

# INFILTRATION AND INFLOW REDUCTION 101

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REGIONAL I/I CONTROL PROGRAM  
DECEMBER 5, 2019



**King County**

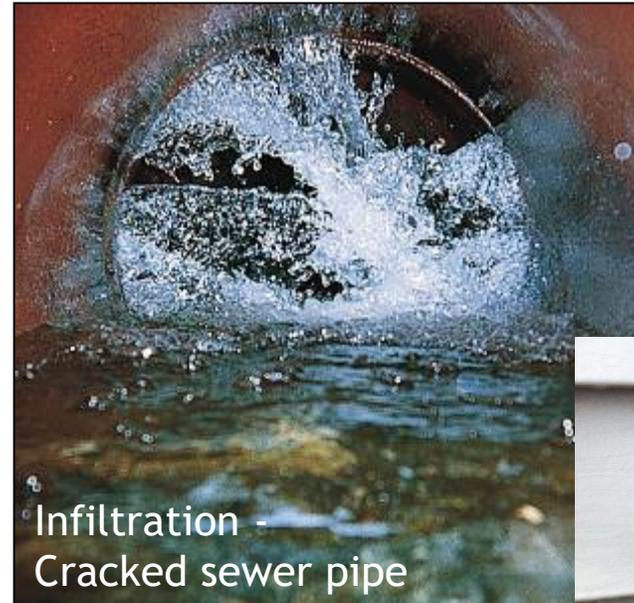
Department of Natural Resources and Parks  
**Wastewater Treatment Division**

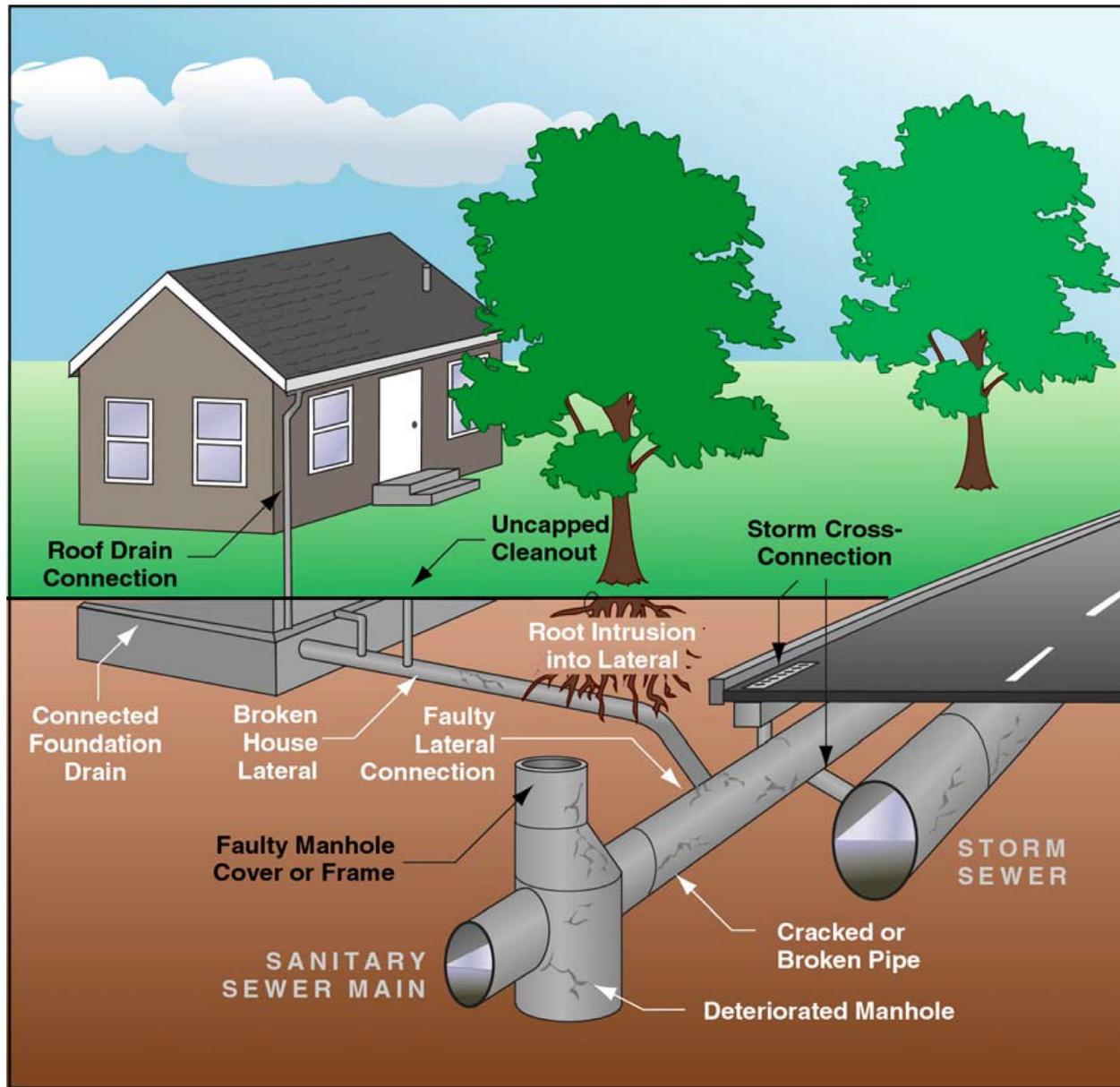
# OVERVIEW / AGENDA

- What is infiltration and inflow?
- How does I/I impact the regional sewer system?
- What has the region done to control I/I?
  - Activities/Accomplishments
  - Lessons Learned
  - Current Work

# WHAT IS INFILTRATION AND INFLOW?

- Infiltration - subsurface flow or groundwater that enter the sewer system
- Inflow - surface water (storm-related) that enters the sewer system





