Chapter 1 SPU Design Process

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Chapter 1 SPU DESIGN PROCESS

This chapter of the Design Standards and Guidelines (DSG) explains a typical design process from project initiation through commissioning for a Seattle Public Utilities (SPU) traditional design-bid-build project. The primary audience for this chapter is SPU engineering staff. DSG standards are shown as underlined text.

At SPU, the design team may include engineers in training or professionally licensed engineers who are responsible for the design of SPU infrastructure. The design team may also include consultants and non-engineers from other SPU departments.

1.1 KEY TERMS

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

1.1.1 Abbreviations

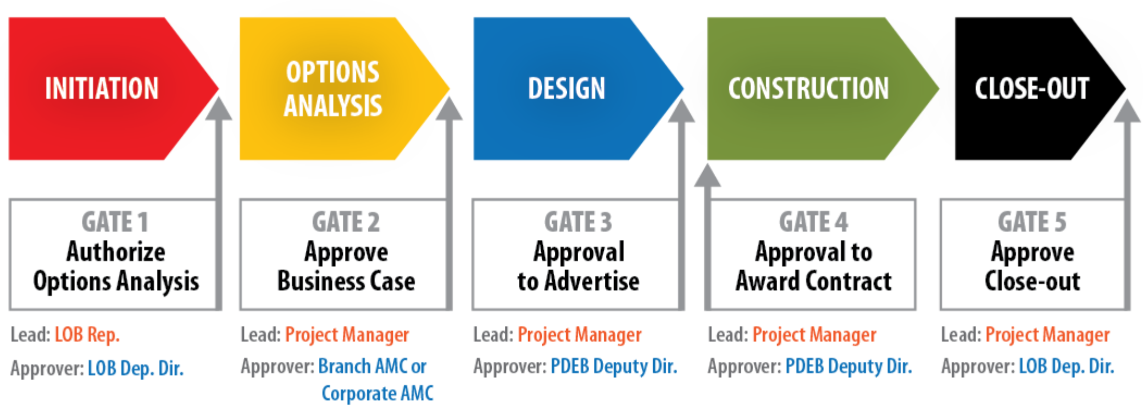
Abbreviation	Term
AMC	Asset Management Committee
APWA	American Public Works Association
CAD	computer-aided design
CIP	Capital Improvement Program
CMD	Construction Management Division
CSI	Construction Specifications Institute
CSO	combined sewer overflow
DIL:	Design Innovation Lab
DSG	Design Standards and Guidelines
FEMA	Federal Emergency Management Agency
GSPs	general special provisions
I&C	instrumentation and control
LEED	Leadership in Energy and Environmental Design
LID	low-impact development
LOB	line of business
MOA	Memorandum of Agreement
O&M	operations and maintenance
PDEB	Project Delivery and Engineering Branch

Abbreviation	Term
PMP	project management plan
QA	quality assurance
QC	quality control
RFI	request for information
SCADA	supervisory control and data acquisition
SDOT	Seattle Department of Transportation
SDCI	Seattle Department of Construction and Inspections
SEPA	State Environmental Policy Act
SMT	Seattle Municipal Tower
SPU	Seattle Public Utilities
WAC	Washington Administrative Code

1.2 GUIDING PRINCIPLES

As depicted in Figure 1-1 below, the SPU Stage Gate System for Governance of Projects and Programs implements five check points that help SPU make informed decisions about the selection, delivery, and operation of a project or program.

Figure 1-1
Stage Gates



Acronyms and Abbreviations

AMC: Asset Management Committee
LOB: line of business
PDEB: Project Delivery and Engineering Branch

SPU policy requires SPU Capital Improvement Program (CIP) projects to be defined and approved through the asset management process before design begins. Apply these SPU policies during the design process:

- Asset management principles guide design decisions, deviations, and time-related effects, both short- and long-term.
- Communicate major changes to the approved goals, risks, schedules, and budgets during design in a timely manner for management review.
- Design of utility components of non-SPU projects follows the principles of asset management.

Use these guiding principles for the design process for either standard designs or deviations:

- **Safety first.** Design to minimize the risk to staff and the public. It is not enough to safeguard public health with reliable drinking water and proper sewage collection. SPU employees will operate and access every facility you design. There is risk inherent to all those activities.
- **Design for the system.** Understand how the utility systems will respond to projects. Avoid solving one problem to create another.
- **Design for today and into the future.** Design for system flexibility wherever possible. Sometimes a future need cannot be predicted. Or it may be economically desirable to incur present costs for a future customer or system need. Make and document each design choice deliberately. Consider current and future customers, operators, engineers, and contractors.
- **Determine and minimize lifecycle costs.** Determine lifecycle costs to evaluate the most economical alternative; usually (but not always) this will mean selecting the alternative with the lowest life cycle costs. Consider the full lifecycle of the asset: construction, operation, maintenance, repairs, replacement, and disposal.
- **Minimize liability.** Design to minimize damage to lives and property. Accidents happen. Sometimes, it is as ordinary as slipping on a meter cover. Other times, it is a heavy rain and inlets clogged with leaves. Ask questions such as, Where will the water go? Who could be harmed? What else will change in the area in the future?
- **Protect the environment.** At each step, question the effect of your design decision on the environment during and after construction. Do not wait until the end of design to prepare an erosion control plan. Early choices can make a big difference.
- **Protect the environment.** Prioritize design approaches that minimize impervious surface, minimize stormwater runoff, and preserve native vegetation.
- **Operational preferences matter.** Talk about deviations with the operators. The people who operate and maintain SPU infrastructure have a say in standards and deviations. Engineering function is important, but habits, standard practice and equipment, and convenience are equally as important to consider. Stage Gate 5 requires Operations' acceptance of the project. Follow the One Team Concept, especially with projects that involve an Operations lead in all project phases.
- **Partner preferences matter.** Make early communications with affected partners a part of the design process. SPU seeks to maintain effective relationships with key stakeholders, businesses, other City of Seattle (City) departments, and government agencies.

1.3 PROJECT TEAM

Specific roles and responsibilities are defined on each team. Team makeup may vary over time, and one individual may play multiple roles. General descriptions of key roles include:

- **Project manager.** Manages overall project, the project team, and project deliverables; responsible for the quality assurance (QA) for the project.
- **Line of business (LOB) representative.** Responsible for business case development, setting project goals and measurements of results, navigating governance, and obtaining funding and approval for the project.
- **Project engineer.** One internal employee is assigned as the project engineer for each project. They handle cross-discipline coordination and decisions. The project engineer oversees, advises, and serves as the primary design contact for consultant design team. A Professional Engineer license may be required, depending on the complexity of the project. They must have sufficient engineering education and experience to provide guidance for the project.
- **Design engineer.** Licensed engineer responsible for the design or review, approval, stamping and signing of contract plans, design calculations, and reports in their area of competency and prepared by them or under their direct supervision. May also act as the technical lead responsible for review of consultant design, checking all design calculations. There can be more than one design engineer for multi-disciplined designs. design engineers stamp and sign each sheet of the plan set related to their discipline.
- **Engineer.** Performs design for a specific discipline or specialty. Works on production of design drawings, technical specifications, calculations, and technical memoranda.
- **Checker.** Supervisor, manager, or assigned senior staff who performs quality control (QC) for deliverables. Checks the design plans for compliance with the DSG, checks the design for consistency with the basis of design (BOD), and checks all calculations in their discipline of expertise. Checkers initial and date each sheet of the plan set they performed checks on. People cannot be the checker for their own design.
- **Technical Resources Staff.** Prepares base maps, drawings, and presentations. Checks conformance with SPU drafting standards. The base map drafter prepares the base map, and a design drafter prepares the drawings and checks for conformance with SPU drafting standards.
- **Land Survey Staff.** Licensed professional land surveyor responsible for a variety of survey services during design and construction.
- **Geotechnical Engineer.** Licensed engineer responsible for a variety of geotechnical specialty tasks during design and construction.
- **Resident engineer.** Manages and enforces construction contract and is the single point of contact with the Contractor.
- **Field inspector.** Responsible for on-site construction inspection, enforces construction work to meet the City's Standard Specifications and Plans and/or project specifications.
- **Construction supervisor.** Supervises the resident engineer and field inspectors during construction and represents Construction Management Division (CMD) during options analysis and design phases.
- **Materials engineer.** Responsible for materials testing and acceptance.

