Chapter 4

Benefit-Cost Analysis

In addition to the RWSP I/I policies described in Chapter 2, conveyance system policy calls for the integration of I/I study results with planning for wastewater conveyance and treatment facilities (Policy CP-5). The results of the benefit-cost analysis presented in this chapter identify cost-effective I/I reduction projects that have the potential to reduce the capital investments necessary to upgrade the conveyance system. Greater detail can be found in the *Benefit-Cost Analysis Report*.

4.1 Benefit-Cost Analysis Approach

The Benefit-Cost Analysis Tool (B/C Tool) was developed to conduct the benefit-cost analysis for the I/I control program. B/C Tool is a database analysis tool that runs on a Microsoft Access platform and has the ability to evaluate a myriad of variables. The tool was used to determine the optimal I/I reduction available and then to generate a list of cost-effective I/I reduction projects based on regional conveyance needs.

Major inputs to B/C Tool were as follows:

- **Conveyance system improvement (CSI) projects.** A Regional Needs Assessment (RNA) was completed in early 2005 as a part of the I/I control study. The RNA identified CSI projects that would be needed to accommodate peak flows[1] through 2050—the projected date when the regional wastewater service area will be fully built out and all portions of the service area will be connected to the wastewater treatment system.
- **Assumptions regarding sizing, costs, I/I reduction potential, and other planning factors.** Most of the assumptions were developed in coordination with MWPAAC's Engineering and Planning (E&P) Subcommittee.[2] They are based on industry standards, experience in operating wastewater systems in the region, and results of the research and I/I pilot projects conducted for the I/I control study.

  The set of assumptions regarding I/I reduction rates was intentionally made conservative for the benefit-cost analysis to avoid potential overestimation of benefits or underestimation of costs. A set of initial assumptions that was less conservative and based on direct experiences in the pilot projects was used to conduct a sensitivity analysis that would provide the upper end of the range for cost-effectiveness outcomes.

[1] Peak flow is the highest combination of base flow and I/I expected to enter a wastewater system during wet weather at a given frequency that treatment and conveyance facilities are designed to accommodate.
[2] MWPAAC = Metropolitan Water Pollution Abatement Advisory Committee.

- **Flow data collected during the I/I study and flow predictions based on the data.** Extensive flow monitoring data were used in commercially available hydrologic and hydraulic models to estimate present and future conveyance system capacity needs. These modeled estimates were supported by information regarding local agency wastewater facilities, current and future land uses, population projections, and other modeling assumptions.
- **Results of the I/I pilot projects.** Lessons learned from the 10 pilot projects about costs and effectiveness of I/I reduction techniques were an important input to assumptions used in the benefit-cost analysis.
- **Definition of cost-effectiveness of I/I reduction projects.** RWSP Policy I/IP-1 calls for the reduction of I/I "whenever the cost of rehabilitation is less than the cost of conveying and treating the flow or when rehabilitation provides significant environmental benefits to water quantity, water quality, stream flows, wetlands, or habitat for species listed under the ESA."[3] For the purpose of the benefit-cost analysis, this definition was further refined to clarify that cost-effective projects are those for which the capital savings that result from I/I reduction exceed the costs of constructing the I/I project. When an I/I reduction project delays, downsizes. or eliminates the need for a conveyance facility improvement, the savings achieved (benefit) must be higher than the cost of the I/I reduction project (cost) to arrive at a positive benefit-cost ratio (greater than 1).
- **Alternative methods for applying cost-effectiveness of I/I reduction.** The *Alternatives/Options Report* identified three alternatives for considering cost-effectiveness: project-specific basis, region-wide basis, and a 30-percent I/I reduction goal. This report presents detailed benefit-cost analysis results for the project-specific alternative (preferred alternative) and summarizes results for the other two alternatives. Detailed results for all alternatives are presented in the *Benefit-Cost Analysis Report.*

4.2 Conveyance Projects Identified in the Regional Needs Assessment

This section describes the CSI projects identified during the Regional Needs Assessment, compares these projects to the CSI projects identified in the 2004 update to the *Regional Wastewater Services Plan* (RWSP), and then shows the locations of the RNA projects in relation to predicted I/I flows for each mini basin.[4] The projects identified are based on the data gathering and modeling efforts completed for the I/I control study. The RNA was developed to allow for an accurate comparison of benefits and costs between CSI projects and I/I reduction projects. More detail is provided in the *Regional Needs Assessment Report*.

[3] Endangered Species Act (ESA).

[4] Mini basins are geographically isolated areas that show variation in I/I flow rates. There are 775 mini basins. On average, they are 150 acres and contain approximately 22,000 lineal feet of pipe. See the *Regional Needs Assessment Report* for a more detailed discussion of mini basins.

4.2.1 CSI Projects

The RNA identified 63 CSI projects that would expand the capacity of the conveyance system to meet the region's projected capacity needs through 2050. Table 4-1 lists each project, including the project type and estimated completion date and cost. Figure 4-1 identifies the location of the projects by the project numbers listed in Table 4-1.

The estimated cost for all CSI projects through 2050 is approximately $780 million (2003 dollars). To provide a baseline for conducting the benefit-cost analysis, the cost estimate assumes that no action will be taken to reduce capacity demand by reducing flow volumes—that the rate of growth in base flow will grow as population and employment grow in the region and that I/I will continue unchecked into the future.[5]

Projects 1 through 23 in Table 4-1 were not included in the benefit-cost analysis. The capacity provided by these projects is needed prior to 2010. It is not possible to design, construct, and test I/I reduction projects in time to alleviate the need for this capacity.

