are constructed ponds that have both a permanent pool of water and extended detention above the permanent pool. General design requirements for extended wet ponds are given in **Table 3.10.** For more specific design criteria refer to Subsection "Extended Wet Pond."

Table 3.10. EXTENDED WET POND CRITERIA

Parameter	Requirement
Area to be served	3 to 150 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	8 percent
Maximum maintained side slopes	4H:1V

C. Extended Dry Pond
Extended dry ponds are designed to drain completely between storm events. This allows the pond to detain stormwater runoff longer than a standard detention pond and provides some treatment for water quality. Dry ponds alone seldom meet the design TSS removal requirements established in Subsection "Water Quality Facility Design Standards," and shall be considered only when combined with other water quality facilities. For more specific design criteria refer to Subsection "Extended Dry Pond."

3.5.9 Wetlands – Constructed Treatment Wetlands

Constructed treatment wetlands remove pollutants through several processes, including sedimentation, filtration, and biologic uptake. When enough volume is provided, constructed treatment wetlands can also provide a significant level of flow control. General design requirements for constructed treatment wetlands are given in **Table 3.11.** For more specific design criteria refer to Section 10, "Stormwater Quality Facility Design." Inlet and outlet structures constructed in wetland areas shall follow the guidelines provided in Subsection "Inlets," and Subsection "Outlets."

Table 3.11. CONSTRUCTED TREATMENT WETLANDS CRITERIA

Parameter	Requirement
Area to be served	No less than 10 acres
Soils requirements (NRCS classification)	C, D (A and B with liners)
Maximum ground slopes	Not applicable
Maximum maintained side slopes	5H:1V

3.5.10 Infiltration

A. The first step in siting and designing infiltration treatment facilities is to conduct a characterization study. Information gathered during initial geotechnical investigations can be used for the site characterization. Key data and issues to be characterized include the following:
   1. Surface features.
   2. Subsurface features.
   3. Infiltration rate determination.
   4. Soil testing.
   5. Infiltration receptor.

B. Site suitability criteria must also be considered for siting infiltration treatment systems, as follows:
   1. Setbacks.
      a) Groundwater protection areas.
      b) High vehicle traffic areas.
      c) Soil infiltration rate/drawdown time.
      d) A minimum infiltration rate of 0.30/inches per hour
      e) Depth to bedrock, water table, or impermeable layer.
      f) Soil physical and chemical suitability for treatment.
      g) Seepage analysis and control.
      h) Cold climate and impact of roadway deicers.
      i) Verification testing of the completed facility.

   Note: Refer to Section 9, “Infiltration Requirements, Site Characterization, and Site Suitability Criteria” for a detailed description of site characterization and site suitability criteria. All infiltration systems shall comply with the requirements of the Oregon DEQ UIC (Underground Injection Control) Program.

   1. Infiltration Trench
      a) An infiltration trench is a shallow trench in permeable soil that is backfilled with sand and coarse stone and lined with filter fabric. The trench surface may be covered with grating, stone, gabion, sand, or a grassed cover with a surface inlet. General design requirements for infiltration trenches are given in **Table 3.12.** For more specific design criteria refer to Subsection “Infiltration Trench.”

Table 3.12. INFILTRATION TRENCH REQUIREMENTS

Parameter	Requirement
Maximum area to be served	1 acre per trench
Soils requirements (NRCS classification)	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met.
Maximum ground slopes:	5 percent
Soil test requirement	ASTM D 3385

2. Infiltration Basin
   a) An infiltration basin is a depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. General design requirements for infiltration basins are given in **Table 3.13.** For more specific design criteria refer to Subsection "Infiltration Basin."

Table 3.13. INFILTRATION BASIN REQUIREMENTS

Parameter	Requirement
Maximum area to be served	50 acres
Soils requirements (NRCS classification	A or B only for publicly maintained facilities; C soils may be used for privately owned facilities if drawdown standards are met
Maximum ground slopes	5%
Maximum maintained side slopes	4H:1V
Soil test requirement	ASTM D 3385

3.5.11 Compost Filters

Compost stormwater filters or CSFs, work by percolating stormwater through compost, which traps particulates and absorbs dissolved materials such as metals and nutrients. Compost filters may be considered as a part of a private water quality treatment facility but will not be allowed as part of a publicly maintained water quality treatment facility.

3.5.12 Other Water Quality Treatment Facilities

The use of other forms of water quality treatment is allowed with the approval of the City Engineer. However, the applicant must provide evidence of the ability of the facility to meet the City's design standards criteria and long-term maintenance requirements.

3.6 OPERATIONS & MAINTENANCE REQUIREMENT

This section describes operation and maintenance requirements that are generally applicable to all private stormwater facilities. The person designated as the responsible party in the

Permanent Access Easement & Stormwater Detention System Easement & Detention System Maintenance Agreement shall be responsible for operation and maintenance of private stormwater facilities. An operation and maintenance plan (O&M plan) shall be prepared by the design engineer for the stormwater facility and shall be submitted to the City of Independence Public Works Department for review and approval. Maintenance activities shall be documented annually by sending a report of what was completed to the City of Independence Public Works Department, by May 1st of each year.

3.6.1 Inspection Program

A. Routine facility inspection will provide three major benefits:
   1. Development of a condition history.
   2. Improved scheduling efficiency.
   3. Preventive maintenance opportunities.
B. Inspection records shall be used to:
   1. Determine where special maintenance conditions exist.
   2. Determine optimal frequencies for future inspection and maintenance.
   3. Generate scheduled and unscheduled repairs.
   4. Assure facility operation and aesthetics.

3.6.2 Inspection Requirements

A. The applicant shall be responsible for having inspections conducted, maintaining stormwater facilities, and submitting yearly reports documenting inspection and maintenance activities to the City of Independence Public Works Department.
B. Inspect the facility, with the record drawing plans in hand, on a quarterly basis for the first two years, and a minimum of semiannual thereafter. Inspections may be required more frequently, depending on site-specific conditions.
C. All required inspections and any maintenance activities performed shall be documented in the annual report as required by the City's "Permanent Access Easement & Stormwater Detention System Easement & Detention System Maintenance Agreement."
D. Inspection reports shall be submitted to the City by May 1st of each year.
E. The applicant shall keep inspection records to track the progressive development of the system over time. The inspection records shall include:
   1. General condition of vegetative area(s), predominant plant species, distribution, and success rate (where applicable).
   2. Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.
   3. Water elevations and other observations (sheen, smell, etc.).
   4. Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.
   5. Unscheduled maintenance needs.
   6. Components that do not meet the performance criteria and require immediate maintenance.
   7. Common problem areas, solutions, and general observations.
   8. Aesthetic conditions.