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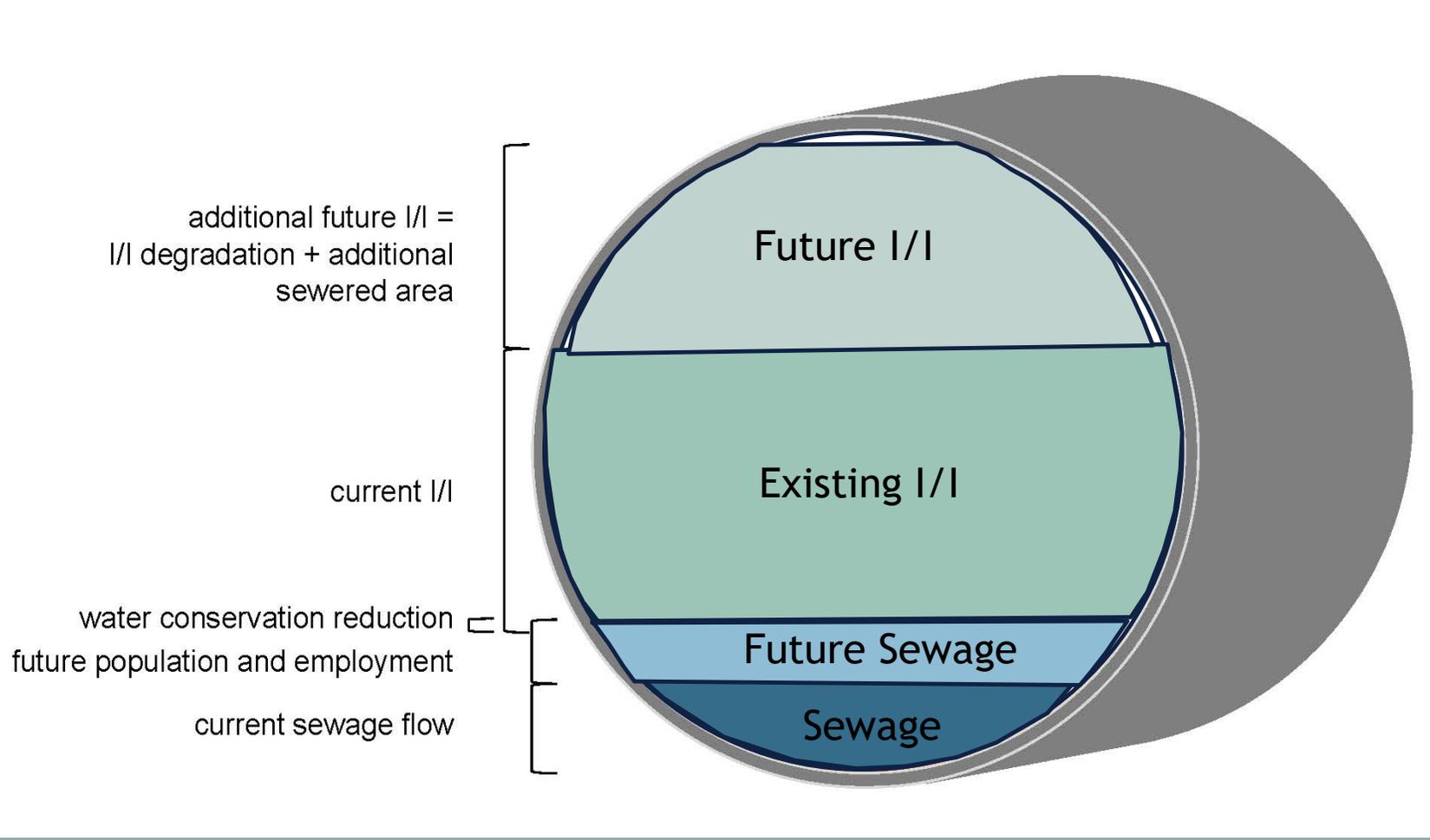
**Key:**



**King County**

Department of Natural Resources and Parks  
 Wastewater Treatment Division  
 Regional I/I Control Program

# TYPICAL COMPONENTS OF FLOW



# SIGNS OF INFILTRATION AND INFLOW



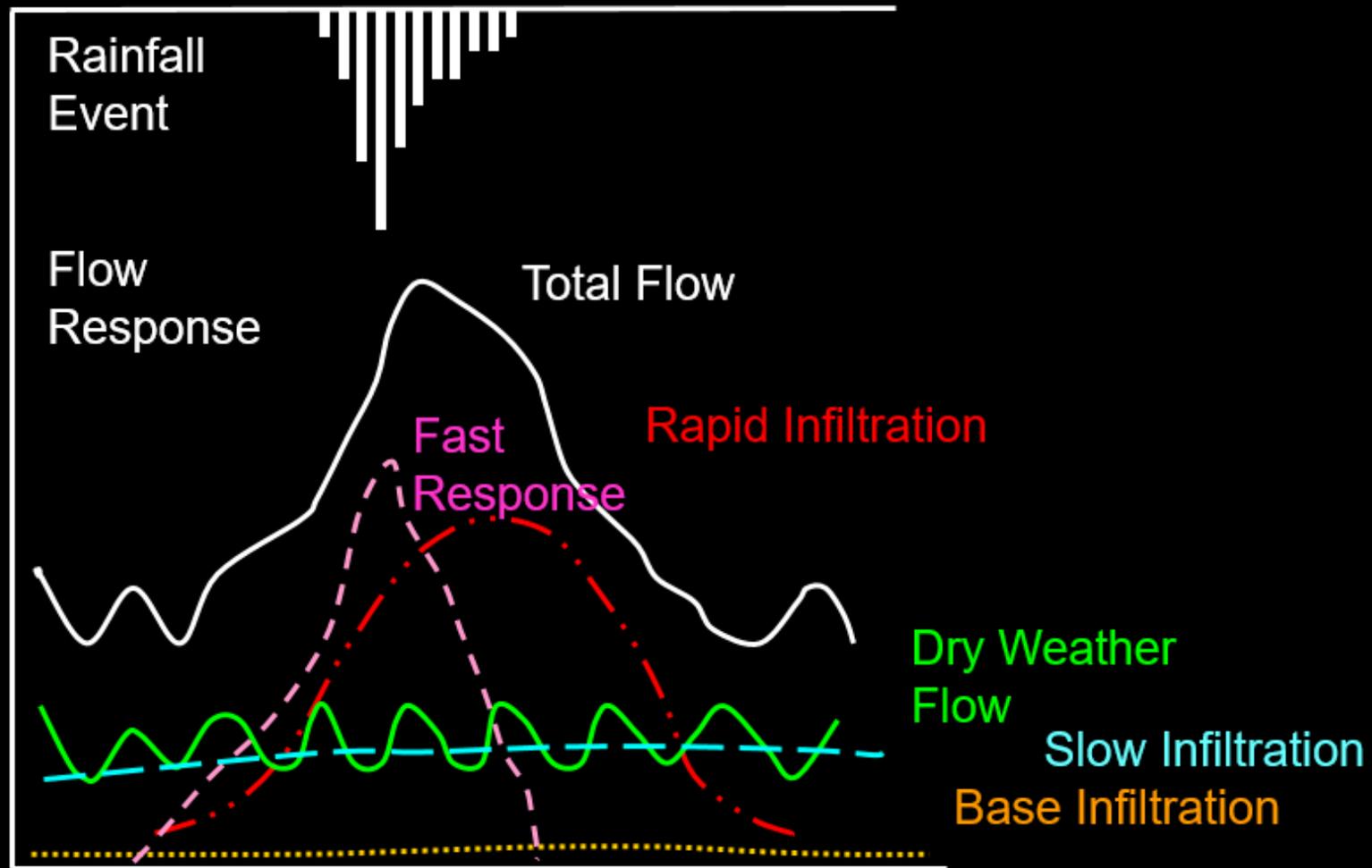
high water mark  
associated with I/I  
from wet season