- **Public Works Contracts staff.** Responsible for developing the Project Manual, see Construction Contracts and Standards section.
- **Project planning and controls staff.** Assists project manager and team in maintaining the project schedule and reporting schedule issues. See Project Management Methodology for details.
- **System Operations, Planning, and Analysis (SOPA) staff.** Supports design team during design process to ensure that the project meets requirements for Operations staff and function. Monitors and documents utility function and alarms and evaluates facility operations after project completion at the SPU Operations Control Center and at Seattle Municipal Tower (SMT).
- **Instrumentation and control (I&C) staff.** Responsible for supervisory control and data acquisition (SCADA) standards and data communications with the utility control center.
- **Operations staff.** Represents the perspective of the final users and operators of SPU facilities. Coordinates crew labor to inspect, maintain, operate valves and bypasses, and make connections and adjustments to existing assets.
- **Commissioning authority.** Leads the start-up, testing, and commissioning efforts for new facilities as part of construction completion and acceptance by the project owner (SPU). Usually not assigned for smaller pipeline projects and is more necessary for facilities with mechanical and electrical and instrumentation components (e.g., treatment plants, pump stations, combined sewer overflow [CSO] facilities).
- **Community outreach and Project Delivery and Engineering Branch (PDEB) liaison staff.** Responsible for direct customer communications.
- **Real Property Staff.** Responsible for acquiring SPU property, permanent easements, and temporary construction easements. Performs land and property research and advises on property-related issues.
- **Architect/landscape architect.** Consultant team members, as required.
- **Economic Services staff.** Responsible for business case lifecycle costs analysis during project development phase and updates to the business case, if required.
- **SPU cost engineer.** Assists in estimating construction costs, replacement cycle for project equipment, annual operations and maintenance (O&M) labor costs, and SPU staff costs.
- **Other subject matter experts.** Staff from other department or utilities (not SPU) involved or responsible for design elements such as paving (SDOT) or providing power (Seattle City Light [SCL]).

Tip: *It is rare for a project team to remain intact from scoping to construction. Be ready for handoffs to new individuals and consider change of personnel as a risk during scoping.*

1.4 INITIATION PHASE

Problems, opportunities, and strategies are typically identified and presented through SPU's comprehensive and programmatic process. They may also arise because of emergencies, external projects, or regulatory requirements. Initiation is the phase when a problem or opportunity is identified or created. By the end of the initiation phase, LOB representatives should have identified options to be evaluated in the options analysis phase and estimated the cost, labor resources, and schedule needed to perform the evaluation and prepare a business case. The assigned designer assists the One Team in this phase.

The initiation phase concludes with a Stage Gate 1 decision, which includes the decision of whether to proceed with options analysis, and if so, the authorized scope, schedule, and budget for the options analysis phase. See the Group of Eleven Report for One Team and Stage Gates Site for additional details.

Tip: *Most successful projects start with a well-defined problem definition and goal. If you do not understand, or you disagree, with either, elevate your concerns early to the project manager, the LOB representative, and your supervisor or manager.*

1.5 OPTIONS ANALYSIS PHASE

The objective of options analysis is a well-documented decision on the preferred option (also referred to as preferred alternative and referred to hereafter as preferred option) to solve a problem and/or meet an opportunity. The options analysis phase builds a business case recommending a preferred option. See the Group of Eleven Report for additional details.

Options analysis should include the following steps:

1. Assemble a project team.
2. Clarify the problem statement and refine the options.
3. Develop a plan for executing options analysis.
4. Conduct analysis and compare options.
5. Build a business case.
6. Develop high-level cost estimates or opinion of probable construction cost (OPCC).
7. Present recommendations to AMC.
8. Obtain a decision from AMC.

Tip: *If an option clearly satisfies the project goals and the location is known, order the base map and geotechnical information during options analysis. But, if many options are still being analyzed, it is better to request survey services and develop base maps as a 30% design deliverable.*

1.5.1 Assembling a Project Team and Scoping

The options analysis lead identifies the members of the project team and, with the team members, affirms that the right skill sets are represented on the team (see DSG section 1.3). Scoping clarifies the problem definition, develops a plan for executing the options analysis, plans the building of a business case that presents the results of options analysis, and recommends a preferred option (in addition to options analysis described in DSG section 1.5). The business case provides enough information for informed decision making and identifies preliminary performance standards for the preferred option.

1.5.1.1 General Activities

At a minimum, scoping should include:

- Reviewing project history and established goals and objectives.
- Visiting the site and assessing the existing conditions, including environmental and constructability issues.
- Documenting potential to minimize impervious surface, minimize stormwater runoff, and preserve native material.
- Gathering information on hydraulics and operating constraints for water, drainage and wastewater projects.
- Reviewing the available records documents.
- Coordinating with other SPU and City needs.
- Determining a strategy for acquiring required permits and State Environmental Policy Act (SEPA).
- Developing a QC plan.

Appendix 1A - Design Checklist includes a detailed list of issues and typical deliverables for a pipeline project. This list may be useful as a guide for non-pipeline projects. A project engineer may use this to help review the design scope with design engineers, and the design engineers may use this to help them make sure all design tasks are completed as they design the project.

1.5.1.2 Other Scoping Provisions

When these common design elements are identified, include a provision for them in the scope:

- Arts Commission
- Communications
- Consultant services and contracts
- Customer service plan
- Design Innovation Lab (DIL)
- Environmentally critical areas
- Geotechnical investigation and reporting
- Leadership in Energy and Environmental Design (LEED)
- Permitting (e.g., SDOT, Seattle Department of Construction and Inspections (SDCI), Environmental, Parks)
- QA by independent peer review
- Real Property
- Reliability-centered maintenance
- SCADA or control strategy
- Seattle Design Commission (SDC)
- Security
- Seismic, landslide, or flood protection
- Utility service (e.g., water, power, gas, side sewer, service drain)
- Value engineering

1.5.1.3 Agreements

Internal SPU staffing agreements should be signed as part of scoping. These agreements clarify the work and commit the resources to complete design.

Memoranda of Agreement (MOAs) with other Seattle departments or other agencies that commit labor resources should be in a draft form as part of scoping. Interagency MOAs should include a governance and dispute resolution structure. The project engineer incorporates the requirements of any agreements into the drawings and technical specifications.

1.5.1.4 Present Recommendation and Obtain Decisions

Complete Stage Gate 2 Form (which incorporates the business case). Use the same form for Asset Management Committee (AMC) and LOB AMC. Present the business case and recommendation to the appropriate decision-making body:

- If the project's total project cost is >= $1M, the business case is presented to AMC.
- If the project's total project cost is greater than $500K and less than $1M, the business case is presented to the appropriate LOB AMC.
- If the project cost is $500K or less, the project will use the Small Project Business Case and project management plan (PMP) template and will follow the Small Project Governance and Management process.

Included in the project decision is an evaluation and determination if the project will modify the 30/60/90% circulation review process.

1.5.1.5 Required Documents/Components

Documents (and/or components of documents) required for completion of options analysis and transition to implementation of the preferred option include the following:

- Business case/Stage Gate 2
- A formal transition document including resource funding cost estimates:
  - Design and performance criteria
  - Capital costs (using SPU's Cost Estimating Guide)
  - Completed SPU Equity Planning Toolkit
  - Value analysis (when required)
  - Communications/outreach plans
  - Initial permitting assumptions
  - O&M cost estimates from best available information, developed and/or reviewed by Operations or other offices carrying out O&M. These estimates should include:
    - Renewal and replacement of physical components
    - Changes in staffing levels and/or effects on existing staffing (e.g., changes in staffing priorities, new training requirements and/or new skill development)

The project team should note any potential labor issues that might arise from changes in staff training and/or skill development.

Related documents that may be modified/replaced by this phase description:

- Stage Gate 2 Form and Instructions
- Quick Start Guide
- Initiation and options analysis (defined)
- Elements of options analysis phase (matrix)
- Various guidance pieces on the Asset Management web site
- Small Project Business Case/Management Plan
- Equity Planning Guide for Project Development
- Project Management Methodology documents (on SPU Forms)
- Definition of the role of a SPU Infrastructure project manager
- Definition of the role of LOB representative in CIP projects

1.5.2 Preliminary Engineering and Preliminary Engineering Report

Preliminary engineering is conducted as part of the options analysis phase. Preliminary engineering refines and extends the analysis of the most feasible options by eliminating uncertainties and fatal flaws; and defining the scope of the project, including major project elements, pros and cons, and cost estimates of each option. This information supports the selection of a preferred option. Design completeness in preliminary engineering can range from 5–30% depending on the project.

The preliminary engineering report is a primary product of the options analysis phase. The objective of options analysis is a well-documented decision on the preferred option to solve a problem/meet an opportunity. The preliminary engineering report describes a BOD, each option, and recommends a preferred option. The report is also used to provide engineering analysis for the business case. The design engineer usually prepares the preliminary engineering report with help from project team members. The preliminary engineering report must include the seal/stamp of the professional engineers responsible for the contents in the document. The preliminary engineering or technical memoranda typically includes the following:

- Documentation of problem definition and project goals (see DSG section 1.5.2.1).
- Options description/conceptual design, including analysis and documentation of how low-impact development (LID) principles were considered and incorporated (see DSG section 1.5.2.3). The three categories of LID principles are measures to minimize surfaces, measures to minimize loss of native vegetation, and other measures to minimize stormwater runoff.
- Surveying, geotechnical reports and base maps services, if appropriate.
- Cost, benefits, and risk analysis and comparison for each option (see DSG section 1.5.2.5).
- Engineering feasibility analysis for each option (see DSG section 1.5.2.6).
- List of applicable permits and expected SEPA elements determination for each option (see DSG sections 1.5.2.7 and 1.5.2.14).

- Documentation of analysis for applying LID principles and what will be included in the design.
- List of Real Property issues for each option (see DSG section 1.5.2.9).
- Class 4 CIP and O&M cost estimate. Follow Cost Estimating Guide (see DSG section 1.5.2.8).
- Preliminary schedule for each option.
- Anticipated project delivery method (for design and construction).

