Design Guidelines for Public Storm Drain Facilities

Revised September 2020

This guideline explains standard criteria for civil engineers to design:

- Pipe Storm Drain (PSD)
- Detention pipes
- Shallow street culverts
- Catch Basin (CB) and Inlet facilities

The guidelines here are general and may be modified by Seattle Public Utilities (SPU). SPU and the Seattle Department of Transportation (SDOT) must approve all drainage improvements in the right-of-way.

1. Determine the Point of Discharge

When available, discharge drainage to the public storm drain system instead of the public combined sewer. Direct pipe connections are preferred over curb or gutter discharge.

Please consult with SPU early to determine the best point of discharge.

2. Grade Roadways and Alleys to Collect Drainage

Guidelines on grading in this document are provided only to illustrate concerns for SPU drainage review. See the City of Seattle Standard Plans for Municipal Construction and Seattle Streets Illustrated for further information.

2.1 Curb returns

Grade curb returns at a minimum 0.5% slope in the flow line so that any low point is not:

- In a marked or unmarked crosswalk.
- In front of a curb ramp.

2.2 Right-of-way behind the curb

Grade right-of-way behind the curb to the street. The standard cross section is shown on Standard Plan 400.

When SPU agrees that the standard cross section is not feasible, especially at curb bulbs and bus bulbs, typical drainage design considerations or exceptions include:

- Direct drainage away from building entrances.
- Direct any overflow towards the street.
- Evaluate alternative curb heights down to 4-inch minimum.
- Evaluate alternative slopes on the sidewalk down to 0.5% minimum.
- Use the existing curb line along the walk as a depression line to drain off water to the street.
- Grade planting strip rain garden overflow to overtop the curb towards the street.
- Direct drainage to landscaping or infiltration facilities.
- Install curb cut outlets from bioretention per Standard Plans 295c and 295d.

2.3 New curb bulbs

To the extent practical, minimize public storm drain extensions while grading new curb bulbs to drain.

When locating low points, consider drainage structure maintenance access. Minimize locating access where vehicles will be parked. to avoid the need for temporary on street parking restrictions when maintenance is required. Survey the roadway cross section at the curb bulb to identify:

- Crown location
- Surface topography
- Impacts to flow line

2.4 Concentrated flow

Collect flow concentrated along a gutter or flow line in a drainage structure. Do not leave to fan out after the flow is concentrated.

2.5 Inlet and catch basin staking points

Set elevations for inlets and CB grates at curb face. Include the drainage transition zone as shown in Standard Plan 260a.

2.6 Alleys

Grade alleys per Standard Plan 403 and to drain to the perpendicular street. Public storm drain extensions to mid-alley low points will not be permitted, except when SPU agrees that there is no feasible alternative. When considered:

- Provide safe vactor truck access without the vehicle needing to back up.
- Protect property, assuming clogged CBs will not be functioning or maintained during storms.

2.7 Raised Crosswalks

After SDOT determines that a raised crosswalk is desired for transportation purposes, SPU will review drainage function and mitigation measures. Detailed grading analysis is required.

SPU concerns for drainage review include:

- Minimize redirecting flow from one mainline to another and the associated impacts to downstream properties. Include analysis of flows bypassing a drainage pickup by turning a corner, or not.
- Avoid creating closed contour low points and minimize new low points that trap stormwater.
- Grade to limit ponding when drainage pickups are plugged. The overflow path must not be over the sidewalk or onto private property. Refer to section 3.7 Gutter flow calculations.'
- Consider drainage sructure maintenance access.

3. Locating Catch Basins and Inlets

3.1 Collection points

Collect drainage:

- At all closed contour low points and minor low points along the roadway
- Upstream of all intersections
- Upstream of all crosswalks and curb ramps
- Before transitions on super-elevated roads
- At the downstream end of developed alleys upstream of the sidewalk

Design considerations and exceptions may include:

- A variance when the distance from a high point to the intersection, crosswalk, or end of an alley is less than 100-feet.
- Additional drainage pickups to limit clogging from tree leaves.
- Additional drainage pickups at abrupt grade changes.