3.6.3 Structures

Applicant shall be responsible for maintaining all facility structures in good working order. Stormwater facility structures include, but are not limited to, the following: stormwater pipes, stormwater manholes, sand/oil separators, monitoring manholes, flow control devices, energy dissipaters, headwalls, trash grates, underground detention facilities, catch basins, ditch inlets, area drains, clean-outs, access roads, safety fences, sediment fences, and biofiltration bags.

Maintenance may consist of cleaning, repairing, and/or replacing structures or portions of structures as needed to maintain their functional purpose.

3.6.4 Planting Bed Soils

A. In areas where greater than 10% of planting bed vegetation has died, have soil tested as recommended by a Professional Landscape Architect registered in the State of Oregon.
B. Amend soil as per recommendations of a Professional Landscape Architect registered in the State of Oregon; if needed redesign plantings to correct problems and reestablish soil coverage.

3.6.5 Vegetation Management

A. Vegetated stormwater facilities may require a number of control practices during their initial 2-year period in order to meet the requirements for establishing healthy vegetation.
B. Requirements
    1. Maintain plantings for a period of two years after the date of final construction approval by the City Engineer. During the establishment period, remove undesired vegetation with minimal (or preferably no) use of toxic herbicides and pesticides at least three times in year 1, and once or twice in the summer of year 2, unless otherwise approved by the City Engineer. Replace plants that die during this period as per recommendations and planting time frame given in Subsection "Landscape Guidelines."
    2. At the end of the two-year warranty period, healthy plant establishment shall be achieved for at least 90% of the vegetation (see Subsection "Landscaping Inspection for Warranty," for landscape survival criteria). The O&M plan shall specify the long-term maintenance schedule after the warranty period.
    3. Selectively irrigate if necessary, during the establishment period, during times of drought, or until the vegetation becomes established. It is preferred that the facility be designed to sustain its function without a permanent irrigation system.
    4. Replenish mulch at least annually and specify the mulching schedule in the O&M plan. Mulching shall be done to retain topsoil, heat, and moisture, and to inhibit weed growth. Use temporary fencing to protect seedlings from foraging animals.
    5. Schedule maintenance outside sensitive wildlife and vegetation seasons. Minimize plant disturbance during maintenance activities.
    6. Do not use fertilizers, herbicides, or pesticides for vegetation maintenance, unless it is specifically called for in the O&M plan.
C. Use replacement plants that conform to the initial planting plan and to Section 8, "Landscape Requirements for Stormwater Facilities."

3.6.6 Sediment Management/Pollution Control

A. Sediment and other pollutants that degrade water quality will accumulate in stormwater facilities. The applicant shall remove all accumulated pollutants and sediment to maintain proper facility operation. Periodic testing will help determine appropriate sediment-removal schedules.
B. Requirements:
    1. Place a sediment marker in the forebay or in an area not likely to be damaged by incoming storm flows and where it can be easily seen by maintenance personnel.
    2. Remove sediment when accumulations reach 1 foot in depth, 50% of the designed sediment storage depth, or if sediment accumulation inhibits facility operation. The 50% full capacity shall be identified and marked on the sediment marker during facility construction.
    3. Test sediment before removing it if the stormwater facility serves a commercial/industrial site or a multifamily structure or development. Sediment shall be

tested according to the protocol established in the O&M plan, and any additional information resulting from site-specific conditions and use. Testing could include parameters such as oil and grease, heavy metals (mercury, lead, zinc, and cadmium), nutrients (e.g., phosphorus), and organics such as pesticides that may accumulate. Testing must be site specific if a commercial/industrial discharger is being served; City of Independence reserves the right to require testing of specific contaminants. Applicant shall provide the test results to the City of Independence Public Works Department prior to excavation and disposal of sediment.

4. Dispose of sediments at the time of excavation in a manner meeting applicable state and federal requirements. If sediment disposal requires special handling, disposal documentation shall be provided to the City of Independence Public Works Department.
5. Investigate and control, or report the pollutant source, if sediment or other pollutants are accumulating more rapidly than assumed when the O&M plan was formulated. Direct pollution-control complaints to the City of Independence Public Works Department.

3.6.7 Insect/Vector Control

A. Standing water associated with some types of treatment systems can attract insects.
B. The following measures shall be the primary methods of insect control. The methods are not presented in order of implementation, but one or all of these methods shall be used before considering any other measures:
   1. Install predacious bird and bat nesting boxes.
   2. Change the water level of ponds every four days or so to disrupt the larval development cycle of mosquitoes.
   3. Stock ponds and other permanent water facilities with fish or other predatory species.
   4. Use mosquito larvicide, such as Bacillus thurengensis or Altoside® formulations, only if absolutely necessary. Any pesticide or larvicide shall be applied by a licensed individual.
C. Additional assistance with vector monitoring and control may be obtained from the local vector control office.

3.6.8 Access and Safety

O&M programs shall provide for safe and efficient access to a facility and shall follow Subsection "Safety Requirements." The following are general requirements; specific conditions may require site-specific modifications:

A. Secure easements necessary to provide facility and maintenance access (if applicable).
B. Use only trained and certified personnel to access confined spaces.
C. Maintain ingress/egress routes to design standards, in a manner that allows efficient maintenance of the facility.
D. Ensure that fencing is in good repair.

3.7 CONSTRUCTED CHANNEL DESIGN STANDARDS

3.7.1 Application

This section applies to open channels constructed to convey runoff to the existing public stormwater and surface water conveyance system. For work in existing stream channels, applicant shall follow the recommendation and requirements set forth in ODFW's *Fish Passage Criteria,* or latest edition, or an equivalent study or guideline approved by the City Engineer. The applicant shall comply with all applicable requirements of the Army Corps of Engineers and Oregon Department of State Lands for construction activities that may impact wetlands or waterways. Development that regrades existing roadside ditches or constructs new roadside ditches shall meet applicable City codes and standards.

3.7.2 Channel Design

A. Channel design shall be in accordance with Subsection "Hydrology and Hydraulics."
B. Vegetation-lined channels shall be used whenever practicable, as determined by the City Engineer. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion. Channels shall be protected in conformance with Subsection "Channel protection."
C. Constructed open channels shall be sized to pass the required flows and have side slopes no steeper than 2H:1V. Any proposed constructed channel improvement that does not meet these requirements shall be piped unless an exception is approved by the City Engineer.
D. Normal maximum depth for open channels constructed adjacent to roadways shall be 3 feet.
E. No protruding pipes, culverts, utilities, or other structures will be allowed that reduce or hinder the flow characteristics of the channel. Channels and connections shall be designed to prevent scouring. All pipe connections shall match side slopes, incorporate a headwall, and be designed with an energy dissipater device (see Subsection "Channel Protection," and Subsection "Outfall Protection").