A preliminary engineering report or technical memorandum must include the seal/stamp of the professional engineers responsible for the contents in the document.

1.5.2.1 Problem Definition and Project Goals

Preliminary Engineering must start with a clear definition of the problem and goals to be addressed. The Preliminary Engineering report should begin with a section that defines the problem and states the project goals. The planning phase should provide problem definition. However, a more detailed definition of the project is developed during options analysis. If the project's scope changes significantly, notify the project manager of the change. The project planning business case and funding may need to be updated.

1.5.2.2 Existing System Description

At a minimum, this section of the report should include detailed system maps and descriptions of any special utility features, as well as descriptions of important systems components and explanations of how the existing system functions. This section should also identify the boundary conditions used to delineate the system area.

For many projects, this part of the report also describes special customer impacts and surrounding land uses and environment, including the transportation network. To avoid duplication, consider that the descriptive requirements in the SEPA effort will overlap.

Tip: *Boundary conditions can be difficult to determine. Often a potential system effect, cost, or benefit can be located far from the defined problem. Discuss boundary conditions with your project team and expect that it will be an iterative process.*

1.5.2.3 Options Description

This section of the report should illustrate the project and describe the sizing, location, and a range of costs for each feasible option. Each option should be described with a similar level of detail and certainty and should follow evaluation criteria. These criteria are not inclusive. The project team should evaluate the criteria based on the specific project.

A. Access and Maintenance

Access for maintenance and operation of each option should be identified. Any non-standard maintenance needs have cost implications that need discussion with Operations staff, the project LOB representative, and the economist. An option without access or that is otherwise not maintainable has a fatal flaw until a plan to mitigate those problems is incorporated into the option description.

B. Power

Options analysis identifies if adequate power is available to meet the demand for any recommended option. A secondary power feed or an upgrade to the existing power supply is a major electrical project that needs significant coordination with Seattle City Light. That work can be a significant design and construction effort and as such may be a fatal flaw for the option.

C. Special Equipment and Instrumentation and Control

Options that include I&C or special equipment should identify that need in the options description section. An early draft equipment list is helpful.

D. Significant Design Issues

Distinguish these design issues in the report:

- BOD information should be documented for each option, including a process flow diagram or evaluation criteria, if applicable.
- Geotechnical conditions: dewatering needs, structural supports, settlement or vibration due to construction, seismic considerations, shoring challenges, contamination, soil modification, corrosive soils, and slope protection.
- Site layout of major facility elements, including description of how conceptual design minimizes impervious surface and preserves native material.
- Stormwater collection, control, and treatment, including description of how conceptual design minimizes stormwater runoff.

Tip: *Stormwater detention and treatment is often required for CIP utility projects and can add cost and complexity. Consult with SPU engineering plan reviewers for early guidance.*

E. Permitting and Property Issues

Permitting and property issues are often decisive factors in option selection. Identify property acquisition needs, including easements. Describe the environmental and permitting impacts of the options. For more detail, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

F. Construction Issues

Options descriptions should consider constructability, describe special concerns, identify construction risks, and estimate effects from costs. For more detail, see *DSG Chapter 3, Design for Construction*.

G. Community Involvement and Benefit

Considering a project's community benefits and community impacts is an important element in options analysis and option selection. Capital projects not only solve their targeted problem, but they can also contribute to a neighborhoods vitality and a community's involvement and support by incorporating the project into the neighborhood, educating people about the project's goals and benefits, and/or providing neighborhood amenities. SPU's DIL is a forum that provides feedback and advises project teams on public benefit concepts and project cohesion, with themes set by the Seattle Design Commission (SDC), if applicable. The DIL is often interested in how a project will fit into a community through items like artwork, pedestrian safety, or project fencing or security proposals that affect the neighborhood and its residents. Appropriate public outreach is a critical part of understanding community needs and addressing DIL input. Project teams can engage the DIL during options analysis and/or during the early design phase.

The SDC evaluates the urban and environmental implications of capital projects. The SDC typically evaluates projects at concept (30%), schematic (60%) and design development (90%) stages. Given the size and complexity of a project, the Commission will also evaluate project alternatives (15%) prior to selection of a preferred concept. Early coordination with the Commission can be important to successful outcomes on issues surrounding urban design, environmental outcomes, and neighborhood integration.

Discuss these community and project issues with the project manager and the LOB representative to be clear on how and if the DIL and the SDC fit into the project schedule and scope.

Learn more about the DIL on their SharePoint site.

Learn more about the SDC, including their handbook and review process, on their website http://www.seattle.gov/designcommission.

1.5.2.4 Base Case

A description of the no-action option is required in every preliminary engineering report. This is the Base Case and it should describe the existing conditions and explain project drivers (e.g., regulatory requirements, existing system deficiencies, and effects on customer), along with the consequences and risks of not implementing the project, including the cost of doing nothing.

1.5.2.5 Options Comparison

The report’s comparison of options can range from simple rankings to complex models that track many variables. For the options analysis phase, the design engineer should work with the project LOB representative and economist on a preferred method for comparing options. Remember that benefits, lifecycle costs, and risk analysis are all needed for selection.

1.5.2.6 Options Considered and Found Not Feasible

Describe any options and options considered and eliminated as not feasible in this section of the preliminary engineering report. Non-feasible options include those that fail to meet objectives, have substantive and unmanageable system impacts or construction obstacles, are not maintainable, or cannot be permitted. Once an option is found not feasible, design development of that option should be stopped and summarized. Non-feasible options should not be in the options analysis section of the report.

Engineering feasibility studies are done either to assess a specific proposal or to narrow down a field of options in the early stages of options analysis or initiation. An engineering feasibility study should be considered for complex projects.

1.5.2.7 Permits Required

The preliminary engineering report should identify all required approvals and permits and their regulating agencies. The project team needs this information for scoping the design effort. It is helpful to include a permit section in the report, rather than placing this information in the options section.

Certain City codes allow SPU a self-regulating status in the right-of-way (ROW). A case in point is the Stormwater Code. Self-regulating means that the design engineer must incorporate code compliance into design and a specific City permit is not required. Identify these code requirements in this section of the report. While SPU may not always need a permit for a project, it must comply with City code.

For a list of potential permits, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

1.5.2.8 Cost Estimating

Identifying project costs is key information for the business case, so it is a critical options analysis product. Typically, design engineers, along with the LOB, the SPU cost engineer, and the project manager, estimate these project elements:

- Construction costs or a construction cost range
- Replacement cycle for major equipment
- Annual O&M labor with Operations staff
- SPU crew labor with Operations staff

Other major costs would include property acquisition and project labor costs defined during scoping. The economist can then develop lifecycle costs.

The Cost Estimating Guide is available to help prepare cost estimates for all infrastructure projects. The Cost Estimating Guide improves the consistency and quality of SPU infrastructure project cost estimates by providing step-by-step directions to people who develop and review cost estimates, including LOB representatives, project managers, engineers, and consultants.

Cost estimates between options should be of a similar level of detail and certainty. When that is not feasible, the differences must be transparent. The Cost Estimating Guide provides a framework for estimating contingencies and cost ranges for each option.

An option approach is to provide a range of costs while considering everything that can raise costs for the high-end estimate. Discuss estimating uncertainty with the project engineer and project manager.

Useful estimating tools include:

- Cost estimate template from the Cost Estimating Guide, which includes unit prices for various bid items using both American Public Works Association (APWA) and Construction Specifications Institute (CSI) specifications. See Chapter 4 of the Cost Estimating Guide.
- Cost model template from the Cost Estimating Guide for early sewer and drainage estimates. This tool is not updated frequently and may lack specifics for detailed cost

estimating. This tool is more useful for high-level or planning-level costs for simple underground pipe projects. See Chapter 4 of the Cost Estimating Guide.

- Price History for Standard Bid Items lists APWA standard bid items described in the City Standard Specifications. This tool is not frequently updated, and thus may lack recent project data or costs. Using the cost estimate template, along with engineering judgement and knowledge of recent projects, will provide more accurate unit prices.
- RSMeans are databases that come complete with city indexes that are used to accurately calculate costs for specific cities or regions. These databases include material cost, labor cost and labor productivity units. There are also equipment costs incorporated into each database. SPU Construction Management site offers training materials for understanding RSMeans Cost Books and RSMeans Software.

Tip: *If you use **bid history**, it looks back in time and does not reflect current conditions. It is a tool for construction estimates for detailed drawings. Use estimating tools carefully. Ask the specifications writer or cost engineer for help.*

1.5.2.9 Real Property Analysis

Identify major property issues during the project development or options analysis phases. The options analysis process should identify costs, risks, benefits, and schedule impacts related to each option's property issues. Design can proceed without a detailed plan and certainty that the project can be built in its selected location, but this is a risk that should be identified and documented.

Acquisition of property rights can often become a project's critical path. The project manager works with Real Property Services to buy, lease, manage, track, analyze, and research property and property rights for SPU. Acquiring easements, even temporary construction easements, can delay the project. The design engineer should help identify needed easements early, and the project schedule should include the acquisition of any easements. Identify easements that may be needed by 30% design and ideally acquire them before Stage Gate 3. To aid in this process, the project team should analyze real property impacts for 30% design. For projects with short design schedules, 30% design may be too late to avoid delays if easements are needed.

