WTD's Long-term Monitoring Program in Separated System

MWPAAC E&P Subcommittee

February 4, 2016

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Today's Presentation

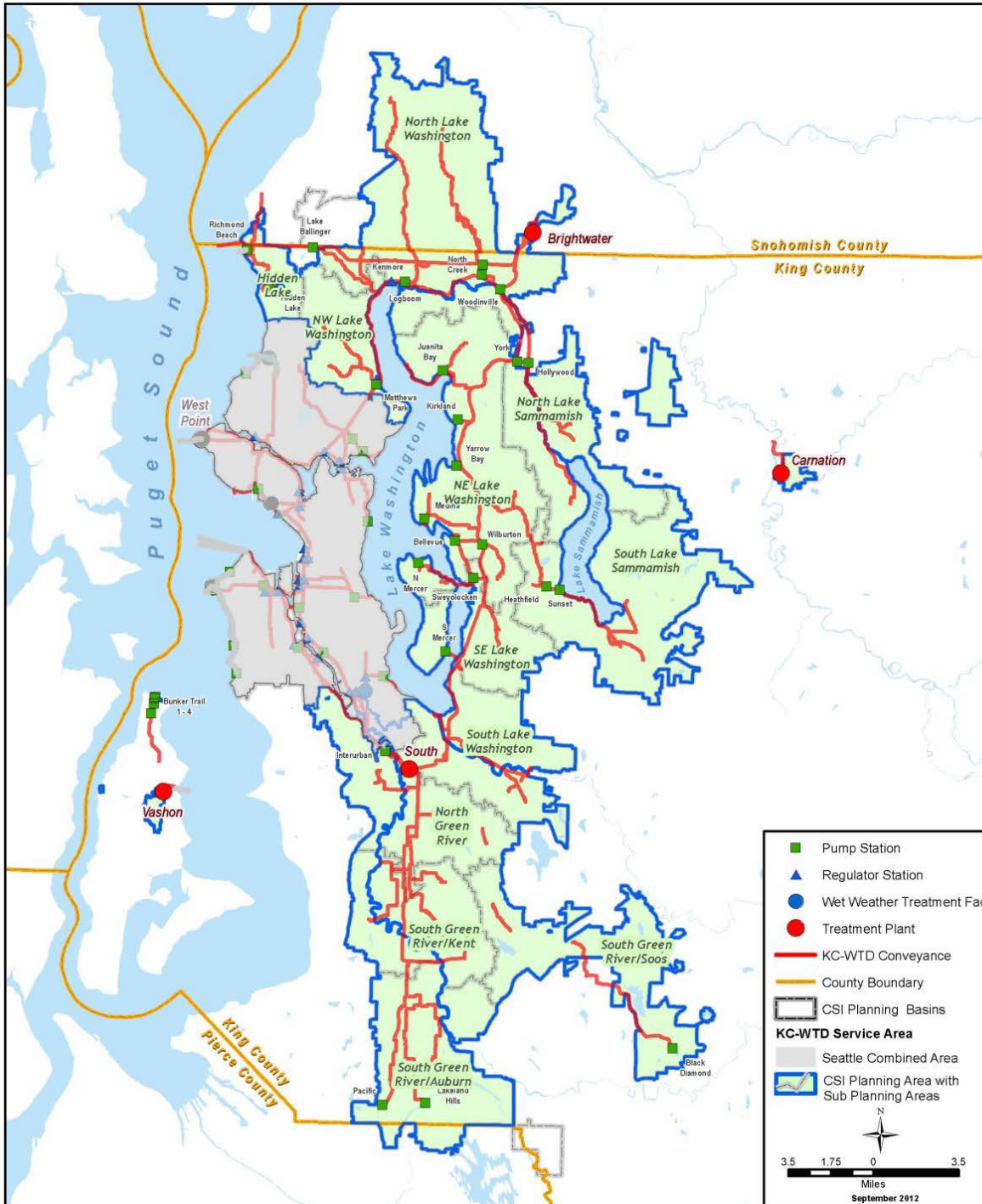
- Purpose of Flow Monitoring
- History of Flow Monitoring in Separated System
- Modeling in Separated System
  - To Estimate Peak I/I and Peak Flows

Why WTD Monitor Flows?

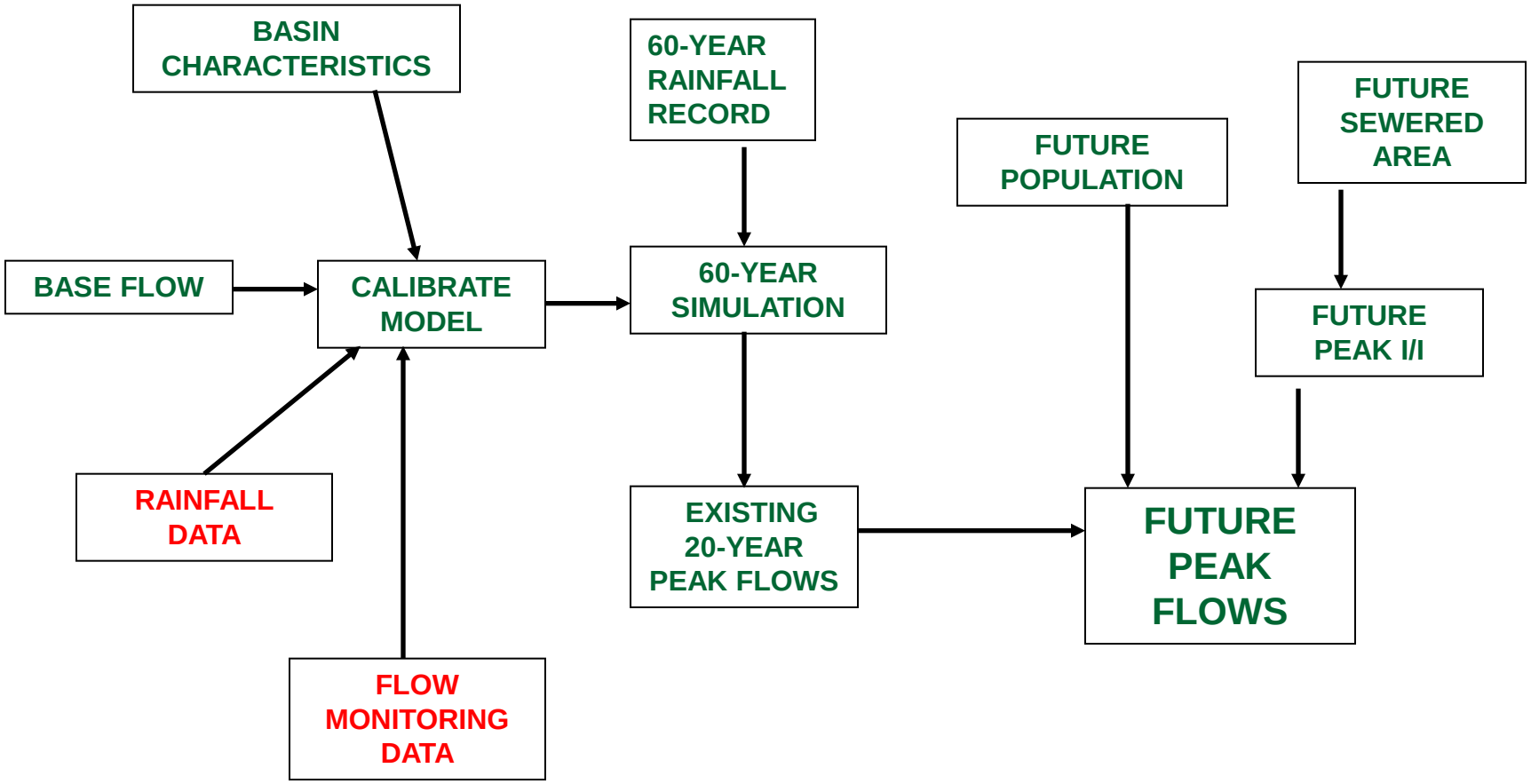
- To quantify flow and detect changes in flows in the service area
- To determine peak Infiltration and Inflow responses in the service area
- To identify and prepare for future needs -- ensure infrastructure and capacity are available when needed

