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Chapter 4 GENERAL DESIGN CONSIDERATIONS

This chapter describes some general design considerations and standards that are not specific to water, drainage, or wastewater infrastructure.

4.1 KEY TERMS

The abbreviations and definitions given here follow either common American usage or regulatory guidance.

4.1.1 Abbreviations

Term	Abbreviation
ADA	Americans with Disabilities Act
CAM	Client Assistance Memo
City	City of Seattle
CIP	Capital Improvement Program or cast iron pipe
CSEC	Construction Stormwater and Erosion Control
DWW	Drainage and Wastewater
ft	Feet
FRP	fiberglass reinforced plastic
GSI	Green Stormwater Infrastrucure
LOB	Line of Business
O&M	Operations and Maintenance
OSSM	On-Site Stormwater Management
ROW	Right-of-Way
ROWIM	Right-of-Way Improvement Manual
SDCI	Seattle Department of Construction & Inspections
SDOT	Seattle Department of Transportation
SMC	Seattle Municipal Code
WISHA	Washington Industrial Safety & Health Act
WSDOT	Washington State Department of Transportation

4.2 PRESENTATION STANDARDS

Describes standards for Drawings, notes, and Specifications, as well as why format matters for the City's record keeping and in communicating with the Contractor. See *DSG Chapter 3, Design for Construction*, section 3.3 for constructability tips and the use of notes on the Drawings.

4.2.1 Drawings and Drafting Standards

There are 2 documents that contain all the information on our Drawing and Drafting Standards. They are the CAD Manual and the CAD Manual Appendices. Both of these can be found on the SPU Engineering web site.

Corporate data, including the record drawings, is an important and critical asset to the City. Managing construction records data is essential to the data-driven decision-making mode that helps us to manage the City's assets. Creating our engineering drawings and documents to a common standard puts us in better control of our engineering data. Common SPU/SDOT standards aid communications with reviewers during plan development and with contractors that work frequently within Seattle.

Using drawing and drafting presentation standards also makes our engineering data compatible with our GIS system and data. It will also make it easier for people in our department to work effectively together using concurrent engineering principles and allow us to more easily reuse and build data for future projects, studies, and initiatives. Over time, these standards will help us realize more efficiency for drafting data reuse and as a result help us to better control design costs.

Use of the SPU/SDOT Inter-Departmental CAD Standard is a requirement in consultant contracts. See SPU/SDOT CAD Requirements for Consultants on the CAD Resources web page for specifics. These standards can run counter to usual practices at many firms and there are many reasonable ways to present the same information. It is therefore worth careful initial thought and discussion with your project team to decide on the type of drawings you want to present, and what will be most clear for the Contractor. Especially with underground information, ask yourself whether a combined utility sheet is appropriate. Do you want sewer and drainage together, but separate from water? The current standard for Street Improvement Permit plans is to show all the street improvements on a single sheet with discipline sheets to follow. This is not generally appropriate for SPU projects, but could make sense on less complex or parcel-centric projects. What will more clearly communicate essential information to the Contractor? The question is not what is convenient for the stamping engineers.

4.3 ACCESS

This section describes typical design considerations related to the on-going access requirements for SPU owned and operated infrastructure and facilities. See *DSG Chapter 11, Pump Stations*, section 11.6.1.1 for pump station access.

4.3.1 Vehicular Access

Design engineers must consider vehicular access constraints for O&M activities, future rehabilitation or replacement, safety, and traffic impacts.

4.3.1.1 Parking

Early in the design process, preferably during preliminary engineering, confer with Operations staff to determine minimum parking requirements. It is typical that space for two vehicles is required, but the space need and frequency of need can vary. Determine if some access is required 24/7 for emergency response, or if no parking signs set up 3 days ahead will be sufficient. Also, check whether infrequent maintenance activities, or rehab and replacement would require multiple vehicle or special equipment staging.

For facilities with offices and other staff spaces, land use codes will have parking requirements and early consultation with the regulating authority is recommended. Parking restrictions within Seattle ROW require early negotiation with SDOT on a case-by-case basis.

Parking for maintenance vehicles should be located so that the vehicle can be parked without interfering with normal road traffic. Whenever possible, parking should be provided on site and not within the ROW. Staff should be able to:

- Safely access the facility, without the need to cross traffic
- Safely enter and exit the parking space without special traffic controls or directing traffic
- Get tools and specialty equipment next to the facility

The recommended parking stall size is 9 feet wide by 20 feet long. This size stall can accommodate most maintenance vehicles (e.g. boom trucks or Vactor trucks).

Pull- through spots are most desirable, especially for large vehicles or vehicles towing a trailer, where backing can be a significant safety issue.

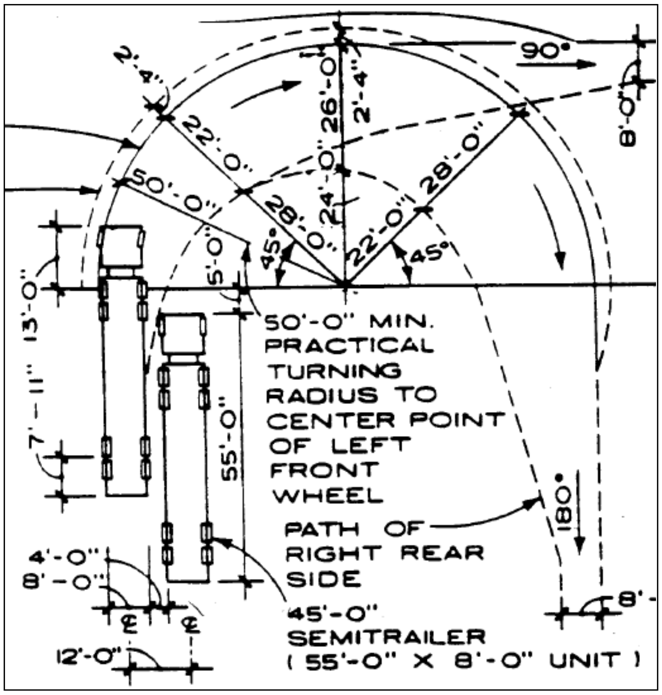
Parking restrictions within the ROW should be marked with both paint channelization and a parking restriction sign, to minimize the conflicts and need to tow.