Design should minimize the need for construction easements by considering clearances and grade matching on private property. When easements and adjustments to private property are unavoidable, you must communicate that to the project manager early.

1.5.2.10 Criticality Assessment

Before design starts, the project team must understand how critical a project is and the expected level of protection for the constructed asset. The starting assumption is to follow all codes and standards (e.g., this DSG or International Building Code) and to avoid additional costs. If an asset is critical, the project lead (LOB representative or project manager) must identify the levels of mitigation required, either through enhanced design and construction or through an operations response strategy. The design engineer identifies hazards and recommends mitigation in the preliminary engineering report.

1.5.2.11 Natural Hazards

Natural hazards should be evaluated during options analysis and avoided when possible. Many, but not all, locations of concern are mapped as environmentally critical areas. When a project is in or near a naturally hazardous location, a geotechnical data report should be prepared as an options analysis deliverable.

A. Seismic

Many liquefaction zones and fault lines have been mapped within the Puget Sound region. See also Seattle's geographic information systems (GIS) maps. Asset design or protection for the 100, 500, or 2,500-year earthquake can greatly differ. For many SPU projects, the level of protection will be a business and engineering decision, not a code requirement. When there is a code requirement, SPU can require a higher level of protection for some assets. The design engineer should work with the geotechnical engineer to identify the level of protection choices, including cost estimates.

B. Landslide

Whenever possible, assets should not be placed in known landslide and landslide prone areas. Often that is not possible because SPU serves customers living in known landslide hazard areas. Environmentally critical area rules for construction in steep slope and landslide prone areas mitigate certain risks and are the minimum BOD even when a permit is not required. The design engineer should work with the geotechnical engineer and identify other protective measures to be considered.

For more detailed design guidance, see *DSG Chapter 16, Landslide Mitigation*.

C. Flooding

Whenever facilities are in or near a flood plain or a closed topographic depression, analyze conditions that could prevent either function of or access to the asset. For locations adjacent to tidally influenced waters, consider potential sea level rise. Reference these guides for detailed information on floodplains and hydraulic modeling requirements:

- *DSG Chapter 7, Drainage and Wastewater System Modeling*
- City of Seattle 2017 Stormwater Manual (Directors' Rule 17-2017, DWW-200)
  - Volume 3, Project Stormwater Control
  - Appendix F, Hydrologic Analysis and Design
- Urban Flood Prone Area Mapping in Seattle
- King County floodplain mapping
- Federal Emergency Management Agency (FEMA) flood insurance information

D. Wind and Snow

Consider location and include whether a facility is more likely to be subject to potential hazards of extreme wind or snow conditions. For critical facilities, the architect or design engineer can recommend design standards that are more protective than code provisions.

1.5.2.12 Power

For any facility relying on electrical power for operation, the consequences of a power outage must be defined. For facilities that must remain in operation, the project must consider backup power either through a secondary power feed (such as a battery) or a generator. Both choices add complexity to project design and operations response strategies. The design engineer should research the available power and level of reliability. The project lead identifies the required power service level and works with Operations if special response strategies are needed to keep the facility in service.

If power must be provided to the new facility, contact SCL as soon as possible. SCL's response to provide power may be protracted and affect the project schedule.

1.5.2.13 Security

Consult the SPU Security Manager to determine what physical protective measures are needed for new SPU facilities and how construction plans and the Project Manual should incorporate security measures. Operations will also have input on access constraints. The design engineer should incorporate the agreed-on security measures into the design package. Security measures that include electronic elements, such as cameras, card readers, and alarms, may require separate contracts for approved security vendors.

1.5.2.14 State Environmental Policy Act

One purpose of SEPA is to assist decision makers in identifying how the project will affect the environment. Relative environmental impacts between options should be identified in options analysis to determine lifecycle costs and benefits. Some environmental impacts could result in a project determined not feasible. SEPA is one tool for describing potential impacts.

Under SEPA, project impacts can be determined to be significant or not significant. If the project's environmental impacts are significant, an environmental impact statement is required. SEPA determination should be made during options analysis, because the scope and risk analysis required for the business case cannot be developed without knowing the SEPA status.

For more information on SEPA permitting, see *DSG Chapter 2, Design for Permitting and Environmental Review*. Contact the Permitting and Environmental Review Section in PDEB early to determine timelines, documentation, and process related information.

1.5.2.15 Contamination Hazards

Underground storage tanks, asbestos, and lead in buildings and soil and groundwater contamination hazards are commonly evaluated in options analysis. The U.S. Environmental Protection Agency and the Washington State Department of Ecology have mapped many of these locations. Records of asbestos pipe can be found on side sewer cards. If property acquisitions are under consideration, environmental specialists in site assessments are required. Assessments are done in phases and range from visual observations and record searches to building, soil and groundwater sampling.

In areas of suspected contamination, the design engineer helps the project manager or geotechnical engineer plan an investigation. Once the type, extent, and quantity of hazard are characterized, reporting and regulatory requirements are common. Risks, costs, and schedule implications must be evaluated for options comparison and the business case.

The design engineer should be prepared to address these project decisions:

- Can the hazard be avoided?
- Can the source of the contamination be removed or managed in place?
- Does project scope change?
- How are health and safety managed during construction?
- Are special disposal requirements needed?

SPU crews may also be exposed to the hazard. When SPU infrastructure lies within a contaminated area, the design engineer must work with Operations to ensure the proper controls are in place to prevent or mitigate future exposure to human health hazards.

1.5.2.16 Risk Planning

All projects have risks. Project teams consider, mitigate, and communicate about risks throughout the life of a project. Design decisions and assumptions can elevate, reduce, or introduce new risks. The design engineer helps identify and quantify risks as part of option selection during Options Analysis and later as part of a PMP.

A. Risk Identification and Assessment Process

The SPU Risk assessment process is a framework for categorizing and assessing risk. It is a general tool to help SPU manage risk in every aspect of its business such as field operations and customer service, not just project management. The framework defines nine categories of risk and probability and consequence that allow project teams to create a project *risk signature*. The following are the nine categories of risk:

1. Asset and service reliability
2. Environmental
3. Financial
4. Legal
5. Public health
6. Public trust
7. Safety
8. Security
9. Workforce

The objective of the risk assessment process is to help SPU identify, evaluate, prioritize, and manage risk.

B. Risk Analysis in Options Comparison

In selecting a project option for a business case, the project team uses the risk assessment process to identify risk. An extensive risk analysis may examine three types of risk:

1. Quantitative risk that increases project costs.
2. Qualitative risk that includes social and environmental risks.
3. Project delay.

Quantitative risks are those with financial or cost implications on the project and are typically identified on all projects. Examples of quantitative risk are tunneling or contaminated soils at a site. Non-cost risks are items that may have social or environmental impacts, such as endangered species or archeological sites.

1.5.2.17 Recommendations

This section of the report should give recommendations and summarize the engineering reasons for them. Under the leadership of the project manager or LOB representative, the project team will recommend an option, or a short list of options. Option selection is based on the business case triple bottom line (economic, environmental, and social considerations), although this type of selection may not fully account for engineering considerations.

1.5.2.18 Appendices

Appendices can be added to the preliminary engineering report. SPU finds the following appendices useful.

A. Cost Estimates

Each option should have a cost estimate or range. Detailed cost calculations should be an appendix to the report. This appendix should also include an explanation of the methodology used to estimate preliminary costs and a summary of the assumptions. Document the assumptions so that changes to the estimates can be explained. Documenting cost assumptions also checks against bias. Cost estimating is detailed in the Cost Estimating Guide.

B. Hydraulic Calculations or Modeling Report

Preliminary engineering determines sizes and service levels of existing and proposed utility pipes and assets. Include calculations, a memorandum from LOB modelers, or a modeling report as an appendix to the report. For more detail on modeling, see *DSG Chapter 7, Drainage and Wastewater System Modeling*.

C. Drawings and Sketches

Include drawings and sketches developed for the preliminary analysis as an appendix to the report.

D. Technical Memorandums

Technical memos that describe either project history or the BOD are often produced in options analysis. Include these memos as an appendix to the report.

1.5.3 Business Case

The business case serves as a decision document for the AMC and documentation of a project's rationale. It is also a tool to track project progress compared to business case projections.

Business cases identify the goals and objectives of a project, and the project team considers options to achieving the goals. The project lead and an economist document the case, according to SPU asset management guidelines. At a minimum, the business case compares the costs and benefits of each option and compares them to the status quo or base case of doing nothing.

1.5.4 Coordination with Other Disciplines

Electrical design, I&C, SCADA, and security are frequent requirements that must be well coordinated. Contact the Security Office for input on security measures related to SPU projects. For details on electrical and I&C design, see *DSG Chapter 9, Electrical Design* and *DSG Chapter 10, Instrumentation and Control*, respectively.

1.6 DESIGN PHASE

Once the options have been narrowed and a design strategy approved, the project obtains Stage Gate 2 approval, and the design phase begins. The primary products of the design phase are design plans and a Project Manual that are advertised and bid on by contractors interested in performing the work.