Infiltration & Inflow Assessment

- Separated System
- Monitoring
- Modeling



Peak Flow Projections



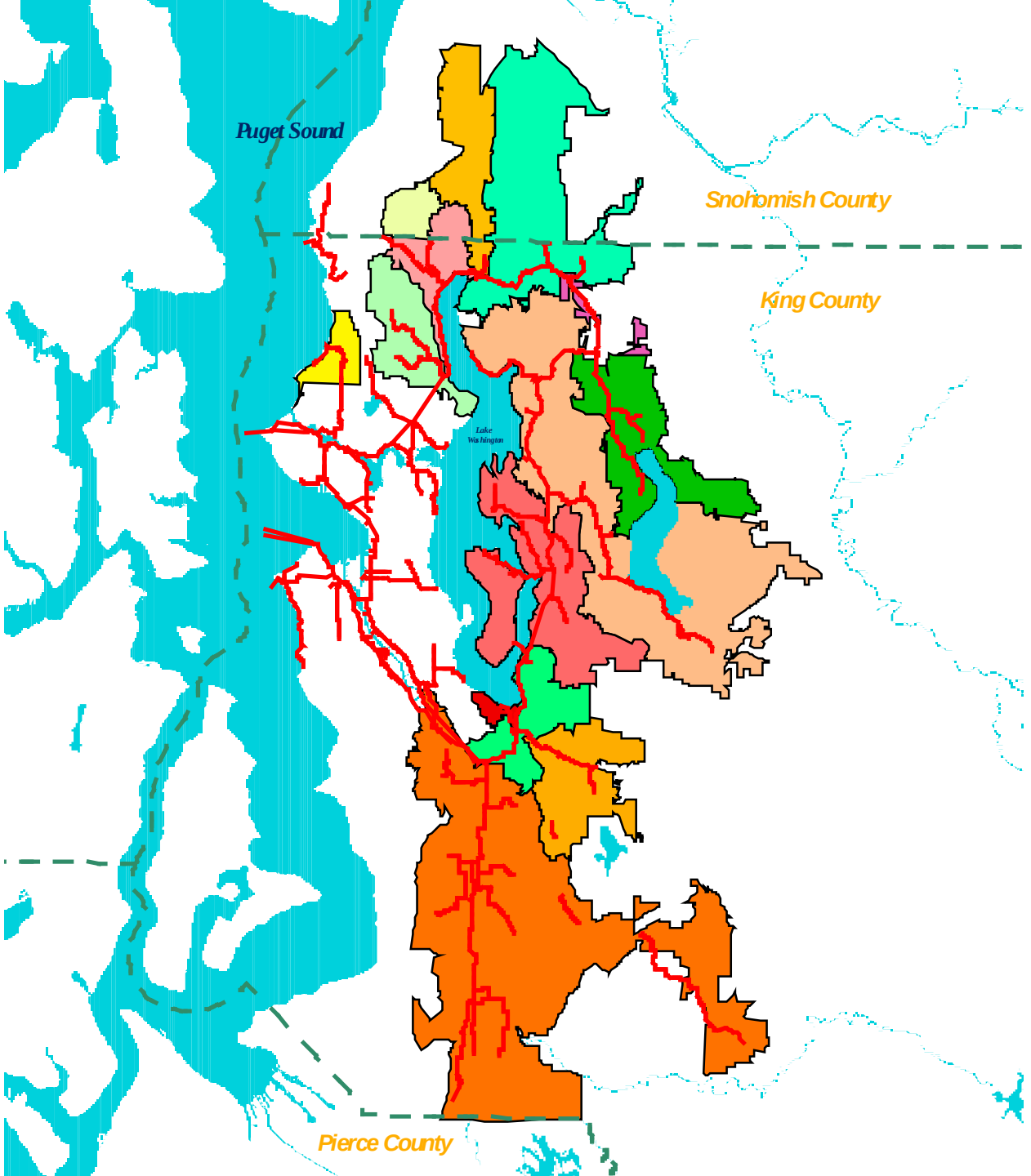
Major Flow Monitoring Efforts in Separated System

- 1970s – 1980s – Mostly Pump Station and T.P. Data
- 1990s – RWSP – added portable flow meters
- 2000 – 2001 - Part of I/I Program
  - 805, 775 meters; two 10-week periods in 2 wet seasons
  - 75 “long-term” meters – 1.7 years
- 2009 – 2011 – Decennial Flow Monitoring
  - 235 meters – 1.7 years
- 2019 – 2021 – next Decennial Flow Monitoring
  - ~235 meters planned for 1.7 years

