

CHAPTER 4

CONVEYANCE SYSTEM ANALYSIS AND DESIGN



**CITY OF KENT
SURFACE WATER
DESIGN MANUAL**

CHAPTER 4

CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The City of Kent has made several minor changes to Chapter 4 of the 1998 KCSWDM. Apart from these changes, the King County version of Chapter 4 applies to proposals in the City of Kent. The City's changes to the County document are documented below.

- **Section 4.1 DESIGN CRITERIA, Easement and Setback Requirements** (*page 4-3 of the 1998 KCSWDM*)—This section shall read as follows:

Permanent onsite Easements for access, maintenance, and construction are required for all public and private stormwater systems serving more than one property located outside of public right-of-way. When Easements are required, then legal descriptions for same shall be submitted with a professional land surveyors stamp thereon. Also at this time, a current title report covering the properties to be encumbered by the Easements shall accompany said description. Under no circumstances shall a Bill of Sale be placed on the City Council agenda for action until all Easements have been approved and recorded.

When offsite Easements and/or onsite Easements for the extension of approved comprehensive stormwater plans are required, these shall be approved and recorded prior to holding any preconstruction meeting. Also the same conditions shall apply regarding legal descriptions and title reports.

A. Easements

The minimum easement widths are as follows:

1. Storm drain pipelines (under 10 feet deep) – 15 feet wide.
2. Storm drain pipelines (10 –15 feet deep) – 20 feet wide. Note: large diameter or deeper sewers may require wider easements as determined necessary by the Director.
3. Access and/or maintenance roads are required to all retention/detention facilities, control manholes, and other drainage structures. The minimum roadway width shall be 12 feet. The road shall be paved with an all weather surface, and the pavement shall be designed to support a HS-20 loading maintenance vehicle.
4. The Easements for detention facilities or other structures shall extend a minimum of 12 feet around the outside of the facility, and shall include access Easements as well.

B. Right-of-way

Where possible, utility extensions shall be located within City Right-of-way. When possible storm drainage Retention/Detention facilities shall be located adjacent to City Right-of-way.

Work inside County and State Right-of-way requires use permits from the appropriate agencies. County and State Right-of-way Permits must be obtained by the developer/owner.

- **Section 4.2.1.1 DESIGN CRITERIA, Acceptable Pipe Sizes (page 4-5 of the 1998 KCSWDM)**— This section shall read, “The minimum diameter of storm drain approved for mainline conveyance systems, or for driveway culverts, shall be 12 inches. Minor laterals and connections to catch basins may be 8 inches in diameter if approved by the City. The minimum diameter acceptable for private systems shall be 8 inches excluding downspouts.”
- **Section 4.2.1.1 DESIGN CRITERIA, Allowable Pipe Materials (page 4-5 of the 1998 KCSWDM)**— This section shall read as follows:

The designer shall have the option of constructing storm sewers, drains, and culverts of the type of pipe listed below within the limits specified. It is not necessary that all pipe on the project be of the same type; however, all contiguous pipe shall be of the same type.

Type of Pipe	Minimum Cover (ft) (from top of bell)	Public Systems
CMP	1	Yes
PCP (Bell & spigot Gasket joint)	2	Yes
RCP	1	Yes
HDPE	1.5	Private only
PVC SDR 35	3	Yes, except for culvert
PVC SDR 21	1.5	Yes, except for culvert
Ductile Iron	0.5	Yes
Ribbed PVC	2	Yes, except for culvert

NOTE: These are minimum depths. Actual depths must meet design loading requirements. This includes maximum depths specified by the pipe manufacturer. Pipe cover in areas not subject to vehicular loads may be reduced to 1 inch minimum.

All materials used for construction of storm drainage systems and appurtenances shall be new and undamaged. All materials used shall be subject to inspection by the City prior to use. The contractor shall provide the City with shop drawings, manufacturer's specifications, and certificates of materials as requested.

The materials referred to herein, shall conform to the applicable provisions of the Standard Specifications and the manufacturer's recommended installation procedures.

1. Plain Concrete Storm Sewer Pipe (PCP) – All nonreinforced concrete pipe shall be ASTM C14-81 Class II or better with gasketed joints. The maximum diameter for unreinforced pipe shall be 12 inches.