3.8 CULVERT DESIGN STANDARDS

3.8.1 Application

A. Culverts provide for passage of water under or through obstructions placed across streams and drainage ways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding.
B. For pipe systems or culverts that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.
C. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria,* or latest edition, unless otherwise exempted by ODFW and the City.

3.8.2 Hydraulic Design

Culverts shall be designed to safely pass the 25-year flow.

3.8.3 Headwater

A. For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter, unless an exception is approved by the City Engineer.
B. For new culverts larger than 18 inches in diameter, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter, unless an exception is approved by the City Engineer.
C. The maximum headwater elevation of a design storm event for new culverts shall be at least 1 foot lower than the road or parking lot subgrade.

3.8.4 Inlets

The embankment around the culvert inlet shall be protected from erosion by lining around the inlet with rock, bioengineering, or other protection approved by the City Engineer. The lining shall extend upstream of the culvert a minimum of 10 feet, be designed to provide a smooth transition for water flow into the culvert and shall be as high as the designed headwater elevation.

3.8.5 Outlets

The receiving channel of the outlet shall be protected from erosion by rock lining, bioengineering, or other energy dissipating devices (Subsection "Channel Protection," and Subsection "Outfall Protection") as approved by the City Engineer.

3.8.6 Inlet Control Analysis

The headwater depth for pipes under inlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual," or a modeling method consistent with FHWA's HY8 software.

3.8.7 Outlet Control Analysis

The headwater depth for pipes under outlet control shall be determined using the nomographs as provided in details of these standards, the ODOT "Hydraulics Manual", or a modeling method consistent with FHWA's HY8 software.

3.8.8 Outfall Design Standards

A. Outfalls shall be above the mean low-water level unless an exception is approved by the City Engineer. All outfalls shall be provided with a rock splash pad or other approved erosion-control measure. Erosion protection at outfalls shall be designed in accordance with the guidelines in Subsection "Outfall Protection," unless exceptions are approved by the City Engineer.
B. Mechanisms that reduce velocity before water discharges from an outfall are required. The dissipaters shall be designed using published references such as FHWA's "Hydraulic Design of Energy Dissipaters for Culverts and Channels," the ODOT "Hydraulics Manual", and others. Design references shall be cited in the construction plan submittal.
C. Non-erosive stormwater flow velocities shall be maintained for the entire overland flow from the energy dissipating device to the receiving public waterway. The City Engineer shall approve structures and/or methods to maintain non-erosive flow velocities prior to construction or installation.

3.9 STORM MANHOLE & PIPE DESIGN STANDARDS

3.9.1 Manhole Design

A. Manholes shall be provided at least every 400 feet, unless otherwise approved by the City Engineer. Manholes shall be located at every grade change, change in pipe size, and change in alignment. Unless an exception is approved by the City, manhole lids placed within the paved right-of-way shall have a minimum of 6 feet of clearance from the edge of a curb or gutter and shall not be in a wheel path of the traveled way (see Street detail drawings of these standards).
B. When a manhole is 5 feet or less deep, a flat-top or shallow manhole shall be used. Flat-top manholes shall be designed to be installed at an elevation to permit construction of the full street section, allowing for the design gradients.
C. All manholes shall be a minimum of 48 inches in diameter for pipe sized up to 18-inches diameter, minimum 60-inch diameter manhole for 18-inch to 30-inch pipe diameter, and minimum 72-inch manhole for 30-inch and larger pipe diameter.
D. Suburban style manholes frames shall not be used in PCC streets.
E. There shall be a maximum of 4 pipes entering/exiting a manhole unless otherwise approved by City Engineer.
F. Detail(s) shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made. The manufacturer or design engineer shall provide the City Engineer with supporting calculations, stamped by

a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.

G. Connections to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted with the plans.
H. All precast manhole bases shall have smooth, clean openings at the design inlets and outlet points. Openings shall not be sawcut or broken out.
I. All manhole bases shall be properly channelized. No more than three side laterals are allowed to be connected to a manhole, unless an exception is approved by the City Engineer. There shall be a minimum of 8 inches separating connections, measured from the outside diameter of the core holes.
J. All manholes shall have inlets at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
K. Manholes shall have a minimum freefall of 0.10 feet for pipes sizes less than 18 inches. For pipe sizes 18 inches and greater, freefall shall match the pipe design grade. Maximum freefall of 1.5 feet is allowed in all manholes.
L. Drop manholes: The maximum inside drop in a manhole shall be 8 feet.
M. An oversize curb inlet manhole may be used in lieu of a manhole, as required by this subsection, when approved as part of a flow-through system. Oversized gutter or curb and gutter catch basins will be allowed in lieu of manholes, with approval of the City Engineer.
N. Water Quality Manhole Design: Refer to Subsection “Pretreatment Devices - Water Quality Manholes.”

3.9.2 Storm Pipe Design

A. Pipe size: The design size shall be based on hydraulic calculations provided by the design engineer. The minimum diameter of public storm pipe is identified below:
    1. Pipe from the catch basin to the mainline in the public right-of-way shall be nominal 10-inch-diameter pipe.
    2. Mainline pipe shall be nominal 12-inch-diameter pipe.
    3. Storm pipes located out of a public street right-of-way, with no reasonable need to be extended, and with roof drains or area drains connected, shall be a minimum 10-inch-diameter pipe.
B. Location: Storm sewers mainlines, wherever possible, shall be installed at least 6-feet and parallel to the face of curb on either side of the street as indicated in the street detail drawings of these standards. Storm laterals in series may be placed under the gutter. All storm sewer locations shall be approved by the City Engineer. Storm drain inlets shall be designed as per Subsection “Catch Basin System Standards” and Subsection “Drain Inlet Design Standards.”
C. Easements: When it is not possible or practical to install the storm sewer line in a dedicated public street, a minimum storm drain easement shall be provided. Sewer lines shall be located in the center of the easement unless an exception is approved by the City Engineer. The centerline of the pipe shall be at least 7½ feet from an easement side line. Easement widths are identified in **Table 3.14A** below.
D. Alignment: Public storm pipe shall be laid on a straight alignment and at uniform grade unless an exception is approved by the City Engineer.
E. Connections: Lateral connections on new construction work shall be done using manufactured tees installed at surveyed locations. Lateral connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection “Stormwater Pipe and Fittings.”

F. Laterals: Storm laterals shall be provided with a cleanout installed at the public right-of-way or easement. Cleanouts shall not be installed in the driveway or sidewalk, unless approved by the City Engineer.

G. Curb Marking: Newly constructed curbs or replaced curbs shall be stamped with the capital letters "D" at the location of each storm lateral crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.

