Chapter 4 General Design Considerations

Appendices

List of Figures

List of Tables

Chapter 4 GENERAL DESIGN CONSIDERATIONS

This chapter of the Design Standards and Guidelines (DSG) presents standards and guidance for general design, including design considerations and standards that are not specific to water, drainage, or wastewater infrastructure. The primary audience for this chapter is SPU engineering staff. DSG standards are shown as underlined text.

4.1 KEY TERMS

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

4.1.1 Abbreviations

Term	Abbreviation
ADA	Americans with Disabilities Act
AASHTO	American Association of State Highway and Transportation Officials
CAM	Client Assistance Memorandum
City	City of Seattle
CSEC	Construction Stormwater and Erosion Control
DWW	drainage and wastewater
ft	feet
FRP	fiberglass-reinforced plastic
GSI	Green Stormwater Infrastructure
LOB	line of business
O&M	operations and maintenance
ROW	right-of-way
SCADA	supervisory control and data acquisition
SCL	Seattle City Light
SDCI	Seattle Department of Construction & Inspections
SDOT	Seattle Department of Transportation

Term	Abbreviation
SMC	Seattle Municipal Code
WISHA	Washington Industrial Safety and Health Act

4.2 PRESENTATION STANDARDS

This section describes standards for drawings, notes, and specifications and explains the importance of standardized format for the City of Seattle's (City's) record keeping and in communicating with the Contractor. See section 3.4 of *DSG Chapter 3, Design for Construction*, for constructability tips and the use of notes on the drawings.

4.2.1 Drawings and Drafting Standards

There are two documents that contain all the information on SPU's drawing and drafting standards: the Computer-Aided Design (CAD) Manual and the CAD Manual Appendices. Both of which are available on the SPU's CAD Resources website.

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 empowers SPU to manage the City's assets. Creating engineering drawings and documents to a common standard allows for better management of engineering data. Common SPU and Seattle Department of Transportation (SDOT) standards aid communications with reviewers during plan development and with contractors that work frequently within the City.

Applying drawing and drafting presentation standards also makes the engineering data compatible with the Geographic Information System (GIS) system and data. These standards also foster an efficient work environment using modern engineering principles and allow SPU to reuse and build data for future projects, studies, and initiatives. Over time, these standards will help SPU realize more efficiency for drafting data reuse, and as a result, help SPU to better manage design costs.

Use of the SPU/SDOT Inter-Departmental CAD Standard is a requirement in consultant contracts (see SPU's CAD Resources website for specifics). These standards can run counter to usual practices at many firms and there are many reasonable ways to present the same information. Therefore, carefully review and discuss the standards with the project team to decide on the type of drawings to present that will be the clearest for the Contractor. Especially with data for underground infrastructure, decide whether a combined utility sheet is appropriate or if it would be beneficial to view the sewer and drainage standards together. SDOT's current standard for Street Improvement Permit plans is to show all the street improvements on a single sheet with discipline sheets to follow. However, this is not generally appropriate for SPU projects but could make sense on less complex or parcel-centric projects. Decide the project's approach based on what will more clearly communicate essential information to the Contractor, not what is convenient for the stamping engineers.

4.2.2 Asset Identifications

A variety of asset identifiers are needed for construction. See section 1.6.3.3 and section 1.9.1.5 of *DSG Chapter 1, Design Process*.

4.3 ACCESS

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

4.3.1 Vehicular Access

Design engineers must consider vehicular access constraints for operations and maintenance (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 SPU Operations staff to determine minimum parking requirements for the project. It is typical that space for two vehicles is required, but the space, need, and frequency of need can vary. Determine whether some access is required 24/7 for emergency response or if “no parking” signs set up three days ahead will be sufficient. Also, check whether infrequent maintenance activities or rehab and replacement would require staging of multiple vehicles or special equipment.

Many parking requirements are documented in Seattle Department of Construction & Inspections’ (SDCI’s) land use codes. Early consultation with the regulating authority is recommended. Parking restrictions within a City right-of-way (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
- Obtain tools and specialty equipment stored next to the facility

The recommended parking stall size is 9 feet (ft) wide and 20 ft long. This size of stall can accommodate most maintenance vehicles (e.g., boom trucks, trailers with portable generators, or Vactor trucks). Always check the size of the specific equipment needed for the facility, including vehicles with outriggers.