4.2.2 Comparison with CSI Projects Identified in the Updated RWSP

The 2004 update to the RWSP listed CSI projects through 2030, with a total estimated cost of $638 million (2003 dollars). The flow monitoring and modeling data developed for the I/I control program indicate that I/I levels in certain areas of the region differ from the assumptions used to update the RWSP. The comparison of these modeled flows to the capacity of the conveyance system resulted in the addition of 10 projects[6] and the deletion of two projects[7] from the list of projects identified in the update to the RWSP. The additional projects increased the estimated costs for projects through 2030 by $10 million, for a total of $648 million. For the projects between 2031 and 2050 identified in the RNA, the estimated cost is $131 million.

[5] Population and employment growth rates are taken from Puget Sound Regional Council (PSRC) forecasts.
[6] Projects 28, 29, 31, 33, 35, 42, 44, 45, 47, and 50 in Table 4-1.
[7] Effluent Transfer System (ETS) Storage project and Tukwila Freeway Crossing project.

Table 4-1. Conveyance System Improvement Projects Identified in the Regional Needs Assessment

Project No.	Project List	Project Type	Year Online[a]	Estimated Project Cost[b]
1	Bear Creek Interceptor Extension	Gravity Line	1998	$400,000
2	Alderwood	Acquisition of Facilities	2001	$16,700,000
3	Swamp Creek	Gravity Line	2003	$10,700,000
4	ESI-11 - Wilburton Siphon/Wiburton Odor Control	Gravity Line	2003	$3,900,000
5	Off-line Storage at North Creek	Storage Facility	2004	$33,800,000
6	ESI-1 (2)	Gravity Line	2004	$8,700,000
7	Fairwood Interceptor (formerly Madsen Creek)	Gravity Line	2005	$21,600,000
8	McAleer I/I Work	I/I rehab work (opportunity)	2005	$3,200,000
9	Pacific Pump Station	Pump Station Upgrade	2006	$7,800,000
10	York PS Subtotal	Pump Station Upgrade	2007	$10,000,000
11	Lake Line Connections and Flap Gates	Gravity Line	2007	$1,400,000
12	Juanita Bay Pump Station	Pump Station	2007	$33,100,000
13	Sammamish Plateau WSD	Acquisition of Facilities	2007	$9,400,000
14	Hidden Lake PS/Boeing Trunk	Pump Station Upgrade and Gravity Line	2008	$28,500,000
15	Kirkland Pump Station and Force Main Upgrade	Pump Station and Force Main Upgrade	2008	$9,600,000
16	Auburn	Interceptor Extension	2008	$11,500,000
17	[CSI] North Creek 1-A	Gravity Line	2009	$16,900,000
18	[CSI] Stuck River Diversion 1	Gravity Line	2009	$5,200,000
19	[CSI] Stuck River Diversion 2	Gravity Line	2009	$2,300,000
20	[CSI] Auburn West Valley Replacement - Section C	Gravity Line	2009	$12,400,000
21	[CSI] Auburn West Valley Replacement - Section A	Gravity Line	2009	$2,900,000
22	[CSI] Auburn West Valley Replacement - Section B	Gravity Line	2010	$25,200,000
23	[CSI] Soos Alternative 3A(3) - PS D w/ Conveyance	New Pump station, Force Main and Gravity Sewers	2010	$35,700,000
24	South Lake City: NWW13-02 TO NWW10-01	Gravity Line	2011	$100,000
25	[CSI] Soos Alternative 3A(3) - PS H w/ Conveyance	New Pump station, Force Main and Gravity Sewers	2011	$42,700,000
26	Piper Creek: T-12 to T-5	Gravity Line	2012	$500,000
27	Piper Creek: T-23 D TO T-12	Gravity Line	2013	$2,200,000
28	Issaquah1 Trunk Pipeline Bifurcation	New Gravity Line	2014	$1,400,000
29	Bellevue Influent Trunk	New Gravity Line	2015	$2,600,000
30	North Mercer and Enatai Interceptors	New Gravity Line	2016	$10,800,000
31	Medina Trunk Minor Upgrade	New Gravity Line	2019	$100,000
32	[CSI] Thornton Creek Interceptor - Sections 1 & 2	New Gravity Line	2019	$3,300,000
33	Bryn Mawr Storage	New Storage Facility	2020	$8,200,000
34	[CSI] Coal Trunk Replacement	New Gravity Line	2020	$6,800,000
35	Factoria Trunk and Wilburton Upgrade	New Gravity Line, Pump Station Upgrade	2020	$27,900,000
36	[CSI] Sammamish Plateau Diversion	New Gravity Line	2020	$18,800,000
37	[CSI] Thornton Creek Interceptor - Section 3	New Gravity Line	2022	$2,400,000
38	[CSI] Mill Creek Relief Sewer	New Gravity Line	2022	$5,000,000
39	North Soos Creek Interceptor	New Gravity Line	2022	$5,600,000