Additional drainage pickups (CBs) are required at closed contour low points.

3.2 Maximum curb length

Water from less than 1,000 total lineal feet of curb on a residential street may discharge into one catch basin. This includes the length of curb for inlets which discharge into a catch basin as well as the catch basin itself. Flat residential streets may require additional drainage pickups.

3.3 Open grates

Do not locate open grates in any crosswalk or in front of curb ramps per Standard Plan 260a. From a curb ramp landing to any grate, the minimum clear distance is 1-foot. When unavoidable, a variance that is Americans with Disabilities Act (ADA) compliant will be considered.

3.4 Pedestrian and bicycle routes

Locate and relocate solid cover CBs to avoid the pedestrian and bicycle access routes. When possible, stay close to the curb to limit lane closures during maintenance and avoid the vehicle wheel path to limit noise and wear.

3.5 Standard locations for drainage grates and exceptions

For standard locations see Standard Plan 260a and b. Typical exceptions to locating structures 1½-feet from the point of curvature (PC) or point of tangency (PT) include:

- A wider crosswalk or curb ramp location that would direct pedestrians to cross a grate.
- Grading results in a low point further up gradient.
- Utility conflicts can be avoided by moving the structure up-gradient.
- Picking up flow collected along a curb prior to grade flattening at the intersection, especially at curb bulbs.

3.6 Trees

Maintaining drainage structures can be a hazard to tree health. To the extent feasible, locate structures outside the full growth drip line of street trees. The minimum distance from the edge of the trunk to the edge of the structure is 5-feet per Standard Plan 030.

3.7 Gutter flow calculations

Gutter flow calculations including sag analysis is required for new arterial streets and significant revisions to arterial streets. As a starting point for an analysis, refer to the WSDOT Hydraulics Manual. Seattle has not adopted strict gutter spread standards. SPU and SDOT will review impacts for specific locations. Evaluating depth and spread of peak flows and grading of the street network beyond the project area may be required.

4. Type of Catch Basin or Inlet to Use Where

4.1 CBs preferred

CBs provide more reliable drainage pickup and are preferred over inlets. Typical exceptions when inlet installation is allowed instead of a CB include:

- The existing condition is an inlet and CB system. See Detail 1 (pdf).
- Utility interferences prevent installing a CB along the curb line.
  See Detail 2 (pdf).

4.2 Replacing existing inlets, CBs and pipe

Inlets along new curbs must conform to Standard Plan 250 or be replaced. Whenever an inlet is replaced, the connection pipe to the CB must be replaced with new pipe. If the existing CB or CB connection pipe is determined to be defective by SPU, it must also be replaced.

4.3 Standard CB installation

Standard CB installation within the street shall be per Standard Plan . 240D, which has a vaned grate and through curb opening. Typical design considerations and exceptions include:

- Type 242B installation:
  - To accommodate locating other shallow utilities behind the curb.
  - To avoid a top slab within the pavement.
- Type 240A installation when inlets provide the open grated surface and the CB has a solid lid.
- Type 240C, or 242A, that do not have a through curb opening, when the structure is not at a curb or the curb height is less than 4-inches.

4.4 Standard inlet installation

Install standard inlets within the street per Standard Plan 250B, which has a vaned grate and through curb opening. Use type 250A when the structure is not at a curb or curb height is less than 4-inches.

4.5 At curb bulbs

For curb bulbs, see Detail 4 (pdf). Locate a Standard Plan 240 CB no further up gradient than 1 ½ feet from the PC or PT of the curb bulb.

Use a Standard Plan 250 inlet when the existing condition is an inlet and CB system and:

- The location is not a closed contour low point or a minor low point.
- The inlet connection pipe can be placed at a minimum slope of 5% with an invert at the CB 2-inches minimum above the outlet pipe invert.
- Either an existing CB in good condition or a new type 240A CB is located in the roadway.

4.6 Closed contour low points

At closed contour low points, two independently connected CBs are required in order to minimize:

- Street flooding caused by plugging of the catch basin or inlet
- Drainage runoff overtopping the curb
- Private property damage

At most locations, the second CB is located on the opposite side of the street. See Detail 3 (pdf).