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

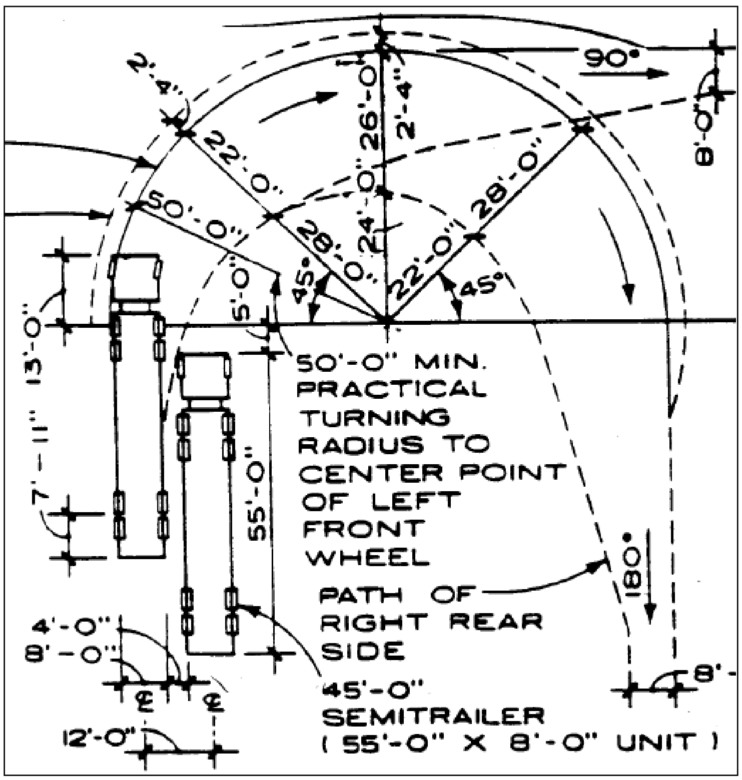
Parking restrictions within the ROW should be marked with both paint channelization and a parking restriction sign (signed for exempt vehicles only), to minimize the conflicts and need to tow.

See section 11.6.1.2 of *DSG Chapter 11, Pump Stations* 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 must maneuver are usually in parking lots. Dead-end streets and alleys are also a unique concern for SPU truck drivers. A typical truck's turning radius design diagram for a 55-ft 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 ft turning radius for intersection design. American Association of State Highway and Transportation Officials (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 Operations 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. Confer with Operations 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 ft 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 are typically acceptable

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, when removing and replacing equipment, and when installing new facilities. Design decisions can be informed by the size of the special equipment and/or 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 ft, or 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 outriggers 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 - Vactor Truck Turning Radius** for the turning radius for the large Vactor truck currently in the SPU fleet. Because effective suction requires the truck to be within approximately 28 ft, it is important to allow truck access close to any below-grade facility needing suction. To accommodate effective suction, SPU's preferred maximum depth of facility from surface to interior bottom needing suction is 17 ft.

C. Portable Generators

Most facilities will require a standby generator. This will require access and parking for a fuel truck. The design engineer must consider ample space close to facilities for parking and connection of a portable generator in case of standby generator failure. Generator sizing is dependent on facility-specific energy generation needs. SPU generators vary from 1 kilowatt (kW) to 1 megawatt (mW) capacity, ranging in size from handheld to the size of a shipping container. The design engineer must determine power generation requirements for the site and then estimate the size of a portable generator accordingly.

4.3.2 Pipeline Access

4.3.2.1 Clearances for Excavation and Shoring

Within the City's ROW, horizontal clearances of 5 ft 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 section 5.12.1 of *DSG Chapter 5, Water Infrastructure* and section 8.12 of *DSG Chapter 8, Drainage and Wastewater Infrastructure*. Vertical clearance needs will vary. 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 DSG 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 an 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. A 5-ft clearance is needed for tapping equipment. Drainage and wastewater (DWW) core taps require a minimum of a 3-ft clearance. With the deeper excavation and the need for shoring at the tap location, 5-ft clearance is also likely required.

4.3.2.3 Clearances from Trees

When feasible, design for clearances greater than the 5 ft to provide clearance from the edges of trees 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.

A minimum horizontal clearance of 5 ft is not fully protective of pipe from potential damage from tree roots. A 5-ft clearance does not fully protect tree canopies or roots from utility excavation or maintenance activities. The minimum 5-ft clearance is based on an agreement between SDOT and SPU that can be found in the agreement's library.

4.3.2.4 Alternative Access

Various means are used to provide non-standard access for replacing SPU utilities. Below are options when standard access is either not possible or in direct conflict with another City goal.

A. Casings

See DSG section 4.11 and section 5.6.3.7 of *DSG Chapter 5, Water Infrastructure*. 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 section 5.8.3.8 of *DSG Chapter 5, Water Infrastructure* for information on tunneling and drilling.

C. Within a Structure

Identify access for maintenance and repairs 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.

D. Clearance from Underground Power

See Seattle City Light (SCL) Construction Standard 0214 for standard minimum separations between water, sewer and drainage, and underground power. This standard documents the minimum separations that SPU has approved. SCL engineers must coordinate with interested parties when these minimum separations cannot be maintained.

SCL Construction Standard 0214 identifies SCL clear zones. For SPU assets to be placed in an SCL clear zone, SCL, SPU, and SDOT should coordinate to resolve the conflict. Common conflicts over utility separations are a result of shifting curbs. One example is needing to place drainage structures over the top of a duct bank, which SCL standards do not permit.

It is important to resolve these contradictory design issues prior to advertising. In addition to the usual issue of obtaining permission to advertise, City Standard Specifications section 1-04.2 indicates that referenced SCL standards supersede the drawings.

4.3.3 Controlled Access with Fencing and Gates

Fencing is regulated through SDCI's land use code. In addition, the design engineer should discuss fencing needs with both SPU Security and Operations staff early in design, including discussions on vegetation and trees in proximity to a fence. It is preferable to identify 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 City ROW, since the swing can have significant impacts on street and sidewalk functions.