RWSP

Conveyance Monitoring

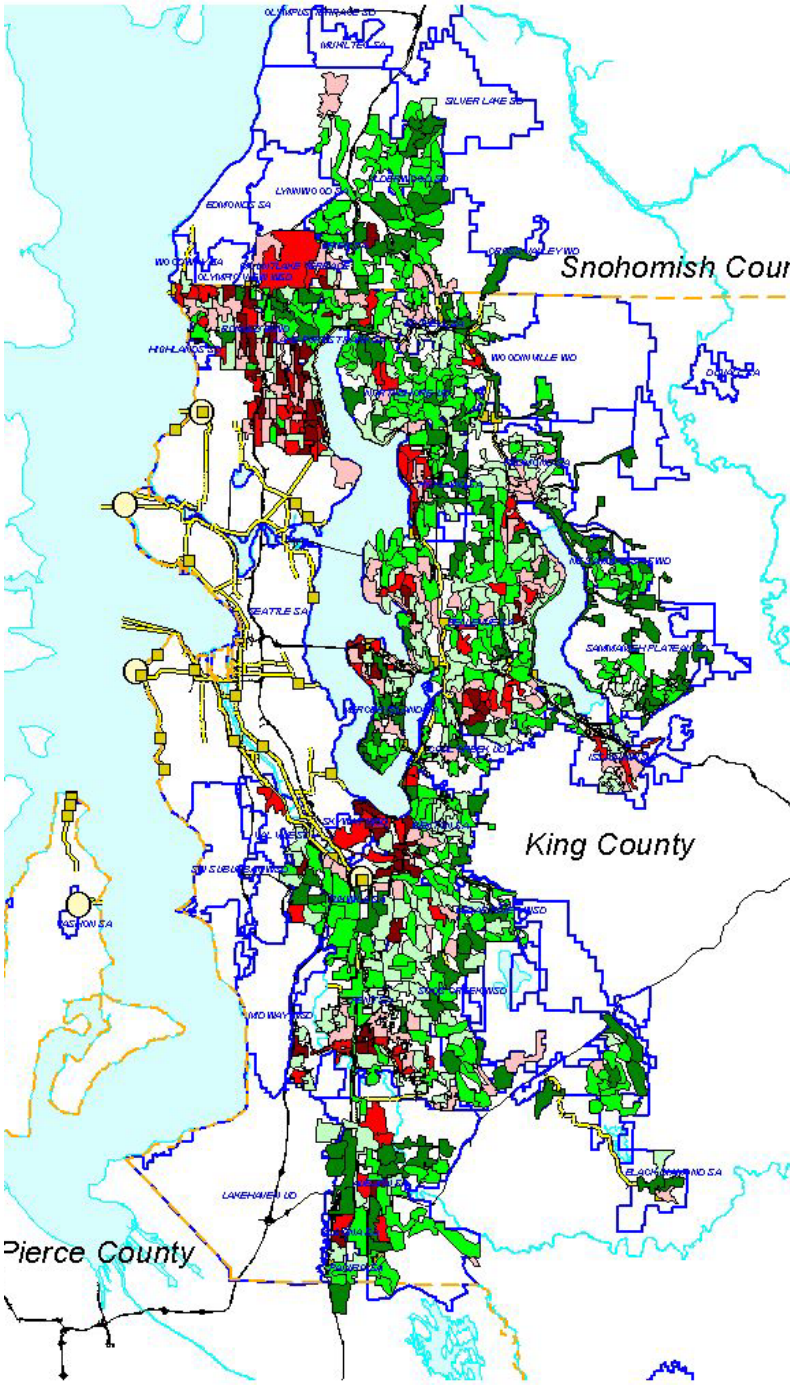
~ 1990 - 1992



2000 – 2002 Monitoring

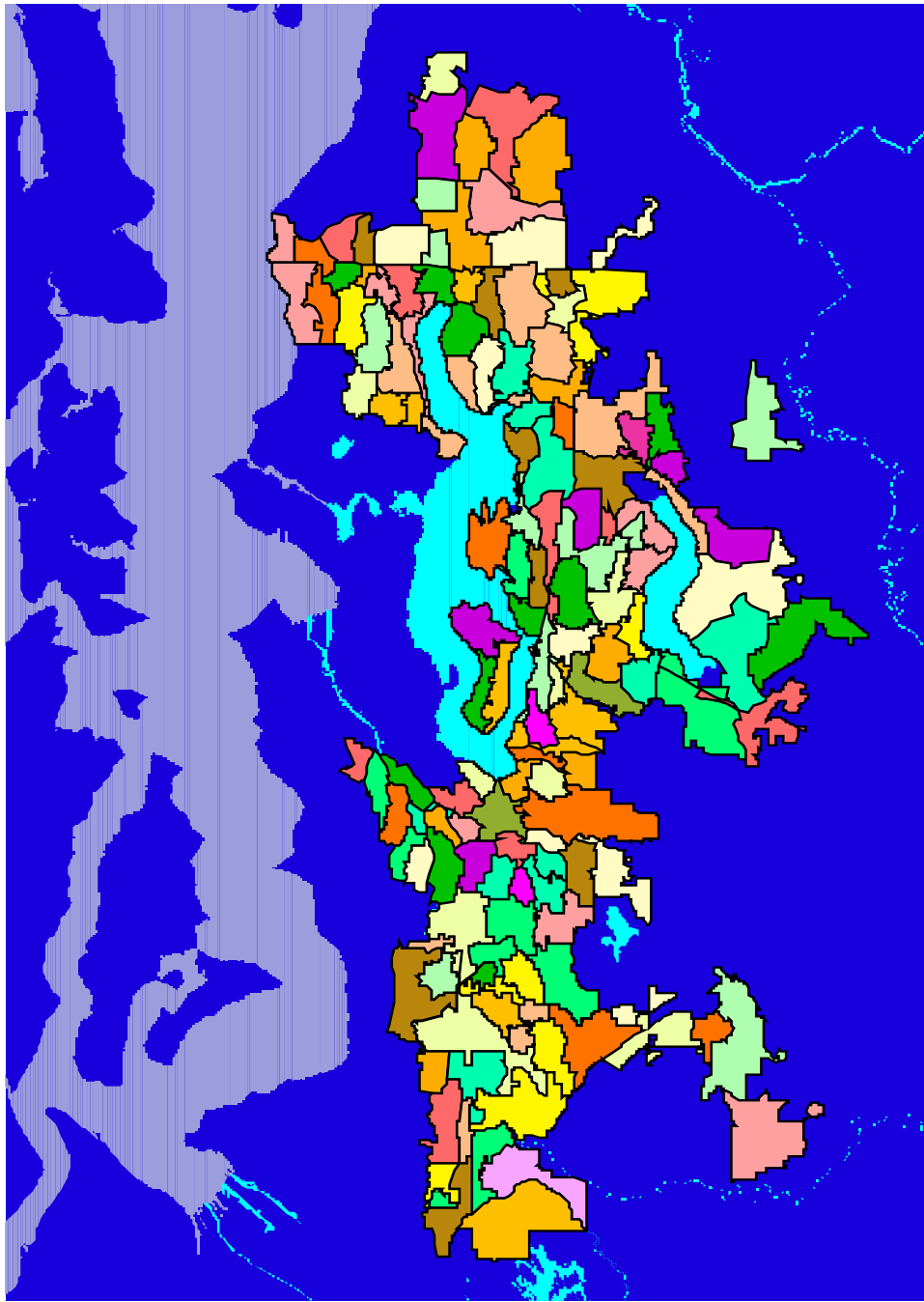
775 Mini-Basins

- Average Size:
  150 Acres
  22,000 LF of
  Sewer Main
- 26 Rain Gauges
- RADAR based
  Rainfall Estimates



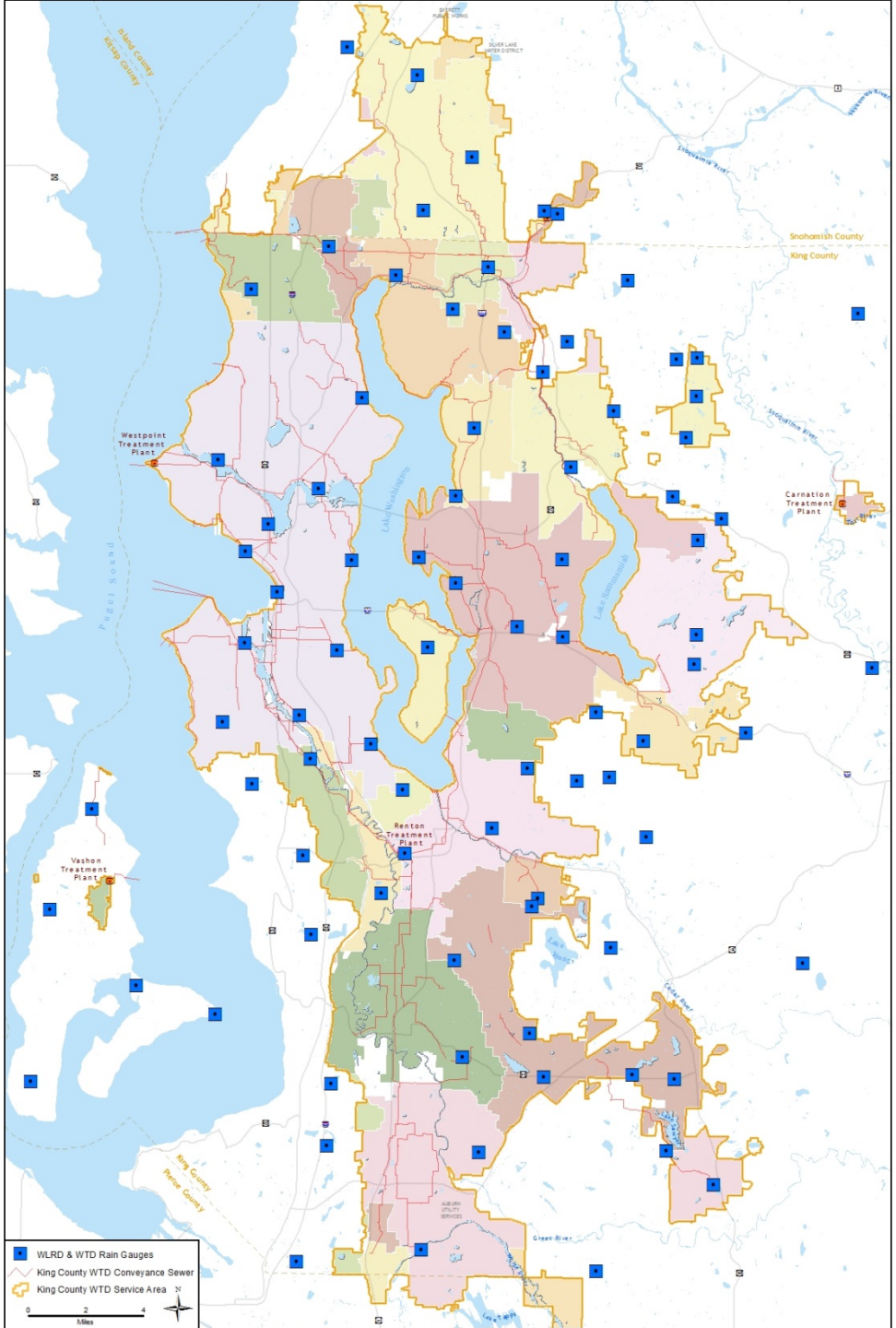
Decennial Flow Monitoring Approach 2009 – 2011