See *DSG Chapter 11, Pump Stations*, section 11.6.1.2 for pump station parking.

4.3.1.2 Turning Radii

Turning radii for vehicles must be considered both in roadways when designing utility access points and in parking, because the tightest corners large vehicles maneuver are usually in parking lots. Dead end streets and alleys are also a special concern for SPU truck drivers. A typical truck turning radius design diagram for a 55-foot semi-trailer is shown in Figure 4-1 and is a conservative choice for most SPU vehicles. SDOT typically uses a single unit vehicle with a 42 foot turning radius for intersection design. AASHTO guidelines should be adhered to for all vehicular access design, especially truck turning radii. Design engineers should consider all types of vehicles that may need to access a site and confer with O&M staff early in the design process, preferably during preliminary engineering.

Figure 4-1
Typical Turning Radius for 55-ft Semi-Trailer



4.3.1.3 Access Roads

Access roads can be needed for a variety of reasons and are typically outside of the ROW as discussed here. Confer with O&M staff early in the design process about what types of vehicles will need to access a facility and frequency of access. In general, SPU prefers

- Pull through access roads that do not require backing
- 20 foot clear width with a 12 ft minimum width
- A road section and wearing surface for heavy truck loads, to reduce maintenance required for the road.
- Shared uses typically ok.

4.3.1.4 Special Equipment Access

The design engineer should consider a plan for access of special equipment used during maintenance activities, such as removing and replacing equipment, periodic cleaning, and when removing and replacing equipment, or installing new facilities. Sometimes the size of the special equipment is a critical design factor and sometimes, it is the number of vehicles required for efficient material handling. When anticipating multiple vehicles, it becomes even more important to eliminate backing movement requirements.

Tip: *Remember to look up and establish overhead clearance requirements (equipment needs to stay away from power lines at least 10 feet and more, if higher voltage) in addition to side to side and below grade movements. Ask surveyors to locate overhead information, including wires, and ask base map researchers to check for hidden foundation information.*

A. Cranes

Heavy equipment such as pumps and motors should be accessible by boom truck or mobile cranes unless alternative lifting equipment such as a monorail is provided. Typically, SPU will choose to rent a crane and operator, instead of adding fixed equipment that needs regular inspection and maintenance.

Boom trucks and cranes require relatively even ground to position for operation with sufficient room for out riggers for stabilization and to maintain uniform clearance from overhead obstructions, such as power lines. Projects should identify a method and type for moving equipment during preliminary engineering. The clear space for a crane with outriggers and overhead clearances are very likely to be critical space constraints.

B. Vactor Trucks

Most facilities will require access for a vactor truck. See **Appendix 4A** for the turning radius for the large vactor truck currently in the SPU fleet. Effective suction is approximately 28 feet, so it is important to allow truck access close to any below-grade facility needing suction. Because of the effective suction, preferred maximum depth of facility from surface to interior bottom needing suction is 17 feet.

4.3.2 Pipeline Access

4.3.2.1 Clearances for excavation and shoring

Within the ROW, horizontal clearances of 5 feet from outside of pipe are generally sufficient for installation of shoring to support future excavation. Within easements, horizontal clearances should provide sufficient space for construction equipment. See *DSG Chapter 5, Water infrastructure*, section 5.11.1 *and DSG Chapter 8, Drainage and Wastewater Infrastructure*, section 8.11.1. Vertical clearance needs vary, but for any location where safe vertical clearances from overhead obstructions, including power cannot be maintained for excavation equipment needed in the future, consider alternative access – see section 4.3.2.4.

4.3.2.2 Clearances for services

Unless there is a clear reason that future services would not be feasibly connected to a SPU pipeline, design should maintain a clear space for access both vertically for the service lateral and horizontally for access to tap or core tap. 5 feet clear is needed for tapping equipment. DWW core taps require a minimum 3 feet clear. With the deeper excavation and the need for shoring at the tap location, 5 feet clear is also a good assumption.

4.3.2.3 Clearances from trees

When feasible, design for clearances greater than the 5 foot minimum clear from edge of tree to outside of pipe. The clash between mature trees and maintenance vehicles or the excavation necessary for repairs and services can be costly to the utility and devastating for the tree.

4.3.2.4 Alternative Access

Various means are utilized to provide non-standard access for replacing SPU utilities. These are samples of choices made when standard access is either not possible or in direct conflict with another City goal.

A. Casings

See DSG section 4.11 Casing Pipe and *DSG Chapter 5, Water Infrastructure*, section 5.6.3.7. Identify sufficient space on at least one side of a casing to excavate and pull existing pipe sections and assemble and push replacement pipe through the casing.

B. Tunneling and Drilling

See *DSG Chapter 5, Water Infrastructure*, section 5.8.3.8.

C. Within a structure

Identify access for maintenance and repairs can be made within a structure, eliminating the need for access through an excavation. Truck access near an access structure is strongly desired even when excavation will not be required. See DSG section 4.4.1 Access to Structures.

4.3.3 Controlled Access with Fencing and Gates

Fencing is regulated through the land use code. In addition, discuss fencing needs with both Security staff and Operations staff early in design. Include discussions on vegetation and trees in proximity to a fence. It is preferable to know SPU security and maintenance needs prior to design review, artist input, or community outreach efforts, all of which can make demands on fence and screening design. Consult with SDOT before scoping any gate that can swing into the ROW, since the swing can have significant impacts.

Any locked facility design requires coordination with Operations staff and security. The Project Manual should include requirements for locks that meet SPU standards and transfer from the contractor.

See *DSG Chapter 11, Pump Stations*, section 11.6.1.3 on fencing at pump stations.