2. Reinforced Concrete Pipe (RCP) – All reinforced concrete pipe shall be ASTM C76-85a Class IV or as specified.
 3. Corrugated Steel Pipe – All corrugated steel storm drain pipe shall be sixteen (16) gauge or thicker. Gaskets are required on all fittings and couplings. Couplings shall be Type F. (See Standard State WSDOT Plan B-13b for coupler).
 4. Protective Treatment – All steel pipe shall be coated with a protective asphalt treatment. The minimum acceptable protective treatment shall be APWA Treatment 1. Aluminum corrugated metal pipe may be substituted for Treatment 1 corrugated metal pipe. If smooth bore pipe is specified to improve hydraulic performance, the pipe shall be Treatment 5 for both annular and helical pipe. Aluminum pipe shall be painted with 2 coats of zinc chromate primer where it contacts concrete. Aluminum storm drain pipe may be used in place of corrugated steel pipe with equivalent structural strength.
 5. Corrugation – All corrugated and steel storm drain pipe 15 inches in diameter and less shall have helical corrugations. Pipe larger than 15 inches in diameter can be either helical or annular.
 6. Aluminum Pipe – Aluminum storm drain pipe may be used in place of corrugated steel pipe with equivalent structural strength.
 7. PVC Pipe – PVC pipe conforming to ASTM 3034, SDR 35 and SDR 21 with rubber gasket joints may be used where adequate cover can be obtained. PVC pipe cannot be used for culvert pipes.
 8. Ribbed PVC – PVC pipe conforming to ASTM F79H/UNI-B-9 with rubber gasket joints may be used where adequate cover can be obtained. Ribbed PVC pipe cannot be used for culvert pipes.
 9. HDPE Pipe – HDPE pipe is approved only for private onsite drainage systems.
 10. Ductile Iron Pipe – DI pipe shall be Class 50 in accordance with USA Standard A-21.1 (AWWA C-51). All joints shall be push-on mechanical or flanged.
- **Section 4.2.1.1 DESIGN CRITERIA, Allowable Pipe Joints (page 4-6 of the 1998 KCSWDM)—**
Replace this section with the following:

Rubber gaskets shall be used for all pipe joints except as described below. The rubber gaskets shall be factory manufactured for the particular type and brand of pipe used. Coupling bands and rubber gaskets are required for all steel or aluminum sewer pipe. Coupling bands for CMP shall be type “F” unless otherwise approved. The manufacturer recommendation shall be adhered to for HDPE pipe.
 - **Section 4.2.1.1 DESIGN CRITERIA, Pipe Alignment (page 4-7 of the 1998 KCSWDM)—**
Replace Requirement 1 with, “All storm drains smaller than 36 inches in diameter shall be designed with a straight alignment between manholes. The use of fabricated pipe bends for larger diameters requires approval by the City and shop manufactured fittings designed for the specific application.”
 - **Section 4.2.1.1 DESIGN CRITERIA, Structures (page 4-8 of the 1998 KCSWDM)—** **The following additional criteria shall apply to projects in the City of Kent:**

Storm Drainage Manholes

- A. Location – Storm drainage manholes or catch manholes for access are required at the following locations on the conveyance system:
 1. All changes in slope.
 2. Changes in pipe diameter.

3. Connections of storm pipes from manholes to the conveyance systems that are larger than 24 inches in diameter.

The following exceptions may be connected to conveyance systems that are equal to a 48-inch-diameter pipe using an approved saddle branch:

- a. Connections of storm pipes from catch manholes that are 24 inches and smaller in diameter.
 - b. Connections of storm pipes from catch basins that are 18 inches and smaller in diameter.
4. Changes in alignment.
 5. Distances not greater than 400 feet on pipe runs.
 6. Dissimilar pipe materials.
 7. In a trunk line smaller than 12 inches, at every other catch basin but no greater than 400 feet.
- B. Flow Channels – Where necessary to maintain the hydraulic gradeline, channeled storm drain manholes shall be used. The manhole shall be fully channeled to the crown of the pipe to accomplish smooth flow and minimize turbulence at junctions. Catch or drop section manholes are permitted on the trunk system.
 - C. Flow at Transition Manholes – To maintain the energy gradient and the velocity through grade changes and changes in diameter at manholes, the invert of the downstream pipe shall be lowered. A general method to achieve the required drop at manholes is to match crowns of the storm pipes. In cases where slopes are at a minimum, an alternate approach is to use the 0.8 rule. Where possible, a 0.1 foot drop in all manholes is desirable.
 - D. Standard Manholes – The minimum diameter of manholes shall be 48 inches and shall be precast reinforced concrete structures. All manholes shall be equipped with safety steps. Larger diameter manholes are required for larger pipelines and special pipe configurations. The following table lists the minimum diameter of manholes for various runs of straight pipelines. (See Standard Details 5-8(a), 5-8(b) and 5-9 in Appendix B of the Kent Construction Standards.)