H. Locating Wire and Tape: Storm laterals and mains shall have tracer wire (10-gauge solid core with white insulation) installed beside the pipe. Surface locating wire at right-of-way cleanouts or shall be tied off to the 2 x 4 marker until cleanout is installed.

I. Grade: All storm lines shall have sufficient slope to maintain a minimum flow velocity of 3 feet per second when flowing full.

J. Steep Slopes: Where soil conditions warrant it, storm pipes on slopes in excess of 20% gradient shall be secured with approved anchor walls. Spacing for anchors shall be as shown in **Table 3.14B**.

Table 3.14A. MINIMUM STORM DRAIN EASEMENT WIDTHS

Storm Drain Diameter	**Depth to Invert**	
	≤6-feet	>6-feet
10 – 15 inches	15-feet	15-feet plus 2-feet for each additional foot (or fraction thereof) deeper than 8-feet to invert.
18 – 24 inches	15-feet	15-feet plus 2-feet for each additional foot (or fraction thereof) deeper than 8-feet to invert.
> 24 inches	15-feet	15-feet plus 2-feet for each additional foot (or fraction thereof) deeper than 8-feet to invert.
Note: Easements shall be a constant width between manholes or other in-line structures. Easements width shall be based on the deepest portion of the line between such structures.		

Table 3.14B. SECURING SEWERS ON SLOPES

Minimum Anchor Spacing Sewer Gradient >20%	
Grade (%)	**Center to Center (feet)**
<35	35
35-50	25
>50	15 (or concrete encasement)

K. Pipe Cover: Minimum pipe cover shall be in compliance with this section unless an exception is approved by the City Engineer. In paved areas, pipe cover shall be measured from the finished grade to the top of the pipe barrel; the pipe bell shall not intrude into the base rock or asphalt section. In areas without pavement, the pipe cover shall be measured from the finish grade to the top of the pipe barrel. Minimum cover requirements are shown in **Table 3.15.**

Table 3.15. MINIMUM PIPE COVER

Type of Pipe	Cover (inches)
Other Pipe Materials	30
Nonreinforced	30
RCP Class III	30
RCP Class IV	24
RCP Class V	12
AWWA C-900, C-905	12
ADS SaniTite HP	12
Ductile Iron	12

3.9.3 Distance between Structures

The maximum distance between structures, such as manholes, area drains, and catch basins, but excluding cleanouts, for 12-inch and larger pipe shall be 400 feet or per Subsection "Drain Inlet Design Standards", whichever is more stringent. Catch basins located on collector streets or greater shall be spaced per Subsection "Drain Inlet Design Standards."

3.9.4 Access

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to every manhole. Access roads shall be constructed as per Subsection "Access Road Design."

3.9.5 Headwalls

Pipe end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to stabilize a slope. Details of all headwalls and end protection shall be included in the construction drawings.

3.9.6 Trash Racks or Debris Barriers

Trash racks or debris barriers are required by the City on inlets for pipe or culvert systems greater than 18 inches in diameter. The design engineer shall submit the trash rack/debris barrier system design to the City Engineer for approval.

3.9.7 Drain Inlet Design Standards

All inlets and catch basins shall be designed to accept a storm event identified in **Table 3.1**. Grates shall be designed, as far as practical, to avoid failure due to accumulation of debris.

A. Design Criteria
    1. Precast and poured-in-place-catch basins and curb inlets are allowed.
    2. All catch basins shall be constructed with an 18-inch minimum sump unless they are part of a series or a flow-through catch basin system and approved by the City Engineer.
    3. A main storm line shall not pass through a sumped catch basin.
    4. Avoid placing curb inlets along curb radius at street intersections.
    5. Spacing of catch basins shall be determined by the capacity of each to pass a 10-year or 25-year storm event as identified in **Table 3.1**. In addition, catch basins shall be installed just before the upstream curb radius at all intersections.
    6. Catch basins shall be a maximum depth of 4 feet from the top of grate to the flow line of the lowest pipe invert.

7. Between the inlet and the mainline or mainline structure, the maximum length of pipeline shall be 40 feet for 10-inch pipe and 60 feet for 12-inch pipe, unless additional length is required to cross the street right-of-way.
8. Tee connections may be used in street right-of-way only with approval of the City Engineer. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the City Engineer. The connecting catch basin shall be oversized for cleaning purposes.

3.9.8 Area Drains and Ditch Inlets

A. The standard area drain shall be as shown in details of these standards, and the ditch inlet shall be as shown in details of these standards, unless an exception is approved by the City Engineer.
B. Area drains in rear or side yards shall not be sumped. Ditch inlets shall be equipped with an 18-inch sump.
C. A main storm line shall not pass through an area drain or a ditch inlet.
D. Area drains or ditch inlets may be located at the upper terminus of a main storm line, may connect to the main storm line at a manhole, or may connect to the main storm line through a tee when the lateral is no larger than 50% of the diameter of the main line.

3.10 MATERIAL SPECIFICATIONS

3.10.1 Manholes and Structures

A. General
Manholes shall be constructed at locations shown on the plans or as required by the City Engineer. The maximum distance between manholes shall be 400 feet, unless otherwise approved by the City Engineer. All manholes shall be a minimum of 48 inches in diameter. When a manhole is less than 5 feet deep, a shallow or flat-top manhole shall be used. Flat-top manholes shall be installed at an elevation to allow for construction of the full street section, allowing for the design gradients.
B. Materials
1. Aggregate and Cement: Aggregate shall meet the standards set forth in ODOT SSC Section 02690, “PCC Aggregates”; Portland cement shall meet the standards set forth in ODOT SSC Section 020, “Portland Cement.”
2. Concrete: PCC for poured in place manholes and structures shall conform to ODOT Class 3000 – 1½, Commercial Grade Concrete. Slump shall be between 2 and 4 inches.
3. Manhole Frames and Covers:
    a) Casting shall be of new material, tough, close-grained gray iron conforming to ASTM A-48, Class 30, and shall be smooth and clean, free of blisters, blowholes, and all defects. Bearing surfaces shall be planed or ground to ensure flat, true surfaces. Covers shall be true and set within rings at all points.
    b) Rings shall be grouted in place and made watertight with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), “Non-Shrink Grout,” such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Rings shall not be brought to grade with lumber.
    c) Frames and covers shall be standard or suburban, depending on the manhole location and as approved by the City Engineer. Suburban style manhole frames shall not be installed in PCC streets.
    d) Manholes installed outside of paved street or sidewalk areas shall be installed with a tamperproof frame and cover.
4. Manhole Types: Manholes shall be one of the following types or equal.