- Replicate 2000 – 2002 at the Modeling Basin level
- 235 monitoring locations (including 30 existing)
- System-wide “snapshot” for comprehensive planning of conveyance needs



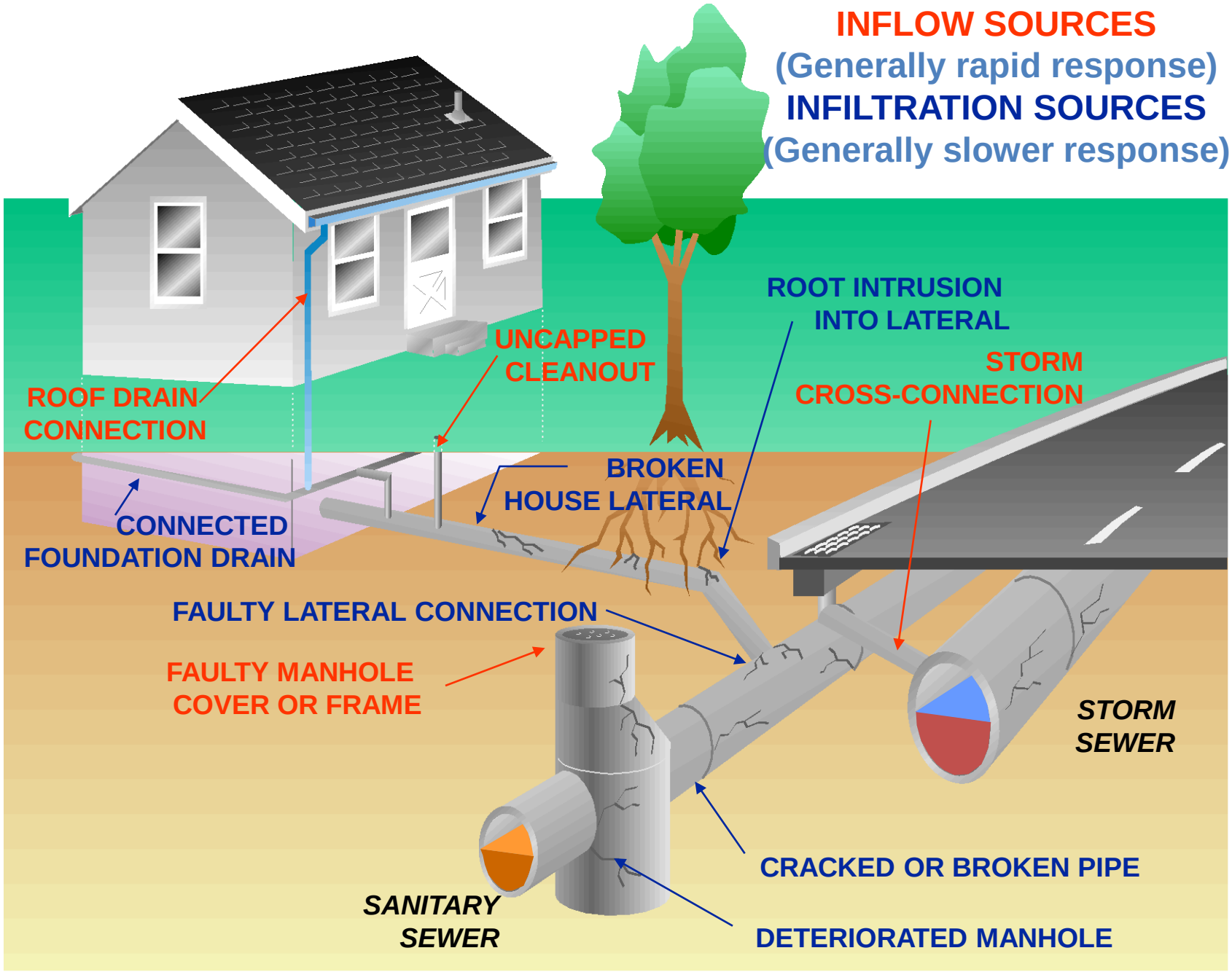
DFM Equipment
HACH Sigma 930 T Meters

Rain Gauges

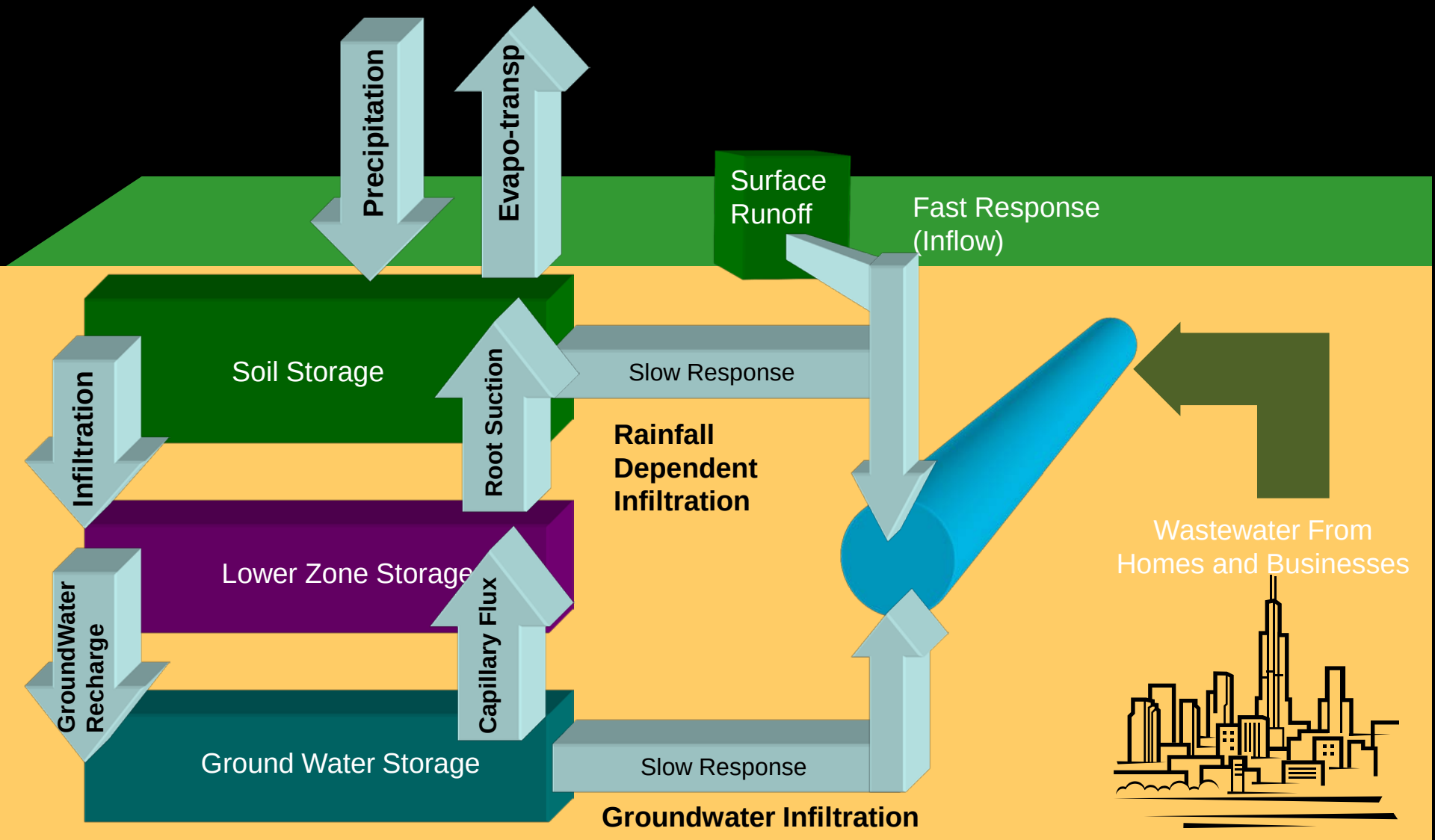

Island County
Kitsap County
Snohomish County
King County
Westpoint Treatment Plant
Carnation Treatment Plant
Renton Treatment Plant
Vashon Treatment Plant
Puget Sound
Lake Washington
Lake Sammamish
King County
Pierce County
WLRD & WTD Rain Gauges
King County WTD Conveyance Sewer
King County WTD Service Area
0
2
4
Miles

