Conceptual Projects to Meet Identified Capacity Needs

Conveyance System Improvement Program

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King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

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Chapter 1

Process for Developing Conceptual Conveyance Improvement Projects

This report was prepared as a part of the 2017 Conveyance System Improvement (CSI) Program update, undertaken by the King County Wastewater Treatment Division (WTD). The 2015 *Regional Needs Assessment* found that the capacities of 77 components or sections of King County's separated sewer system are below or will fall below the 20-year peak flow design standard (KCC 28.86.060) sometime in the 50-year planning period (2010–2060).[1, 2] Over half of the facilities (40) do not currently meet the standard. This chapter discusses the processes used to develop conceptual CSI projects and lists proposed conceptual projects to address the system capacity needs identified in the needs assessment. Chapter 2 describes the projects.

1.1 Evaluating Options for Conceptual Projects

WTD considered the following capital project options for addressing capacity needs:

- Paralleling existing conveyance pipes with new pipes
- Upgrading pump stations
- Replacing undersized pipes or pump stations with larger ones
- Diverting flows to other conveyance facilities
- Building storage facilities that reduce peak flow volumes by storing wastewater during high flow periods until it can be safely conveyed by the downstream system

The process for developing a list of conceptual projects was an iterative one in which early project lists were reviewed and revised to incorporate local information and cost-saving measures (Figure 1-1). Key activities are listed below and described in the text that follows:

- Review the list of projects in the 2007 CSI Program update.

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[1] The 2015 *Regional Needs Assessment* can be found at http://www.kingcounty.gov/~/media/services/environment/wastewater/csi/docs/1505_Final_RNA_web.ashx?la=en.

[2] The 2014 *Updated Planning Assumptions for Wastewater Flow Forecasting* describes the assumptions, such as planning periods and flow standards, used for CSI planning: http://your.kingcounty.gov/dnrp/library/wastewater/wtd/construction/Planning/RWSP/CompReview/13/1407_UpdatedPlanningAssumptions2014.pdf.

- Assess whether to replace or parallel an existing pipeline or rebuild or upgrade a pump station that has an identified capacity constraint.
- Size each project to convey the projected 20-year peak flow in 2060.
- Determine possible routes for new pipelines.
- Develop initial project cost estimates.
- Evaluate whether diversion or storage projects would provide cost-effective alternatives to parallel pipelines.
- Consider whether construction of a project in phases could potentially spread the cost of addressing the need over a period of decades and result in near-term cost savings.
- Revise project alternatives, as needed, to reflect information from local sewer agencies.
- Refine cost estimates.

The process used to develop projects depended on whether or not conveyance facilities with identified needs can convey a 20-year peak flow without surcharging and/or overflowing under current conditions (2010). Facilities that can currently convey the peak flow were assigned a level of service (LOS) of greater than 20. Two options were considered for these facilities:

- If the need was identified in the 2007 update, the conceptual project developed for the need in 2007 will be carried forward.
- If the need was not identified in the 2007 CSI update, the pipeline or pump station will be replaced or upgraded.

Facilities that cannot currently convey the peak flow were assigned an LOS of 20 or less; for example, an LOS below 5 means there is a one in five chance that an overflow will occur in any given year. For these facilities, the condition, age, and composition of pipes were considered in order to decide whether to parallel or replace them. Replacement projects were developed for pipes greater than 50 years old and in poor condition. It was assumed that paralleling would occur in areas with relatively new pipes made of durable materials like reinforced concrete or metal, with enough room available, and with few pipes in the corridor.

The size for each new parallel or replacement pipe was then determined by projecting the 20-year peak flow in 2060 to be conveyed through the pipe. After the pipes were sized, possible pipeline routes were developed based on GIS data, aerial photographs, and elevations of existing conveyance facilities. Factors considered in developing possible routes included stream crossings, major street and culvert crossings, wetlands, public rights-of-way, topography, water bodies, and high water tables. Stream and wetland crossings were avoided if possible; major street crossings were minimized; and public rights-of-way were preferred to private properties.

Flow diversion and storage were evaluated if paralleling was infeasible or to determine if these options were more-cost effective than paralleling all or part of a the length of a pipeline where capacity is needed. Sometimes an iterative process was used to find the optimal combination of storage, diversion, and downstream paralleling costs.