The design plans and Project Manual result from the evolution of the design packages at each of the four major milestones of the design phase: 30%, 60%, 90% and Final Design. The project manager (design phase lead) convenes the project team and together with other team members affirms that the right skill sets are represented on the team. Roles and responsibilities for producing deliverables and any exceptions to the design packages are documented in the PMP, which should include:

- Initial scope statement
- Scope, schedule and risk plans
- Cost plan (using SPU's Cost Estimating Guide)
- As needed, include:
  - Quality plan
  - Communications/outreach plan
  - Procurement plan
  - Human resource/project team management plan
  - Commissioning plan

Obtain approval from the governing body to endorse the PMP and baseline cost, schedule, and scope. During the design phase, discuss with the LOB representative and the project manager any necessary planning for special reviews or milestones, such as presenting to the DIL. If DIL feedback was received during options analysis, ensure that those elements are clearly identified as part of the scope and schedule of the project. If the project has not met with the DIL, discuss with the project manager and the LOB representative if the project is required to engage the DIL and help identify the resources that will be needed for making presentations to the DIL. This could include support from landscape architects, architects, public outreach staff, and engineers.

The project team should review the design package deliverable prior to circulating the deliverable through the Design Package Circulation Process. The checker checks design plans and calculations, and the project engineer uses the design package deliverables checklists below to help make sure the deliverable is complete. The project engineer and the checker are required to complete the Technical QC Review Report form to document who did the review, when was the review done, what was reviewed, what were the review comments, and how were the comments resolved for all design milestones.

Tools and Templates

- 30% Design Package Deliverables
- 60% Design Package Deliverables
- 90% Design Package Deliverables
- Final Design Package Deliverables
- Technical QC Review Report

This section describes common processes for the design phase.

1.6.1 30/60/90 Review Circulation Process

Circulating the design package and incorporating comments is a critical part of the design process. The design engineer advises the project engineer of project impacts throughout the project and at 30/60/90% drawing submittals. The design engineer responds to reviewers' technical comments.

Tip: *Early coordination with other departments and utilities (including private) can be critical to the scope and schedule.*

1.6.2 Basis of Design

The BOD memorandum catalogs the background for the project, the goals of the project and how the goals will be accomplished, the description of options that were considered, the specific design elements required to achieve the project goals, and the permits required for the project. The BOD memorandum should be created at the beginning of the project and is used to develop the PMP. The memorandum should be reviewed and modified for any changes at each design milestone. The memorandum should be saved to the project folder for each milestone design phase. The Final BOD memorandum includes the seal/stamp and signature of all professional engineers responsible for the contents in the document.

The BOD memorandum communicates design intent primarily to staff and future users of a constructed facility. Documenting the BOD and archiving it with the project folder provides future staff access to design decisions. Options analysis should identify any special conditions that should be included in design as well as what LID principles will be applied to the project. This document should identify how to apply LID principles.

The BOD memorandum should be a scalable document, the length will vary based on the complexity and detail of a proposed project. Simple projects such as a sewer main reline or a water pipe replacement may require less detail and text than a complex pump station rehabilitation or treatment plant project. To avoid rework and confusion, discuss the required level of detail and appropriate format with your supervisor early in the design phase.

Along with the BOD memorandum, the BOD plan sheet should be started during the 30% design phase.

1.6.2.1 Basis of Design Plan Sheet

The BOD plan sheet is a general informational document that shows a plan overview and lists significant design assumptions and requirements for major design elements. The BOD plan sheet is not intended for construction and should not be included with the bid set. The sheet is inserted as part of the record drawings. The BOD plan sheet will not be part of the plans for construction. The sheet will be completed during final design and submitted to be part of the project's record drawings. Examples of this document can be found in **Appendix 1B - Basis of Design Plan Sheet**. When preparing the plan sheet, work with the project's design-drafting technician to obtain the most up-to-date computer-aided design (CAD) template for the BOD plan sheet. The section below describes the purpose of the sheet.

The BOD plan sheet ensures that design intent is part of the permanent record. The sheet shows the criteria used in the design of major project elements and has standardized blocks for that data. BOD documentation can start as a list of requirements for the designer, but that list should not simply be summarized on a plan sheet. Documentation may include information for equipment installed. For example, documentation for pumps would include manufacturer, model, and horsepower. It may also include revisions to the design that were made during construction.

Tip: *For complex projects, consider developing naming conventions early on. If elements are named, consistency is important. The BOD plan sheet sets that standard.*

1.6.2.2 Design Calculations

Calculations are developed during options analysis and should be updated and checked at specific points in project development. Final stamped calculations should be in the project electronic files. Design calculations always include:

- Project name, number, date, person completing the calculations, person checking the calculations, and page number of total pages should all be included in the header or footer of each page of the calculations.
- Sketch or reference plan sheet for which calculations are intended.
- Assumptions, including all equations.
- Unit conversion factors.
- Calculations.
- Reference material attached.

1.6.2.3 Equipment Data Sheets

Equipment data sheets are an important design tool. In preliminary design, the design engineer should develop an equipment data sheet for each major piece of equipment. At a minimum, the sheets must be developed for all equipment, instruments, and items that require power (including HVAC, plumbing, SCADA, security, and architectural items). Include specific dates on which draft equipment data sheets will be available in the project schedule.

Electrical design cannot begin substantial design until receipt of manufacturer's equipment data sheets, including electrical loads. The equipment data sheet should be progressively updated.

Important uses of the equipment data sheet include:

- Formalizing document equipment selection.
- Establishing infrastructure requirements (e.g., electrical, structural, I&C) to support equipment.
- Communicating within the design team and with Operations staff to determine working clearances.
- Assigning and documenting equipment numbers, names, manufacturer's installation requirements, certifications, and testing procedures.
- Checking drawings and calculations.
- Communicating with potential equipment suppliers.
- Checking technical specifications.
- Reviewing shop drawings to confirm the Contractor is providing the proper equipment.
- Cross-referencing the following multiple numbers describing a *single* piece of equipment: contract plans, tag ID, manufacturers, and SPU MAXIMO.
- Documenting equipment for the O&M manual and record documents.

For an equipment data sheet template, see **Appendix 11E** of *DSG Chapter 11, Pump Station Infrastructure*.

1.6.2.4 Process Flow Diagram

Process flow diagrams are simplified drawings that clarify a process, by showing intended choices at each control point. They are a critical design document for projects with I&C. Process flow diagrams should be updated as design progresses and may be incorporated into the BOD plan sheet. The diagrams are also useful for facility mapping and O&M manuals. Whenever I&C is part of the process, a technical specification with the control strategy must accompany the flow diagram.

For a process flow schematic example, see Figure 11-5 in *DSG Chapter 11, Pump Station Infrastructure*.

1.6.3 Operations and Maintenance

Identify O&M strategies during design. They can range from those for simple assets (pipes, vaults, or maintenance holes [MHs]) to those for complex assets (remote communications or I&C). For complex projects, the design engineer should rely on project team members and staff from SCADA, SOPA, and Operations to integrate the project design into existing SPU systems.

1.6.3.1 Maintenance Strategy

The business case for every project describes an initial maintenance strategy for establishing lifecycle costs. For projects building standard pipelines in the ROW, this may be sufficient. The design engineer should identify any obstacles to access (e.g., railroads, overhead trolley wire, arterial street closures needed) or non-standard details, and discuss them with the team members from Operations.

For facilities outside of the ROW and more complex projects, the design engineer should work with Operations staff to identify:

- Access needs
- Maintenance procedures
- Repair or replacement procedures (including permits)
- Special equipment to maintain the facility and site configuration to allow for operation

O&M manuals are the deliverable for these types of projects.

For landscape maintenance, the design engineer works with the project team to determine planting schedule, water supply needed, and a plan for plant establishment and maintenance. That information should be incorporated into the technical specifications. Coordinate landscape plans with the operation procedures for the facility, which may require a landscape O&M manual. For more detailed information on landscape design, see *DSG Chapter 4, General Design Considerations*.

1.6.3.2 Control Strategy

Projects with electrical and mechanical equipment will need a control strategy, which includes a programmable logic controller and are connected through SCADA to the control center. Technical specifications to build and test the facility are the basis for the control strategy. The control strategy must detail a post-construction plan for how to handle data, status reports, or alarms that require SPU action. For detailed information on electronic control equipment, see *DSG Chapter 10, Instrumentation and Control*.

Tip: *Project success is often judged by schedule and budget. The real project legacy is the success of the facility operations. Operated facilities can be judged daily by those receiving the data and alarms. The design engineer should work with the end users during the design process to ensure successful long-term operations.*

1.6.3.3 Asset Onboarding Documentation

To maintain databases documenting SPU assets using GIS and IBM's Maximo, each project's assets must be documented, described, and ultimately shared with various workgroups to ensure that these databases are populated with accurate data. This includes horizontal assets, such as pipes and valves, and vertical assets, such as pumps and electrical equipment. Operations staff and the design team are critical partners in documenting and approving asset lists and assignments in SPU's asset management databases. See DSG section 1.9.5 for asset work related to Record Drawings.