Modeling Software used in WTD's Separated System

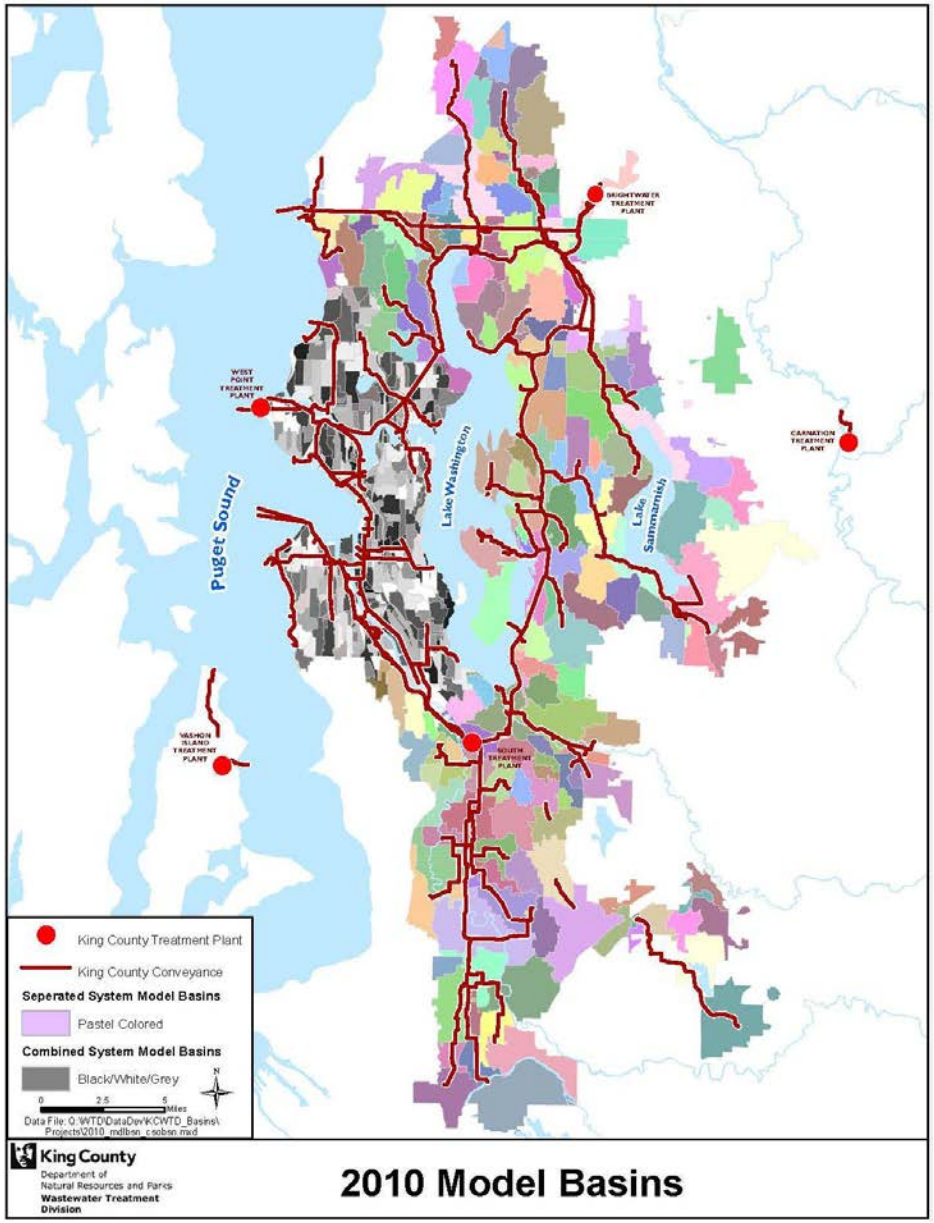
- 1990s – Runoff and UNSTDY
- I/I Program – MOUSE and MIKE URBAN, by DHI
  - Has been used as a starting point by local agencies for more detailed modeling


INFLOW SOURCES
(Generally rapid response)
INFILTRATION SOURCES
(Generally slower response)
ROOT INTRUSION
INTO LATERAL
UNCAPPED
CLEANOUT
STORM
CROSS-CONNECTION
ROOF DRAIN
CONNECTION
BROKEN
HOUSE LATERAL
CONNECTED
FOUNDATION DRAIN
FAULTY LATERAL CONNECTION
FAULTY MANHOLE
COVER OR FRAME
STORM
SEWER
CRACKED OR BROKEN PIPE
SANITARY
SEWER
DETERIORATED MANHOLE