Project No.	Project List	Project Type	Year Online[a]	Estimated Project Cost[b]
40	Heathfield/Sunset Pump Station and Force Main Upgrade	New Force Main, Pump Station Upgrade	2022	$16,000,000
41	Eastgate Trunk	New Gravity Line	2022	$1,800,000
42	Medina New Storage	New Storage Facility	2023	$3,600,000
43	[CSI] Soos Alternative 3A(3) - PS B w/ Conveyance	New Force Main, New Pump, New Gravity Line	2023	$10,600,000
44	Northwest Lake Sammamish Interceptor	New Gravity Line	2024	$28,900,000
45	Rainier Vista Trunk	New Gravity Line	2024	$600,000
46	Garrison Creek Trunk	New Gravity Line	2024	$12,900,000
47	Lake Hills Trunk Fourth Barrel Addition	New Gravity Line	2025	$12,400,000
48	[CSI] North Creek 2-A	Gravity Line	2026	$45,500,000
49	[CSI] Swamp Creek Parallel - Section 1B	New Gravity Line	2026	$7,300,000
50	Algona Pacific Trunk Stage 1	New Gravity Line	2026	$4,300,000
51	[CSI] Issaquah New Storage	New Storage Facility	2026	$15,100,000
52	[CSI] Sammamish Plateau Storage	New Storage Facility	2027	$20,500,000
53	Issaquah Creek Highlands New Storage	New Storage Facility	2029	$3,900,000
54	Planning, Studies, Administration, and Program Development	Ongoing Program	2030	$15,200,000
Sub-Total of projects through 2030				***$648,000,000***
55	Auburn3 New Storage	New Storage Facility	2030-2050	$33,800,000
56	[CSI] North Creek 3-A	New Gravity Line	2030-2050	$6,700,000
57	Lakeland Trunk	New Gravity Line	2030-2050	$4,800,000
58	ULID 1 Contract 4	New Gravity Line	2030-2050	$2,300,000
59	Issaquah2 Trunk	New Gravity Line	2030-2050	$2,300,000
60	South Renton Interceptor	New Gravity Line	2030-2050	$6,900,000
61	North Creek Trunk	New Gravity Line	2030-2050	$4,000,000
62	Algona Pacific Trunk Stage 2	New Gravity Line	2030-2050	$1,300,000
63	Lakeland Hills Pump Station Upgrade	New Force Main, Pump Station Upgrade	2030-2050	$3,700,000
2nd phase of Project 34	[CSI] Coal Trunk Replacement	New Gravity Line	2030-2050	$7,000,000
2nd phase of Project 30	North Mercer and Enatai Interceptors	New Gravity Line	2030-2050	$12,000,000
2nd phase of Project 36	[CSI] Sammamish Plateau Diversion	New Gravity Line	2030-2050	$4,600,000
2nd phase of Project 40	Heathfield/Sunset Pump Station and Force Main Upgrade	New Force Main, Pump Station Upgrade	2030-2050	$21,900,000
2nd phase of Project 52	[CSI] Sammamish Plateau Storage	New Storage Facility	2030-2050	$7,200,000
2nd phase of Project 51	[CSI] Issaquah New Storage	New Storage Facility	2030-2050	$4,900,000
2nd phase of Project 48	[CSI] North Creek 2-A	Gravity Line	2030-2050	$7,200,000
Sub-Total of 2031–2050 projects				***$130,600,000***
Total project cost estimate				**$778,600,000**

[a] Year online balances capacity needs with estimated funding availability.
[b] All estimated costs are in 2003 dollars.