Tip: *SPU does not typically use chain link fencing and gates as shown in the standard plans and specs. The swing gate shown in the standard can be a hazard to traffic both in the swing mechanism and for a truck waiting. The gate length needed for large truck access can also sag and be a fence maintenance nuisance.*

4.4 STRUCTURES

This section discusses general design considerations for SPU structures. Major structures will be designed by a licensed structural engineer and should follow all applicable design codes and City policy on environmental design. Early determination measurable environmental design requirements, like LEED goals, is critical for scoping of new structures. In this standard, design of pipeline structures, including access requirements and structures, is typically addressed in *DSG Chapter 5 Water Infrastructure* and *Chapter 8 Drainage and Wastewater Infrastructure*.

4.4.1 Access to Structures

Structure access is key for maintenance, operation, cleaning, testing, repair and replacement of critical infrastructure. Safe access is a key goal and can be challenging.

Safety issues that the design engineer should consider include:

- Unassisted lifting restriction of 50 pounds
- Confined space entry
- Head protection and fall protection
- Size of ingress and egress
- Pinch points
- Passing vehicle and passing pedestrian traffic

SPU prohibits employees from lifting, unassisted, any object that weighs over 50 pounds. Most SPU maintenance vehicles have 1-ton lift assistance, so it is important that vehicles and booms can be stationed close to utility access points.

Entering a confined space, such as a vault or maintenance hole, will require the use of a tripod, safety harnesses, and gas monitoring safety precautions.

Use railings and landings, cage ladders and fall protection grating as required by building codes and WISHA rules to prevent and restrict falls. Orient ladders to clear openings and provide head space of a minimum 6 feet for occasionally accessed structures. More is desirable. More is required for regularly accessed structures.

Size doors, hatches and other access for equipment to be installed and removed without dismantling, whenever possible. Add sufficient space to reduce pinch points between the opening and other equipment.

Locate utility access points to allow for good traffic control of both vehicles and pedestrians.

4.4.1.1 Hatches and Castings

Vault covers, castings and drainage grates should not be placed within a crosswalk, curb ramp, or landing area behind or in front of the ramp. In cases where you cannot identify a feasible alternative, identify the conflict and work with SDOT to minimize hazard and inconvenience for pedestrians and to satisfy ADA requirements.

Locate hatches and castings to minimize pedestrian safety issues related to slipping and crosswalk, sidewalk and ramp closures during use. Avoid driveways, as they are difficult to shut down to access hatches and castings. To the extent possible, locate castings so that traffic lanes in all directions can be maintained around open hatches or castings. This can be particularly difficult in intersections. To reduce noise and wear on castings, do not locate in wheel tracks.

Hatches are difficult to set within pavement and need to be adjustable to match the surrounding grades, while still freely opening. Hatch drains must also stay functional. Consider impact loading, dents, and anti-slip surfaces (diamond plate does not count) when specifying. The standard is for HS25 loading, not HS20. Use of castings is preferred.

Prior to the start of any roadway construction, identify all SPU castings in the pavement area, identify castings that need to be replaced due to wear or for not meeting standards and which adjusted. Also, identify on the drawings whether SPU, or the contractor, is responsible for the replacement, or adjustment.

4.4.1.2 Gratings

Gratings are required in many SPU facilities and can promote better ventilation and be helpful for visual inspections. It is important to facilitate easy removal of both the grating and the support system if necessary for maintenance activities and removing equipment. Gratings and grating support systems can be a variety of materials, depending on the specific loading and environment anticipated. If maintenance activities could require kneeling on the grating, consider – and discuss with Operations staff – the trade-off between anti-slip properties and knee and hand injuries.

Galvanized (minor corrosion protection) or coated steel bar grating should be designed in accordance with ASTM (A123). Galvanized materials are not appropriate for use in drainage facilities, since the zinc material is a pollutant that can be released into a waterway. Grating should be designed for a uniform minimum distributed live load of 100 pounds per square foot (psf) with a maximum live load deflection of 1/4 inch, or the calculated anticipated applied loads, whichever is greater. The weight of grating or plate segment should be limited to 50 pounds maximum for any material that may need to be lifted by hand.

Gratings and supports used in wastewater facilities should be fiberglass reinforced plastic (FRP) construction to combat corrosion. Grating should be one-piece molded construction suitable for stair treads, platforms or walkways and have a slip resistant surface. SPU requires UV inhibitors for all FRP grating and supports exposed to sunlight. Typically, the manufacturer's engineer will be responsible for design of FRP grating and supports, so it is important that the design show details of critical clearances, openings and span restraints when needed.

4.4.1.3 Stairs and Ladders

Stairways and ladders should conform to building codes and WISHA rules. In addition, design for railings that can be gripped well with both a bare and a gloved hand. Design for visual clues that can be followed even in low-light environments.

4.4.1.4 Doors

Doors should be large enough to allow equipment removal and replacement. Anticipate above door lighting will be needed. Consult early with Security staff on locks. Consult prior to bidding with Operations staff on hardware preferences. SPU maintains some hardware within the warehouse and compatibility can be important.

4.4.1.5 Clearances in a structure

Drawings should show detail of equipment and clearances so that the users can review during the design process. See *DSG Chapter 10, I&C (SCADA)*, section 10.5.3.2 Clearances for electrical and instrumentation.

4.4.2 Waterstops and Structure Penetrations

Many SPU structures need to be watertight to hold water or to exclude groundwater. For cast-in-place structures, the contract documents should include control of the concrete pours to provide continuous structural elements and should show the allowable construction joints and expansion joints. PVC water stops are required at all joints that will be or could be under water. Penetrations of the structure for pipes, power conduit, hatches or castings have the potential for leaks and allowable methods and products should be specified by the design engineer. In addition to grouting, boots, or cast-in-place products, it is good practice to slope connecting pipes and conduits away from the structure penetration when possible, since groundwater typically will follow the trench slope.

Pre-cast structures, which are generally designed by the manufacturer's engineer, can have many more joints than in a cast-in-place structure, because of the need to ship and handle the structure in smaller pieces. Carefully specify requirements for a watertight structure, especially for multiple joint structures such as panel vaults.