Currently, draft asset spreadsheets are being used to document and describe proposed assets during design. SPU is working to improve the asset onboarding process using new database management tools and anticipating implementation of an improved and clearly defined process in late 2020.

The project engineer, with design team support, should assemble a list of all existing and proposed assets during the 60% design phase. This list, along with the design plans, should be reviewed by Operations staff to confirm completeness and to assign asset and Maximo numbers. Operations staff will also remove any existing assets that are being decommissioned as part of the project from Maximo. The design team should work with their assigned design drafter to coordinate with GIS staff for obtaining asset and equipment numbers for horizontal assets such as MHs and pipes. Until the previously referenced improvement initiative is complete, this process may not be enacted consistently across all business and service types.

1.6.3.4 O&M Manuals for Equipment

O&M manuals are required for mechanical and electrical equipment. A draft manual should be prepared during the design phase. Final manuals are required prior to SPU's acceptance of the facility. The contents, format, requirements, and number of manuals needed should be specified in the Project Manual. At a minimum, equipment O&M manuals should include:

- Approved shop drawings and each contractor's coordination and layout drawing
- Electrical test reports
- List of spare parts, manufacturer's price, and recommended quantities
- Manufacturer's printed operating and maintenance instructions, parts list and current prices, illustrations, and diagrams
- Mechanical test reports
- Name, address, and telephone numbers of local service representatives
- Routine maintenance procedures
- Special operating instructions and safety precautions
- Starting and stopping procedures
- Title and cover cross-referencing to the location, vault plan number and sheet, and specification
- Warranty information
- Wiring diagram

1.6.3.5 Facility Manual for Projects

Some projects require a Facility Manual to document facility operations and a plan or requirements for maintenance. Complete the Facility Manual after construction to allow incorporation of photographs and O&M manuals for equipment. See Commissioning Guidelines for details of what to include in the Facility Manual. The commissioning agent is the lead for preparing the Facility Manual and the Facility Operating Plan, as applicable, depending on each project's level of complexity, types of assets, and team roles and responsibilities. For clarity, discuss the responsibilities for these elements with the project team, especially SOPA staff and the project manager, during the PMP process and the development of the project team.

1.6.4 Project Risk Management

The objectives of project risk management are to decrease the probability and impact of risk. Risk planning for a project includes three main activities: risk identification, analysis, and response development. SPU requires documenting this information in a risk plan. For details on how to create a risk plan, see Project Management Lifecycle, in the planning section of the Project Management Methodology.

The primary deliverable of a risk plan is a Risk Register representing the baseline risk profile of the project. Risk management involves monitoring and controlling risk throughout the execution phase of the project. It includes keeping the risk register up to date by identifying new risk events, and continually reviewing and assessing identified risk events and risk response strategies. Ultimately, the Risk Register can be used to establish project reserves based on risk probability, consequences, and response strategy. See the Cost Estimating Guide for details.

1.6.5 Drafting Standards

SPU and the Seattle Department of Transportation (SDOT) have adopted joint CAD drafting standards. CAD standards allow a uniform look for drawings to improve communication with reviewers and contractors and aid in archiving and GIS. Include time for checking and revising the CAD standards in the project schedule.

1.6.6 30% Design

At the 30% design level, the design should show progress toward a coordinated plan set which includes a preliminary list of technical specifications and preliminary equipment list. Review the design package to assess the basic design concepts and how it meets the project objectives, design assumptions, and suitability of information available. If the design team determines that the design option does not meet the objectives or solve the problem, it is appropriate for the project manager, LOB representative, and Operations lead to communicate this to management.

1.6.6.1 Design Plans at 30% Design

The 30% design plans are a compilation of plan sheets that explain the major elements of the project to understand how the design will meet the project objectives. The base maps must meet SPU drafting standards.

1.6.6.2 Technical Specifications at 30% Design

The design engineer generates a preliminary list of technical specifications and any special items.

1.6.6.3 Design Review at 30% Design

The 30% design package gives reviewers a framework for what will be constructed. Reviewers should look for major issues, including conflicts that might alter the design. For circulation of design packages, see Design Package Circulation Process.

If the project is not going through a value engineering process, the project team should review the design at 30% to confirm that the design meets project objectives, identify constructability issues, opportunities for cost savings, and additional technical specification needs.

1.6.6.4 30% Design Deliverables

The project engineer uses the design package deliverables checklist below to help ensure completeness of the design package.

Tools and Templates

- 30% Design Package Deliverables

1.6.7 60% Design

At the 60% design level, the design should show significant progress toward a completed plan set. The 60% design should reflect changes resulting from 30% review, and subsequent meeting and design decisions. The design should establish final locations, alignments, and configurations.

1.6.7.1 Design Plans/Drawing at 60% Design

The 60% design plans are a substantially developed project design that includes a plan and profile view of all major facilities. At this stage, the design plan should begin resembling a final design package. All design features should be identified and located, but additional detail will be necessary. Cross sections are shown at critical locations. Major conflicts should be resolved and minor conflicts identified. Regulatory agency requirements, right of way needs, a restoration plan, and temporary erosion and control plan should be identified and represented in the 60% design plan set. Include a draft control strategy for any project that has I&C.

1.6.7.2 Project Manual at 60% Design

The draft Project Manual at this stage should include technical specifications provided by the project engineer, standard specification amendments, material specifications and an engineer's draft estimate with bid items and quantities. Major bid items are identified, construction procedures are developed, and the construction estimate is modified.

1.6.7.3 Design Review at 60% Design

The 60% design package gives reviewers a set of plans that provides locations, alignments, and configurations. Reviewers should look for major issues, including conflicts that might alter the design. For circulation of design packages, see Design Package Circulation Process.

Reviewers should review the 30% review comments and responses, confirm that existing facilities are correctly located and there are no major conflicts, and provide any comments and concerns with appropriate solutions. SPU review staff should also address constructability, meeting standards, and facility maintenance.

1.6.7.4 60% Design Deliverables

The project engineer uses the design package deliverables checklist below to help ensure completeness of the design package.

Tools and Templates

- 60% Design Package Deliverables

1.6.8 90% Design

The drawings, including details and specifications, are almost complete at this point. The 90% submittal should reflect review comments from the 60% submittal along with subsequent meetings and design decisions, including a control strategy and commissioning requirements. All permit conditions should be incorporated. This submittal should reflect coordination between all design disciplines and should require only detailed level corrections to result in a biddable set of documents. The project team should consider the design complete enough that a contractor could build the project from the design package. See Public Works Contracting Process for a Typical $1 Million Design-Bid-Build CIP Project.

1.6.8.1 Design Plans/Drawings at 90% Design

Design Plan is substantially complete.

1.6.8.2 Project Manual at 90% Design

With 90% design plans, prepare a Project Manual to include boilerplate documents, technical specifications, specific provisions required by the permits and known regulatory agencies, site conditions, schedule constraints, and measurement and payment clauses. Complete the cost estimate to include all bid items, quantities, and bid options.

A. Project Manual

The Project Manual includes front-end documents, City Standard Specifications, technical specifications, supplemental general special provisions (GSPs), and bid items. The specifications writer assigned to the project develops the Project Manual under the direction of the supervising engineer in the Public Works Contracts group. The Project Manual can be prepared in either CSI or APWA format. Simple, linear projects within the ROW, such as pipe installation, use the City Standard Specifications, which follow APWA format. CSI format is typically used for construction of buildings or facilities.

Tip: *Communicate changes to the specification writer as a package and at milestone dates. Changes that trickle in can get lost.*

B. Front-end Documents

SPU contracts are often referred to as *front-end documents*. Typical information in the front-end documents includes information on bid preparation and evaluation, measurement and payment, standard construction contract requirements, general conditions, and published wage rates.

C. City of Seattle Standard Plans and Specifications

The City Standard Plans and Specifications approximately every three years. The City's Standard Plans and Specifications are updated based on Washington State Department of Transportation Specifications and specific Seattle practices and policies. Seven City departments sign off on the standards before they are adopted by the Department of Financial and Administrative Services (FAS). These standards, with the front-end documents, comprise the Project Manual for many Seattle construction contracts.

The City Standard Plans and Specifications are in APWA format and apply to all work in the public ROW.

D. General Special Provisions

When the Standard Specifications need alteration or modifications between updates, GSPs are developed. Specification writers incorporate GSPs into the Project Manual. GSPs may be incorporated into the next update of the Standard Specifications depending on their applicability to a broad range of City infrastructure.

E. DSG Standard Specifications

DSG Standard Specifications are not adopted by other City departments. The DSG offers SPU standards in this document under the heading *SPU Resources* in each of the major infrastructure chapters. Notes to the design engineer are embedded within the specifications to be used in preparing project-specific technical specifications. Design engineers should tailor these standards to specific projects.

While most DSG Standard Specifications are in CSI format, the DSG will continue to expand and add new specifications in either APWA or CSI format. When working on project-specific technical specifications, design engineers should consider their potential use in expanding these SPU resources.

1.6.8.3 Project-Specific Technical Specifications

Every item in the design drawings should also be described in a technical specification. The technical specifications are the responsibility of the design engineer and describe products, requirements, constraints, and associated standards. Project-specific technical specifications are required when the standard City or SPU specification does not exist or needs modification.