base flow

# SIGNS OF INFILTRATION AND INFLOW



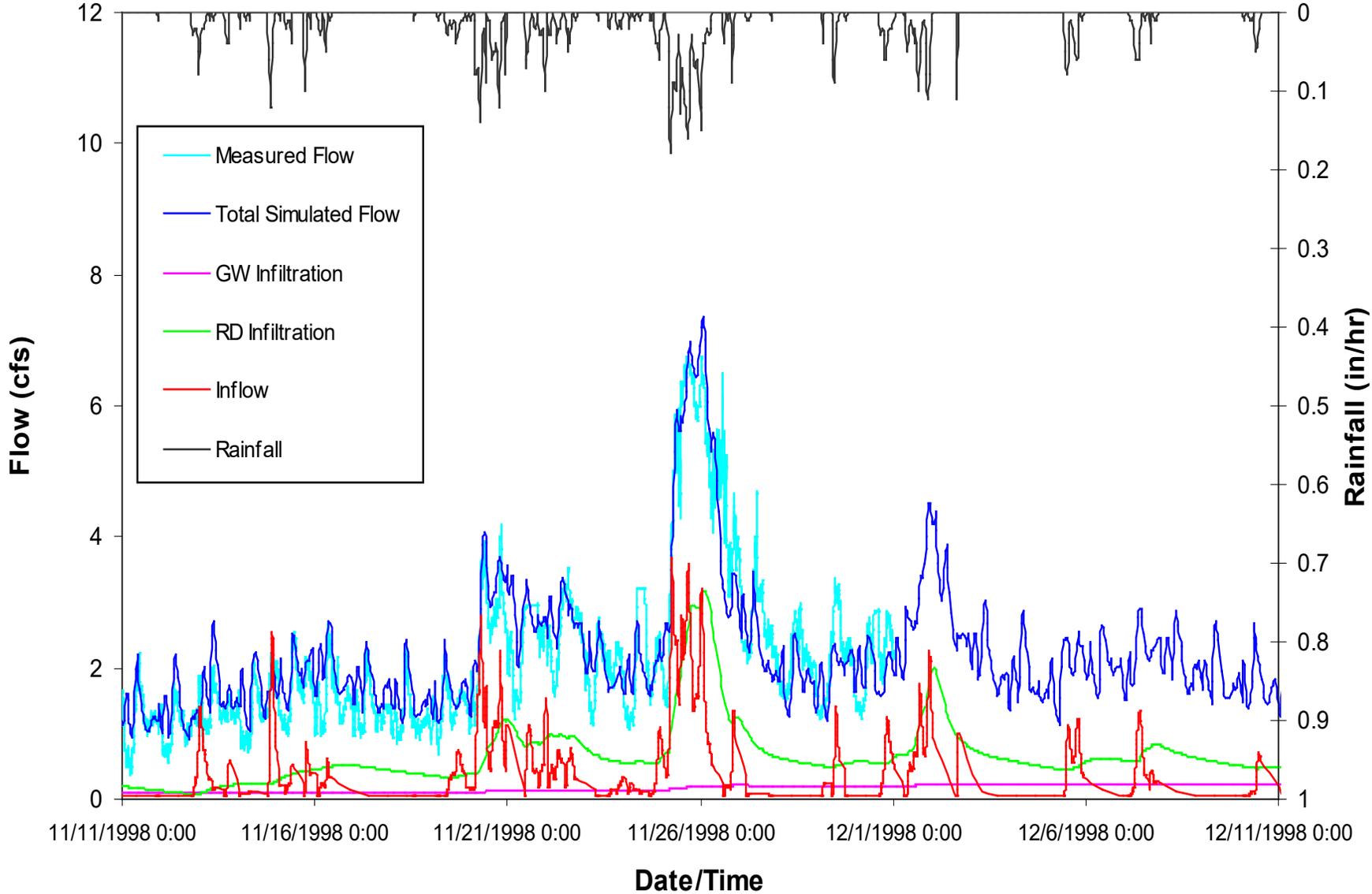
# MONITORING & MODELING FLOW



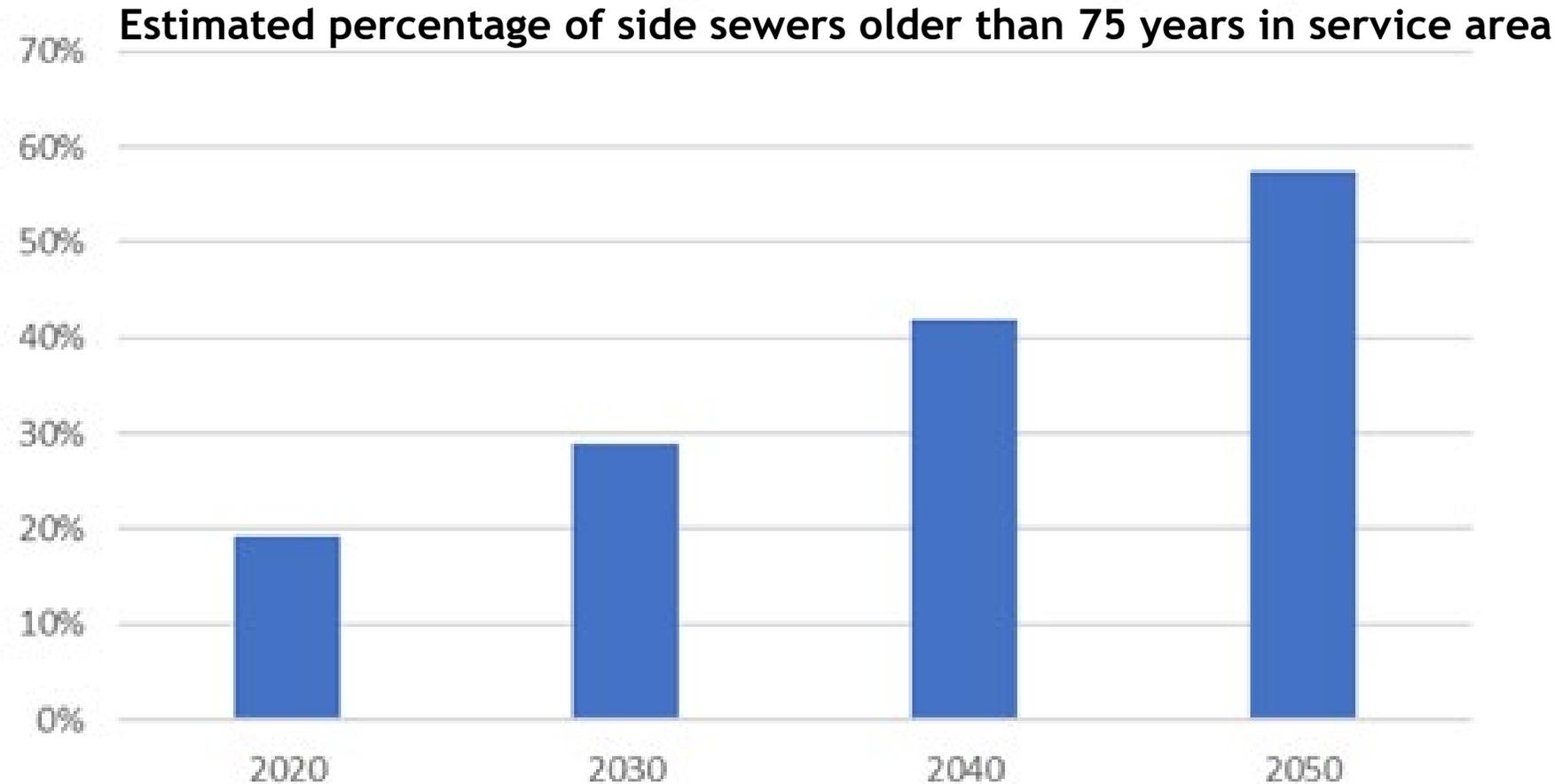
Source of I/I

- Surface water