Contract documents should specify testing requirements and allowable leakage for structures. Testing can be by filling with water and checking for leaks or damp spots, by air pressure loss or vacuum loss, depending on the structure. Since watertight structures can be difficult to construct, the design engineer should also specify possible repair methods.

4.4.3 Concrete, Curing and Coatings

Consult with Materials Lab staff for assistance on structural concrete specifications. Also, ask for advice with constructability considerations, such as acceptable slump in dense rebar locations such as wall to floor connections.

Sometimes the Materials Lab can provide special inspectors to support the inspections required by SDCI permit.

Special coatings are available for a multitude of different purposes and are constantly changing. Consult with manufacturers for up-to-date information.

4.4.4 Vehicle Loads

All new structures subject to traffic loading will need to incorporate the standard HS25 vehicle loading

Impact loadings should be calculated in accordance with AASHTO Standard Specifications for Highway Bridges. For pipelines, and valve, meter, and similar structures, the impact factor should be 50% and should not vary with depth of cover. For pipelines over 12 feet deep, impact does not need to be considered.

4.4.5 Seismic

See *DSG Chapter 5, Water infrastructure*, section 5.9.2.1. Consult with Geotechnical staff for seismic design considerations. See *DSG Chapter 3, Design for Construction*, section 3.15 Geotechnical Services.

4.4.6 Soil Design Parameters

Geotechnical design criteria, including allowable bearing pressures, lateral pressures, and minimum footing depth and width requirements will vary for each site and should be determined in each case from the site-specific geotechnical report. See *DSG Chapter 3, Design for Construction*, section 3.15 Geotechnical Services.

4.4.7 Roofs

When selecting roof shape and materials, maximize the design life of the roof. Re-roofing carries major project costs and coordination with operations beyond the cost of the new roof material. Lifecycle costs for a roof can be distorted by City contracting processes.

Avoid flat or low slope roof designs to avoid maintenance problems in the future. Keep the roof slope to a minimum of two percent but avoid steep slopes also to allow safe access for workers.

See also the Stormwater Manual on vegetated roofs. Uncoated metal roofs are not acceptable since they are a pollutant source in stormwater.

4.4.8 Finishes

Above-grade exterior structural finishes will be influenced by design review, artist input, and community outreach efforts, as well as the building code. In addition, consider finishes not attractive to theft and resistant to graffiti, especially at remote facilities. Copper cladding is not acceptable since it is a pollutant source in stormwater.

See *DSG Chapter 11, Pump Stations*, section 11.6.2.4 Painting for pump stations.

4.5 GENERAL PIPE CONNECTIONS AND SUPPORTS

Pipe connections, supports, and restraints vary significantly by manufacturer, pipe material, and intended function. Care must be used in selecting the correct device for the intended use and may be designed by a licensed mechanical engineer. In this standard, design of pipeline connections and restraints for buried pipe, is typically addressed in *DSG Chapter 5 Water Infrastructure* and *Chapter 8 Wastewater and Drainage Infrastructure*. See DSG section 5.6.3.6 Pipe Supports.

4.5.1 Facility Piping Connections

Table 4-1 lists some common pipe connections and their typical uses.

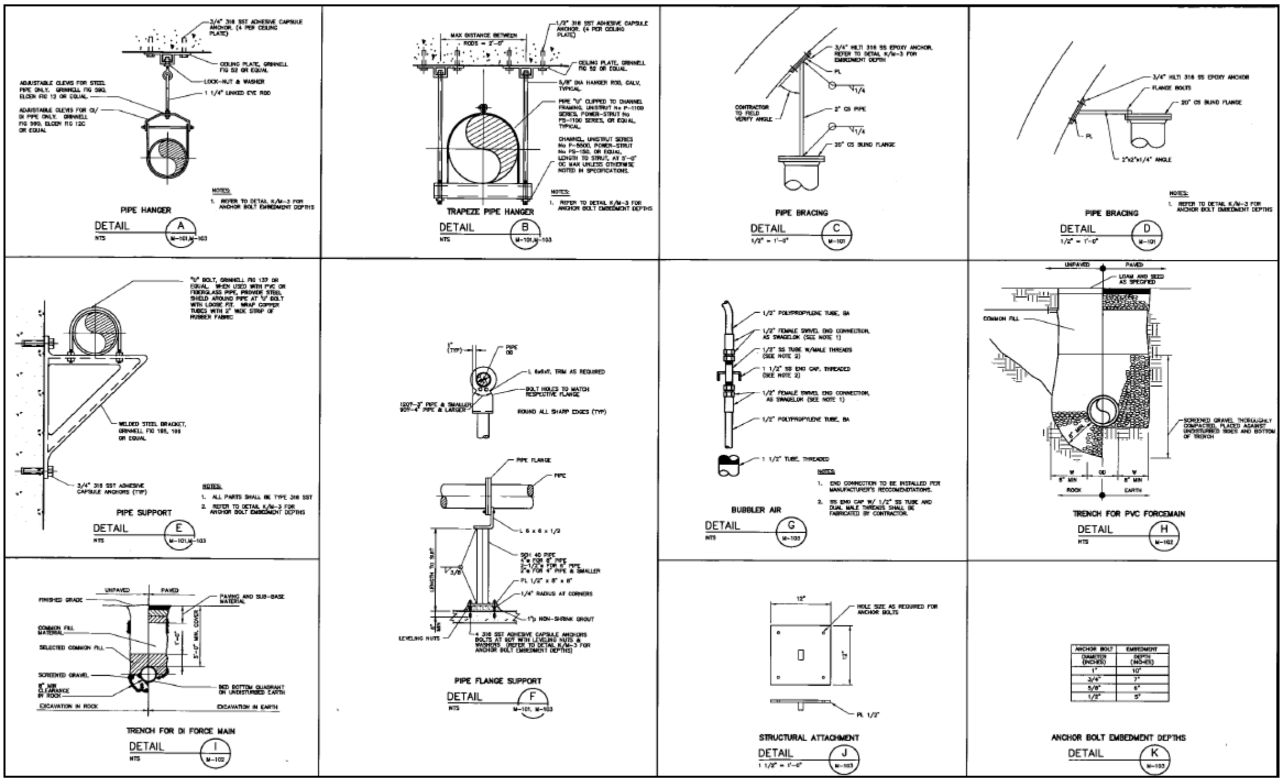
Table 4-1
Pipe Connection Types and Uses

Pipe Connection	Typical Uses
Threaded	Joints and connections 4” and smaller. Metal only.
Flanged	Joining exposed piping and valves – allows for ease of disassembly
Mechanical Joint	Joints 6” and larger where anticipated deflection is between 2 and 5 degrees
Compression Coupling	Joining two dissimilar materials
Welded	For rigid connections – plastics require specialty welds
Flexible Coupling	Absorb deflections from intermittent flows or transient pressures
Expansion Joint	Between rigid points to absorb pipe expansion and contraction
Dismantling Joint	Allows for ease of disassembly – use on long piping runs with many pieces of mechanical equipment, fittings, etc.