Specifications on how to measure and pay for the work are prepared by the specification writer. In CSI format specifications, specifying measurement and payment is part of the front-end documents. In APWA format, measurement and payment are found in Standard Specifications section 1-09.

1.6.8.4 Engineer's Estimate

The specification writer makes the final construction cost estimate, which is called an Engineer's Estimate. The Engineer's Estimate summarizes the project work, as shown on the drawings, with a list of bid items (itemized on the bid form), quantities, and estimated costs. SPU uses the Engineer's Estimate to compare bids from contractors. The lead design engineer should check the Engineer's Estimate and may do an independent estimate as a check.

1.6.8.5 Design Review at 90% Design

The project team will confirm that 60% review comments are addressed and check to make sure the design package is complete and make sure the Project Manual adequately supports the design plans. For the project team, this should be the last opportunity to comment on the design package.

When the 90% Project Manual is completed, the specification writer will circulate the 90% Project Manual and design drawings to all stakeholders affected by the improvements for review and comments. For circulation of 90% design packages, see Design Package Circulation Process. Also consider including in the circulation any adjacent property owners that will be affected or any community organizations that are interested in the improvements.

1.6.8.6 90% Design Deliverables

The project engineer uses the design package deliverables checklists below to help ensure completeness of the design package.

Tools and Templates

- 90% Design Package Deliverables

1.7 100% AND FINAL DESIGN

This section describes the 100% complete and final design package documents. At this point, the specification writer takes more of a lead role with assistance from the project manager and project engineer.

After the circulation of the 90% Project Manual and design plans, the project team will evaluate and resolve all comments and incorporate subsequent changes to the Project Manual and design plans. After incorporating these changes, the results are the 100% Project Manual and design plans. The 100% Project Manual and design plans include the seal/stamp of the professional engineers responsible for the contents in the manual and on the plans.

The project engineer uses the design package deliverables checklist below to help ensure completeness of the design package.

Tools and Templates

- Final Design Package Deliverables

1.7.1 Design Review at 100% Design

Reviewers ensure that all 90% comments are addressed and perform a final check for completeness. The design engineers incorporate changes from the 90% circulation into the drawings and stamps and signs off on the drawings prepared by them or under their direct supervision.

The specification writer incorporates changes from the 90% circulation into the Project Manual. The design engineers incorporate any changes to the technical specifications in the Project Manual. After incorporating all changes, the specification writer places their stamp on the portions of the Project Manual prepared by them or under their direct supervision, and the design engineers place their stamps on the technical specifications prepared under their supervision.

1.7.2 Circulate Bid Set

The 100% bid set comprises the design plans and a Project Manual for advertisement. Once the design package is completed, the project goes through Stage Gate 3 – SPU approval to advertise. The approved project is circulated to the Finance and Administrative Services (FAS) Department for their review and approval to advertise (referred to as department circulation). The engineering seals on the design plans and the Project Manual do not need to be signed prior department circulation and FAS review.

After all departments affected by the project have approved it for advertising, City Purchasing & Contracting Services (CPCS), a division of FAS, reviews the contract for compliance with the latest rules, regulations, and policies. The specification writer, in coordination with the design team, resolves CPCS comments and finalizes the design package.

1.7.3 Final City Purchasing and Contracting Services Approval

After the specification writer addresses all CPCS comments from the 100% review, the specification writer submits an advertise-ready, signed and sealed Project Manual and Drawings for CPCS approval. To provide final approval, CPCS reviews to ensure that all previous CPCS review comments have been incorporated. Once CPCS approves the design package, FAS approves the project for advertising, usually indicated by an FAS signature on the cover sheet of the design plans.

1.7.3.1 Digitally Signing Drawings for Advertisement

Past practice for stamping and signing plans used wet (i.e. an ink pen) signatures on full-size Mylar sheets. Wet signatures were previously the only legal method of authenticating engineering plans for construction under the Washington Administrative Code (WAC). As of 2018, WAC 196-23 allows for digital signatures on engineering plans and documents, under specific conditions. In 2019, SPU began using DocuSign software for digital signatures, while other City departments continued to use other software (e.g., Blue Beam). SPU has recently purchased Adobe Sign software and is currently developing the necessary processes to implement this effort and replace DocuSign.

Coordinating signatures between multiple design groups, consultants, and/or various City departments can be challenging, especially given the current changing processes. Contact your supervisor for the current status of this effort and if it applies to your project.

1.7.4 Advertisement and Bid Evaluation

After FAS has approved the contract documents and the Project Manual and the design sheets have been signed by the respective design engineers, the contract documents are prepped for advertising. Contracts go a minimum three-week bidding period, are advertised in the *Daily Journal of Commerce,* and all contract documents (including addenda) are posted on the City of Seattle Procurement site.

After the advertising period, bids are submitted by contractors. CPCS opens the bids, bid tabulations are prepared, and the apparent low bidder is determined. All bids are reviewed for any errors or red flags. After bid review, the low bidder is contacted and submits the Supplemental Bidder Responsibility Criteria Form to CPCS. The qualifications and references of the low bidder is reviewed. If the low bidder meets all the required qualifications, the project goes to Stage Gate 4 – SPU approval to award. The PDEB Deputy Director signs the Request to Award letter and forwards the letter to CPCS. After CPCS receives the letter, the Contractor submits bonding and insurance to CPCS for review and approval. Upon approval, the contract is signed and executed. Contract execution completes the design phase.

1.8 QA/QC IN DESIGN

QA/QC is necessary to ensure completeness and accuracy in design work. QA includes processes that ensure QC is performed and documented on work products. Examples of QA include process checklists and project audits that confirm that the appropriate process was followed during development of the deliverable. QC includes verification that deliverables meet functional design requirements, are of acceptable quality, and are complete and correct.

QC checks by checkers are a minimum requirement on SPU projects. During the project management planning process, the project team may develop a QC plan, identifying additional key reviewers, major milestones, and processes for checking work items. Quality checks by the project team are performed prior to, or during, the Design Package Circulation Process. By signing the Final Design Package Deliverables checklist, the project engineer affirms that QC has been performed. The checkers add their initials to plan sheets to confirm completed QC checks on the specific design elements. The project engineer and the checkers also need to complete the Technical QC Review Report form and include the form in the project folder. The project engineer and the checker are required to complete the Technical QC Review Report form to document who did the review, when the review was completed, what was reviewed, what were the review comments, and how were the comments resolved for all design milestones.

See **Appendix 1A - Design Checklist** and the Technical QC Review Report form.

1.8.1 Quality Management for In-House Design Work

Table 1-1 identifies the roles of SPU Staff on the design team and their responsibilities.

Table 1-1
Quality Management Roles for In-House Design Work

Role	Responsibilities
Project manager	• Ensure that the project engineer has performed the required QA function and that checkers have provided the QC function. • Save documentation of QA/QC in the project file. • Include the Final Design Package Deliverable checklist in the Stage Gate 3 approval documents.
Project engineer	• Provide continual input to the design process by assisting the team with developing concepts, selecting/evaluating design options, and making design decisions, especially in the early phases of the project, to ensure design meets functional requirements documented in the BOD. • Ensure all necessary elements of the design milestones are complete at each milestone. • Ensure that QC is performed on each design element.
Design engineer	• Ensure that all design calculations have been prepared per the DSG and that all designs and calculations have been checked by a checker. • Discuss major review comments with project engineer. Ensure comments are addressed and resolution is documented and implemented.
Checker	• Perform reviews of design elements to ensure conformity with established design standards and consistency of the design process. At a minimum, perform reviews at major project milestones. • The checker must be a person who has the expertise to check the calculations. • In general, the checker should be familiar with the process or facility being designed. • The calculation check should occur as soon after preparation as practical to minimize rework if a problem is found in the calculations.

Role	Responsibilities
	• Review must include a logic check to ensure the overall system will perform as intended by meeting the project goals and objectives specified in BOD. Initial startup and design conditions must be checked. • The engineer checking the calculations must document the check by initialing each page of calculations and initialing each sheet of the plan set they checked.

Acronyms and Abbreviations

BOD: basis of design

QA: quality assurance

QC: quality control

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1.8.2 Quality Management Responsibilities for Consultant Design Work

Consultants may perform the design engineer or checker role on SPU projects. The QA/QC process and expectations are similar to in-house design. It is common to require a consultant to provide a QC Plan that outlines the procedures and staff they plan to use for the QC of their design. The project engineer is always an SPU employee.

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1.9 CONSTRUCTION PHASE

After the contract is signed and executed, the main responsibility for project oversight transitions to SPU's CMD. The level of involvement by the design engineer during this phase varies and should be considered part of staffing and communication planning for the construction phase of the project. The design engineer is involved in pre-construction meetings and should be prepared to identify concerns or areas needing special attention, clarify the purpose of the project, and answer questions about why non-standard or more expensive design features were selected. On some projects, the design engineer may provide ongoing support by attending weekly meetings. At a minimum, the design engineer should review submittals, respond to requests for information (RFIs) and change proposals, be prepared to provide any design changes necessary, and do a final inspection to help identify punch list items. The project engineer will be involved in the commissioning phase if the project has a commissioning phase.