4.7 Alleys

In alleys, use a Standard Plan 241 catch basin.

4.8 Elevated structures

For all elevated structures, consult with SPU early about requirements. If drains are required on a bridge, install per Standard Plan 290 with a grate per Standard Plan 265. New bridge downspouts shall have a minimum pipe diameter of 6-inches and a minimum bend radius of 4-feet.

4.9 Non-standard installations within shallow ditch and culvert system

For non-standard installations within the shallow ditch and culvert system, consult with SPU early about requirements. Typical design considerations and exceptions include:

- Replacing all existing sand boxes within the project area with either a CB or a junction box, depending on the function.
- Grading and defining depression lines to reduce the number of structures needed.
- CB to CB connections along the culvert. This avoids offset CBs that require a junction box because a tee connection to the existing shallow culvert is not feasible.
- Eliminating the trap when connecting CB to CB.
- Installing a Standard Plan 241 CB with a vane grate within the roadway.

- Reducing or eliminating riser sections, if the street surface is flat enough to allow adjustment of the casting with a reduced riser.
- Inverted frames to reduce the height of the casting.
- Situation specific designs of shallow structures.

4.10 Other non-standard installations

Other non-standard installations and modified structures may be approved if SPU agrees that grading to eliminate the need is not feasible. Structures will be individually reviewed, using the following criteria:

- The non-standard structure is:
  - Accessible and maintainable,
  - Does not increase the risk of flooding, and
  - ADA compliant.
- Within the roadway, consider in the following order:
  1. Use of one or two smaller standard structures to increase storage volume (ex. Standard Plan 241 with vaned grate).
  2. A modified shallower CB that has a standard grate, the maximum sump possible and a trap. Detail required.
- Behind the curb installations will be evaluated in the following order:
  1. Depression line to an inlet connected to existing CB.
  2. Depression line to CB and connection to main.
  3. Trench grates will only be approved if there is no infrastructure available for CB connection.

5. Inlet and CB Connecting Pipes

5.1 Sizing

Inlet connection and CB connection pipe standard size is 8-inch diameter. Typical exceptions include:

- When the CB is being connected to a 10-inch or smaller combined sewer, use a 6-inch diameter pipe.
- Allowing a variance to reconnect to an existing 6-inch connection pipe in good condition, rather than replacing the pipe all the way to the mainline. Use a 6-inch diameter pipe and a flexible gasketed coupling with stainless steel shielding. Connecting new 8-inch pipe to an existing 6-inch pipe is not allowed.
- Installing a 6-inch pipe when collecting sidewalk drainage only.

5.2 Inlet connections

Inlet connections must be straight and:

- Placed at a minimum slope of 5%
- Have a maximum length of 50-feet
- Have an invert at the CB that is at least 2-inches above the outlet pipe invert

Inlets must connect to a CB. Direct connection to a mainline must be made from a structure with a sump and outlet trap.

5.3 Outlet location and orientation

See Standard Plans 240, 242, 250 and 261 for allowable location and orientation of outlets from structures. Pipe must be oriented to allow tool access utilizing the length of the casting opening and traps shall be below the casting, so they can be reached.

5.4 CB connections

CB connections must be placed at a minimum slope of 2% and a maximum of 100% slope. Horizontal and vertical bends are expected, but shall not exceed 22½º in a single fitting. A straight pipe section of 1-foot minimum is required between fittings.

5.5 Pipe material

Pipe material is ductile iron (DIP). See standard construction notes "Drainage CB and Inlet Notes" (docx) and Standard Specifications for Municipal Construction . Typical exceptions include:

- Use of a non-metallic pipe when site conditions include corrosive soils or other corrosion source.
- Evaluating matching the existing pipe material when coupling to an existing pipe to remain.

5.6 Connecting to the mainline pipe

Connections to new mainline pipe must be by manufactured tee unless the new mainline is:

- 24-inch or greater, or
- Reinforced concrete pipe (RCP).

For information on allowable connections and procedures for connections to existing mainline pipe, see Core Tap Procedures for Storm and Sewer Mains. Connections to maintenance holes are non-standard and will be evaluated by SPU on a case-by-case basis.