a) Precast 48-Inch-Diameter Manholes: Materials shall conform to the requirements of ASTM C-478. Minimum wall thickness shall be 5 inches. Cones shall be eccentric. Before precast manhole sections of any size are delivered to the job site, the sections shall meet the permeability test requirements of ASTM C-14.
b) Precast Large-Diameter (60-inch or larger) Manholes: Materials shall conform to the requirements of ASTM C-478.
c) Cast-in-Place Large-Diameter Manholes: Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 020, "Portland Cement."
d) Precast Bases: Precast base sections or manhole bases shall be used, except over existing pipe where poured-in-place bases shall be used. Precast manhole bases shall be inspected and approved by the City Engineer prior to installation. Where precast bases are not channelized, the contractor shall construct smooth channels to connect the flow from inlet pipe(s) to outlet pipe.
e) Poured-in-Place Bases: Poured-in-place bases shall be used over existing pipelines. The contractor shall remove water from the excavated area, provide a minimum 8-inch-thick layer of compacted 1"-0" crushed aggregate for a base, and construct the concrete base so that the first precast manhole section has a uniform bearing throughout the full circumference. There shall be a minimum of 8 inches of concrete between the compacted gravel and the lowest invert of the manhole. The contractor shall deposit sufficient concrete on the base to assure a watertight seal between base and manhole wall. Twenty-four hours shall be allowed to elapse before the remaining manhole sections are placed on the base, unless otherwise approved by the City Engineer.

5. Pipe Stub-outs for Future Sewer Connections: Pipe stub-outs shall be the same type as approved for use in the lateral, main, or trunk sewer construction. Strength classifications shall be the same class as in adjacent trenches. Where two different classes of pipe exist at a manhole, the higher-strength pipe shall govern strength classification. Connect stub-outs to manholes as specified in this Subsection "Connection to Existing Manholes." Rubber-gasketed, watertight plugs shall be furnished with each stub-out and shall be adequately braced against air test pressures.
6. Gaskets: Manhole sections shall be installed with either preformed rubber gaskets or plastic gaskets. Rubber gaskets shall conform to ASTM C-443. Plastic gaskets shall be Kent-seal No. 2 or Ram Neck, or approved equal, and shall meet all requirements of ASTM C-990.
7. Manhole Steps: Steps shall be required and shall be constructed unless otherwise approved by the City Engineer. When pipe is 24 inches in diameter or smaller, steps shall be located as indicated in standard details. For pipe larger than 24 inches in diameter, steps shall be located over a bench as coordinated with the City Engineer. Maximum drop from rim to first step shall be 27 inches.

C. Workmanship

1. Foundation Stabilization: If, in the opinion of the geotechnical engineer or the City Engineer, unstable subgrade material exists that will not support the manhole or other structure, the contractor shall excavate below grade and backfill with foundation-stabilization material approved by the City Engineer.
2. Pipe Connections: All rigid pipes entering or leaving the manhole shall be provided with flexible joints within 1 foot of the manhole structure and shall be placed on firmly compacted bedding. Special care shall be taken to see that the openings through which pipes enter the structure are completely watertight. All flexible pipe shall be connected to manholes according to the manufacturer's recommendations.

3. Flexible Joints: Where the last joint of the line laid up to the manhole is more than 1 foot from the manhole base, a 6-inch concrete encasement shall be constructed around the entire pipe, from the manhole base to within 1 foot of the pipe joint, at the discretion of the City Engineer. The pipe encasement shall be constructed integrally with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first flexible joint is no more than 1 foot from the manhole base.
4. Manhole Connections: The contractor shall connect sewer pipe to manholes as specified in this Subsection, "Types of Connections."
5. Drop Manholes: The maximum inside drop in a manhole shall be 8 feet. See also in this Subsection, "Manhole Design" for construction of this connection.
6. Placing Manhole Section: The contractor shall clean the end of each sections of foreign material. Manholes shall be installed with either watertight rubber O-rings or preformed plastic gaskets in conformance with the manufacturers' recommendations. If plastic gaskets are used, the inside seams shall be grouted with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout® or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Manholes will be visually inspected for water leakage by the City Engineer. Any leakage observed shall be repaired at the contractor's expense, and the manhole re-inspected.
7. Manhole Inverts: The contractor shall construct manhole inverts in conformance with these standards. Inverts shall have smooth transitions to ensure an unobstructed flow through the manhole. The contractor shall remove all sharp edges or rough sections that tend to obstruct flow.
8. Manhole Stub-outs: The contractor shall install stub-outs from manholes for future extensions, as shown in these standards or as required by the City Engineer. A watertight flexible connection shall be used for pipe sizes 6 inches through 18 inches in all new manholes. The contractor shall construct invert channels in accordance with standard details. The minimum length of stub-outs in existing manholes shall be 12 inches from the outside manhole wall. Pipes shall be grouted in precast walls or the manhole base to create a watertight seal around the pipes. The contractor shall add compacted base rock, as specified in these standards, to undisturbed earth under all stub-outs.
9. Manhole Extensions, Rings, and Covers: The contractor shall install rings and covers on top of manholes to prevent all infiltration of surface water or groundwater into manholes. Rings shall be set in a bed of high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, with the grout carried over the flange of the ring, and shall be set so that tops of covers are flush with the surface of the adjoining pavement, or 1 foot above natural ground, unless otherwise directed by the City Engineer. Unused grout shall be disposed after 20 minutes and shall not be used. Total thickness of grade rings shall not exceed 12 inches; rings shall be grouted watertight. Drop from rim to first manhole step shall not exceed 27 inches. In designated floodplain areas, all manholes shall be at an elevation of at least 2 feet greater than the 100-year storm event.

D. Types of Connections
1. Connection to Existing Manholes: The contractor shall connect sewers to existing manholes at the locations shown on the plans. Contractor shall submit a plan for diversion control and receive written approval from the City Engineer before proceeding with construction. The contractor shall provide all diversion facilities and shall perform all work necessary to maintain sewage flow in existing sewers while connections are being made to the manholes. Connections to existing manholes shall be core-drilled,

and the bases shall be grouted as necessary to allow a smooth flow into and through the existing manholes.

2. Manholes over Existing Sewers: The contractor shall construct manholes over existing operating sewer lines at the locations shown on the plans. The contractor shall construct a poured-in place base under the existing sewer and the precast sections as specified. The contractor shall not cut into any existing lines until the new manhole(s) are grouted and the new lines are balled, flushed, and deflection tested, and all portions of the storm line have been approved and accepted by the City Engineer. After acceptance, the contractor shall saw cut into the existing line; cut edges of concrete pipe shall be covered with grout and troweled smooth; with ductile iron or plastic pipe, grout shall be applied up to cutout and troweled smooth.
3. Shallow Inside Drop Manhole: Where the invert of the connecting pipe is above the manhole shelf and 18 inches or less above the outlet, beaver slide shall be constructed utilizing Portland cement concrete. The stormwater entering the manhole shall follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Stormwater shall not be allowed to fall freely to the manhole base.