Storage and diversion considerations were as follows:

- **Storage.** Storage facilities, such as tanks or online or offline pipes and tunnels, store flow in excess of capacity and release the flow when downstream capacity becomes available for conveyance to a treatment plant. The downstream benefits of storage were analyzed using the MOUSE HD hydraulic model to determine if building storage capacity rather than paralleling the pipe could provide needed capacity. A storage curve was developed to determine how much storage would be required. If the modeling indicated that storage was feasible and if the estimated cost of storage was less than increasing capacity in the downstream system, storage was assumed. Possible locations and types of storage facilities were identified. It is usually better if flow enters and exits a storage facility via gravity to avoid the need for pumps and associated electrical and mechanical equipment, and large pipes are usually less expensive than tanks for underground storage.
- **Diversion.** Diversion involves construction of a new pipeline to divert upstream flow to existing WTD facilities. Analysis of the feasibility of diversion took into consideration proximity to existing conveyance facilities, infrastructure and environmental constraints, and possible impacts to downstream facilities. If the analysis indicated that diversion was feasible and if the estimated cost of diversion was less than increasing capacity in the downstream system, diversion was assumed.

The list of proposed projects and cost estimates were modified based on information from local sewer agency representatives on local conditions, including topographic or permitting issues, and on plans for future road and utility projects that may provide the opportunity for coordination with CSI projects.

Prior to initiating any of the identified conceptual projects, WTD will (1) conduct additional flow monitoring and modeling to verify or update the flow projections, (2) analyze the feasibility of including reclaimed water conveyance and access, and (3) assess the feasibility of reducing infiltration and inflow (I/I) as a means to reduce, delay, or eliminate the need for a project (see below).

1.2 Cost Estimating Methodology

The methodology for estimating conceptual CSI project costs produces an order of magnitude, planning-level estimate for each project using only a rudimentary scope defined in the form of a need. General assumptions are made and documented throughout the process. The process and supporting tools/techniques align with AACEI standards and Total Cost Management (TCM) practices for development of a conceptual Class 5 estimate. Class 5 estimates are considered to have an accuracy range of –50 percent to +100 percent.[3] The level of project definition is minimal or near 0 percent level of engineering development.

The steps in the process are as follows:

- **Prepare Basis of Estimate.** A Basis of Estimate is prepared for each project that defines what is known and unknown about the planning-level project. It includes elements such as the project scope, underlying estimate assumptions, allowances, risks, contingencies, and the basis for design, planning, and cost. This initial Basis of Estimate is a living document that is updated at significant project milestones or when considerable changes occur to the identified need or project approach.
- **Estimate Direct Construction Costs.** Construction cost estimates are developed using the Tabula Rasa Costing Tool (Version 3.1.2). Tabula is a Web-based construction cost estimating program developed specifically for WTD. The program contains unit construction cost estimates and allied costs associated with designing and constructing the range of conveyance facilities needed across the regional system.[4] Assumptions for project components in the Basis of Estimate are input into Tabula, which generates a conceptual planning-level AACEI Class 5 construction cost estimate. The Tabula data is then transferred to the WTD estimating tool (a Microsoft Excel workbook). The data for each major project component is input to its own tab, complete with detailed item descriptions, unit costs, and quantities. The total from each project component detail is captured in a summary estimate and then summed to create a project subtotal. The subtotals are summed to estimate baseline direct project construction costs.
- **Estimate Direct and Indirect (Allied) Costs.** Project direct and indirect (allied) costs are developed with the aid of algorithms in WTD's PRISM database program. The algorithms are based on $5 billion of historical project data and are used to forecast anticipated expenditures for a given project type and scale. The PRISM allied costs and project allowances are included in the WTD estimating tool in the form of imbedded formulas that mimic PRISM functionality. Several allied cost assumptions must be input based on user-defined unique project factors. These include street use permits, mitigation construction contracts, owner furnished equipment, outside agency construction, and local agency mitigation. PRISM-forecasted values or user-defined inputs can be customized (overridden) to accommodate more project detail. (Project allowances in the project estimates are documented as assumptions in the Basis of Estimate.)
- **Develop Total Project Cost Estimate.** The Basis of Estimate is updated to reflect the assumptions underlying the estimate. The planning-level cost information is presented in

[3] AACE RP No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries: http://www.aacei.org/toc/toc_18R-97.pdf.
[4] Additional information on Tabula can be found at http://www.kingcounty.gov/services/environment/wastewater/csi/tabula.aspx.