- Surface Soil Storage
- Sewage
- Lower Soil Storage
- Groundwater

# Calibration Results



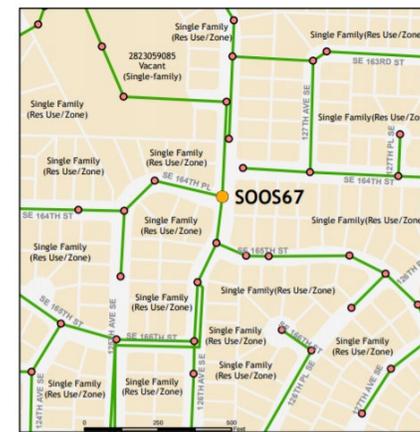
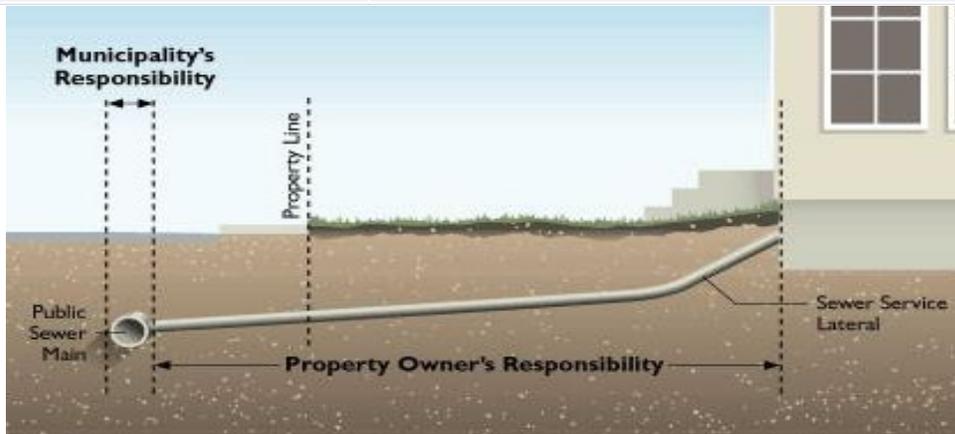
# AGING INFRASTRUCTURE