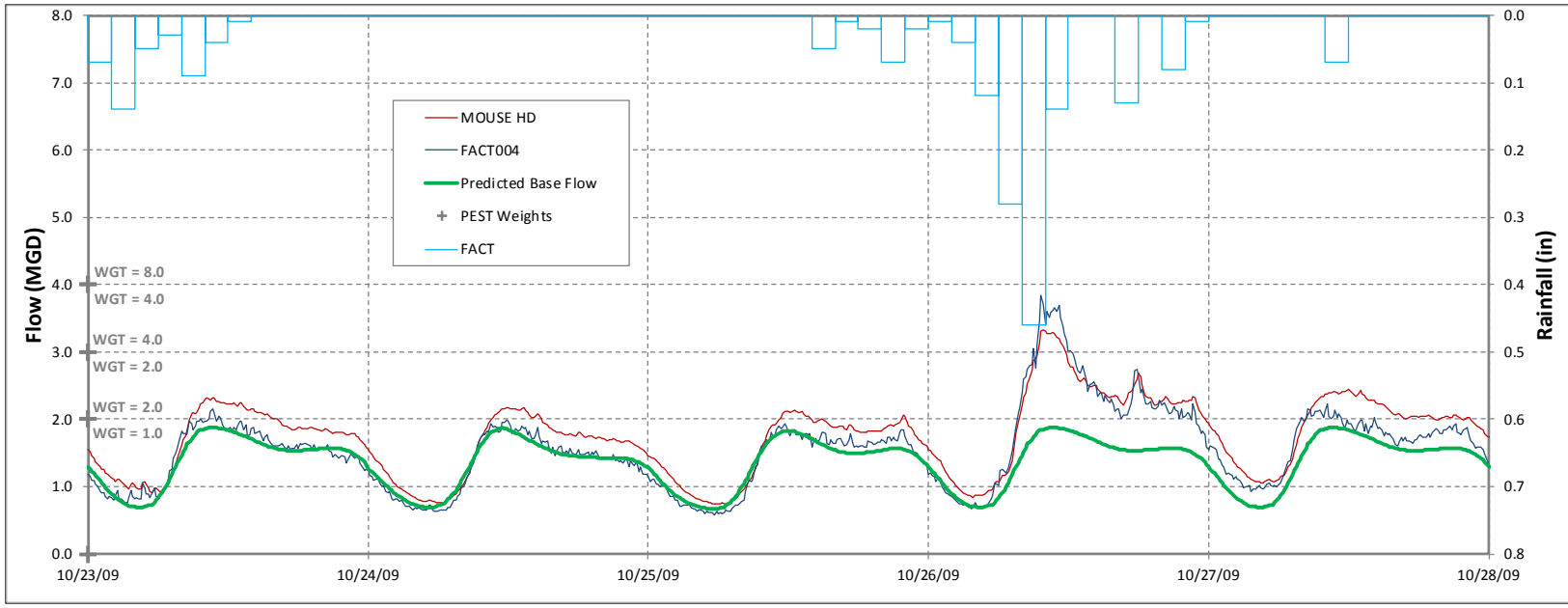
Model Schematic



Sewer Model Basins



- Monitor 180 modeling basins in separated system

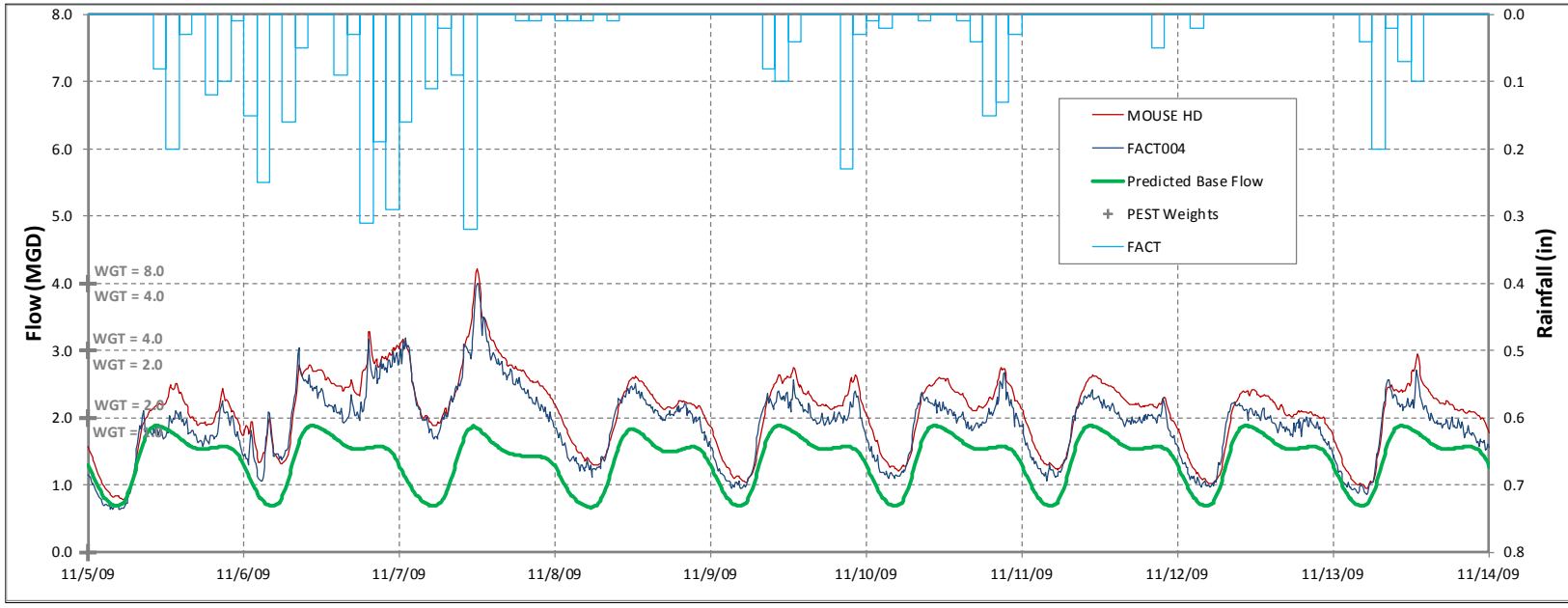


Event 02

10/23/09 to 10/28/09

PEST Optimization	
RDII_AREA	1.9 %
A_IAREA	0.2 %
A_CTIME	82 min
UMAX	3.85 in
LMAX	3.49 in
CQOF	0.288
CK	4.9 hr
CKIF	770.8 hr
CKBF	23.6 hr

Goodness-of-Fit	
Threshold	0.00
Bias	0.15
RMSE	0.25
Nash	0.82
Q_{pk} Error	-13.12%
V_{tot} Error	12.10%

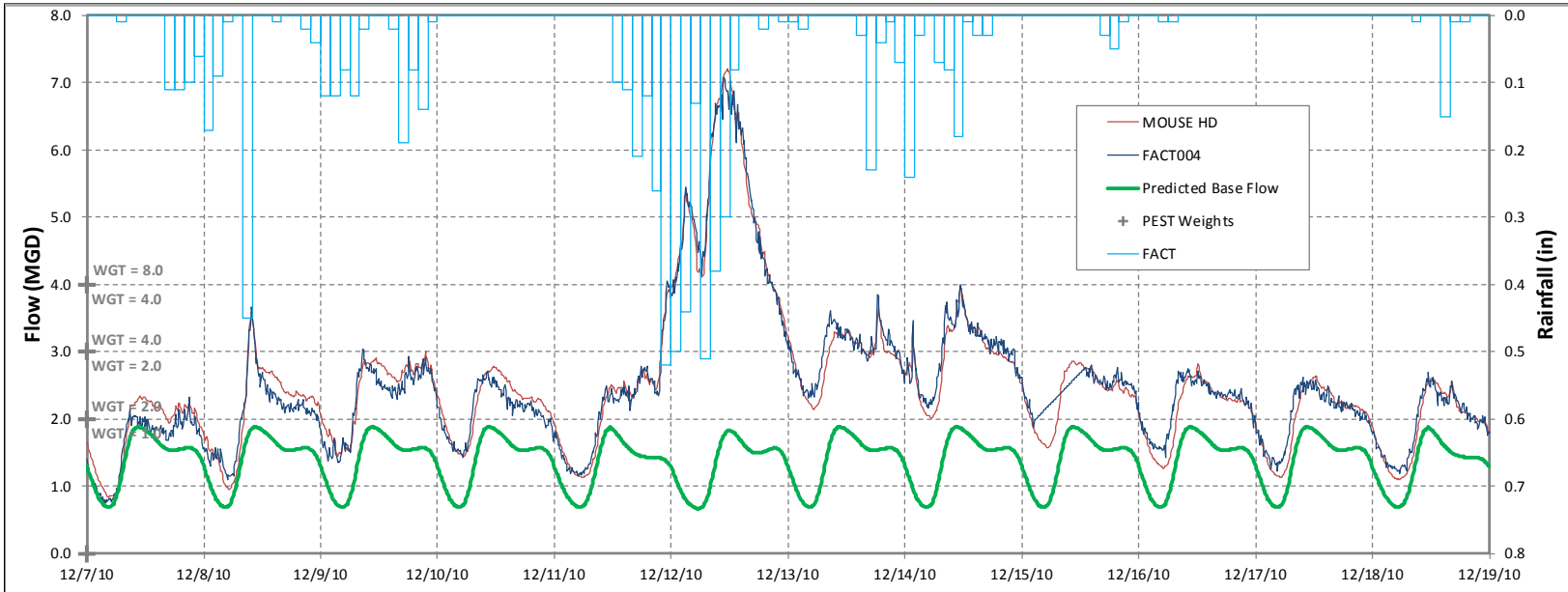


Event 03

11/05/09 to 11/14/09

PEST Optimization	
RDII_AREA	1.9 %
A_IAREA	0.2 %
A_CTIME	82 min
UMAX	3.85 in
LMAX	3.49 in
CQOF	0.288
CK	4.9 hr
CKIF	770.8 hr
CKBF	23.6 hr

Goodness-of-Fit	
Threshold	0.00
Bias	0.11
RMSE	0.25
Nash	0.79
Q_{pk} Error	5.20%
V_{tot} Error	10.15%