5.7 Shallow street culvert connections

When it is not feasible to install a tee on the existing culvert above springline, connect to shallow street culverts with a junction box.

5.8 Ditch connections

Connections to a ditch must be tapered to match the ditch grading and armoring to prevent erosion may be required.

5.9 Plan submittal requirements

- Station and offset to staking point at face of curb per Standard Plan 260a.
- Profiles are not required for inlet or CB connection pipe, except to show known conflicts or non-standard laying conditions, or connections to mainlines. The standards allow for some field adjustment. However, checking for clearances from other utilities is advised.
- Call out to provide polyethylene foam protection when clearances are less than 6-inches.
- Call out measured lengths per Standard Plan 010.

6. Mainlines- Pipe Storm Drains (PSD)

6.1 Standard location

Locate storm drains in the standard location, 7-feet south or west of the right-of-way centerline, as shown in Standard Plan 030. Alternate alignments require approval by SPU and SDOT.

6.2 Sizing

Storm drains must be designed for full gravity peak flow with a 4% annual probability (25-year recurrence). The hydraulic grade line (HGL) for that peak flow must stay a minimum 4-feet below the rim of all drainage structures and a minimum 3-feet below the lowest elevation served by gravity on adjacent private properties.

For more information on requirements for hydrologic analysis, including tidal and lake backwater constraints, see Appendix F of the Stormwater Manual Hydrologic Analysis and Design (pdf).

PSDs must be a minimum of 12-inch diameter.

6.3 Pipe slope

Pipe slope shall generally follow the surface topography at a standard depth of cover of 6-feet. Desired minimum pipe slope is 1%. Typical exceptions include:

- Downstream system is deeper, or shallower than 6 feet.
- Surface topography is flat and pipe slope is 0.5%.
- Connection cannot be made unless pipe slope is less than 0.5%

6.4 Minimum velocity

Minimum velocity required is 3-feet per second (fps). If velocity exceeds 20 fps, energy dissipation in the downstream MH is required to minimize hydraulic jumps.

6.5 Pipe material

Pipe material will be as approved by SPU, most typically DIP. See standard construction notes "SPU Mainline and Detention Pipe Notes" (docx) and Standard Specifications for Municipal Construction.

6.6 Plan submittal requirements

- Pipeline profiles. Calculate and show invert elevations at MHs by projecting pipe slopes to the center of the structure.
- Call out measured lengths per Standard Plan 010.
- HGL shown on the profile, if the pipe is surcharged.
- Notes documenting major hydrologic and hydraulic design assumptions.
- A drainage report documenting all calculations.

7. Maintenance Holes

7.1 Where maintenance holes are required

Maintenance holes (MH) are required at intersecting streets for future extensions every 375-feet and at:

- Pipe ends
- Pipe junctions
- Grade breaks
- Changes in horizontal alignment

Typical exceptions include:

- Setting a MH on the smaller pipe within 30 feet of the connection when the connection is to a very large diameter PSD.
- Not requiring a MH:
  - At an end of pipe that is less than 100 feet in length, especially if a future extension is anticipated.
  - For a single vertical or single horizontal bend no greater than 22½º between MHs.
  - If the MH spacing requirement results in difficult access to the MH.

7.2 Match pipe crowns

Crowns of pipe must match at MHs. For details on MHs, see the Standard Plans 204 through 212. For standard installations, use Type A unless the pipeline is too shallow.

7.3 Drop connections

Drop connections may be approved when SPU agrees that slope or depth makes matching crowns not feasible. For inside drop connections, see Standard Plan 233b.

7.4 Sizing

For information on MH sizing, see maintenance hole selection. (pdf).

8. Detention Pipe and Flow Control Structures

8.1 Detention pipe standards

Detention must be in a detention pipe conforming to Standard Plan 270.

8.2 Locating detention and flow control structures

Locate detention to minimize traffic impacts during maintenance, including:

- Locate off arterials, when feasible.
- Locate MHs to allow a single lane closure when inspecting or maintaining the structure.