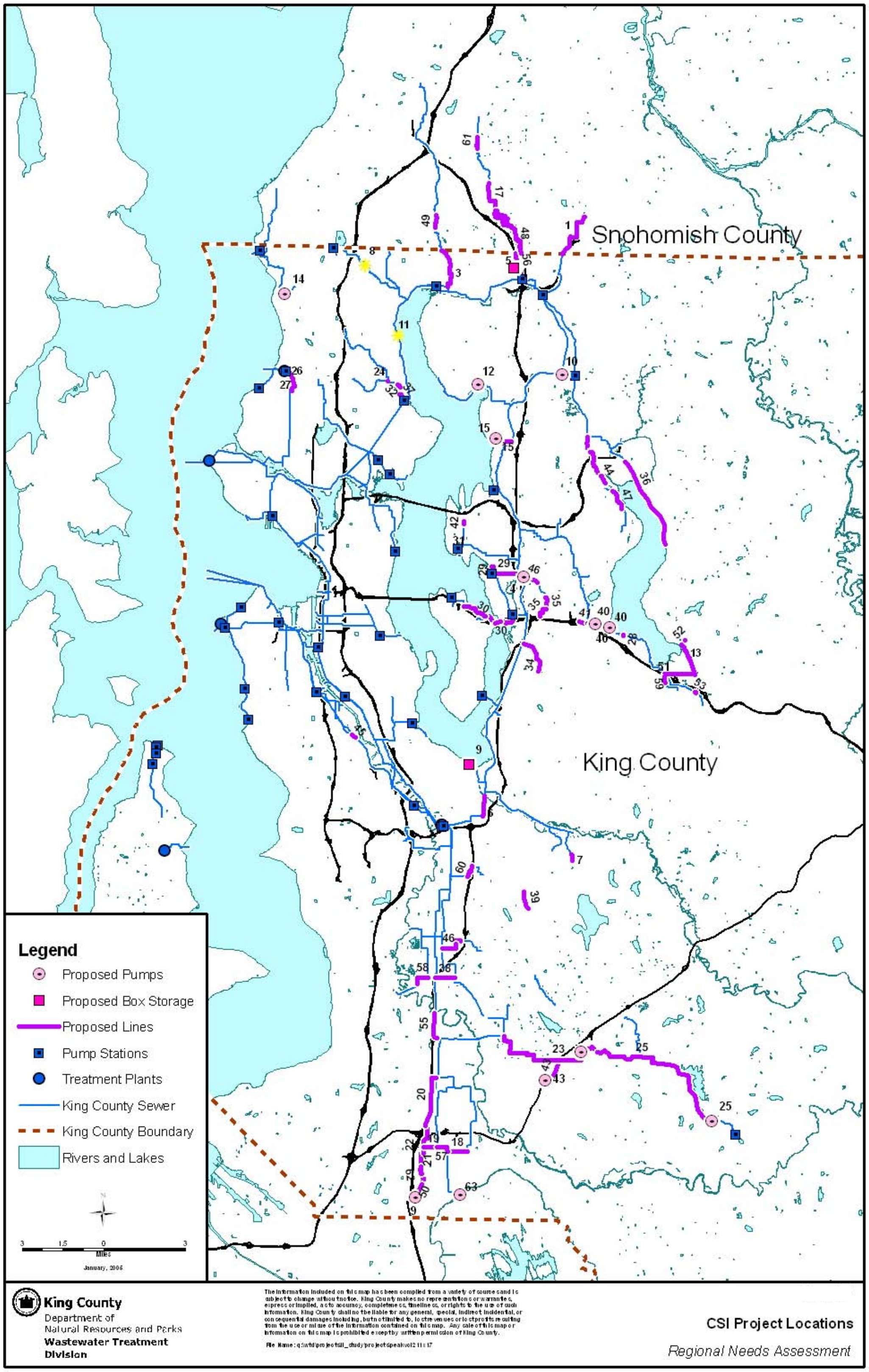


Figure 4-1. Conveyance System Improvement Project Locations

4.2.3 Locations of CSI Projects in Relation to I/I Flows in Mini Basins

During storm events, I/I is by far the largest contributor to wastewater volumes that must be conveyed and treated (see Figure 2-4 in Chapter 2). If I/I flows could be reduced in targeted mini basins, it may be possible to reduce the need for conveyance system improvements because the capacity needed to convey and treat wastewater from these mini basins would also be reduced. Figure 4- shows the location of needed CSI projects in relation to metered I/I levels in mini basins throughout the service area. As can be seen, a number of the CSI projects are near mini basins with relatively high I/I flows.

4.3 Assumptions Used in the Analysis

The County and local agencies developed assumptions based on engineering judgments and lessons learned from the pilot projects. The assumptions were used to estimate the costs and effectiveness of identified CSI projects and I/I reduction projects upstream of the CSI projects.

4.3.1 Planning Assumptions for the I/I Control Program

A number of conditions drive the timing, sizing, and costs of facilities that occur in the future; each require planning level assumptions to arrive at a value. To accurately project CSI needs, King County used assumptions developed for the I/I control program. After completing the I/I pilot projects, local agencies and the County collaborated to further develop these assumptions for use in the flow modeling done for the benefit-cost analysis. Table 4-2 summarizes several of the more significant planning assumptions.[8]

[8] For details about planning assumptions, see Appendix A5 of the *Regional Needs Assessment Report*.