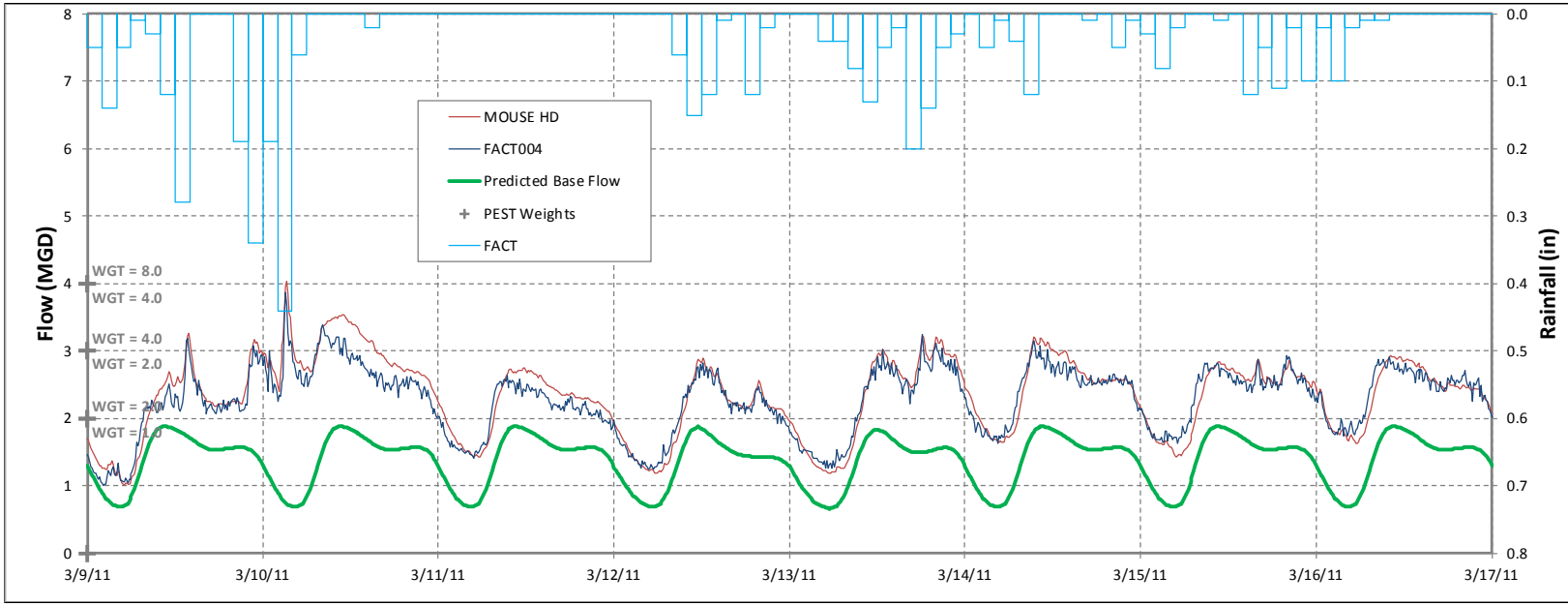


Event 07

12/07/10 to 12/19/10

PEST Optimization	
RDII_AREA	1.9 %
A_IAREA	0.2 %
A_CTIME	82 min
UMAX	3.85 in
LMAX	3.49 in
CQOF	0.288
CK	4.9 hr
CKIF	770.8 hr
CKBF	23.6 hr

Goodness-of-Fit	
Threshold	0.00
Bias	0.00
RMSE	0.19
Nash	0.97
Q_{pk} Error	1.71%
V_{tot} Error	-0.05%