Pipe Diameter	Manhole Diameter
8 inches – 21 inches	48 inches
24 inches – 36 inches	54 inches
36 inches – 42 inches	72 inches
42 inches – 60 inches	96 inches

Stormwater Inlets

Stormwater inlets, installed to intercept surface runoff, include catch basins, catch manholes, curb inlets, and headwall structures. Catch type inlets are required to trap or minimize silts, sediment, and debris from entering the main drainage systems. Curb type inlets without a drop section are permitted only where approved by the City.

- A. Catch Basin Locations for Street and Roadways – Catch basins or catch manholes shall be installed at these locations:
 1. At all street gutterline intersections in such a configuration as to minimize gutter flows through pedestrian crossings.

2. At locations along gutters so as to provide a maximum gutter flow of 200 feet for street grades up to 3%.
 3. Where Type II catch basins are used for access to the trunk storm sewer, the maximum spacing shall be 400 feet.
 4. At all low points of vertical curves and grade breaks.
 5. At the inlet of minor ditches to the drainage system.
- B. The low point of vertical curves or roadway grades require catch basins with through curb inlet to minimize the potential for property damage. Cul-de-sacs located at the low end of roadway grades also require catch basins with through curb inlet. (See Standard Detail 5-2(a) and (b) in Appendix B of the Kent Construction Standards.)
- C. In all cases, the location, size, and number of catch basins to be installed shall be sufficient to ensure that there is adequate capacity to efficiently collect the stormwater.
- D. Catch Basin Locations for Private Developments – Catch basins or catch manholes are required at these locations for private developments:
1. At the junction of private storm drainage systems with City drainage systems.
 2. At adequate locations throughout the development to provide efficient drainage of paved areas and to ensure that surface water runoff to adjacent City streets and private property is minimized.
 3. At locations as required to intercept natural drainage entering the site.

Castings

- A. Manhole frames and covers shall be cast gray iron or ductile iron. All manhole covers located outside the street shall have locking lids. (See Standard Details 4-5, 4-6[a] and 4-6[b] in Appendix B of the Kent Construction Standards.)
- B. Public catch basin frame and grates shall be ductile iron and bolt down. (See Standard Details 5-1[a] and 5-1[b] in Appendix B of the Kent Construction Standards.)
- C. Public catch basins used in areas not designed to receive surface drainage or where required by the Director shall have ductile iron bolt down frame with solid lid. (See Standard Detail 5-1[b] and 5-1[c] in Appendix B of the Kent Construction Standards.)
- D. Public catch basins used in low point of vertical curves or roadway grades and at the low end of roadway grades in cul-de-sacs shall have through curb inlet frame and self-locking vaned grate. (See Standard Detail 5-1[d], 5-2[a] and 5-2[b] in Appendix B of the Kent Construction Standards.)
- E. Public catch basins used in steep roadway grades of 6% and greater shall have ductile iron self-locking vaned grate with vaned grate frame. (See Standard Detail 5-1[d] and 5-1[e] in Appendix B of the Kent Construction Standards.)
- F. Public catch basins used in rolled curb and gutter shall have rolled curb frame and grate. (See Standard Details 5-1[f] and 5-1[g] in Appendix B of the Kent Construction Standards.)
- G. Block lettering is required on the top surfaces of storm drain castings, and shall read as follows:
“NO DUMPING! DRAINS TO STREAMS!”

Manhole and Catch Basin Adapters

- A. All aluminum surfaces in contact with the concrete or concrete pipe shall be painted with 2 coats of zinc chromate primer. The aluminum pipe to be painted shall be cleaned with solvent to remove contaminants. After cleaning, the pipe shall be painted with 2 coats of paint conforming to Federal Specification TT-P-645 (Primer, Paint, Zinc Chromate, Alkyd Vehicle).

- B. PVC pipe adapters shall be Kor-in-seal type flex joints or sand collars meeting ASTM D-303H-78 SDR35 specifications or other materials as approved by the Director to permit slight differential movement.
- C. Ribbed PVC adapters shall be Ribbed PVC sand collars meeting ASTM D-303H-78 SDR35 specifications. Where the pipe enters square to the manhole or catch basin, double gaskets may be used. The gaskets must fall within a 1-inch tolerance of the inside and outside face of the wall of the structure.
- D. All pipe materials other than the above shall be mudded directly into the manholes and catch basins using a smooth 45 degree bevel from the pipe to the structure. The allowable protrusion is 2 inches inside the structure unless otherwise approved by the Director.