Source: 2016 King County Housing Stock Analysis

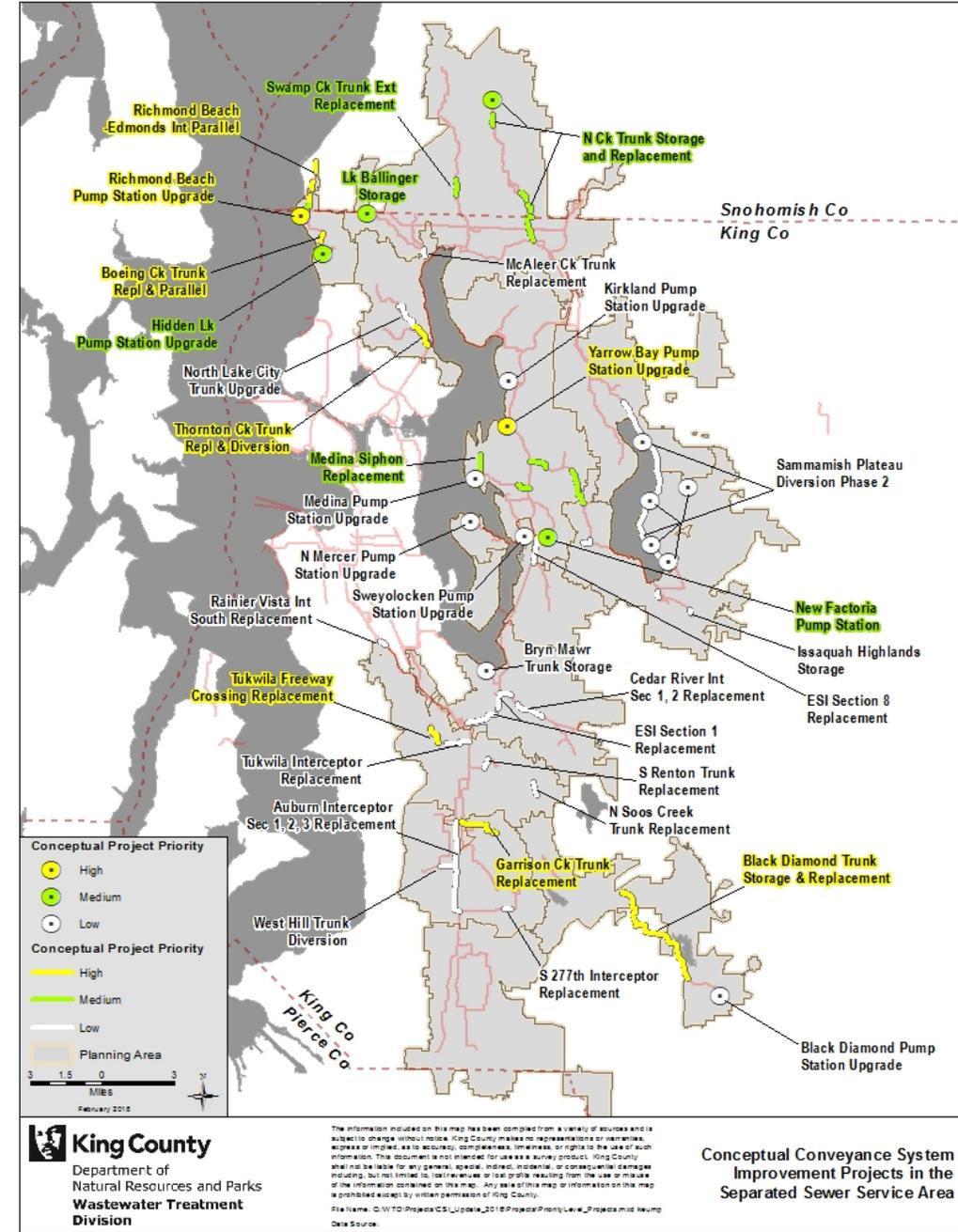
# SEPARATED WASTEWATER COLLECTION SYSTEM COMPONENTS

	Side Sewers	Local Agency Sewers	King County Conveyance
Ownership	Private	City/Sewer District	King County
Diameter	4-6 inches	8-20 inches	> 20 inches
System Length	No estimate	5,200 miles	390 miles
Influence on I/I	High	Low	Low

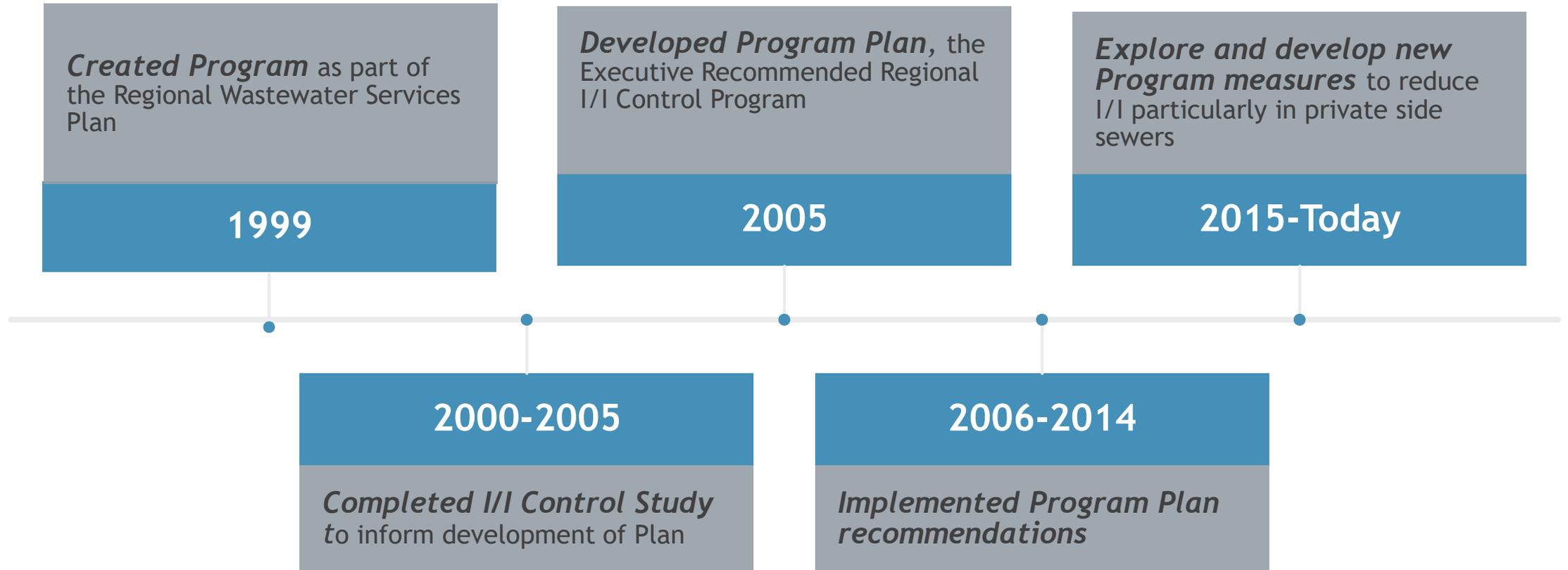


# IMPACTS TO REGIONAL SYSTEM

- As much as 75% of peak flow is I/I
- Approximately \$1.7 billion (2016\$) in CSI Projects through 2060
- Cost is expected to increase due to inflation and other factors