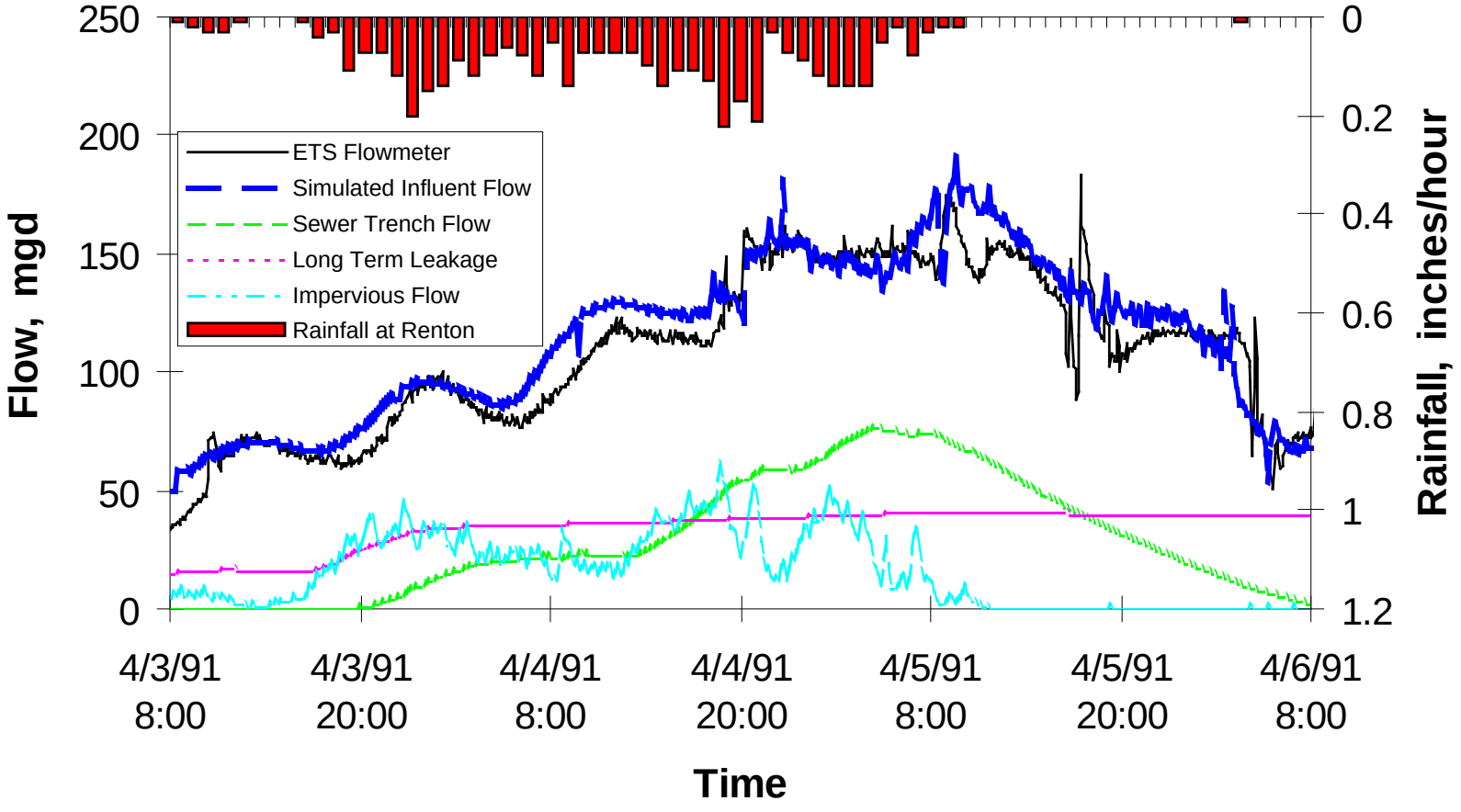
Event 09

03/09/11 to 03/17/11

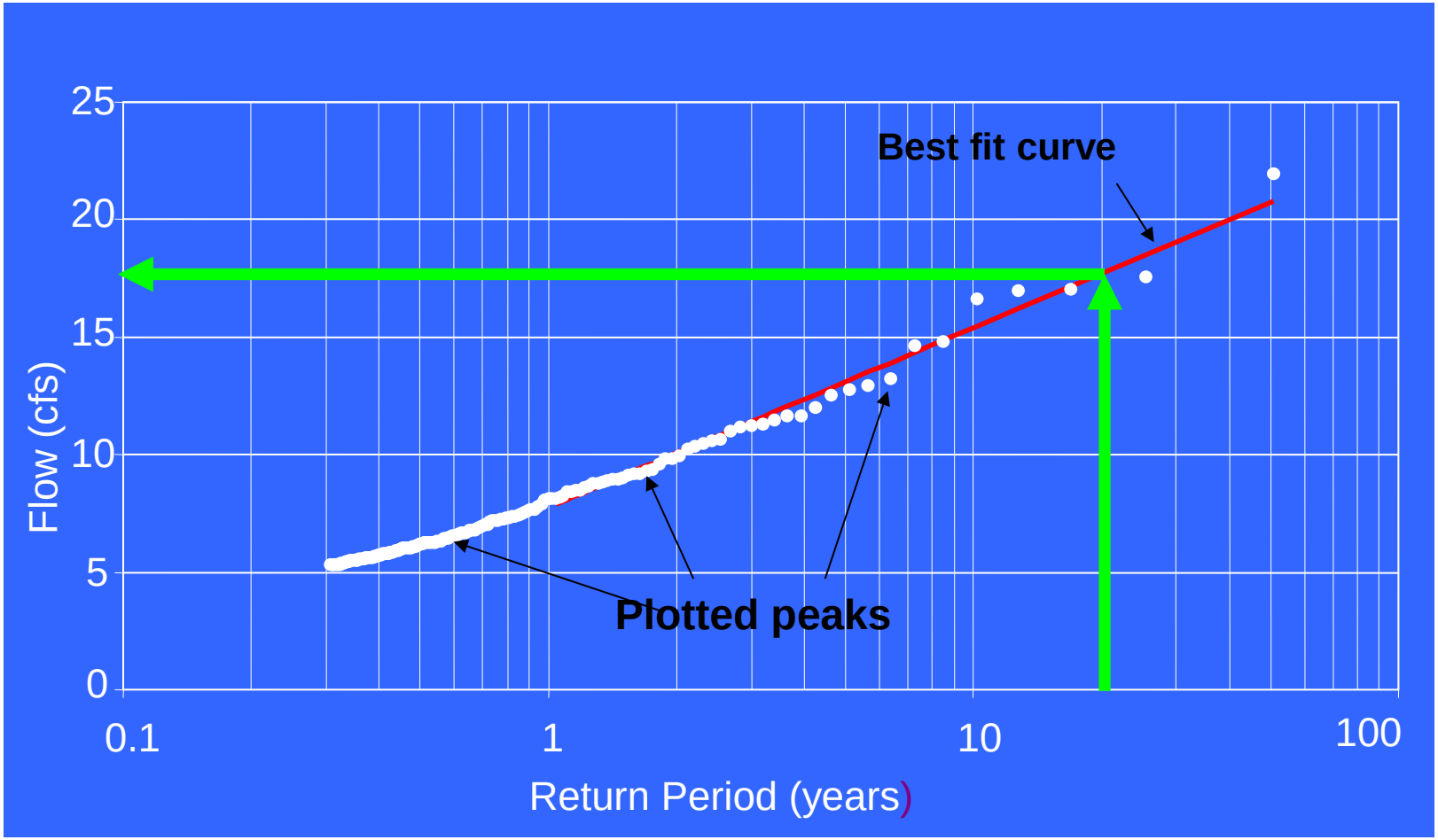
PEST Optimization	
RDII_AREA	1.9 %
A_IAREA	0.2 %
A_CTIME	82 min
UMAX	3.85 in
LMAX	3.49 in
CQOF	0.288
CK	4.9 hr
CKIF	770.8 hr
CKBF	23.6 hr

Goodness-of-Fit	
Threshold	0.00
Bias	0.03
RMSE	0.19
Nash	0.86
Q_{pk} Error	4.25%
V_{tot} Error	2.97%

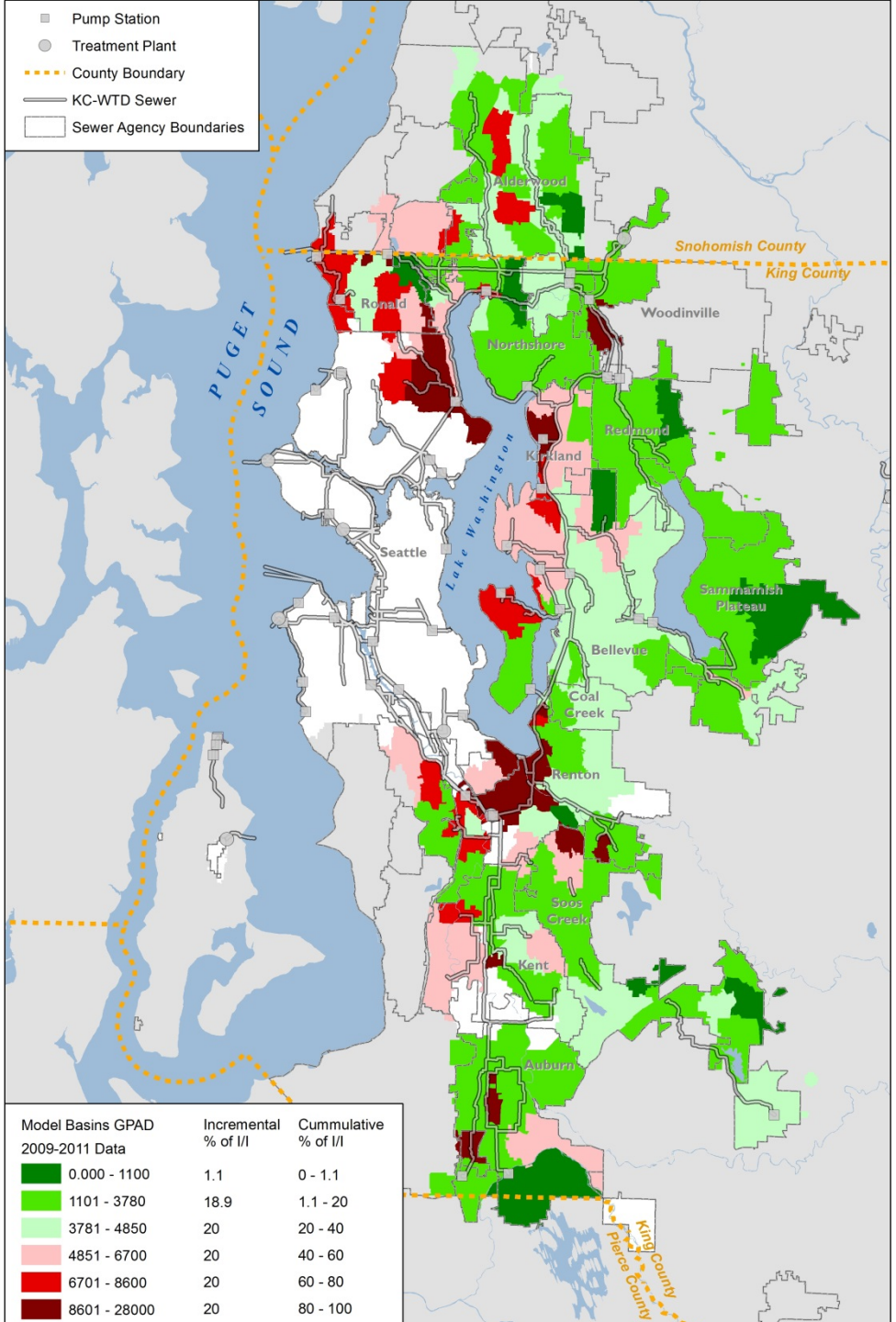
Figure 3
April 1991 EDRP Model Results
137 Square Mile Service Area



Probability Analysis



20-year Peak I/I by Model Basin



Ongoing and Upcoming Flow Monitoring

- Flow Verification Monitoring
  - For near-term capital projects
- Next Decennial Flow Monitoring
  - 2019 – 2021

For additional information or questions, please contact:

Bob Swarner, Modeling Supervisor
Bob.Swarner@kingcounty.gov
Janice Johnson, Flow Monitoring Lead
Janice.Johnson@kingcounty.gov
Steve Tolzman, Project Manager, CSI Program Update
Steve.Tolzman@kingcounty.gov