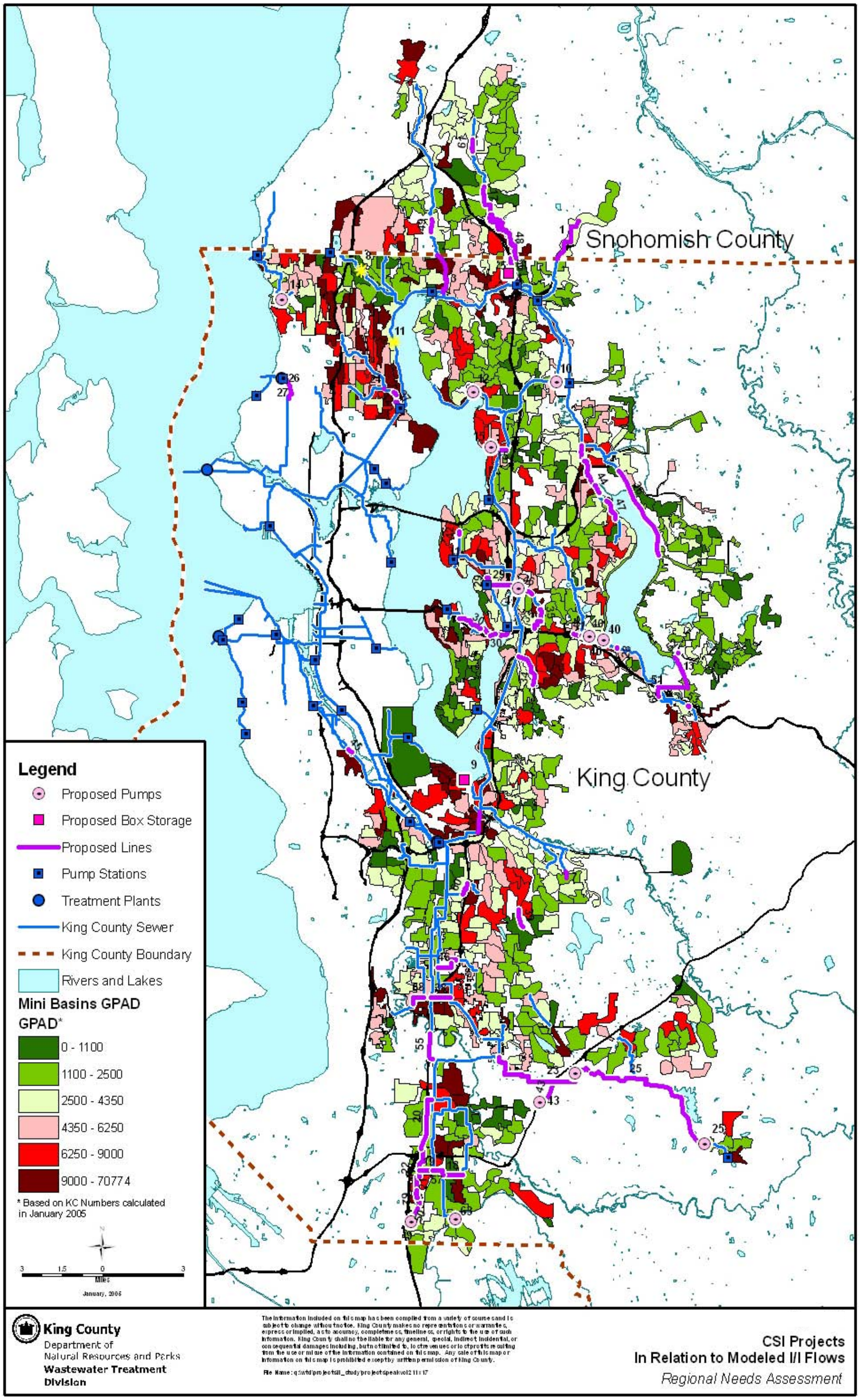


Figure 4-2. Conveyance System Improvement Projects in Relation to I/I Levels

Table 4-2. Planning Assumptions for the I/I Control Program

Item	Assumption
Water conservation (base flow projections)	10% reduction by 2010; no additional reduction thereafter
Septic conversion	90% of unsewered but sewerable area in 2000 sewered by 2030; 100% by 2050
New system I/I allowance	1,500 gallons per acre per day (gpad)
Design flow	20-year peak flow, based on Sea-Tac 60-year rainfall record, adjusted per annual average rainfall over each part of the service area
Degradation	7% per decade starting in 2000 up to 28% for existing pipe; 7% per decade starting after date of construction up to 28% for new construction
Sizing of facilities	Design flow at saturation plus 25% safety factor (when sizing facilities, a safety factor of 25% of additional capacity will be used)
Discount rate	6%
Inflation rate	3%
Operation and maintenance	Update the following from the *Regional Wastewater Services Plan* (RWSP): • New pipes: $0.15 per linear foot annually • New pump stations: $4,104 per million gallons per day (mgd) + $60,384 • New storage facilities: $34,091 per million gallons (MG) + $4,546 • Treatment plants: $15,000–$30,000 per mgd of average annual flow reduction (plant specific); covers energy and disinfection costs

4.3.2 Assumptions for Estimating Capital Costs of CSI Projects

Table 4-3 lists the assumptions used to estimate costs for conveyance facility construction and allied activities (such as project management, engineering, inspection, and mitigation). These costs were generated by TABULA, a planning level software tool developed by King County that extends unit costs, applies construction cost indices, and allows for consistent estimating across Wastewater Treatment Division projects.

Table 4-3. Conveyance Facility Construction and Allied Cost Assumptions

Item	Cost Assumption
Construction	Based on TABULA with factors for traffic, utility conflicts, and groundwater
Utility conflicts	None: $0 Average: $20/linear foot Heavy: $40/linear foot
Traffic control	None: $0 Average: $5/linear foot of main Heavy: $10/linear foot of main
Dewatering	None: $0 Average: $20/linear foot Heavy: $50/linear foot
Sales tax	8.8% of construction estimate
Planning, predesign, design, construction, closeout, and land acquisition contingency	51.4% of construction estimate
Project contingency	30% of construction estimate
Mitigation (environmental, land use, public disruption, private property, and others)	Project-specific

4.3.3 Assumptions for I/I Reduction

In addition to developing planning and capital cost assumptions, the County and local agencies developed assumptions for the amount of I/I reduction that could be expected from types of I/I projects. Table 4-4 lists the I/I reduction technique (system components to be targeted for rehabilitation), the percent of the total basin that would be rehabilitated (based on lessons learned from the pilot projects), and the percent of I/I reduction assumed possible.

These I/I reduction assumptions reflect concerns raised by the local agencies that initial assumptions generated from pilot project experiences may be based on too limited an application. The local agencies did not want to overestimate capital facility and I/I reduction benefits while underestimating I/I reduction project costs. The initial assumptions were adjusted to make them more conservative and to provide greater confidence in the I/I reduction and cost projections derived from the benefit-cost analysis. It was agreed that the initial assumptions would be used to run a sensitivity analysis that would provide the upper end of the range for cost-effectiveness outcomes. Results of the sensitivity analysis are summarized at the end of this chapter.

Table 4-4. I/I Reduction Assumptions

Technique	Description	% Basin Rehabilitated	% I/I Reduction Assumption
1	Direct disconnects	4%	10%
2	Replace everything and direct disconnects	95% Sewer mains 95% Manholes 95% Laterals and side sewers 4% Direct disconnects	80%
3	Replace public sewers and direct disconnects	50% Sewer mains 50% Manholes 50% Laterals 4% Direct disconnects	40%
4	Private property and some laterals and direct disconnects	50% Laterals and side sewers 45% Side sewers only 4% Direct disconnects	60%
	Minimum remaining I/I after rehabilitation	3,500 gallons per acre per day (gpad)	

Notes:

Laterals are the portion of the private sewer pipe that is in public right-of-way; a side sewer is the portion of the private sewer pipe that is on private property.

Direct disconnects are the disconnection of connections to the sewer system, usually located on private property, that allow stormwater to flow into the sanitary sewer. Examples of such connections include roof gutter drains, catch basins, sump pumps, and foundation drains.

A sewer main is a principal sewer to which branch sewers are tributary.

4.3.4 Assumptions for Unit Costs of I/I Reduction Techniques

Unit costs for I/I reduction techniques were developed based on I/I pilot project costs and historical sewer rehabilitation costs available locally and nationally. These costs were reviewed by the E&P Subcommittee, and unit cost assumptions were established as shown in Table 4-5.