a single, one-page summary of all direct and indirect project costs, including key direct construction project elements from which the PRISM algorithm is applied. The one-page estimate summaries present the following cost information:

- Total direct construction costs (subtotals of project construction cost elements from Tabula, additional direct construction costs from PRISM and user-defined allowances, and other direct capital charges from PRISM)
- Total indirect non-construction costs from PRISM and user-defined allowances
- Total project cost of the identified conceptual project

1.3 Consideration of I/I Control to Address Capacity Needs

The effort to formulate conceptual projects did not include consideration of I/I control as a means to address capacity needs. An I/I analysis will be done as part of design flow criteria development as projects are implemented and will be informed by the following:

- Assumptions developed by King County's Regional I/I Control Program, including high and low ranges of I/I reductions
- Lessons learned from I/I program pilot and initial projects

Possible outcomes of the evaluation include a recommendation as to whether I/I reduction should be considered as a project alternative during predesign and/or further evaluated through a sewer system evaluation survey.

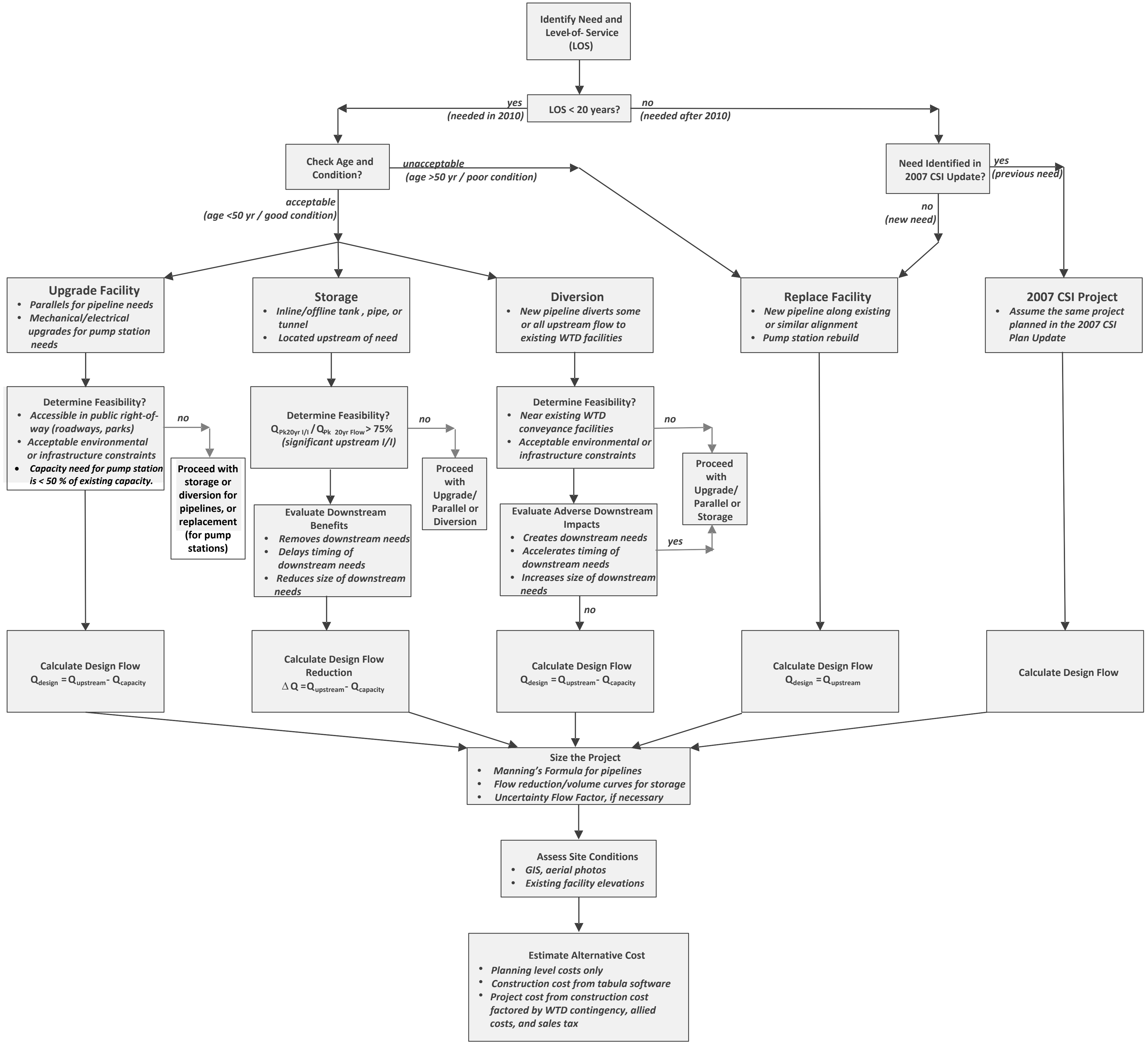

Figure 1-1. Process for Developing Recommended Conceptual Conveyance System Improvement Projects