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

See section 11.6.1.4 of *DSG Chapter 11, Pump Stations* for fencing at pump stations and sections 15.4 and 15.5 of *DSG Chapter 15, Physical Security* for physical security measures and electronic physical security equipment

Tips: *SPU does not typically use chain-link fencing and gates, as shown in the City's Standard Specifications and Plans. 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.*

Coordinate fencing choices with landscaping. Both SPU Security and Operations staff should have input. Fencing choices like chain link can seriously complicate gardening maintenance activities.

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 of measurable environmental design requirements, such as Leadership in Energy and Environmental Design (LEED) goals, is critical for scoping new structures. Design of pipeline structures, including access requirements and structures, is addressed in *DSG Chapter 5, Water Infrastructure* and *Chapter 8, Drainage and Wastewater Infrastructure*.

4.4.1 Access to Structures, Doors, Castings, and Ladders

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 some 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, ladder fall prevention safety systems, and fall protection grating as required by building codes and Washington Industrial Safety and Health Act (WISHA) rules to prevent and restrict falls. Ladder fall prevention safety systems such as cables are required on ladders over 24 ft in height. Ladder cages are not considered a fall prevention method but may be installed on ladders to reduce apprehension on tall ladders. Place ladders to clear openings and provide head space of a minimum 6 ft for occasionally accessed structures. More clearance is desirable, if possible. More clearance is required for regularly accessed structures. For ladders that do not extend above the surface elevation, consider installing a ladder-up mechanism to assist users in accessing the ladder

Size doors, hatches, and other access areas 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 hazards and inconvenience for pedestrians and to satisfy Americans with Disabilities Act (ADA) requirements.

Locate hatches and castings to minimize pedestrian safety issues related to slipping and closures of crosswalks, sidewalks, and ramps during use. Avoid driveways, as they are difficult to shut down to access hatches and castings. To the extent possible, locate castings to ensure 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. Use of castings is preferred. For access hatches, discuss with SPU Operations whether to install fall prevention grate under the hatch.

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. Replace existing 18-inch SPU castings (see Standard Plan 220). 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. For maintenance activities and removing equipment, facilitate easy removal of both the grating and the support system, if necessary. Gratings and grating support systems can be a variety of materials, depending on the anticipated loading and environment. If maintenance activities could require kneeling on the grating, consider, and discuss with SPU 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 International (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 ft (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 a maximum of 50 pounds for any material that may need to be lifted by hand. If using marine-grade coatings on steel bar grating, do not use zinc-based paints in drainage applications.

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

4.4.1.3 Stairways 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. Where ladders are constructed of galvanized steel, use manufactured galvanized steel treads, such as TRACTION TREAD by McNichols.

If considering FRP for handrails, grating, or treads, be aware that FRP can degrade and shed fibers over time, which can puncture crew members in their hands or through clothing.

4.4.1.4 Doors

Doors should be large enough to allow equipment removal and replacement. Anticipate that above-door lighting will be needed. Consult early with SPU Security staff on locks. Prior to bidding, consult with SPU Operations 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 to allow users to review during the design process. See section 10.5.3.2 of *DSG Chapter 10, I&C (Supervisory Control and Data Acquisition [SCADA])* for electrical and instrumentation clearances.

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. Polyvinyl chloride (PVC) or hydrophilic 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, because 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 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. Waterproof membranes or coating systems can also be considered.

Contract documents should specify testing requirements and allowable leakage for structures. Testing can be completed by filling the structure with water and checking for leaks or damp spots or 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 the SPU Materials Lab for assistance on structural concrete specifications. Also, ask for advice with constructability considerations, such as acceptable slump in dense rebar locations like wall-to-floor connections.

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

Special coatings are available for a multitude of purposes and are constantly changing. Consult with manufacturers for current information.

4.4.4 Vehicle Loads

All new structures subject to traffic loading must incorporate the standard HS25 vehicle loading.

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

4.4.5 Seismic

Seismic design requirements for new water pipelines and facilities are described in section 5.10 of *DSG Chapter 5, Water infrastructure*. Consult with the SPU Geotechnical Engineering group and refer to section 5.9.2.1 of *DSG Chapter 5, Water Infrastructure* for seismic design geotechnical parameters and considerations. See section 3.15 of *DSG Chapter 3, Design for Construction* for a description of 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 based on the site-specific geotechnical report. See section 3.15 of *DSG Chapter 3, Design for Construction*.

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 City of Seattle Stormwater Manual on vegetated roofs. Metal roofs are only acceptable if they have an enamel coating; other coatings are considered 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 building codes. In addition, consider theft-preventive and graffiti-resistant finishes, especially at remote facilities. Copper cladding is not acceptable because it is a pollutant source in stormwater.

See section 11.6.2.4 of *DSG Chapter 11, Pump Stations* for guidance regarding painting at 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. Design of pipeline connections and restraints for buried pipe is addressed in *DSG Chapter 5 Water Infrastructure* and *DSG Chapter 8 Wastewater and Drainage Infrastructure*.

4.5.1 Facility Piping Connections

Table 4-1 lists SPU's common piping connections and their typical uses.