Table 4-5. Unit Costs Assumptions for I/I Reduction

Technique	Description	Unit Cost Assumption
1	Direct disconnects	$3,000 each
2	Replace everything and direct disconnects	Sewer mains: $110/linear foot Manholes: $3,600 each Laterals and side sewers: $6,800 each Direct disconnects: $1,000 each
3	Replace public sewers and direct disconnects	Sewer mains: $110/linear foot Manholes: $3,600 each Laterals: $3,900 each Direct disconnects: $1,000 each
4	Private property and some laterals and direct disconnects	Laterals: $3,900 each Side sewers: $3,500 each Laterals and side sewers: $6,800 each Direct disconnects: $3,000 each

Notes:

Laterals are the portion of the private sewer pipe that is in public right-of-way; a side sewer is the portion of the private sewer pipe that is on private property.

Direct disconnects are the disconnection of connections to the sewer system, usually located on private property, that allow stormwater to flow into the sanitary sewer. Examples of such connections include roof gutter drains, catch basins, sump pumps, and foundation drains.

A sewer main is a principal sewer to which branch sewers are tributary.

4.4 Definition of Cost-Effectiveness

To evaluate cost-effectiveness of I/I reduction projects, the following **benefit-cost ratio** was calculated for each candidate CSI project:

$$\frac{\textbf{(CSI Project Savings After I/I Reduction)}}{\textbf{(Cost of Proposed I/I Reduction Project)}}$$

When an I/I reduction project delays, downsizes, or eliminates the need for a conveyance facility improvement, the savings achieved (benefit) must be higher than the cost of the I/I reduction project (cost) to arrive at a positive benefit-cost ratio. Projects with a benefit-cost ratio of greater than 1 were considered as cost-effective for purposes of this analysis.

The following is an example of the application of the benefit-cost ratio to a hypothetical scenario:

Original CSI project cost:	**$30 million**
Cost to do I/I reduction work:	**$10 million (cost)**
Saving to CSI project resulting from I/I reduction (project is downsized):	**$15 million (benefit)**
Benefit-Cost ratio	**1.5**

In this example the benefit is the $15 million saved. This is compared to the cost of the I/I reduction work. The benefit-cost ratio is therefore $15 million/$10 million, which equals a benefit-cost ratio of 1.5.

4.5 Monitoring, Modeling, and Pilot Project Data

In addition to the assumptions described in this chapter, cost and performance data from County and local agency systems and from the 10 I/I reduction pilot projects were used for the benefit-cost analysis. These efforts are summarized here and described in more detail in Chapter 3.

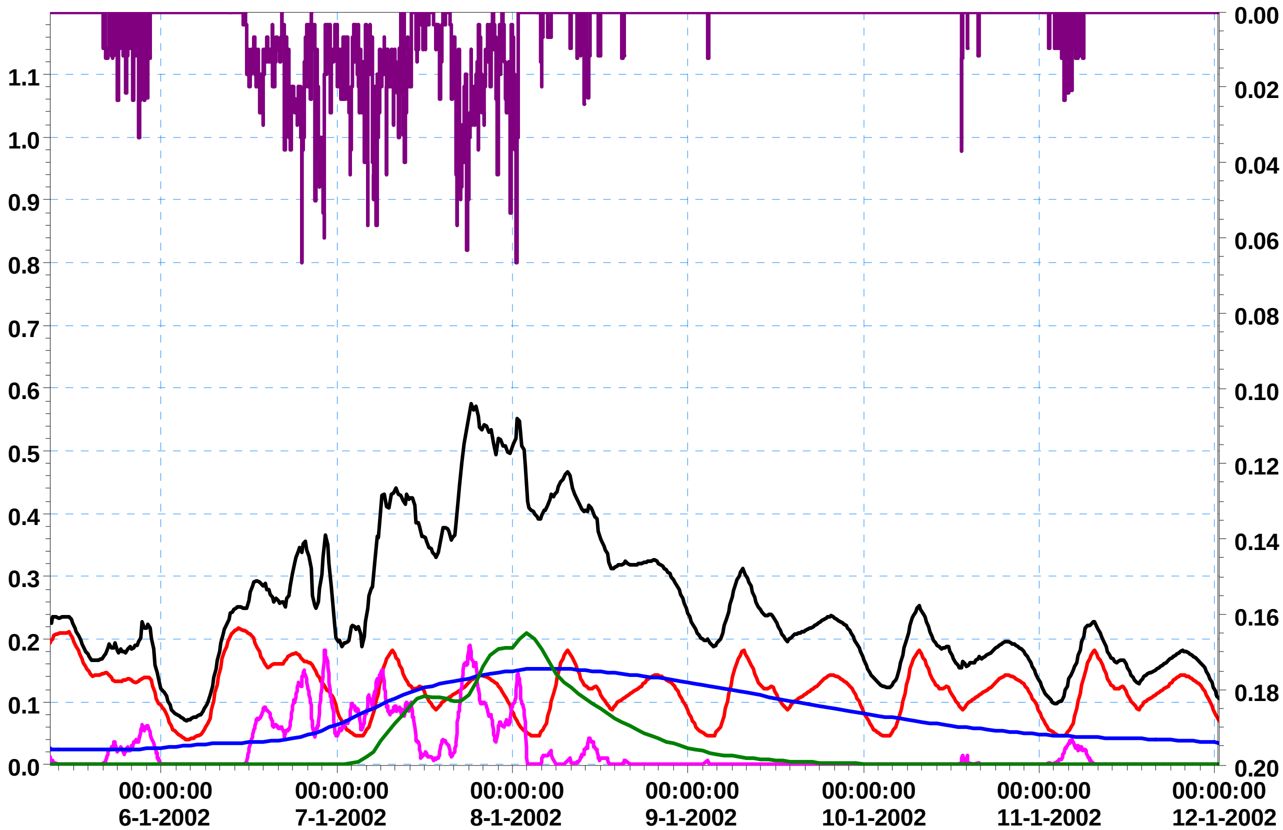
Local agency system data were key inputs to the benefit-cost analysis. Information about the physical configuration of local agency facilities was accessed through the King County geographic information system (GIS). Data showing the physical layout of collection system pipes and existing land use were provided by local agencies and were imported into the County's GIS database. Information about local agency geography, property parcel lines, and the location of future service areas was provided by the County and verified with the local agencies.