Chapter 2

Conceptual Projects

Forty-one conceptual CSI projects were developed to address the capacity needs of conveyance facilities in the separated sewer portion of the regional wastewater system. Ten conceptual projects are located in the Northeast Lake Washington Planning Area and six in the Hidden Lake Planning Area. The number of projects in other planning areas range from zero to four.

Table 2-1 lists the planning-level project and construction cost estimates for the conceptual projects. Figure 2-1 shows the locations of the projects in each of the planning areas, followed by descriptions of the conceptual projects.

Table 2-1. Estimated Project and Construction Costs for Conceptual Projects

Planning Area	Project Name	Estimated Total Project Cost (M 2016$)	Estimated Construction Cost (M 2016$)
North Lake Washington	North Creek Trunk Storage and Replacement	85.4	43.6
	Swamp Creek Trunk Extension Replacement	17.4	8.4
	McAleer Trunk Replacement	5.1	2.5
	Lake Ballinger Storage	82.9	43.6
Hidden Lake	Richmond Beach Pump Station Upgrade	46.8	24.6
	Richmond Beach Force Main Parallel	11.7	5.7
	Richmond Beach – Edmonds Interceptor Parallel	13.8	6.7
	Boeing Creek Trunk Replacement and Parallel	9.7	4.7
	Hidden Lake Pump Station Upgrade	10.9	5.3
	Hidden Lake Force Main Replacement	6.9	3.4
Northwest Lake Washington	Thornton Creek Trunk Replacement and Realignment	34.6	18.1
	North Lake City Trunk Replacement and Realignment	44.8	23.5
Northeast Lake Washington	Medina Trunk Replacement	14.2	6.9
	Medina Siphon Replacement	13.8	6.7
	Factoria Trunk Diversion	20.5	9.6
	Lake Hills Interceptor Replacement	70.4	37.0
	North Mercer Pump Station Upgrade	18.2	9.2
	Yarrow Bay Pump Station Replacement	18.8	9.5
	Sweyolocken Pump Station Upgrade	29.8	15.0
	Kirkland Pump Station Upgrade	22.7	11.5
	Medina Pump Station Upgrade	22.2	11.2

Planning Area	Project Name	Estimated Total Project Cost (M 2016$)	Estimated Construction Cost (M 2016$)
	Eastside Interceptor Section 8 Storage	112.1	57.9
North Lake Sammamish	No conceptual projects	–	–
Southeast Lake Washington	No conceptual projects	–	–
South Lake Sammamish	Sammamish Plateau Diversion Phase 2	218.9	113.0
	Eastgate Trunk Replacement	8.1	3.9
	Issaquah Interceptor Section 2 Replacement	3.7	1.8
	Issaquah Creek Highlands Storage	8.6	3.7
South Lake Washington	Eastside Interceptor Section 1 Replacement	207.4	108.0
	Bryn Mawr Trunk Storage	50.0	26.3
	Cedar River Interceptor Section 2 Replacement	8.3	4.0
	Cedar River Interceptor Section 1 Replacement and Parallel	16.2	8.2
North Green River	Tukwila Freeway Crossing Replacement	24.2	12.2
	Tukwila Interceptor Replacement	30.3	15.3
	South Renton Trunk Replacement	10.6	5.1
	Rainier Vista Interceptor South Replacement	5.0	2.4
	North Soos Creek Trunk Replacement	9.1	4.4
South Green River – Kent	Garrison Creek Interceptor Replacement, Realignment, and Diversion	55.7	29.3
	Auburn Interceptor Sections 1, 2, and 3 Replacement	270.3	142.1
	South 227th Interceptor Replacement	9.4	4.6
	West Hill Trunk Diversion	10.0	4.9
South Green River – Soos Creek	Black Diamond Pump Station Upgrade	4.5	2.2
	Black Diamond Trunk Storage and Replacement	82.5	43.4
South Green River – Auburn	No conceptual projects	–	–