Connect the flow control structure to a MH on the mainline. When possible, use and rechannel an existing MH.

8.3 Detention pipe material

Detention pipe material will be as approved by SPU, typically DIP or RCP. Polypropylene or steel reinforced polyethylene will be allowed if pavement restoration can wait 30 days after installation for flexible pipe testing. See standard construction notes “SPU Mainline and Detention Pipe Notes" (docx) and Standard Specifications for Municipal Construction.

8.4 Plan submittal requirements

- Detention pipe profile.
- A detail of the flow control structure.
- Notes with the detail documenting the major hydrologic and hydraulic design assumptions.
- A drainage report documenting all detention calculations.

9. Culverts

Within the informal ditch and culvert system, the City of Seattle does not generally permit the filling of a ditch in the street right-of-way.

Culverts on fish-bearing creeks or streams, even with intermittent flows are not addressed in this guideline.

9.1 Sizing culverts

Size roadside culverts to maintain the capacity of the existing ditch. Culverts must be a minimum of 12-inch diameter, or match an existing larger culvert size.

9.2 Culvert pipe material

Use ductile iron with Class D bedding. Alternate materials may be approved by SPU when pipe cover is greater than 2 feet.

9.3 Direction of laying culvert pipe

Lay the bell end of any pipe on the upstream side.

Related Information

Related information on permits and plan preparation, including standard construction notes for Street Improvement Permits are available at the SDOT Street Improvement Permit website.

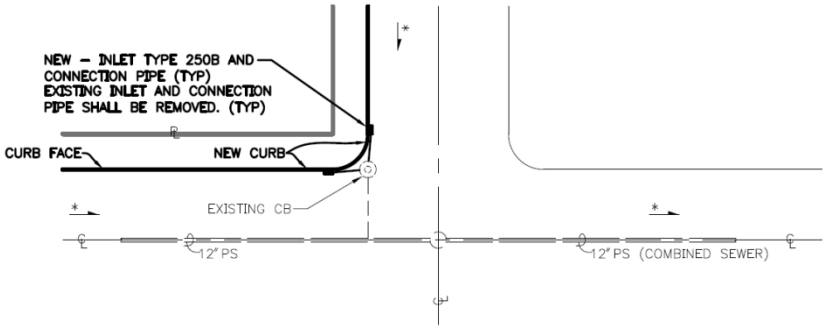
For Standard Plans of drainage and roadway system components, see the latest edition and most current amendments of the City of Seattle Standard Plans and Standard Specifications for Municipal Construction.

For information on how to make connections to existing pipe, see the Core Tap Procedures for Storm and Sewer Mains..

For roadway design standards see Seattle Streets Illustrated.

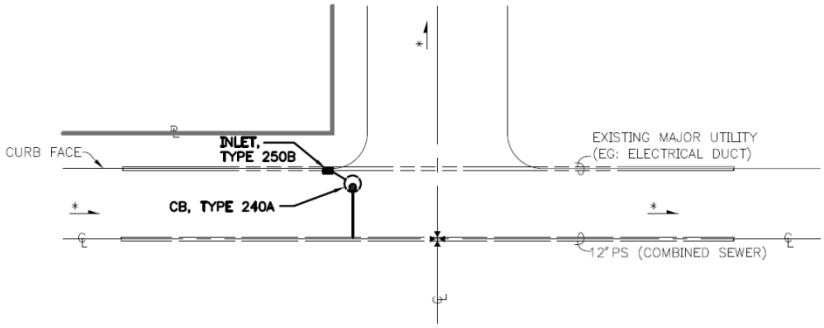
For Stormwater Code requirements, see the Seattle Department of Construction & Inspections (SDCI) Stormwater Code website.

For additional information on gutter flows and sag design for roadways, see the Washington State Department of Transportation Hydraulics Manual.