Table 4-1
Pipe Connection Types and Uses

Pipe Connection	Typical Uses
Threaded	Joints and connections 4 inches and smaller. Metal only.
Flanged	Joining exposed piping and valves. Does not allow clearance for removal and disassembly. Do not use in buried applications.
Victaulic coupling	Grooved fittings typically installed at pump stations to help with disassembly at key locations. Normally used as a dismantling joint.
Mechanical joint	Joints 6 inches 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. Do not use rubberized expansion joints on pump connections.
Dismantling joint	Allows for ease of disassembly. Use where length adjustment is required to remove equipment or mechanical fittings.

Where process piping and equipment is installed inside vaults or other structures, provide joints on either side of valves and equipment that allow for length adjustment and disassembly. SPU recommends using dismantling joints, flange adapters, and grooved couplings in this application. Where practical, process piping should be designed to allow a section of pipe in each direction to be cut while in the field. This greatly reduces the need for precise pipe fabrication and provides contractors with significant flexibility during pipe fitting and assembly.

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 are also used to assist with installation and dismantling of appurtenances, such as valves and flow meters. Pipe supports, such as concrete saddles, can reduce vibration in piping. Pipe supports 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 and Figure 4-3 shows typical details for common pipe supports.

Figure 4-2
Typical Details of Pipe Supports I

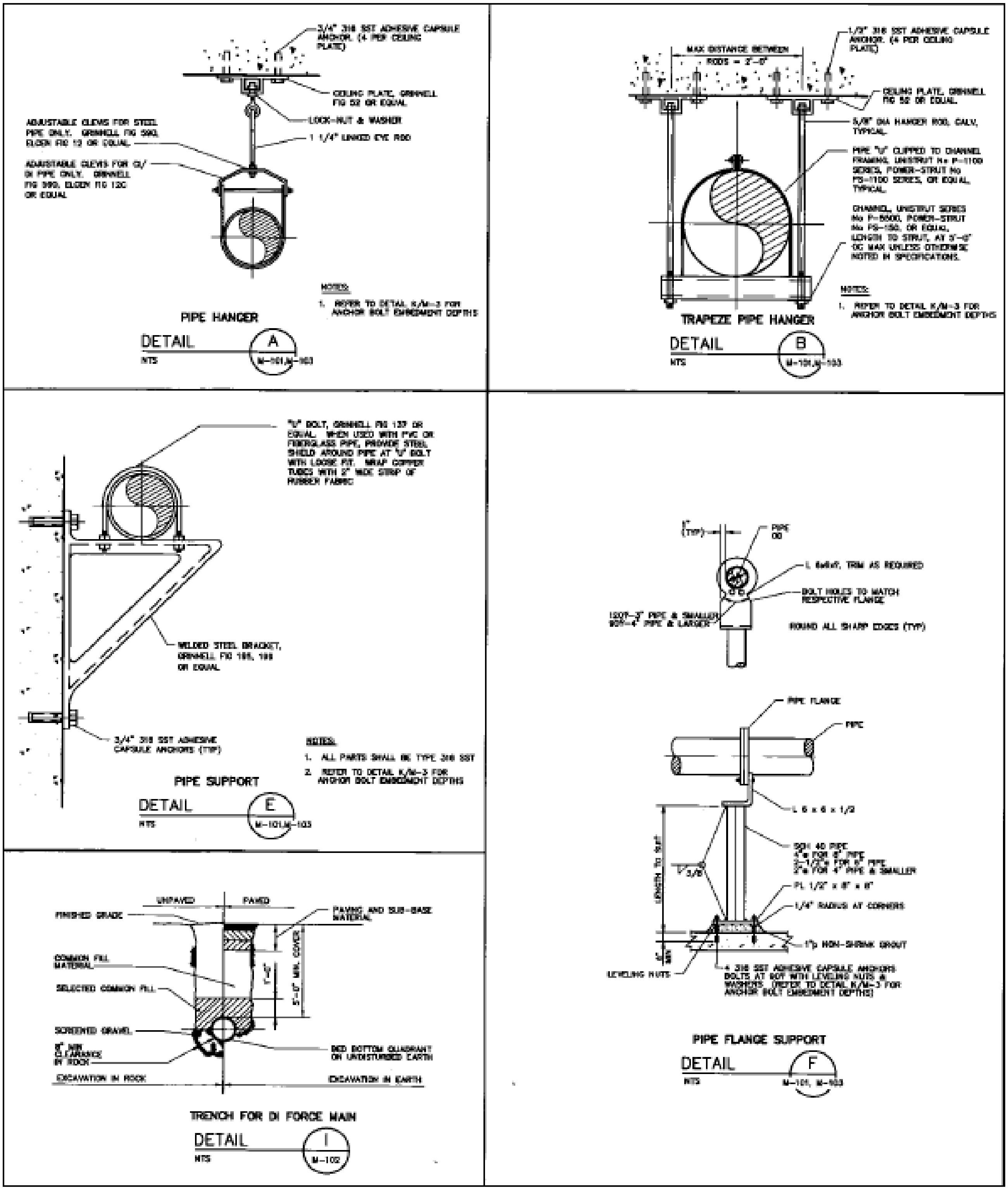
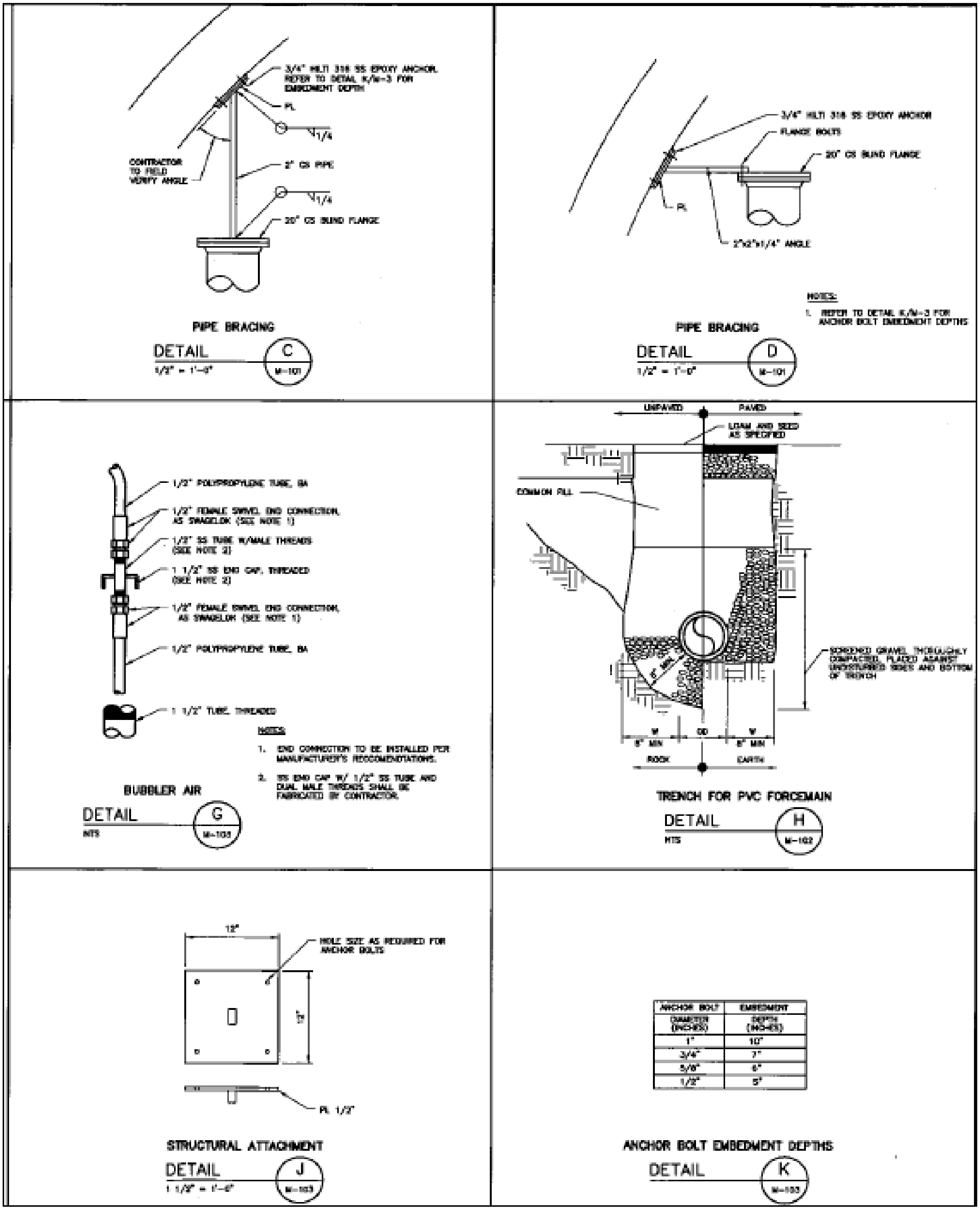