3.10.2 Catch Basins and Inlets

A. Materials
   1. Aggregate, Cement, and Concrete: These materials shall meet the requirements of Subsection “Manholes and Structures.”
   2. Frames, Grates, and Covers: All materials shall be flat bar steel (standard grade), cast iron or ductile iron complying with the requirements of ASTM A-36, A-663, or A-709. Drainage grate inlets in paved roadways shall meet the requirements of “Drainage Grates” in Subsection “On-Street Design Standards.”
   3. Forms: All exterior surfaces shall be formed with steel or plywood. Other surfaces shall be formed with matched boards, plywood, or other approved material. Trench walls, rock, or earth will not be acceptable as form material.
   4. Metal Reinforcement: All metal reinforcement shall conform to the requirements of ASTM A-615, Grade 60, deformed bars.
   5. Precast Concrete Units: All precast units shall conform to the same requirements as manholes (ASTM C-478).

B. Workmanship
   1. Excavation and backfill shall conform to the requirements of “Workmanship” In Subsection “Manholes and Structures.”
   2. Bedding: The contractor shall remove all water and debris from the excavation area and shall install an 8-inch-minimum layer of compacted 1”-0” crushed aggregate for a base.
   3. Cast-in-Place: Cast-in-place catch basins shall have a minimum of 6 inches of concrete between the compacted crushed aggregate and the lowest invert. The forms used for cast-in-place catch basins shall be tight and well-braced. The storm pipe material shall extend into the poured concrete of the catch basin. All corners shall be chamfered. Immediately after placement, the concrete shall be consolidated with an approved vibrator. The top surface shall be screed, and exposed surfaces shall be troweled to a smooth finish, free from marks or irregularities. After forms are removed, the contractor shall patch any defects in the concrete with approved material.
   4. Precast: After the base is prepared, the contractor shall set the precast catch basin to the proper line and grade. The storm pipe material being used shall connect to the precast catch basin.
   5. Inverts, Stub-outs, and Sections: Contractor shall clean the ends of all pipes and sections that contact the catch basin. All inverts, stub-outs, and sections shall be installed

according to these standards, using a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, making sure all sharp edges or rough sections are removed, to prevent obstruction of the flow. Unused grout shall be discarded after 20 minutes and shall not be used.

6. Catch Basin Steps: All catch basins deeper than 5 feet, measured from the top of the frame to the flow line, shall be oversized and have steps.

3.10.3 Stormwater Pipe and Fittings

A. General

The materials used shall be adequate to carry anticipated dead and live loads within the deflection limits specified by the manufacturer. All pipe and culverts shall have a minimum design service life of 75 years. Joints shall be gasketed, unless otherwise approved by the City Engineer.

B. Materials

Materials shall be the following types or approved equal:

1. Concrete Pipe (NRCP/RCP):
   a) Non-reinforced concrete pipe shall conform to requirements of ASTM C-14. Unless otherwise specified, pipe shall conform to Class 3 design requirements.
   b) Reinforced concrete, non-pressure pipe shall conform to the requirements of ASTM C-76 or C-655 and shall be of the class specified. Unless otherwise specified, pipe shall meet the design requirements of Wall B. Reinforced concrete low-head pressure pipe shall conform to the requirements of ASTM C-361.
   c) Gaskets shall conform to the requirements of ASTM C-443.
   d) All steam-cured concrete pipe must be at least seven days old before it can be used. If the pipe has not been steam-cured, it must not be used before it has cured for 28 days.
   e) Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe. Field taps shall be machine-drilled.
   f) Mortar used shall be standard non-shrink premixed mortar conforming to ASTM C-387 or in a proportion of one-part Type II Portland cement to two parts clean, well-graded sand that will pass a ⅛-inch screen. Mortar mixed for longer than 30 minutes shall not be used.
2. Ductile Iron Pipe (D.I.):
   a) Ductile iron pipe shall conform to the requirements of American Water Works Association (AWWA) C-151 or American National Standards Institute (ANSI) A21.51, cement lined push-on joint. The minimum thickness class shall be Class 50 (up through 12-inch diameter pipe) and Class 51 (for 14-inch diameter and larger pipe).
   b) Fittings shall be mechanical or push-on. Mechanical joint ductile iron fittings shall conform to AWWA C-110. Push-on joint fittings shall be gray iron, with body thickness and radii of curvature conforming to ANSI A-21.10. Rubber gasket joints shall conform to AWWA C-111/ANSI A-21.11.
3. Polyvinyl Chloride Pipe (PVC):
   a) PVC pipe shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1784, ASTM D-1785, ASTM F-679, ASTM F-794, AWWA C-900, and AWWA C-905.
   b) PVC fittings shall conform to the applicable portions of the following specifications: ASTM D-3034, ASTM D-2729, ASTM D-1785, ASTM D-2466, and ASTM D-2467. Fitting joints shall be the same as the pipe joints. Threaded

connections shall conform to the requirements of ASTM D-2464 for schedule 80 pipe.

c) A2000 (PVC): All A2000 PVC pipe and fittings shall conform to ASTM F-949 specifications.

d) PVC rib: PVC rib pipe and fittings shall be made of PVC, as defined ire ASTM D-1784. The pipe stiffness shall correspond with the series, in accordance with ASTM D-2412. Series 46 and 28 are allowed. Gaskets shall conform to ASTM F-477.

4. Corrugated high density polyethylene (HDPE):
   a) Corrugated high density polyethylene pipe, double wall, and fittings shall be made of polyethylene compounds that conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33, P34, Class C, with the applicable requirements defined in ASTM D-1248. Spiral pipe is not acceptable. Corrugated high density polyethylene pipe shall conform to AASHTO M-294 specifications.
5. Corrugated Aluminum Pipe (CAP) and Corrugated Aluminum Pipe Arches (CAPA):
   a) Corrugated aluminum pipe and fittings shall conform to the requirements of AASHTO M-196 and AASHTO M-197.
   b) The connecting bands shall conform to the requirements of AASHTO M-196, except that the minimum width of bands for 12-inch and larger pipe shall be 12 inches. The minimum width for pipes less than 12 inches shall be 7 inches. The base metal of the connecting bands shall be the same base metal as that of the pipe. The gauge of the connecting bands may be two standard-use thicknesses lighter than that used for the pipe, but not less than 0.060 inch thick. The band couplers shall be connected with stainless steel bolts not less than 0.5 inch in diameter.
   c) Corrugated aluminum pipe shall not be placed in a ditch in direct contact with hydrating Portland cement or lime.
   d) Corrugated aluminized steel pipes are not allowed for storm systems.
6. Fittings:
   a) General
      1) Manufactured tee fittings shall be provided in the sewer main for side sewers. Fittings shall be of sufficient strength to withstand all handling and load stresses encountered.
      2) Fittings shall be of the same materials as the pipe. Material joining the fittings shall be of the same material as the pipe.
      3) Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.
      4) All fittings shall be capped or plugged and shall be gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout lug. The plug shall be able to withstand all test pressures without leaking. When later removed, the plug shall permit continuation of piping with jointing similar to joints in the installed line.
   b) Mechanical Couplings: Mechanical couplings shall be wrought steel. Installation procedures must meet the manufacturers' recommendations.
7. Line Tap Saddle:
   All saddles approved for sanitary sewer tap installation (see Subsection "Gravity Sewer Pipe and Fittings) shall be allowed on storm taps, except the following:
   a) DFW/HPI saddle—an elastomeric polyvinyl chloride saddle with steel-reinforced edges and stainless-steel bands, series 300. This saddle is allowed on PVC, clay, IPS, concrete, asbestos cement, and PE pipe.