Typically, timely responses to support construction activities take precedence over other work, because of the high potential costs of construction delays to the City. If there is a conflict, discuss with your supervisor or manager immediately.

1.9.1 Submittals

The resident engineer reviews contractor submittals for conformance with the contract. If there are questions with the submittals, the resident engineer refers them to the design engineer. These submittals include shop drawings, manufacturer's design data, and design submittals. The SPU materials lab approves material samples and sources. If the design engineer is not satisfied that the work can proceed, they will mark submittal responses as *Rejected*, *Revise and Resubmit*, or *Submit Specified Item*. Responding either *Make Corrections Noted* or *No Exceptions* indicates the Contractor can proceed. An additional submittal is not required from the Contractor when the submittal is returned with the notation *Make Corrections Noted*. No further submittal is required when *No Exception* is taken.

Tip: ***Rejected*** *is the most severe response to a submittal.* ***Make Corrections Noted*** *is typically used only for easily detailed corrections. A large gray area lies between. Carefully check material callouts and dimensioning. Discuss with your supervisor which category of response is warranted.*

1.9.2 Requests for Information, Changes, and Change Orders

SPU uses both formal and informal modes of clarifying contract intent. The resident engineer should be informed on any discussions with the Contractor. The design engineer is not authorized to make any changes to the contract. Informally, the design engineer might attend construction meetings, or respond to questions from Construction Management. Minor changes for convenience or through mutual agreement should be approved by the design engineer and the resident engineer and documented in meeting minutes or by email. For example, a minor change would be to move a structure for better clearance from a driveway or to substitute a similar, readily available aggregate for one that is hard to source locally. Minor implies no change to either the permitted or negotiated conditions, the function of the project, and does not require new stamped engineering calculations.

1.9.2.1 Requests for Information

RFIs are a formal communication from the Contractor that some part of the contract is unclear or that they want to change part of the requirements. The design engineer works with the CMD resident engineer to respond to design-related RFIs within the timeframes of the contract.

1.9.2.2 Change Orders

Either the Owner (SPU) or the Contractor can request a change order. One type of change order is *administrative* and relates to quantities, time, or methods. It does not affect the final function of an improvement. The other type of change order is *engineering related*. The design engineer should prepare and stamp owner-initiated or engineering-related major changes to the design drawings and technical specifications. Any contractor-designed items should be identified as such in the specifications, along with the qualification requirements for the Contractor's engineer. The engineer of record for those items should review, approve, and stamp changes to those items in addition to contractor-initiated, engineering-related change orders.

1.9.3 Start-Up, Testing, and Acceptance

The design engineer, in conjunction with the project's commissioning authority (as applicable), is responsible for coordinating with Operations to incorporate any non-standard start-up and testing specifications into the bid documents. These provisions should consider:

- Factory or laboratory testing before delivery

- Field testing of individual components or sub-assemblies
- Testing of the complete system
- Operational testing
- Communications (SCADA) testing
- Start-up of remote operations
- Training of SPU staff.
- Start-up and transition to SPU Operations

At the end of the construction phase, the design engineer should assist CMD and the commissioning authority with testing and troubleshooting as well as with startup and commissioning (see DSG section 1.10). There is frequently an overlap between Contractor and SPU responsibilities. The Contractor's interest is in getting the contract closed out. Operations will want adequate operating experience to identify problems they want the Contractor to fix before SPU accepts the work. One way to minimize this gap is to define the transition in the Contract and include a defined staffing and duration for the Contractor's support of SPU.

1.9.4 Punch List

When the Contractor considers the work substantially complete and ready for final inspection, they notify the resident engineer, who calls for a final inspection. One product of final inspection is listing any unacceptable work or deficiencies in the work (commonly referred to as a punch list). The design engineers should make a visual inspection of the completed project and provide a written list of needed corrections to the resident engineer. Remember, final inspection is typically on a short timeline. Once all of the punch list items are addressed to the satisfaction of the resident engineer and the design engineers, the project achieves the physical completion milestone.

1.9.5 Record Drawings

Record drawings are an important record for SPU's documentation of the constructed state of each project based on Contractor and SPU resident engineer records. Record drawings are based on the as-built documentation that is maintained by the Contractor throughout the construction process. The resident engineer works with the Contractor to develop the official redline drawings based on as-built field documentation and notes. The design engineer may review the redline drawings before the resident engineer signs it "as-built," if necessary. Once the redline drawings are signed as-built, CMD sends the official as-builts to the Design Drafting/Technical Resources group for creating CAD drawings from the as-builts. Once the CAD drawings are complete, Design Drafting/Technical Resources stamps the CAD drawings with "Record Drawing" on the plans. The CAD drawings are then shared with the Engineering Records Center (the Vault) and GIS to insert the new or revised facility and assets into their respective programs (e.g., GIS and Maximo, a database for asset tracking and maintenance planning/scheduling). A consultant-designed project can have the record drawing work completed by the design consultant, as long as they follow the documented process and receive QC from technical resources staff.

Permanent and original drawing records are kept in the Engineering Records Center on SMT 47th floor by unique Vault Plan ID number. Many of these record drawings are available electronically from the Virtual Vault.

1.10 COMMISSIONING PHASE

SPU has not historically considered commissioning and optimization a phase of new capital projects. Past practice has been to construct and hand off to Operations at commissioning. Problems identified would then either be worked around by staff or would trigger a new project to fix them. This section discusses changing that pattern by incorporating commissioning into the project plan for facilities that include I&C.

1.10.1 Commissioning

Commissioning is defined as a systematic approach and process of ensuring that all component systems perform interactively according to the design intent and SPU's operational needs with actual verification of performance. It encompasses and coordinates the traditionally separate functions of system documentation, equipment startup, and acceptance testing and training. The process begins at the options analysis phase and ends at Stage Gate 5.

The project engineer may refer to the Commissioning Guidelines for a complete description of SPU's commissioning process.

1.10.1.1 Stabilization Phase

More complicated or first-of-a kind facilities will require a stabilization phase. This phase occurs when SPU takes ownership and operational control of the facility. It will verify the facility can be operated to meet the Facility Operating Plan. This phase will include integration with other facilities, and fine tuning of the facility operations to ensure the facility meets the project requirements as defined in the business case and BOD. The design engineer assists the project's SOPA representative and helps define needs, opportunities, and goals for stabilization.

1.11 PROJECT DOCUMENTS AND FILING

PDEB has adopted project filing standards, and all options analysis and design phase project documentation must be filed electronically in the project folders.

Once construction starts, SPU's Contract Administration section controls the Construction Management project files. Submittal, materials, inspection, and payment records are filed on SMT 47th floor.

SPU project documentation is not centralized. Locations include:

- Project development/planning design process docs may be with a project specifier or LOB.
- Inter-departmental and inter-agency agreements may be with a LOB, in the PDEB Agreements Library, or in Seattle Municipal Archives.

- Old Standard Plans and Specifications or Project Manuals may be found on SMT 47th floor (Construction Contracts and Standards section).
- Record Drawings are in the Engineering Records Center on SMT 47th floor and/or in the water files on SMT 45th floor.
- Wastewater and CSO facility documentation may be available on the Drainage and Wastewater (DWW) SOPA SharePoint site, including rain gauge information, CSO map books, training materials, O&M manuals, and reports.

1.12 LESSONS LEARNED

For all team members, remember you are probably not the first or the last to encounter a specific problem during design and construction. The Project Management Division maintains a lessons learned repository on SharePoint as a searchable database. Designers should review this database during design to learn from any applicable lessons that might relate to the current project.

Contribute to the lessons learned repository. When you learn something, especially the hard way, meet immediately with those involved and draft a lesson learned. Do this while memories are fresh. The project manager should set up the lessons learned workshop before project closeout.

1.13 DEVIATIONS AND CHANGES

This section describes how to document and share deviations and changes from this DSG.

1.13.1 Deviations from DSG

You must follow this guide. However, SPU acknowledges that there will be cases when standard locations, standard structures, standard materials, or standard details do not fit, or just are not the best fit for the project or SPU. When deviating from the DSG, discuss your actions with the project team (especially with Operations staff) and your supervisor, and document these deviations in the BOD report and/or plan sheet for the project file.

1.13.2 Permanent Changes to DSG

The DSG reflect industry and SPU best practices when they are published. As practices evolve and improve, the DSG will be modified. Each chapter of the DSG has a content owner. Talk to them and share your ideas and concerns.

If you know of changes that are needed to the DSG, submit the decisions from the lessons learned for the DSG Program to consider. The DSG Program Manager works with the chapter owner and subject matter experts to review suggestions and schedule revisions.

Keep in mind that the DSG should not be confused with the City's Standard Plans and Specifications. These reports are a joint product of seven City departments. They are updated and published every three years. GSPs with changes can be issued on SPU contracts between printings.

The DSG may develop standards that could be included in the City Standard Plans and Specifications. When you propose changes to the DSG, identify any City standard plans or specifications that also need updating. Contact the City's construction standards program coordinator with change proposals.

1.14 RESOURCES

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