Figure 4-3
Typical Details of Pipe Supports 2



Pipe supports should be located adjacent to items with concentrated loads on the piping system, such as pipe bends, and at valves, meters, pump nozzles, and fittings requiring independent support. Properly designed piping support prevents load transfer across these fittings and allows them to be disassembled readily. Pipe loadings should never be transferred to pump nozzles. In general, sufficient support should be provided to ensure that piping only carries hydraulic loads.

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 (also referred to as equipment bases). Pads must be designed to carry the fully loaded weight of equipment, including fluids such as fuel and water. Independent pads placed on the ground must consider stability and allowable ground reactions. Equipment pads should be a minimum of 6 inches above ground elevation or a minimum of 4 inches above a concrete floor. If leveling grout is needed, SPU will review the plan for leveling to ensure contact for the entire surface and to ensure that voids are filled with grout after removal of leveling equipment. Anchorage requirements must consider all potential loads created by, or experienced by, the equipment, including static, hydrostatic, dynamic, seismic, and wind. Equipment manufacturers can provide some criteria, such as operational dynamic loads. Anchorage must be able to safely absorb and withstand equipment thrust from shut off, turn on, and possible water hammer loads. Construction should include testing for leveling, vibration, and thrust. For rotating equipment adequate mass of the foundation should be considered.

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 three conduit runs, or that have specific requirements on the conduit location, are considered 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 or from the actual piece of equipment to be installed.

