

CHAPTER 7. DRAINAGE

7.01 General

- A. Designs: Drainage facilities shall be designed consistent with King County Code 9.04 and the King County Surface Water Design Manual, **latest** edition. Structures shall be placed and constructed as shown in the Standard Drawings.
- B. Specifications: Materials, construction, and testing are specified in the **WSDOT/APWA** standard Specifications. The Engineer may amend, delete, or add specifications or Standard Drawings.
- C. Conflicts: Where technical conflicts may occur between this document and the Surface Water Design Manual the Engineer shall decide which document governs.

7.02 Road Ditches

The following standards shall only apply in design of drainage ditches not requiring drainage review under the provisions of the Surface Water Design Manual.

- A. On grades up to 6 percent, grass lined ditches with grasses as specified in **7.02D** shall be used for the drainage requirement. These ditches shall be designed and constructed in accordance with Drawings No. 1-001, 1-004 and **1-007**. If grass cannot be readily established by usual seeding method, other methods such as sodding or seeding with slope mat protections shall be used as necessary. For grades between 3 percent and 6 percent, grass lining alone may not be sufficient to stop erosion. Preferred methods to further reduce potential erosion problems include the use of check dams or wider ditch sections. Rock-lined ditches shall be avoided whenever possible.
- B. Where the grade is over 6 percent and not over 9 percent, the Engineer may direct use of a standard rock-lined ditch or alternatively a closed (pipe) drainage system under a paved shoulder with asphalt curb or turnpike shoulder. As an exception, cul-de-sacs with over 6 percent grade shall be provided with pipe drainage and not with rock-lined ditches.
 - 1. The standard rock lining shall be in accordance with the Surface Water Design Manual and Section 9-13.6 of the **WSDOT/APWA** Standard Specifications. Rock gradation shall be as follows:

Passing 8-inch square sieve	100 percent
Passing 3-inch square sieve	40 percent max.
Passing 3/4-inch square sieve	10 percent max.
 - 2. Rocks shall be placed so as to form a firm, dense, protective mat consistent with examples in Drawing No. 2-024 and conforming to the design surface of the ditch. Individual rocks shall not protrude more than three inches from that surface.

- C. Where the grade exceeds 9 percent either pipe drainage or a special rock-lined ditch shall be provided unless otherwise approved by the Engineer. The special rock-lined ditch shall be designed by a professional engineer, based on soils and hydraulic analyses. Design shall include rock sizing, together with filter rock gradations and/or filter fabric, and be subject to approval by the Engineer.
- D. Grass seed mixture by weight may be 10 percent Colonial bentgrass, 40 percent Tall or Red fescue, 10% White clover, hydroseed at 120 lbs./acre, handseed at 3 lbs./1,000 square feet. Where there is high groundwater, the following species may be substituted or added: Meadow or Pacific foxtail, Timothy, or Redtop.

7.03 Storm Sewers and Culverts

- A. Minimum pipe size shall be 12-inch diameter. Eight-inch diameter may be permitted on cross street laterals less than 66 feet long to avoid utility conflict or meet shallow gradient.
- B. Where the time of concentration creating the greatest flow is less than 15 minutes and the system predominately serves the road, determine flow rates using the rational formula.
- C. Driveway culverts shall conform to Drawing No. 3-003.
- D. The following pipes, specified in Section 9-05 of the WSDOT/APWA Standard Specifications are allowed: plain and reinforced concrete storm sewer pipe, aluminumized Type 2 corrugated steel, steel spiral rib and corrugated steel with asphalt coating Type 1, spiral rib and corrugated aluminum, ductile iron, polyvinyl chloride (PVC), lined corrugated polyethylene (LCPE) and solid wall polyethylene (SWPE) pipe.
- E. LCPE pipe shall have a smooth interior wall meeting or exceeding Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM 01248, minimum cell Class ASTM D3350, 324420C. LCPE shall also meet or exceed the requirements of AASHTO M294, Type S. Pipe shall be placed in accordance with County Specifications.
- F. SWPE pipe with maximum SDR of 32.5, minimum cell Class ASTM D3350, 334434C and meeting County Specifications for ductile iron pipe with restrained mechanical joints may be used for outfalls on steep slopes.
- G. PVC pipe shall require the use of bedding material for flexible pipe specified in Section 9-03 of WSDOT/APWA Standard Specifications.
- H. LCPE and SWPE shall be bedded on gravel backfill for pipe bedding as specified in Section 9-03 of WSDOT/APWA Standard Specifications. Above ground installation of SWPE does not require pipe bedding.

- I. PVC, LCPE and SWPE shall be tested using the deflection test procedure described in Section 7-17.3 of the WSDOT/APWA Standard Specifications. Unless otherwise specified the mandrel for the deflection test shall have a minimum of nine runners equally spaced, a base length equal to or less than the diameter of the pipe, and a diameter no less than 95 percent of the base inside diameter of the pipe, which is described as follows:

For pipes with controlled inside diameter, PVC and SWPE: $\text{base inside diameter} = \text{average inside pipe diameter} - ((\text{inside diameter tolerance})^2 + (\text{out of roundness tolerance})^2)^{.5}$.