4.5.2 Pipe Supports

Pipe supports are used to support pipes off the ground/floor, off the wall, or from the ceiling (pipe hangers). Pipe supports can also reduce or eliminate vibration in piping. They are used to prevent damage to the pipe or equipment attached to the pipe, and to reduce vibration in locations such as pump discharge pipes. Figure 4-2 shows typical details for common pipe supports.

Figure 4-2
Typical Details of Pipe Supports



Pipe supports should be located adjacent to items with concentrated loads on the piping system, such as pipe bends, and at valves, meters, and fittings requiring independent support.

Pipe support spacing is a function of pipe material, diameter, wall thickness, pipe deflection limit, vibration control and fluid load (liquid or gas in the pipe). Support spacing should never exceed the pipe manufacturer’s recommended spacing for the pipe and load specified.

All pipe supports must be designed for seismic loads.

4.6 EQUIPMENT ANCHORAGE

Typically, equipment will be rigidly anchored to metal base plates mounted on concrete equipment pads. Pads must be designed to carry the fully loaded weight of equipment, including fluids such as fuel and water. If leveling grouting is needed, SPU will review the plan for leveling to ensure contact for the entire surface, and that voids are filled with grout after removal of leveling equipment. Anchorage must be able to safely absorb and withstand equipment thrust from shut off, turn on, and possible water hammer loads. Testing should include testing for leveling, vibration, and thrust.

All equipment anchorage must be designed for seismic loads.

Tips: *Work with geotechnical engineers to determine soil bearing and risks of settling. The equipment pad may need to be larger in poor soils, or soils may need amendment to support the pad.*

Add a requirement to the Contract for a layout template; for more complex equipment layouts, the Drawings should include conduit detailing. Equipment pads that include more than 3 conduit runs, or that have specific requirements on the conduit location, count as more complex. A layout template for reinforcement, conduits, and studs can be useful. Studs set in concrete should also be installed from a template made for the actual piece of equipment to be installed.

4.7 UTILITY SERVICES AT SPU FACILITIES

Facilities often require one or more utility services (electrical, water, sewer, natural gas, etc.) The availability and capacity of existing utilities must be investigated and compared to the estimated demands of the permanent facility. See *DSG Chapter 11, Pump Stations*, section 11.6.2.10 Utilities for pump stations.

Tip: *During preliminary engineering, work within a minimum and maximum demand for needed power, fire flow, and drainage. Since needing to expand a project to bring in water, power or drainage, for example, is common and can result from relatively small changes in demand.*

4.7.1 Power

The presence of power lines at or near the site does not guarantee that ample electrical capacity will be available. New services or additional capacity may be required to fulfill site requirements. Identify power needs, at least a range of possible needs during preliminary engineering. If additional power or a different phase of power is needed, that electrical work can be a major project expansion.

4.7.2 Water and Fire Service

For information on obtaining a new water service, see SPU Development Service Office.

4.7.3 Sewer and Drainage

For information on permitting new sewer and drainage services for a project on a parcel, see Side Sewer Permits. For new facilities in the ROW, sewer and drainage service can be reviewed through SPU internal review processes, but design must conform to the Side Sewer Code.

4.7.4 Communications / Telephone

Discuss needs for telephone or lines with SCADA staff.

4.8 PIPELINE AND CONDUIT CORRIDORS AT SPU FACILITIES

Corridors for pipelines and conduits within a facility will need to be identified on the site layout by 30% design. The following are guidelines for laying out the pipeline corridors:

- Pipes and conduits should not be under buildings, except for entering and exiting.
- Pipes should be located away from building footings and outside of the footing influence zone which extends down and out from the edge of the footing at a 45 degree angle
- SPU prefers separate handholes for power, SCADA and security conduit

See *DSG Chapter 11, Pump Stations*, section 11.6.1.5 Pipeline Corridor for pump stations and *DSG Chapter 10, I&C (SCADA)*, section 10.5.3.3 Separation of Signal and Power Circuits for instrumentation and control.

4.9 TEMPERATURE REQUIREMENTS

Buildings and some equipment should be maintained between 50 °F and 90 °F to prevent damage to equipment and process lines due to freezing or overheating. Ambient heating can be supplemented by using heat tracing, while cooling can be supplemented by increased ventilation and air exchanges and use of a heat pump if temperature is expected to be a concern. It is important to identify the need during preliminary engineering, since these design elements typically require a mechanical engineer. See *DSG Chapter 10, I&C (SCADA),* section 10.8.1.2 Environmental Requirements for instrumentation and control equipment.

4.9.1 HVAC

HVAC systems are typically designed for occupied buildings or for equipment protection according to ASHRA and other related industry standards. The number of air changes required depends on location and area. Generally, a separate ventilation system should be employed for each enclosed building area. Areas that share a common environment in any fashion (connected ductwork, normally closed doors and hatches, etc.) must be treated as single common areas and carry the most stringent of the area classifications. For pump station HVAC requirements, see *DSG Chapter 11, Pump Stations*, section 11.6.2.1.

4.9.1.1 Insect and Pest Screening

To prevent insects and other small animals from entering facilities through opening required for HVAC equipment, mesh screening of size ¼-inch, constructed of stainless steel is recommended.