The location and intensity of wastewater flows and I/I within the local agency systems provided the basis for estimating the costs of CSI and I/I reduction efforts and also provided necessary information about I/I volumes. To obtain this information, the County conducted a comprehensive flow monitoring study during the winters of 2000–2001 and 2001–2002.[9]

Models were developed to determine the required system capacity before and after implementing proposed I/I reduction projects and to predict the impact of wet-weather conditions on the system. System configuration information, measured flows in local agency systems, and historical rainfall data were input to hydrologic and hydraulic models to represent and quantify how the regional wastewater system behaves with respect to I/I.[10]

[9] For more information about the flow monitoring study, see the *2000/2001 Wet Weather Flow Monitoring Technical Memorandum* and the *2001/2002 Wet Weather Flow Monitoring Technical Memorandum*.
[10] Detailed descriptions of the modeling efforts can be found in both the *Regional Needs Assessment Report* and the *Benefit-Cost Analysis Report*.

Modeled I/I consists of multiple flow components, as shown in Figure 4-. During dry weather, only wastewater and a relatively constant amount of clear water, or infiltration flow, are present in the wastewater system. During wet weather, basins that are impacted by I/I typically exhibit (1) a fast response almost immediately after rainfall begins that may continue throughout the rainfall event and subside quickly at the conclusion of the event and/or (2) a slow response that has less severe peaks and has a relatively longer duration after the rainfall event. Modeled I/I flow components point to likely system sources of I/I. For example, a sudden increase in flow after rainfall tends to indicate direct stormwater connections to the sewer (inflow) or infiltration from shallow side sewers. This modeled information, coupled with information from the pilot projects that demonstrated costs and reduction effectiveness of targeting specific system components for rehabilitation, provided key inputs to the benefit-cost analysis.



Legend:

Dry Weather Flow	Total Simulated I/I Flow
Base Infiltration	Fast Response Component
Measured Rainfall	Slow Infiltration
Date Format (dd-mm-yyyy)	Rapid Infiltration

Figure 4-3. Simulated Flow Components

4.6 Benefit-Cost Analysis Results

B/C Tool synthesized all required data and assumption inputs. The analysis identified nine cost-effective I/I reduction projects (Table 4-6). All of these projects yield a benefit-cost ratio of greater than 1—that is, the savings (benefit) achieved by an I/I reduction project that results in downsizing or eliminating the need for a CSI project is greater than the cost of doing the I/I reduction project (cost).

In response to direction in the RWSP, alternatives for evaluating cost-effectiveness were identified and documented in the *Alternatives/Options Report.* The definition of cost-effectiveness and the nine resulting cost-effective projects are based on the preferred alternative—that cost-effectiveness will be considered on a project-specific basis. Results of the benefit-cost analysis for the other two alternatives are summarized at the end of this section. Consensus-based recommendations regarding all three alternatives are discussed in Chapter 5. All cost and savings estimates are the result of a planning-level analysis done to support decision-making about how to proceed with I/I reduction efforts in the regional wastewater service area and are subject to change as further information is developed for each project.

The three alternatives for evaluating cost-effectiveness are as follows:

- **Project specific basis (preferred alternative).** Each project has to meet the criterion of a benefit-to-cost ratio of greater than 1. The savings from I/I reduction for a particular CSI project would have to exceed the I/I project costs on a stand-alone basis. Savings from projects with a greater than 1 ratio could not be used to fund projects with benefit-cost ratios of less than 1.
- **Region-wide basis.** Savings would accumulate from projects with a benefit-to-cost ratio that is greater than 1. These accumulated savings could then be applied to additional I/I reduction projects with benefit-cost ratios of less than 1; thus, I/I reduction would be cost-effective on average over a region-wide basis.
- **A 30 percent I/I reduction goal.** RWSP Policy I/IP-2.4 states: “The overall goal for peak I/I reduction in the service area should be thirty percent from the peak twenty-year level identified in the (RNA) report.” The benefit-cost analysis would therefore need to evaluate the cost that would be expended to reach a goal of 30 percent I/I reduction.