Pipe Bedding

Pipe bedding for storm drain and culvert pipe shall be 5/8-inch minus crushed rock. (Pea gravel is not allowed). A continuous and uniform bedding shall be provided in the trench for all buried pipe. Bedding material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe to 95% compaction ASTM D-1557, in accordance with the standard specifications and details and in conformance with the following gradation:

Sieve Size	Passing
3/4 Inch	100%
5/8 Inch	95 – 100%
1/4 Inch	45 – 65%
U.S. No. 40	6 – 18
U.S. No. 200	7.5 Max.
% Fracture	75 Min.
Sand Equivalent	40 Min.

L.A. wear 500 rev. 35% Max., Degradation 25% min. Free from wood waste, bark, and other deleterious material.

Bedding shall be placed 6 inches under or around the pipe and 6 inches over the pipe where, in the opinion of the Director, existing material is found unsuitable. The pipe shall be protected from damage when compacting. At least 2 feet of cover is required over the pipe prior to using heavy compaction equipment.

Where determined necessary by the Director, ballast material shall be used below bedding to stabilize the trench. Ballast shall conform to the requirements of Foundation Material in Section 3.8.2 of the City of Kent Construction Standards.

Backfill

Pipe trench backfill shall be in accordance with Section 4.7.6 of the City of Kent Construction Standards unless otherwise approved by the Director.

Cleaning

All storm drain pipe including the downstream system shall be thoroughly cleaned to remove any solids or construction debris that may have entered the pipe system during construction.

The Contractor shall be responsible to ensure that materials flushed from the storm drain are trapped, removed, and do not enter the downstream drainage system.

Storm Drain Stenciling

The pavement adjacent to all new catch basins shall be stencil painted with a standard pollution prevention stencil such as the thermoplastic example below. The Contractor is responsible for purchase and installation of the stencils.

Repairs

All storm drain system installations shall be new and undamaged. Repairs by grouting or collars are not acceptable for new piping systems. The contractor shall bear all costs for correction of deficiencies.

Television Inspection

All new City storm drain extensions, 24 inches in diameter and smaller shall be TV camera inspected by the City of Kent Utility Department prior to acceptance. All construction must be completed and approved by the inspector prior to the TV inspection. The manholes and catch basins must be set to grade, channeled, and grade rings set in place prior to TV inspection. Castings and the top grade ring must be removed for paving and grouted in place after paving.

It is the responsibility of the contractor to string each storm main when required prior to the inspection. The string shall be a nylon cord of sufficient strength for the City equipment.

- **Section 4.2.1.1 DESIGN CRITERIA, Pipe Design Between Structures (page 4-9 of the 1998 KCSWDM)—Add the following to the list of requirements:**
 - 4. Storm sewers with design velocities greater than 10 fps shall be designed with energy dissipation structures as deemed necessary by the City. Pipes installed at slope greater than 20% require pipe anchors.
- **Section 4.2.1.1 DESIGN CRITERIA, Spill Control (page 4-10 of the 1998 KCSWDM)—Delete Item d “An active spill control plan.” This is not an acceptable option for spill control in the City of Kent.**
- **Section 4.2.2.1 DESIGN CRITERIA, General (page 4-27 of the 1998 KCSWDM)— Add the following to the list of requirements:**
 - 5. Points of discharge from culverts and storm sewers into ditches and swales 15% or greater in grade shall require the design and installation of special energy dissipators.
- **Section 4.3.1.1 DESIGN CRITERIA, General (page 4-35 of the 1998 KCSWDM)— Add the following to the list of requirements:**

3. The minimum diameter of culvert for roadside ditches or other installations shall be twelve (12) inches in diameter. Larger diameter culverts shall be installed where required by appropriate hydraulic analysis.
- **Section 4.3.1.1 DESIGN CRITERIA, Headwater** (*page 4-35 of the 1998 KCSWDM*)—**Requirement 3 has been revised** to read “The maximum headwater elevation at design flow shall be at least 12 inches below finished grade.”
 - **Section 4.3.1.1 DESIGN CRITERIA, Inlets and Outlets** (*page 4-36 of the 1998 KCSWDM*)—**Requirement 4 is revised** to apply to all pipe larger than 12 inches. **Requirement 5 shall apply to all new culverts** unless deemed unnecessary by the City.
 - **Table 4.4.2 Datum Correlations to KCAS** (*page 4-75 of the 1998 KCSWDM*)—The Kent datum is NGVD, USGS and USC and GS 1947 (adjusted to the 1929 datum).