4.10 LANDSCAPING AND IRRIGATION

During design of a landscape and irrigation system, consider the installation, maintenance, and management phases, to minimize impact to resources. The design engineer needs to consult with landscape maintenance staff during the landscape design process. For work within the

ROW, consult with SDOT Urban Forestry staff. For projects in Seattle parks and boulevards, see Parks Standards. On SPU property, use the principles of Crime Prevention Through Environmental Design to avoid security threats and hiding places. Check on-site requirements in the Stormwater Manual and Green Factor requirements for the project. At a minimum, Drawings should identify all landscaped areas, all turf areas, and the requirements for amended soil for each type.

Tip: *Consult early about the landscaped area and availability of water.* Removed for security *This will help SPU determine what landscape may be appropriate for the site or whether to install a full irrigation system, a hose bib, or plan for watering by truck. This will help determine when the project team will need to include a consultant landscape architect and the scope of their work.*

4.10.1 Landscape Design

The following are general guidelines for landscape design:

- Minimize ground disturbance and protect existing soil and vegetation where possible, and identify protected areas on the Drawings per Specification 8-01.3(2)B.
- Restore soils disturbed by construction with compost amendment per Standard Plan 142.
- Select non-invasive plant species that fit with the neighborhood landscaping and grow in the type of soil present.
- When piping or venting is aboveground, consider masking it with bushes, but also isolate ledges and small openings to structures that would provide places for insects, birds, or rodents to reside.
- When identifying trees for preservation during construction and selecting trees for installation in the ROW, consult with SDOT's Urban Forestry group.
- Add a Bid item to require a Tree, Vegetation, and Soil Protection Plan. See Specification 8-01.3(2)B

The following are design considerations for weed and pest control:

- Minimize or, if possible, eliminate vegetative plantings and weeds that would require mechanical or chemical control.
- City of Seattle prefers mechanical control and suppression of undesired vegetation. Pesticides may not be used without express consent from the SPU Landscape Specialist.
- Use native plants where appropriate.

4.10.2 Landscape Plan

A final landscape plan must be signed by a licensed landscape architect prior to submittal for approval.

Plans must differentiate turf and landscape zones, and the soil amendments required for each. Plans must show:

- The name, size, quantity, location, and water use needs of each plant.
- Mulch type, depth, and location.
- A Hydrozone Matrix with planting areas arranged into hydrozones according to watering needs.

4.10.2.1 Plant Material

Plant material should be selected based on low resource and maintenance needs. Right Plant – Right Place. Refer to Choosing the Right Plants for Your Site.

Look for hardy native, or site adapted non-native and drought tolerant plants.

Plants should be located to meet their short and long-term cultural needs.

Plant material should be selected for a hydrozone.

4.10.2.2 Turf

Wherever possible, avoid using turf in places where SPU is responsible for landscape maintenance, to minimize ongoing mowing and maintenance requirements. Turf should only be considered for recreational or play areas, and for places where people are encouraged to frequent.

The landscape designer must ensure that no turf area is smaller than 12’ x 12’.

4.10.2.3 Soil

The landscape plan must meet all topsoil and soil amendment requirements in Specification 8-02.3(2).

4.10.3 Irrigation Plan

Early coordination with Operations staff and the SPU Landscape Specialist is required to select a water option. Options to consider include trucked water, a water supply with hose bib, or a full irrigation system.

If a hose bib or full irrigation is selected, identify on the Drawings the water meter service location, which will be under separate permit. Typically, SPU – as the owner – will order the new water service. The specifics of water service coordination will be in the Project Manual.

A backflow prevention assembly (with its annual inspection requirement) is required between any irrigation system and the water meter. See Specification 9-30.16 and note that a double check valve assembly may be installed below ground, but only in an approved enclosure.

When SPU chooses a full irrigation system, irrigation design must be done by an Irrigation Association Certified Irrigation Designer (CID) with a Commercial specialty. Irrigation systems must be designed to current industry best practices for water conservation. Refer to the Irrigation Association best practices and SPU Irrigation Tips.

The designer is responsible for verifying the actual pressure at the site before designing the irrigation system.

See Specification 8-03 for irrigation system requirements.

4.11 CASING PIPE

This section describes common design considerations for casing pipe for water, sewer and drainage. Pipelines may be installed in a casing for several reasons, including:

- Crossing rails including heavy, light rail and street cars.
- Crossing major arterials and highways.
- Water crossings
- Shallow depth of cover with heavy traffic to provide structural integrity to protect carrier pipe.
- Challenge for accessing the carrier pipe for future maintenance and replacement such as:
  - Built over
  - Tiebacks around the pipe.
  - To avoid future surface disruption, such as within an easement or non-standard, or expensive surfaces.
- Lack of adequate separation between watermain and sewer line per Washington Department of Health requirements (a casing pipe may be used to mitigate the situation).

4.11.1 Casing Pipe Material

The standard casing pipe material is bare or coated steel, especially for a jacked casing installation. See Standard Specification 7-11.3(7)C STEEL CASING PIPE

Thick wall PVC C900, C905 DR 14, ductile iron, polypropylene, or concrete may be used as casing for trench installation if it can support the loading without causing deflection that can impact the spacers or carrier pipe which can make future maintenance and removal more difficult.

4.11.2 Minimum Casing Diameter

The casing diameter must be sized to provide a minimum of 4 inches between the inside of the casing to the largest outside dimeter of the carrier pipe including the pipe bells. This is to allow for potential deflection of the casing pipe and installation of the casing spacers.
The sizing must accommodate slope (especially for sewer or drainage pipe), fittings and slight bends/adjustment needs)

Tip: *Provide elevation information on the carrier pipe and let the contractor establish elevations for any casing. This is an easy area for error due to design changes, field changes or specific requirements for the casing and spacers selected by the contractor.*

4.11.3 Minimum Casing Thickness

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The Engineer of Record shall confirm the adequacy of the casing pipe structural capacity in each specific application. For jacked casing pipes, the earth loading should be calculated for the pit locations and selection of a minimum casing thickness. But the contractor's jacking equipment often will determine the actual required thickness.