Table 4-6. Cost-Effective I/I Reduction Projects

CSI Project No.	Project	I/I Available (mgd)	I/I Reduction (mgd)	Benefit: Capital CSI Cost Reduction	Cost: I/I Reduction Project	B/C Ratio	No. of Private Properties
60	South Renton Interceptor (RE*SRENTON.R18-16(9))	7.0	0.81	$7,270,000	$2,217,645	3.3	119
58	ULID 1 Contract 4 (RE*ULID 1-4.S-31(8))	5.5	1.08	$2,410,000	$999,123	2.4	101
55	Auburn 3 New Storage (Auburn3 Twin Tube Storage)	52.8	6.87	$22,990,000	$11,362,511	2.0	1,176
59	Issaquah 2 Trunk (RE*ISSAQ2.R17-40(3))[a]	5.4	1.05	$5,770,000	$3,964,850	1.5	395
33	Bryn Mawr Storage (Bryn Mawr Tube Storage)	16.2	2.04	$8,510,000	$6,018,534	1.4	557
47	Lk Hills Trunk 3rd Barrel Upgrade (WE*LKHILLST.ENTR(3))	10.8	2.20	$14,438,000	$11,307,052	1.3	1,086
41	Eastgate Storage and Trunk[b] (Eastgate Tube Storage)[a]	8.7	3.55	$16,629,000	$14,459,862	1.2	1,163
35	Wilburton PS / Factoria Trunk (RE*FACTOR.RO6-05(7))	10.4	2.39	$12,058,000	$10,550,378	1.1	976
46	Garrison Creek Trunk (RE*ULID 1-5.57I(10))	5.7	2.12	$13,660,000	$12,013,489	1.1	1,275
	TOTAL	**122.5**	**22.11**	**$103,735,000**	**$72,893,444**		**6,848**

Note: Identified projects are based on E&P Subcommittee–approved assumptions.

[a] The Eastgate Tube Storage and RE*ISSAQ2.R17-40(3) projects are related and are considered as one project for construction.
[b] Modeling for the Eastgate trunk facilities was updated since the *Regional Needs Assessment Report* was published in March 2005. The updated project now includes the new Eastgate storage facility.

Considering cost-effectiveness on a project-specific basis focuses I/I reduction where downstream conveyance benefits are the greatest. This alternative also achieves the greatest possible savings to the region. Highlights of the nine cost-effective I/I reduction projects resulting from this analysis are as follows:

- The estimated cost of implementing the nine cost-effective I/I reduction projects is approximately $73 million.
- The anticipated I/I reduction achievable is estimated at 22 million gallons per day (mgd), or approximately 18 percent of the I/I present in the affected mini basins and approximately 5 percent of the I/I present in the entire regional service area.
- As a result of reducing I/I flows, the capital costs for associated CSI projects could be reduced from approximately $268 to $164 million, resulting in a regional CSI savings of nearly $104 million.

- The net overall savings realized from implementing the nine identified cost-effective I/I reduction projects is estimated at approximately $31 million.

The benefit-cost analysis for the second alternative—evaluating cost-effectiveness on a regional basis—identified 13 projects, with benefit-cost ratios ranging from a high of 3.3 to a low of 0.48. While several projects on the list were less than cost-effective, the savings from the other projects were spread out to make the average benefit-cost ratio 1.02, essentially a break-even ratio. To pursue this alternative, approximately $132 million would be spent on I/I reduction to achieve a $134 savings (benefit), for a net overall saving of $2 million.

The benefit-cost analysis for the third alternative evaluated the cost of removing 135 mgd of I/I from the regional collection system, which is 30 percent of the region's total estimated 450 mgd of I/I. The total cost to achieve this level of I/I reduction was calculated at approximately $398 million and would result in a savings in capital CSI project costs of $116 million. For this alternative, the benefit ($116 million) to cost ($398 million) ratio for achieving 30 percent I/I reduction would be 0.29, which is below the standard set for cost-effectiveness.

4.7 Sensitivity Analysis Results

At the request of the E&P Subcommittee, the initial assumptions regarding I/I reduction levels were used to complete a sensitivity analysis that would put an upper limit on the potential savings available to the region through I/I reduction. The sensitivity analysis was conducted for comparison purposes only, in order to provide the range of cost-effective projects possible. Recommendations for use of sensitivity analysis results are discussed in Chapter 5 of this report.

The initial assumptions used in the sensitivity analysis are shown in Table 4-7; a comparison of the results of the benefit-cost and the sensitivity analyses is shown in Table 4-8. Using the initial assumptions results in identification of 11 cost-effective I/I reduction projects with a greater total projected net regional savings and level of I/I reduction than the 9 projects identified through the benefit-cost analysis.

Table 4-7. Sensitivity Analysis Using the Initial Assumptions for I/I Reduction

Technique	Description	% Basin Rehabilitated	% I/I Reduction Assumption
1	Direct disconnects	4%	15%
2	Replace everything and direct disconnects	95% Sewer mains 95% Manholes 95% Laterals and side sewers 4% Direct disconnects	80%
3	Replace public sewers and direct disconnects	50% Sewer mains 50% Manholes 50% Laterals 4% Direct disconnects	45%
4	Private property and some laterals and direct disconnects	25% Laterals and side sewers 70% Side sewers only 4% Direct disconnects	75%
	Minimum remaining I/I after rehabilitation	1,500 gallons per acre per day (gpad)	

Notes:

Laterals are the portion of the private sewer pipe that is in public right-of-way; a side sewer is the portion of the private sewer pipe that is on private property.

Direct disconnects are the disconnection of connections to the sewer system, usually located on private property, that allow stormwater to flow into the sanitary sewer. Examples of such connections include roof gutter drains, catch basins, sump pumps, and foundation drains.
A sewer main is a principal sewer to which branch sewers are tributary.

Table 4-8. Comparison of Benefit-Cost and Sensitivity Analyses Results

	Conservative Assumption	Initial Assumption
Total I/I removed	22 mgd	59 mgd
% removed	**5%**	**13%**
Total capital savings	$104,000,000	$216,500,000
Total I/I rehabilitation costs	$73,000,000	$107,000,000
Total net regional savings	**$31,000,000**	**$109,500,000**
CSI projects no longer needed	10	28
CSI projects downsized	18	12