When determining locations for new equipment pads, understand what may be located where the pad will be placed. For example, if there is a watermain adjacent to the pad, ensure that there is not a block for the main that extends into the pad. Modifying equipment bases (i.e. pads) during construction can have long term consequences.

4.7 UTILITY SERVICES AT SPU FACILITIES

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

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

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 and the utilities' requirements during preliminary engineering. If an upgrade of power service is needed, that electrical work can require a major project expansion. See section 9.2.3.1 of *DSG Chapter 9, Electrical Design*.

4.7.2 Water and Fire/Hydrant Service

For information on obtaining a new water or fire/hydrant service, see SPU's Forms and Resources.

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 City ROW, sewer and drainage service can be reviewed through SPU's internal review processes, but design must conform with SDCI's 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 must be identified on the site layout by 30% design. The following are SPU's guidelines for laying out the pipeline corridors:

- Pipes and conduits should not be under buildings, except for entering and exiting a building.
- 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.
- Separate handholes should be included for power, SCADA, and security conduits.

See section 11.6.1.6 of *DSG Chapter 11, Pump Stations* and section 10.5.3.3 of *DSG Chapter 10, I&C (SCADA)* for guidance on pipeline corridors for pump stations and instrumentation and control, respectively.

4.9 TEMPERATURE AND VENTILATION 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. Adequate heating to control issues such as condensation on walls and pipes, and dripping valve packing can help prevent corrosion and damage to equipment. 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. The design engineer should identify temperature and ventilation requirements during preliminary engineering since these design elements typically require a mechanical engineer. See section 10.8.1.2 of *DSG Chapter 10, I&C (SCADA)* for guidance on environmental requirements for instrumentation and control equipment.

4.9.1 Ventilation

Heating, ventilation, and air conditioning (HVAC) systems are typically designed for occupied buildings or for equipment protection according to ASHRAE 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 (connected ductwork or normally closed doors and hatches) must be treated as single common areas and carry the most stringent of the area classifications. For pump station HVAC requirements, see section 11.6.2.1 of *DSG Chapter 11, Pump Stations*.

4.9.1.1 Insect and Pest Screening

To prevent insects and other small animals from entering facilities through openings required for HVAC equipment, SPU recommends 3/16-inch mesh screening constructed of stainless steel. Mesh screening must also be provided for all louvers on electrical cabinets.

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 must consult with landscape maintenance staff during the landscape design process.

For work within the City ROW, consult with SDOT Urban Forestry. For projects in or adjacent to City parks and boulevards, see Seattle Parks and Recreation Standards. For natural areas not on Seattle Parks and Recreation property, consult Green Seattle Partnership Specifications. On SPU property, use the principles of Crime Prevention Through Environmental Design (see section 15.5.1 of *DSG Chapter 15, Physical Security*) to avoid security threats and hiding places, use native plants for new plantings (King County Native Plant Guide), and work to control invasive plants ([King County Noxious Weed Guide]). Check on-site requirements in the Stormwater Manual, Green Factor, and Environmentally Critical Area (ECA) code requirements for the project. At a minimum, drawings should identify all landscaped areas to include vegetation types (turf, groundcover, shrub, tree), planting palette for each vegetation type, recommended spacing and quantity for each plant species, and notes and/or requirements for each plant species. In addition, drawings should delineate areas and define materials and methods for erosion control (e.g., coir logs, geotextile, wattles) and soil amendments (e.g., compost, clean-green arborist's mulch). Best efforts should be made to install plants from the Puget Lowlands seed zone.

Tip: *Consult early about the landscaped area and availability of water.* Removed for Security

This will help SPU determine what landscape, plant selection, weed control, amendments, and erosion control measures may be appropriate for the site or whether to install a full irrigation system, install a hose bib, or to define a plan for watering by truck. This will help determine when the project team will need to include an ecological restoration or landscape design consultant and the scope of their work.

4.10.1 Landscape Design

The following are SPU's general guidelines for landscape design:

- Minimize ground disturbance and protect existing soil and vegetation where possible and identify protected areas on the drawings per Standard Specifications section 8-01.3(2)B. Work to protect the native soil profile as much as possible.
- When ground disturbance is unavoidable, work to restore the native soil profile from bottom to top. Add compost and then "clean (weed free), green (nitrogen rich – including leaves and needles)" arborist wood chip mulch amendment as the last step for soil restoration.
- Restore soils disturbed by construction with compost amendment per Standard Plan 142.
- Select native plant species that are appropriate for the urban ecosystem landscape setting and adjacent neighborhood; have proven success in the type of soil and conditions present; and are relatively low maintenance.
- For built assets (e.g., piping, venting, other drainage features) above ground, the design engineer must determine, based on the site specifics, how close vegetation should be to the built asset. Considerations include fish, bird, and wildlife habitat; risks to built assets; and adjacent property.
- When identifying trees for preservation during construction and selecting trees for installation in the City ROW, consult with SPU's and SDOT's staff arborists.
- Add a bid item to require a Tree, Vegetation, and Soil Protection Plan (TVSPP). See Standard Specifications section 8-01.3(2)B.