b) Saddles installed on corrugated aluminum pipe shall be fabricated and installed using stainless-steel nuts and bolts. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11.

C. Workmanship
   1. Line and Grade:
      a) Survey control hubs for both line and grade shall be provided by the design engineer in a manner consistent with accepted practice. The contractor shall establish line and grade for pipe by the use of lasers or by transferring the cut from the offset stakes to the trench at a maximum of 50-foot intervals to maintain the line and grade.
      b) Variance from the established line and grade shall not be greater than ¼ inch for grade and ½ inch for line, provided that such variation does not result in a level or reverse-sloping invert.
      c) The contractor shall check line and grade, as necessary. If the limits prescribed in these standards are not met, the work shall be immediately stopped, the City Engineer notified, and the cause remedied before proceeding with the work.
      d) Variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, shall not exceed 1/64 per inch of pipe diameter, or ½ inch maximum.
      e) Tee stations shall be staked as specified in Subsection “Surveying,” to enable the contractor to install services at the correct property location.
   2. Pipe Handling:
      a) The contractor shall unload pipe only by approved means. Pipe shall not be unloaded by dropping it to the ground and pipe shall not be dropped or dumped into trenches.
      b) The contractor shall inspect all pipe and fittings before lowering them into trenches to ensure that no cracked, broken, or otherwise defective materials are used.
      c) The contractor shall clean the ends of pipe thoroughly, remove foreign matter and dirt from inside the pipe, and keep it clean during laying and joining.
      d) The contractor shall lower the pipe into the trench in such a manner as to avoid any physical damage to the pipe.
      e) The contractor shall remove all damaged pipe from the job site.
   3. Foreign Material:
      a) The contractor shall take all necessary precautions to prevent excavated or other foreign material from entering the pipe during the laying operation.
      b) At all times, when laying operations are not in progress, the contractor shall use a mechanical plug at the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints.
   4. Pipe Laying:
      a) Pipe laying shall proceed upgrade, with the spigot ends pointing in the direction of flow.
      b) After a section of pipe is lowered into the prepared trench, the contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe.
      c) At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly.
      d) The joint shall be assembled according to the recommendations of the manufacturer. The contractor shall provide all special tools and appliances required

for the joint assembly. After the joint is made, the pipe shall be checked for alignment and grade.

e) The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.
f) Do not lay pipe in water or when, in the opinion of the City Engineer, trench conditions are unsuitable.

5. Movable Shield: When pipe is laid in a movable trench shield, the contractor shall take all necessary precautions to prevent the pipe joints from pulling apart when the shield is moved ahead. The bottom of the shield shall not extend below the spring line of the pipe without recompacting the pipe zone.
6. Cutting Pipe: When cutting or machining the pipe is necessary, the contractor shall use only the tools and methods recommended by the pipe manufacturer and approved by the City Engineer. The contractor shall cut ductile iron pipe using a method approved by the City Engineer; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.
7. Transition Fittings: Connections of service branches to existing sewers shall be made watertight. Transition couplings between dissimilar pipe materials shall be made using approved commercial adapters with stainless steel bands such as Fernco or approved equal.
    a) PVC couplers or adapters shall meet the specifications for ASTM D-3034, SDR 35 pipe fittings.
    b) Ductile iron transition couplings shall be manufactured from ductile iron conforming to ASTM A-536, grade 65-45-12, for center and end rings. Rubber gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11.
8. Concrete Closure Collars
    a) The contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, and construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth, as indicated in these standards.
    b) Closure collars shall be used only when approved by the City Engineer, and then only to make connections between dissimilar pipe, or where standard rubber-gasketed joints are impractical.
    c) Before the closure collars are installed, the contractor shall wash the pipe to remove all loose material and soil from the surface where they will be placed.
9. Pipe Zone Material: The contractor shall install pipe zone material uniformly on both sides of the pipe, up to the spring line of the pipe. Material shall be placed in lifts not exceeding 6 inches. Material shall be well worked with hand tools to ensure proper support in the haunching area.
10. Line Taps
    a) Line taps shall be core-drilled unless otherwise approved by the City Engineer. Core-drilled holes shall be made using a cylinder-style hole saw for plastic pipe material only, or a diamond core bit for concrete and ductile iron pipes.
    b) Line tap connections to existing storm lines may be done using either saddle tees or by using Inserta Tee® as per Subsection “Stormwater Pipe and Fittings.”
    c) Line taps shall be centered on the spring line of the pipe being tapped.
    d) The area around the saddle installation site shall be cleaned and free of all rough edges before installing the saddle.
    e) While installing the saddle, no rock, dirt, or debris shall be allowed to enter the main sewer line from the core hole.
    f) The contractor shall install ¾”-0” crushed aggregate in the pipe zone around the line tap, from 6 inches below the pipe to 12 inches above the pipe.

g) Laterals shall have tracer wire (10-gauge solid core with white THNN insulation) installed beside the pipe.

3.11 CONSTRUCTION SPECIFICATIONS

3.11.1 General Provisions

The specifications outlined here, together with the standards established by the Oregon DEQ, the U.S. Environmental Protection Agency, and any other applicable requirements of the City, shall govern the character and quality of material, equipment, installation, and construction procedures for gravity-flow portions of public storm systems.

3.11.2 Scheduling

The contractor shall plan their construction work in conformance with Chapter 1 Subsection "Scheduling."

3.11.3 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Chapter 1 Subsection "Environmental Protection, Erosion Prevention, and Sediment Control."

3.11.4 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Chapter 1 Subsection "Interferences, Obstructions, and Abandoned Utilities."