For SWPE up to 30-inch the above equation simplifies to: $\text{base inside diameter} = \text{nominal diameter} \times 0.9665$.

For pipes with controlled outside diameter, LCPE: $\text{base inside diameter} = (\text{average outside diameter} - (2 \times \text{wall thickness}) - (\text{outside diameter tolerance}) + (12 \text{ percent} \times \text{wall thickness})^2 + (\text{roundness tolerance})^2)^{.5}$.

Average diameter and tolerances shall be as specified by applicable ASTM standards. Pipe sections failing the mandrel test shall be replaced except that reshaping SWPE and LCPE sections to meet requirements shall be allowed if the original deformation is less than 20 percent.

- J. Concrete pipe shall be rubber gasketed and metal pipe shall be gasketed and securely banded. Leak testing shall be conducted if required by the Engineer.
- K. If the depth of a pipe exceeds eight feet or the Engineer questions the pipe selection, then the selection of pipe material must be made by a professional engineer.
- L. Bevel the projecting ends of culverts within the right-of-way.

7.04 Catch Basins and Junctions

- A. Catch basins shall be spaced no greater than 150 feet for grades less than one percent, 200 feet for grades between one and three percent; and 300 feet for grades three percent and greater. Where the width of the tributary road surface exceeds 35 feet, the cross slope exceeds four percent, or the 10-year, 24-hour rainfall exceeds three and one-half inches, catch basin spacing analysis is required. The analysis must show the depth of water at the edge of the traveled way does not exceed 0.12 feet or extend more than five feet into the traveled way for the 10-year storm event, using flows generated by the rational formula.
- B. Use catch basins, rather than inlets, to collect water from road surfaces, unless approved by the Engineer.

- C. Connections to pipe systems may be made without placing a catch basin or manhole on the mainline by meeting all of the following conditions:
 - 1. The mainline pipe is 48 inches or greater and at least two times the size of the connecting pipe.
 - 2. Make connections in accordance with the manufacturer's recommendations. Standard shop fabricated tees, wyes and saddles shall be used, except for concrete pipe connections constructed in accordance with Drawing No. 2-002.
 - 3. There shall be a catch basin or manhole on the connecting pipe within two to ten feet of the external wall of the main line. See Drawing No. 2-002.
 - 4. Offset angle of connecting pipe to **mainline**, horizontally and vertically, shall be less than 45 degrees.
- D. Connections to an existing system shall avoid directing project runoff through downstream **quality/quantity** control facilities. Receiving systems may have separate conveyance facilities: one connecting to **quality/quantity** facilities and one by-passing them. Connection shall be to the bypass system where available.
- E. Use Type 2 catch basins where the depth to the invert of the pipe exceeds five feet.
- F. Manholes may be used in lieu of catch basins **if** they do not collect surface water.
- G. Roof and yard drains, or other concentrated flow from adjacent property shall not discharge over the surface of roadways or sidewalks.
- H. Catch basins or manholes are required when joining differing types of pipes.

7.05 Frames, Grates, and Covers

- A. Unless otherwise specified, use vaned grates with standard frame in the traveled way, gutter, or shoulder. Vaned grates shall not be located within cross walks,
- B. At sag vertical curves, or before intersections with a grade 4% or greater, use through curb inlet frames. Where through curb inlets cannot be used, three vaned inlets shall be used. One shall be located at the approximate low point and another on either side at 25 foot horizontal spacing, but not greater than 0.1 foot above the low point.
- C. Use rolled curb frame and (vaned) grates along rolled curbs and in asphalt turnpike shoulders. See Drawing No. 2-024.

- D. New catch basins that do not collect runoff shall use locking manhole covers. See Drawing No. 2-022. Existing catch basins which no longer collect runoff shall have their frame and grates replaced with solid covers (See Drawing No. 2-015).
- E. All storm drain covers and grates shall be locking. Manufacturer as approved by the Engineer.
- F. Slit drains may be used when approved by the Engineer. At a minimum slit drains shall have catch basins at either end unless used as a driveway culvert. The maximum distance between catch basins along a slit drain shall be 50 feet.

7.06 Erosion Control

Provide erosion control as required in the Surface Water Design Manual.

Filter fabric fences shall be constructed of material designed specifically for erosion control. The fabric shall be composed of rot-proof woven or non-woven polymeric fibers and be free of chemical treatment or coating that may reduce permeability. The fabric shall meet the following test requirements: minimum 110 **lbs** grab tensile strength per **ASTM D-1682**, minimum 40 lbs puncture strength per **ASTM D-751 Modified**, and 20-100 Equivalent Opening Size (**EOS**) based on **U.S.** standard sieves.

7.07 Trenches. See Section 8.03.