The following are SPU's design considerations for weed and pest control:

- Choose native plants and design planting plans that are low maintenance and foster an invasive and weed-free area.
- Control invasive plants weeds through appropriate plant choice and spacing for the site, followed by mechanical methods, and lastly by chemical methods, only when other methods do not work.
- The City prefers mechanical control and suppression of undesired vegetation. Pesticides may not be used without express consent from the SPU Landscape Asset Program Manager.

4.10.2 Landscape Plan

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

Plans must identify all landscaped areas, including vegetation types (turf, groundcover, shrubs, and trees), planting palette for each vegetation types, recommended spacing and quantity for each plant species, and notes and/or requirements for each plant species. In addition, drawings should delineate areas and define materials and methods for erosion control (e.g., coir logs, geotextile, wattles) and soil amendments (e.g., compost, clean-green arborist's mulch). Best efforts should be made to install plants from the Puget Lowlands seed zone.

Landscape plans must show:

- The name, size, quantity, location, and water use need of each plant.
- Soil amendment and mulch type, depth, and location.

Depending on the site area, work to have a uniform hydrozone for all of the plants considered, for ease of maintenance and watering. If unavoidable, minimize the different hydrozone needs of selected plants and group plants within similar hydrozones.

4.10.2.1 Plant Material

The following are SPU's design considerations for plant materials:

- 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 and drought-tolerant plants. Choose plants that can handle hotter and drier conditions from late spring to fall per climate change forecasts for the Puget Sound.
- Consider plants that are native and/or adapted to neighboring hotter and drier ecoregions, such as west side of the Cascades Oregon and Northern California.
- Plants should be located to meet their short and long-term cultural needs.
- Plant material should be selected for the appropriate hydrozone.

4.10.2.2 Turf

The design should minimize mowing and maintenance requirements. When possible, avoid using turf in places where SPU is responsible for landscape maintenance. Turf should only be considered for recreational or play areas and for places where people are encouraged to frequent. Where turf is needed, consider seeding with native fescues and rye grasses, per recommendations from University of Washington’s Center of Urban Horticulture.

The landscape designer must ensure that no turf area is smaller than 12 ft by 12 ft.

4.10.2.3 Soil

The landscape plan must meet all topsoil and soil amendment requirements defined in Standard Specifications section 8-02.3(2).

4.10.3 Irrigation Plan

Choosing new landscape designs that do not require long-term irrigation is an important part of SPU’s climate preparedness strategy. Even for sites that need a full irrigation system initially, the goal should be to phase out use of these systems after the third year of installation of new plants.

Early coordination with SPU Operations, including the SPU Grounds Crew Supervisor, and the SPU Landscape Asset Program Manager is required when selecting a water option. Options to consider include no need for irrigation due to proximity to surface or groundwater (e.g., wetland or riparian areas), transported water, a water supply with hose bib, or a full irrigation system.

If a hose bib or full irrigation system is selected, ensure that the drawings specify the location of the water meter service, which will be under a separate permit. Typically, SPU, as the owner, will order the new water service. The Project Manual defines the process for water service coordination.

A backflow prevention assembly (with its annual inspection requirement) is required between any irrigation system and the water meter. See Standard Specifications section 9-30.16, which notes 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. For additional information, refer to SPU’s Water Efficiency Tips. Where appropriate, consider automated drip systems as the most water efficient system for designed landscapes.

The designer is responsible for verifying the actual flow and pressure at the site to design an irrigation system appropriate for the site. See Standard Specifications section 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.
- Access to the carrier pipe for future maintenance and replacement for various reasons:
  - Built over
  - To add 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 Specifications section 7-11.3(7)C.

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 affect 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 and the largest outside diameter of the carrier pipe, including the pipe bells. This allows 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 likely opportunity 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

The engineer of record should 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. However, the Contractor’s jacking equipment will often determine the actual required thickness.

Table 4-2 lists the minimum steel casing wall thickness for under roads, highways, and rails for between 4.5 ft and 20 ft of cover.

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

Nominal Diameter (Inches)	Wall Thickness (Under Road)	Wall Thickness (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

Notes
[1] Adopted from Iowa Department of Transportation Design Manual and modified for standard steel pipe thickness standards.
[2] Minimum thicknesses assume a minimum of 4.5 ft of cover over the top.
[3] Casing with depths of over 20 ft 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.
[4] 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 primary reasons for installing casings is for easier removal of carrier pipe and to reinstall a replacement carrier pipe without disrupting traffic or requiring disruption of rail tracks, which will be very expensive in the future.

The design engineer must always think about the engineers, utility crews, and contractors that must work on future installations and maintenance. Toward these ends, design engineers should consider:

- Adequate spacing at the ends of the casing pipe to accommodate future pipe replacement.
- The jacking pit for future access must 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. Consider acquiring permanent easement rights.
- 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 must follow the same specifications as the water pipe, transmission, or sewer pipe standards. That is, Standard Plan 350 for watermain trench and bedding or Class B per Standard Specifications section 7-17.3(1)B for sewers.

4.11.5 Spacers and End Seals

Always install casing end seals to prevent groundwater from moving through the casing, which can potentially increase the corrosion rate of the casing and carrier pipe. See Standard Specifications section 7-11.3(7)C.