3.11.5 Contaminated Soil or Hazardous Materials

If during construction contaminated soil or with hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Chapter 1 Subsection "Contaminated Soils or Hazardous Materials."

3.11.6 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill Standards."

3.11.7 Preservation, Restoration, and Cleanup

A. Cleanup: Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Chapter 1 Subsection "Preservation, Restoration, and Cleanup."

B. Preservation of Drainage Ditches: After backfilling the trenches, the contractor shall restore all public and private storm drain ditches that were destroyed, damaged, or otherwise modified during construction to the condition of the ditch before construction. Ditches shall be built in their original locations unless otherwise redesigned as part of the project.

3.11.8 Bores

A. General

The carrier pipe in all bores shall be installed inside a steel case, unless otherwise approved by the City's authorized representative.

B. Installation

1. Casing: The casing shall he smooth steel of a size to permit proper construction to the required line and grade. The steel casing shall be fabricated in sections for field-welded joints. The casing wall thickness shall be a minimum of/ inch for pipe diameters of 6 to 12 inches and shall be a minimum of 5/16 inch for pipe diameters of 15 to 24 inches, or in accordance with the requirements of the jurisdiction of the right-of-way.

2. Pipe Supports: The sewer pipe shall be continuously supported on three sides by pipe supports, except at joints. Pipe supports shall be No. 2 HDPE plastic block or approved equal. Strapping and hardware shall be stainless steel.
3. Placing Fill in Casing: The annular space shall be completely filled between the casing and pipe with lean grout or sand to prevent pipe flotation.
4. Concrete Seals and Fill: After the storm pipe is tested and approved, concrete plugs shall be poured at each end of the casing. The annular space between the casing and pipe shall be completely filled with lean grout or sand to prevent pipe flotation.

C. Railroad Crossings

Prior to beginning any under-track work, applicant shall obtain proper permit(s) from ODOT and written approval of plans from user(s) of railroad line. Install the pipe by tunneling, jacking, boring or similar methods, approved by the Railroad. Install the pipe to the lines and grades established and backfill completely all voids around the installation with specified material, to the satisfaction of the railroad.

3.12 TESTING PROCEDURES

3.12.1 General

A. The contractor shall furnish all necessary testing equipment and perform the tests in a manner satisfactory to the City's authorized representative.
B. All gravity storm systems shall be inspected and tested after backfill has passed the required compaction test(s) based on AASHTO T-180 and roadway base rock has been placed, compacted, and approved. All details of testing procedures shall be subject to approval of the City's authorized representative.
C. If repair work is required on a section of the system, that portion of the system shall be retested.
D. All testing shall be completed and accepted by the City's authorized representative before paving of overlying roadways will be permitted.

3.12.2 Line Cleaning

Before testing and City inspection of the system, the contractor shall ball and flush and clean all parts of the system. The contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole. If necessary, the contractor shall use mechanical rodding, bucketing or vactor equipment. When the City's authorized representative inspects the system, any foreign matter still present shall be flushed and removed from the system. Contractor shall provide screening; no material shall be flushed into the downstream city sewer system.

3.12.3 Deflection Test for Flexible Pipe

Storm systems constructed of flexible pipe shall be deflection-tested by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95% of the nominal pipe diameter, unless otherwise specified by the City's authorized representative. The mandrel shall be a rigid, nonadjustable, odd-numbered-leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be done manhole-to-manhole and after the line is completely balled and flushed with water, and after compaction tests of backfill are completed and accepted. The contractor shall be required to locate and repair any sections that fail the test and to retest those sections. All repairs shall follow and be in compliance with the manufacturer's recommendations.

3.12.4 Video Inspection of Gravity Systems

All storm systems shall be video-inspected and approved prior to City acceptance. Video inspection shall take place after trench backfill and compaction has been completed and accepted, and channels have been poured in manholes. All pipes shall be thoroughly flushed immediately prior to the video inspection; only that water remaining from flushing shall be present in the system. The camera shall have the ability to tilt up to 90 degrees and rotate 360 degrees on the axis of travel. An inspection of all lateral connections shall be conducted using the tilt capabilities of the camera. A 1.0-inch target ball shall be placed in front of the camera. Observed sags must be less than 0.5 inch.

The City's authorized representative shall be notified and shall be present during video-inspection of the system, unless otherwise approved by the City's authorized representative. A copy of the video and a written video inspection report, on a City-approved form, shall be supplied to the City's authorized representative. The video shall be recorded in color and in DVD format on a thumb drive and shall include a visual footage meter recording. Problems revealed during the inspection shall be noted on the video and in the written report. After repairs have been made, the line shall be re-inspected and re-tested. If excessive foreign material, in the opinion of the City's authorized representative, is encountered during video inspection, the line shall be balled and flushed, and re-video inspected. All reports shall use NASSCO Codes for Condition Assessments.

3.13 WARRANTIES & ACCEPTANCE

3.13.1 Stormwater and Surface Water Acceptance Policy

The City of Independence will accept new stormwater and surface water installations or systems built to the "Public Works Standards," providing that the following conditions are met.

A. Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.
B. After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Chapter 1 Subsection "Project Closeout."
C. The Contractor or Applicant shall be responsible for providing maintenance assurance for public improvements as outlined in Chapter 1 Subsection "Maintenance Assurance and Warranty." Public storm improvements shall be warranted for a minimum of two years; public landscape improvements shall be warranted for a minimum of two years.
D. At any time during the warranty period, the City's authorized representative has reason to believe the public stormwater improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to video-inspect the sewer line and repair any problems or faults revealed during video inspection by replacing those sections. The video inspection shall be done during the winter, if possible, or during the wet weather months, to identify all leaks.
E. Before the end of the construction maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.

F. The landscape maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Subsection “Landscape Inspection for Warranty”).

3.13.2 Landscaping Inspection for Warranty

A. The City's authorized representative shall inspect the condition of all landscaping located within the public right-of-way and/or the water quality/quantity facility at the end of the first and second year of the post-construction period. The City's authorized representative shall provide an interim inspection report to the applicant with a specific summary of any deficiencies. Failure of the City to provide the interim report shall not release the applicant from the responsibility for providing established landscaping at the end of the two-year landscaping maintenance period.
B. If at any time during the warranty period the landscaping falls below the 90% survival level, the applicant shall reinstall all deficient planting at the next appropriate planting opportunity. The two-year maintenance period shall begin anew from the date of replanting.
C. The 90% survival level shall meet the following criteria:
    1. In the opinion of the City's authorized representative, landscaping is established and healthy.
    2. Each plant group (trees, shrubs, herbaceous, and aquatics) shall meet the 90% survival level.
    3. Each p/anting zone (wet, moist, and dry) shall meet the 90% survival level.
D. Areal coverage shall meet the 90% survival level.