DETAIL 1
INLET PLACEMENT ALONG NEW CURB
NTS

NOTES: EXISTING CATCH BASIN IS NOT REQUIRED TO BE REPLACED IF IN GOOD WORKING CONDITION.
• SLOPE (TYP)

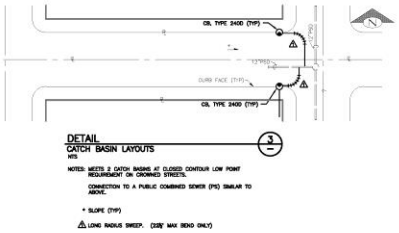


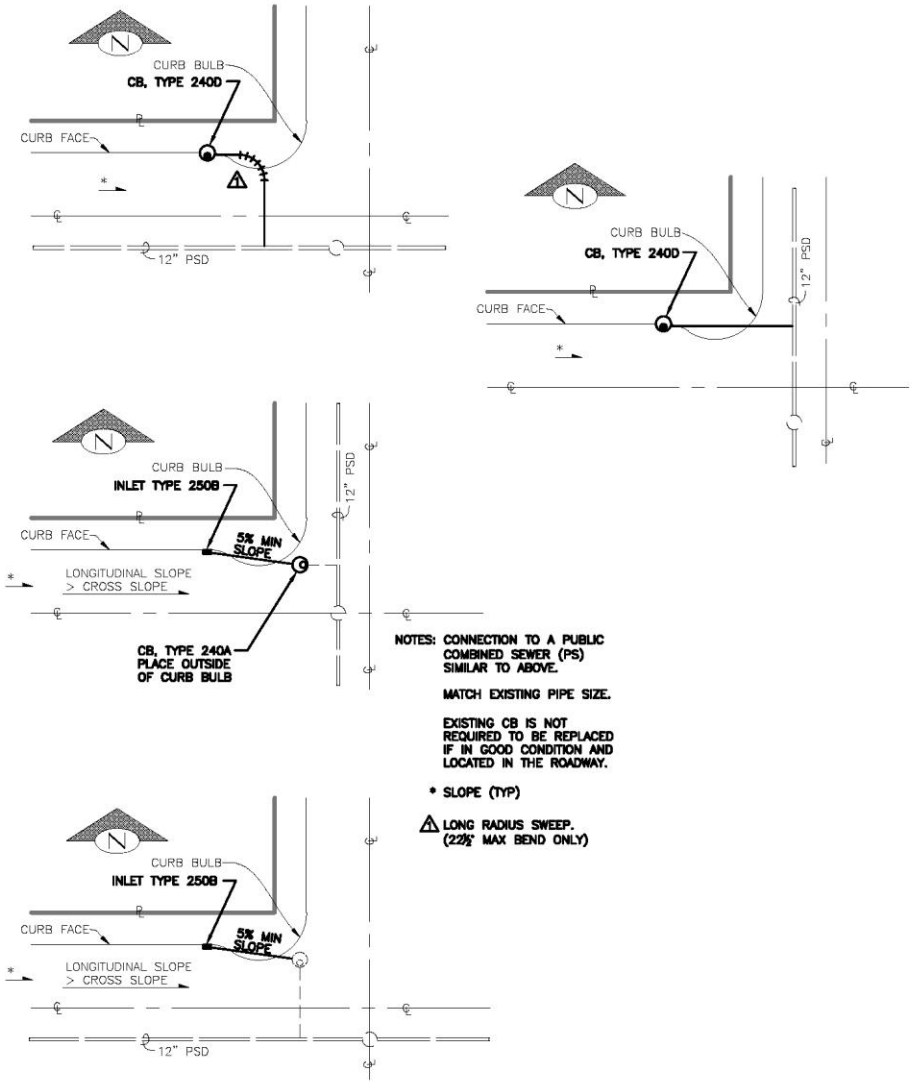
DETAIL 2
INLET PLACEMENT AT UTILITY CONFLICTS
NTS

NOTES: TO BE USED ONLY WHEN MAJOR EXISTING UTILITIES CONFLICT STANDARD CB PLACEMENT.

NOT APPROPRIATE AT CLOSED CONTOUR LOW POINTS WHERE PLUGGING OF THE INLET COULD RESULT IN DAMAGE.

• SLOPE (TYP)





DETAIL 4
INLET/CATCH BASIN LAYOUT AT CURB BULBS

NTS