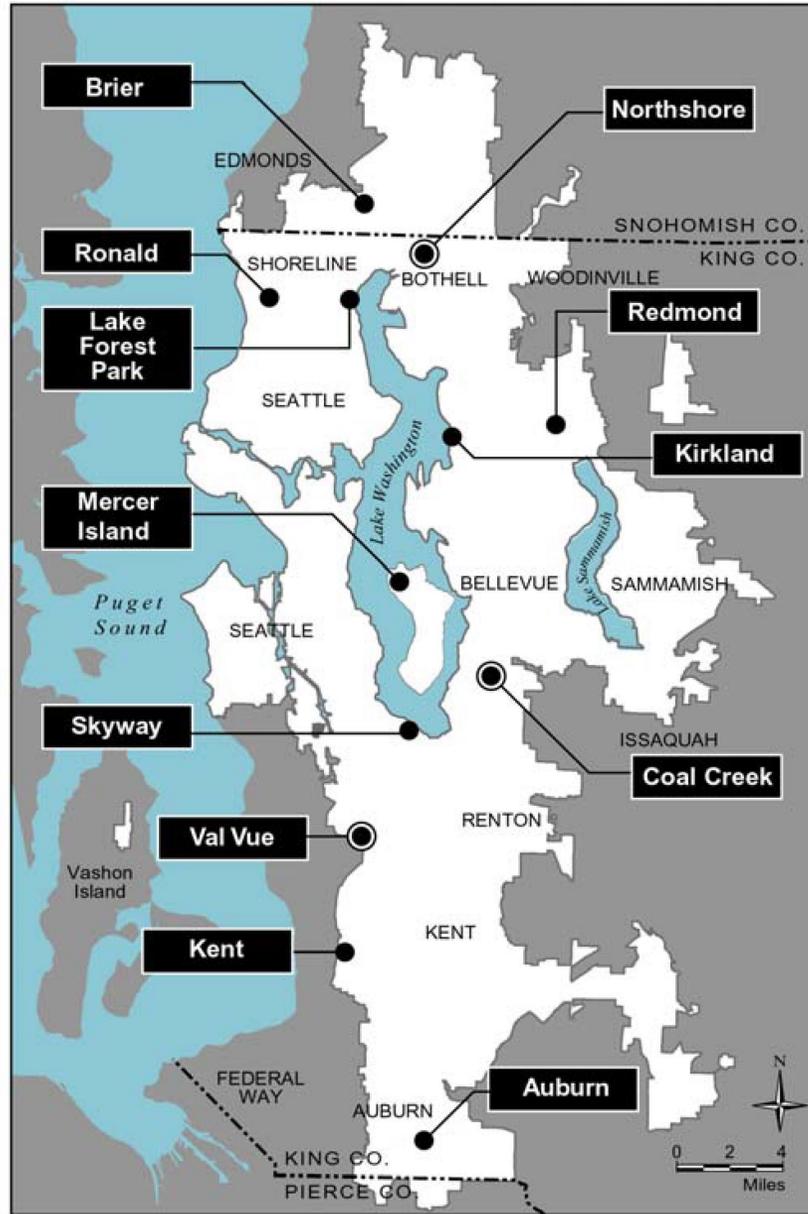


# WHAT HAS THE REGION DONE TO CONTROL I/I?





# I/I CONTROL STUDIES: PILOT PROJECTS



- Selected Pilot Project
- Selected Pilot Project (Combined Manhole Rehabilitation Project)
- King County Wastewater Service Area

	Mains	Manholes (MH)	Laterals (L)	Side Sewers (SS)	% of Basin Improved <sup>a</sup>	20 Year Peak I/I <sup>b</sup>	
						Reduction %	
Auburn	●	●	●	●	11% of mains		NMR
Brier	●	●			23% of mains		50%
Kent			●	●	100% of L and SS		76%
Kirkland	●	●	●		25% of mains		28%
Lake Forest Park	●	●			35% of mains		69%
Manhole Project		●					23% <sup>c</sup>
Mercer Island	●				70% of mains		37%
Redmond	●	●	●		36% of mains		NMR
Ronald			●	●	72% of L and SS		74%
Skyway	●	●	●	●	100% of mains		87%

NMR = no measurable reduction.

# I/I CONTROL STUDIES: PILOT PROJECTS LESSONS LEARNED

- Sewer system evaluation surveys are most effective when done in the wet-weather season
- A high percentage of I/I tends to originate in side sewers and laterals
- Very little I/I reduction will likely result from manhole rehabilitation alone
- Success of I/I control projects depends on a high level of cooperation with local agencies and private property owners
- Rehabilitating sewer mains at the same time that side sewers and laterals are rehabilitated may be done for a relatively small increased in cost

# I/I CONTROL STUDIES: 2005 BENEFIT/COST ANALYSIS REPORT

- Developed MWPAAC agreed upon program assumptions
- Compared the estimated costs of constructing conveyance system improvement projects with the estimated costs of proposed I/I reduction projects

- Benefit/cost ratio =  
$$\frac{\text{CSI project cost savings after I/I reduction}}{\text{cost of proposed I/I reduction project}}$$

Example:

Original CSI Project Cost:	\$30 million
Cost to do I/I reduction work:	\$10 million (cost)
Savings to CSI project resulting from I/I reductions:	\$15 million (benefit)

Benefit/cost ratio: 1.5

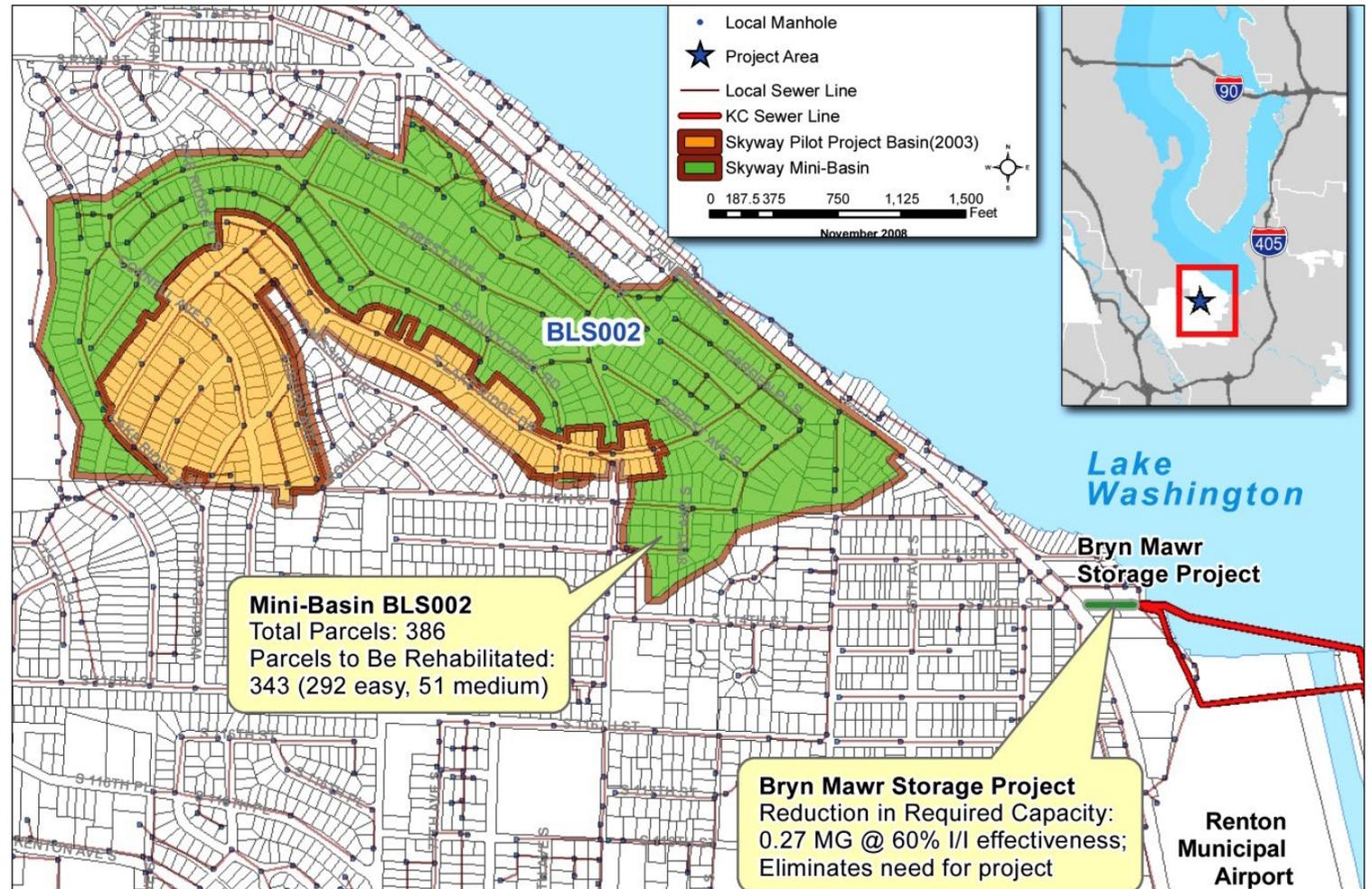
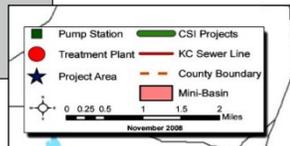
- Identified cost effective initial projects

# IMPLEMENTATION OF I/I PROGRAM PLAN (2006-2014)

- Select, implement, and evaluate “initial” I/I reduction projects to test the effectiveness of I/I reduction on a larger scale than the pilot projects.
- Implemented 1 “initial” project - Skyway I/I reduction project
- Proceed to apply I/I reduction planning to all CSI project planning