Table 4-2 shows minimum steel casing wall thickness for standard trench direct bury between 4.5 feet of cover and 20 feet of cover.

Table 4-2
Minimum Steel Casing Pipe Thickness for Road and Highway and Rail Applications

Nominal Diameter Inches	Wall Thickness	
	Under Road	Under Rail Tracks
6 thru 14	0.25	0.25
16	0.25	0.375
18	0.313	0.375
20	0.313	0.375
22	0.313	0.375
24	0.313	0.375
26	0.313	0.5
28	0.375	0.5
30	0.375	0.5
32	0.375	0.625
34	0.375	0.625
36	0.375	0.625
38	0.375	0.625
40	0.375	0.625
42	0.375	0.625
44	0.375	0.75
46	0.375	0.75
48	0.375	0.75
50		0.75
52		0.75
54		0.875
56		0.875
58		0.875
60		0.875
62		0.875
64		0.9375
66		0.9375
68		0.9375
70		1.0
72		1.0

Table 4-2 Notes:

- Adopted from- Iowa DOT Design Manual and modified for standard steel pipe thickness standards.
- Minimum thicknesses assume a minimum of 4.5 feet of cover over the top.
- Casing with depths of over 20 feet must be designed for the specific location and loading conditions. If site conditions limit depth of cover, perform design calculations to

determine minimum thickness of the casing, with a limit on deflection that permits the carrier pipe bells and casing spacers to function normally.

- The railroad values are based upon American Railway Engineering and Maintenance-of-Way Association design standards. Individual railroad standards may vary.

4.11.4 Installation Considerations for Future Access and Carrier Pipe Replacement

One of the major reasons for installation of casings is to make it easier to remove the carrier pipe and reinstall a replacement carrier pipe without disrupting traffic, or removal of rail tracks which will be very expensive in the future.

The designer must always think about the engineers, utility crews and contractors that must work on what we install in the future.

1. Provide adequate spacing at the ends of the casing pipe to accommodate future pipe replacement.
2. The jacking pit for future access will need to be wide enough to provide adequate working room and long enough to accommodate a 20-ft. stick of pipe in addition to space for jacking and shoring.
3. Casings with depths of over 20 ft. must be designed for the specific location. If the casing is installed using trenching, the trench bedding, and compaction shall follow the same specifications as the water pipe or transmission or sewer pipe standards, i.e. standard plan number 350 Watermain Trench and Bedding or be Class B per Standard Specification 7-17.3(1)B for sewers;

4.11.5 Spacers and End Seals

Always install casing end seals to prevent movement of ground water through the casing. This can potentially increase the corrosion rate of the casing and carrier pipe.
See Standard Specifications 7-11.3(7)C STEEL CASING PIPE.

Do not grout the annular space between the casing and the carrier pipe. This will make any future work for maintenance and repair much more difficult.

4.11.6 Cathodic Protection

If the carrier pipe and casing are in an area with corrosive soil, near electrified rail systems, or near other utilities with an active corrosion protection system; the carrier pipe and casing can be protected using bonded coatings, and linings, passive(anode) or active cathodic protection systems.

See DSG Chapter 6 and consult a corrosion protection engineer for each location for advice.

4.12 RESOURCES AND LINKS FOR STORMWATER CODE COMPLIANCE

Information on meeting stormwater code requirements and related City of Seattle standards are scattered around the Seattle.gov web site. The tables in this section provide links to some of those locations. The most comprehensive source and the best place to start, is the SDCI Stormwater Code web site at the top of table 4-3.

Tip: *Many SPU projects have potential impacts far beyond the immediate surface area planned for construction. Look at the surrounding topography to identify stormwater impacts and solutions as an integral piece of the project definition and scoping.*

4.12.1 Determine Project Minimum Requirements

While scoping a project, it is important to determine the stormwater code requirements. Refer to Volume 1: Project Minimum Requirements of the Stormwater Manual. When a project is located within Seattle ROW, also see ROW Flowcharts 1 through 4.

Table 4-3
Links to General Stormwater Code Information

Document/ Topic Link	Description
Stormwater Code and Manual	SDCI web site with links to code, stormwater manual and related information
ROW Flowchart 1	DS&G Appendix 18C Seattle Stormwater Code Flowchart (1) for projects in the ROW provides a shortcut to minimum requirements developed for plan reviewers
ROW Flowchart 2	DS&G Appendix 18F Seattle Stormwater Code Flowchart (2) for trail and sidewalk projects in the ROW to be used in combination with ROW Flowchart 1. Flowchart of on-site stormwater requirements.
ROW Flowchart 3	DS&G Appendix 18D Seattle Stormwater Code Flowchart (3) for roadway projects in the ROW to be used in combination with ROW Flowchart 1. Flowchart of on-site stormwater requirements.
ROW Flowchart 4	DS&G Appendix 18E Seattle Stormwater Code Flowchart (4) on stormwater treatment for roadway projects in the ROW to be used in combination with ROW Flowchart 1.
Flow Control and Treatment Guidance	DS&G Section 8.7.0 Flow Control, Section 8.7.10 Green Stormwater Infrastructure and 8.7.11 Water Quality Treatment.
SPU Policies and Procedures	SPU site maintained by Risk and Quality Assurance includes rules, policies and procedures. Under the bullet Drainage & Wastewater (DWW), find the Stormwater Manual and code related policies. Also includes a procedure for determining when utility work is integral and contiguous to a project.
DWW430-1 Flow Control Requirements for Projects in Identified Public Combined Sewer Basins	Identifies combined sewer basins where SPU has determined flow control will not be required.
Side Sewer Code and Director's Rule	SDCI web site with links to side sewer code and related information
Appendix F – Hydrologic Analysis and Design	General hydrologic modeling guidance to meet the requirements of the Stormwater Code.

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All SPU capital improvement projects should plan for City of Seattle stormwater code review by the Standards and Plan Review Section. Initial review should be of a 30% draft drainage report and updated at 60% and 90% until the drainage report is final. This review does not typically include review of the conceptual Construction Stormwater and Erosion Control plan.