Do not grout the annular space between the casing and the carrier pipe, which would make future work for maintenance and repair 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, Cathodic Protection* and consult a corrosion protection engineer for advice for each location.

4.12 RESOURCES AND LINKS FOR STORMWATER CODE COMPLIANCE

Information on meeting stormwater code requirements and related City standards are provided throughout the City's website. 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 website 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 the City ROW, see ROW Flowcharts 1 through 4.

Table 4-3
Links to General Stormwater Code Information

Document/ Topic Link	Description
Stormwater Code and Manual	SDCI website with links to code, stormwater manual and related information
Appendix 18C – 2016 ROW Flow Chart	DSG Appendix 18C Seattle Stormwater Code Flowchart (1) for projects in the ROW provides a shortcut to minimum requirements developed for plan reviewers
Flow Control and Treatment Guidance in *DSG Chapter 8, Drainage and Wastewater Infrastructure*	DSG Chapter 8, sections 8.7.8 Water Quality Treatment and 8.7.10 Green Stormwater Infrastructure.
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 Rules	SDCI website 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.

Acronyms and Abbreviations
ROW: right of way
SDCI: Seattle Department of Construction & Inspection

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All SPU capital improvement projects should plan for City stormwater code review by the Standards and Plan Review Section. Initial review should be of a 30% draft drainage report. The drainage report should also be reviewed at 60%, 90%, and final. This review does not typically include review of the conceptual Construction Stormwater and Erosion Control (CSEC) plan.

Tip: *Consider structuring your drainage report to explain how the project meets the minimum requirements for all projects summarized in Volume 1, Chapter 3 of the Stormwater Manual. It is common to focus on questions about flow control and water quality requirements and thus miss a requirement (for example, ensuring sufficient capacity or protect wetland) with a bigger impact on the project.*

Requirements are more complicated for parcel-based projects within the City 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 limits, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

4.12.2 Construction Stormwater and Erosion Control

Refer to *DSG Chapter 3, Design for Construction* for details regarding CSEC. Additional links and references are provided in Table 4-4.

Table 4-4
Links with Information on CSEC

Document/Topic Link	Description
DSG Chapter 3, Design for Construction	DSG Section 3.7 Construction Stormwater and Pollution Prevention in *DSG Chapter 3, Design for Construction*
Ecology Permit Information	Ecology website 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 describing BMPs
Standard Specifications	Refer to Specification sections 1-05.13(3), 1-07.15, 1-07.16(2) and 8-01
Appendix 18B – Temporary Discharges	DSG Appendix 18B Temporary Discharges of *DSG Chapter 18, Development Services*
King County Construction Dewatering	King County's website on construction dewatering, administered under its Industrial Waste Program.

Acronyms and Abbreviations
BMPs: best management practices
CSEC: construction stormwater and erosion control

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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 of the Stormwater Manual. This and additional links are provided in Table 4-5.

The Stormwater Manual allows two methods for demonstrating compliance. Use the on-site list and list approach calculator if best management practices (BMPs) for flow control or water quality are not included in the design of the project.

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 website includes the List Approach Calculator (under Forms and Documents). Reference materials include SPU Allowable Permeable Pavement Wearing Course Materials.
DSG Chapter 3, Design for Construction	DSG Section 3.15 Geotechnical Services. Also see 3.19.4 Bioretention and biofiltration in *DSG Chapter 3, Design for Construction*
Appendix D – Subsurface Investigation and Infiltration Testing for Infiltrating BMP's	Guidance on subsurface testing and reporting to meet the requirements of the Stormwater Code.
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.
Appendix 7H – GSI Modeling Methods	DSG Green Stormwater Infrastructure Modeling Methods
Standard Specifications	See Section 5-06 Pervious Cement Concrete Pavement and 7-21 Bioretention.
Standard Plans	See Standard Plans 291 through 299, 403 and 425.

Acronyms and Abbreviations
BMPs: best management practices
CAM: Client Assistance Memorandum
GSI: Green Stormwater Infrastructure

Tip: *Infiltration testing required by the stormwater code can complicate the scope and schedule of a 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 section 3.17 of *DSG Chapter 3, Design for Construction* for details on restoration of disturbed areas.

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 SPU Operations.

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

Public safety signage warns the public of potential hazards that exist at a facility or site. Hazards include chemicals stored on-site, wastewater, high voltage, relief valve discharge, and more. Public safety signs are to be placed in clear view in an easily accessible location without having to enter the property. If a facility is entirely in the public ROW, proposed signage should be placed as near to the facility as possible and may have to be mounted to nearby fencing or a free-standing post outside of vehicle and pedestrian areas. Sign placement in the ROW must be permitted by SDOT. All warning signs must be in accordance with industry standards (National Electrical Code [NEC], Occupational Safety and Health Administration [OSHA], and Institute of Electrical and Electronics Engineers [IEEE]) and other applicable regulatory items.

4.15 GEOTECHNICAL SERVICES

See section 3.15 *DSG Chapter 3, Design for Construction* for SPU guidance on geotechnical services.

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. Therefore, project teams should document any future considerations in the basis of design plan sheet and project files.

4.17 RESOURCES

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