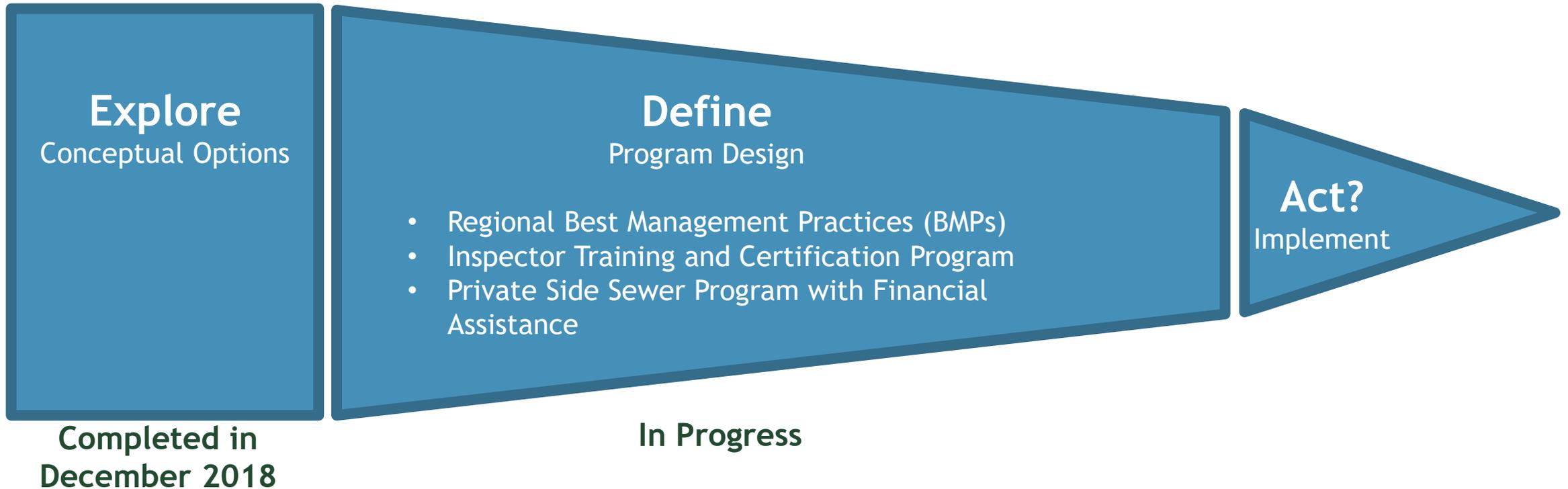
# IMPLEMENTATION OF I/I PROGRAM PLAN: INITIAL PROJECT IN SKYWAY



# IMPLEMENTATION OF I/I PROGRAM PLAN: SKYWAY PROJECT LESSONS LEARNED

- Benefits of rehabilitation work are most apparent in the local system in which the work is performed
- Downstream translation of I/I reduction more difficult to achieve
- While repairing one basin, other tributary basins continue to age. Effects of degradation need to be factored in.
- Specific lessons for design and construction of I/I reduction projects

# CURRENT I/I WORK



# I/I REDUCTION IN WTD CAPITAL PROJECTS

2007 & 2017 CSI  
Program  
Conceptual  
Projects

Planning

Evaluate potential  
for I/I reduction  
using MWPAAC  
agreed upon  
program  
assumptions

Problem Definition

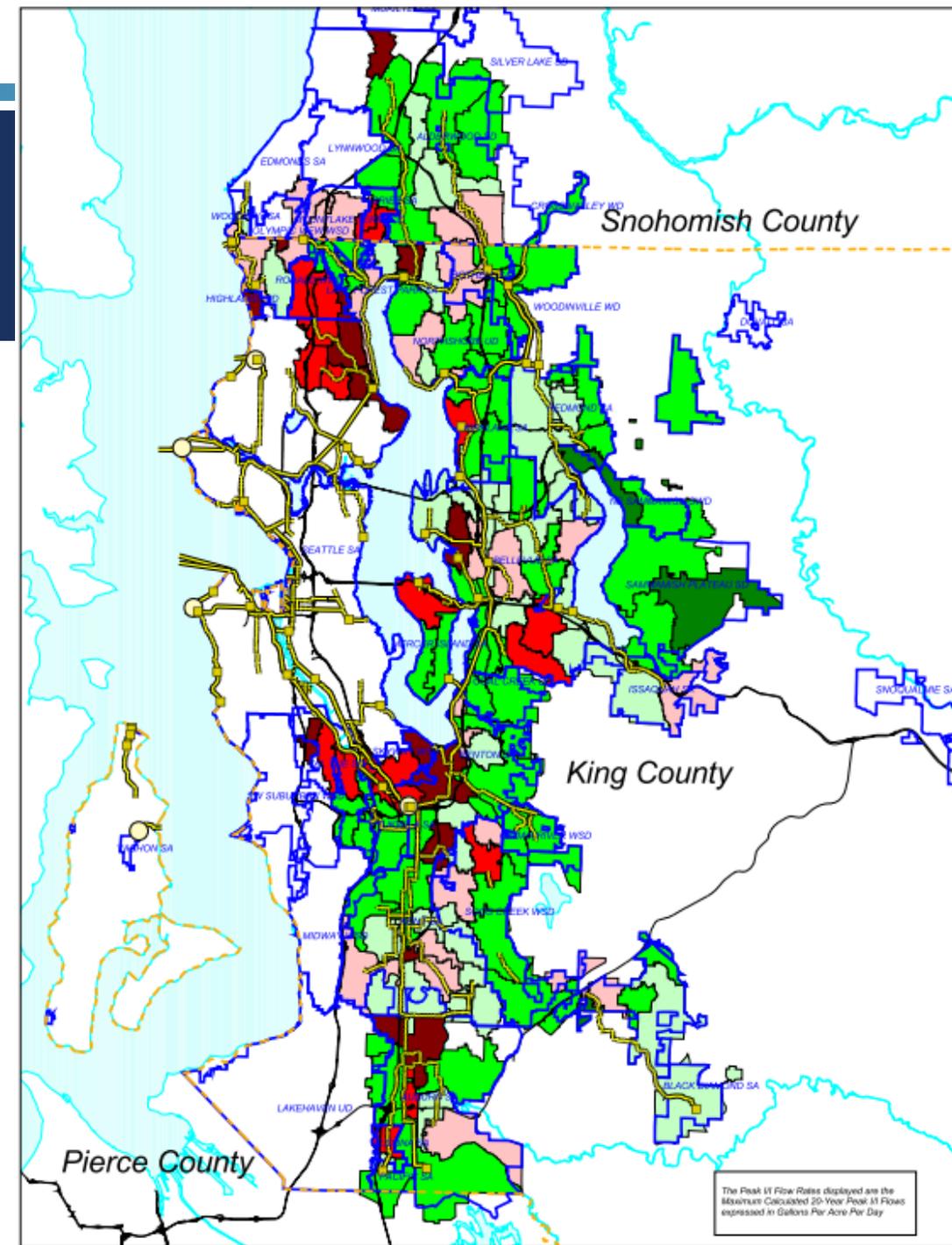
Determine  
whether to  
include I/I  
reduction in  
predesign

- If yes, I/I reduction included
- If no, I/I reduction not included

Project Predesign

# DECENNIAL FLOW MONITORING

- 2010 DFM deployed meters at the Modeling Basin level
- 2020 DFM will deploy meters at the Modeling Basin level
- Future comparison of 2010 and 2020 DFM



# QUESTIONS

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