Tip: *Consider structuring your drainage report to explain how the project meets the minimum requirements for all projects summarized in Volume I Chapter 3 of the Stormwater Manual. It is common to focus on questions about flow control and water quality requirements and miss a requirement (for instance: Ensure Sufficient Capacity or Protect Wetland) with a bigger impact on your project.*

Requirements are more complicated for parcel-based projects within Seattle and are tied to building permits issued by SDCI. Allow extra time to work through code requirements and consult early with SDCI.

For projects outside the City of Seattle limits, see *DSG Chapter 2 Design for Permitting & Environmental Review*.

4.12.2 Construction Stormwater and Erosion Control

CSEC is discussed in DSG Chapter 3. The link is at the top of table 4-4.

Table 4-4
Links with Information on Construction Stormwater and Erosion Control

Document/ Topic Link	Description
DS&G on CSEC	DS&G Section 3.7 Construction Stormwater and Pollution Prevention
Ecology Permit Information	Ecology web site Construction Stormwater General Permit for projects with one acre or more of disturbed surface
Volume 2: Construction Stormwater Control	Stormwater Manual volume includes Chapter 3 on selecting construction stormwater controls, including checklists and Chapter 4 deescribing BMPs
Standard Specifications	Refer to Specifications 1-05.13(3), 1-07.15, 1-07.16(2) and 8-01
Temporary Discharge Guidance	DS&G Apppendix 18B Temporary Discharges (Dewatering) into SPU's Drainage & Wastewater System.
King County Industrial Wastes	Kingcounty.gov web site on construction dewatering.

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4.12.3 On-Site Stormwater Management

The terms low impact development and green stormwater infrastructure are also used to refer to the same general best management practices using dispersion, infiltration and retention described as “on-site stormwater management” within the stormwater code and manual. Refer to Volume 3: Project Stormwater Control. The link is at the top of table 4-5.

The Stormwater Manual allows two methods for demonstrating compliance. Use the on-site list and list approach calculator if you’re not also designing BMPs for flow control or water quality.

Table 4-5
Links with Information for Design of On-Site Stormwater Management (GSI)

Document/ Topic Link	Description
Volume 3: Project Stormwater Control	Stormwater Manual volume includes Chapters 3 on selecting BMPs and requirements for determining infiltration feasibility. Chapter 5 describes BMP design
Rain Gardens for Sidewalk Runoff	CAM 1190 Rain Gardens for On-Site Stormwater Management of Sidewalk Runoff
SDCI Forms and Documents	Part of the SDCI Stormwater Code web site includes the List Approach Calculator. Reference materials include SPU Allowable Permeable Pavement Wearing Course Materials.
DS&G on Geotechnical Services	DS&G Section 3.15. Also see 3.19.4 Bioretention and biofiltration.
Appendix D – Subsurface Characterization and Infiltration Testing for Infiltration Facilities	Guidance on subsurface testing and reporting to meet the requirements of the Stormwater Code.
DS&G Appendix 8C GSI Manual	Volume 3 on the design phase of the Green Stormwater Infrastructure Manual for Seattle. The manual was jointly developed for capital improvement projects by SPU and King County.
Streets Illustrated 3.3 Drainage	Guidance on use of on-site stormwater management BMPs in Seattle Streets.
Streets Illustrated Clearances and Setbacks	Describes required clearances from on-site stormwater management BMPs from utilities and street features.
Green Stormwater Infrastructure	SPU web site on green stormwater infrastructure, includes links to current and completed GSI projects.
DS&G Green Stormwater Infrastructure Modeling Methods	DS&G Appendix 7H.
Standard Specifications	See Section 5-06 Pervious Cement Concrete Pavement and 7-21 Bioreetention.
Standard Plans	See Standard Plans 291 through 299, 403 and 425.

Tip: *Infiltration testing required by the stormwater code can complicate the scope and schedule of your project. There are also specific requirements for locating tests close to any infiltrating BMP and reporting results. For advice on scope and schedule, consult with the Geotechnical Engineering Section.*

4.13 RESTORATION OF DISTURBED AREAS

See *DSG Chapter 3, Design for Construction*, section 3.17 Site Restoration.

4.14 SIGNS AT SPU FACILITIES

Facilities will typically have two types of signage visible on the outside of the facility: facility identification signage, and public safety signage. Signage should be designed in accordance with Seattle's Sign Code (Seattle Land Use Code Ch. 23.55). Signs can be specified in the contract drawings, or supplied by Operations staff.

Facility identification signage should contain basic information on the facility, facility name, and identification number, type of facility (water supply, wastewater/sanitary, or stormwater pump station), owner (SPU), and contact information for general inquires and emergencies.

Public safety signage warns the general public of potential hazards that exist on a facility site. Hazards include chemicals stored onsite, wastewater, high voltage, relief valve discharge, etc. Public safety signs are to be placed in clear view in an easy accessible location without having to enter the property. All warning signs must be in accordance with industry standards (NEC, OSHA, IEEE) and other applicable regulatory items. See *DSG Chapter 11, Pump Stations,* section 11.6.1.4 Signage at pump stations.

4.15 GEOTECHNICAL SERVICES

See *DSG Chapter 3, Design for Construction,* section 3.15.

4.16 FUTURE EXPANSION CONSIDERATIONS

During preliminary design, an estimate of future expansion needs for the facility should be identified. Future expansion may include installation of the following:

- Permanent backup power supply
- Additional equipment
- Additional storage capacity
- Maintenance and storage facilities
- Parking

Facility layout should be made as if the future conditions were included now. Locations should be clearly identified on the drawings. Examples of future facility configuration include the following:

- Construction of the expansion should not significantly disrupt ongoing operations at the facility.
- Equipment, electrical and instrumentation should allow new equipment to be added while the existing equipment remains in service.

Currently, SPU does not have a standard for storing design information for a future condition. So, project teams should carefully consider how to preserve design information in the Basis of Design documentation, in the Contract Drawings, in project files, and in an O&M Manual.