100-year approach for building stormwater facilities to restore stream flows and water quality:

WRIA 9 Stormwater Retrofit Project

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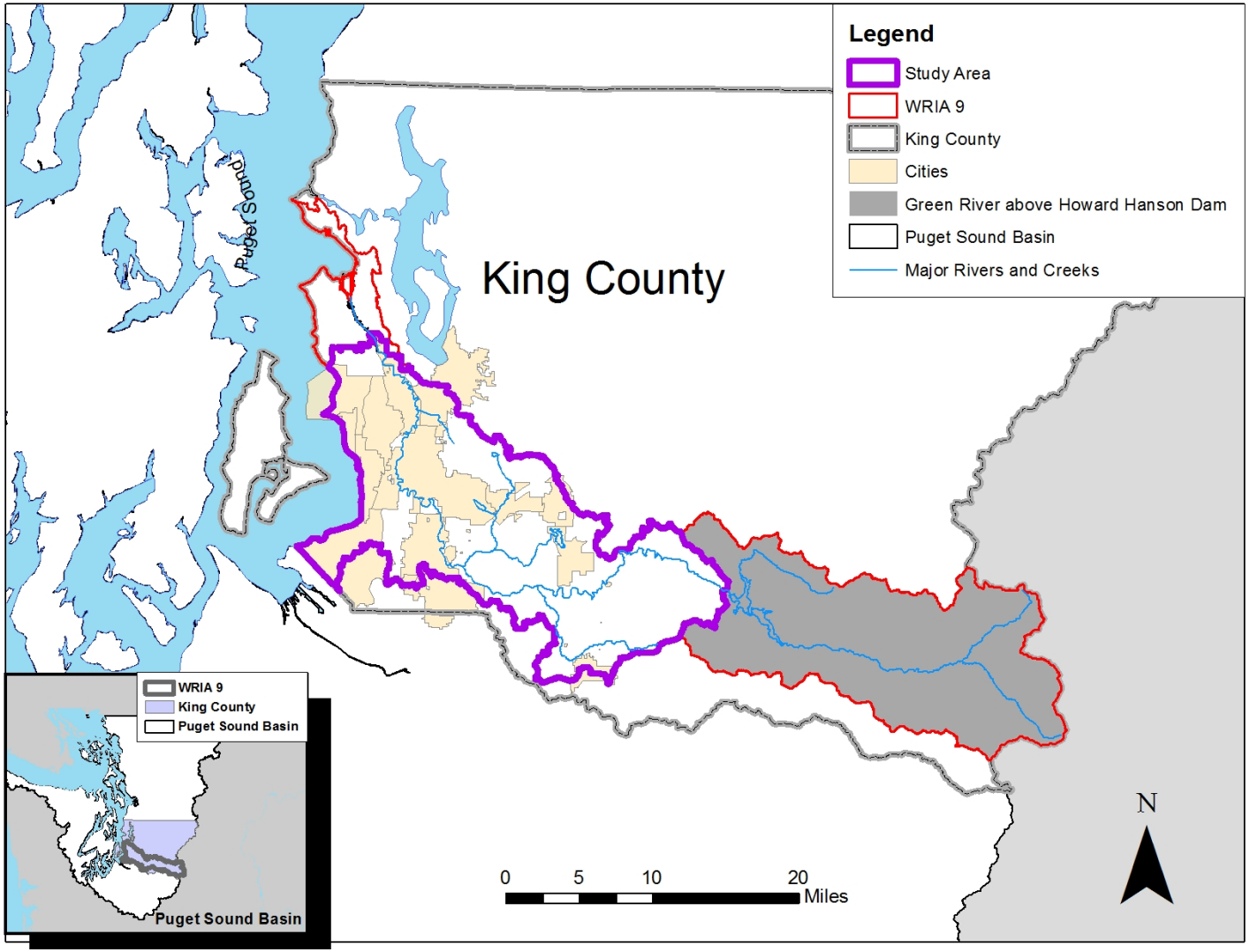
2014 Science Seminar

11/05/2014

Project Objectives

- Estimate planning-level stormwater facility needs for the future development in the WRIA 9 study area.
- Model cost-effective combinations of BMPs to reach stormwater goals using the EPA SUSTAIN model.
- Extrapolate model results to Puget Sound.
- Compare 30-year and 100-year planning horizons.

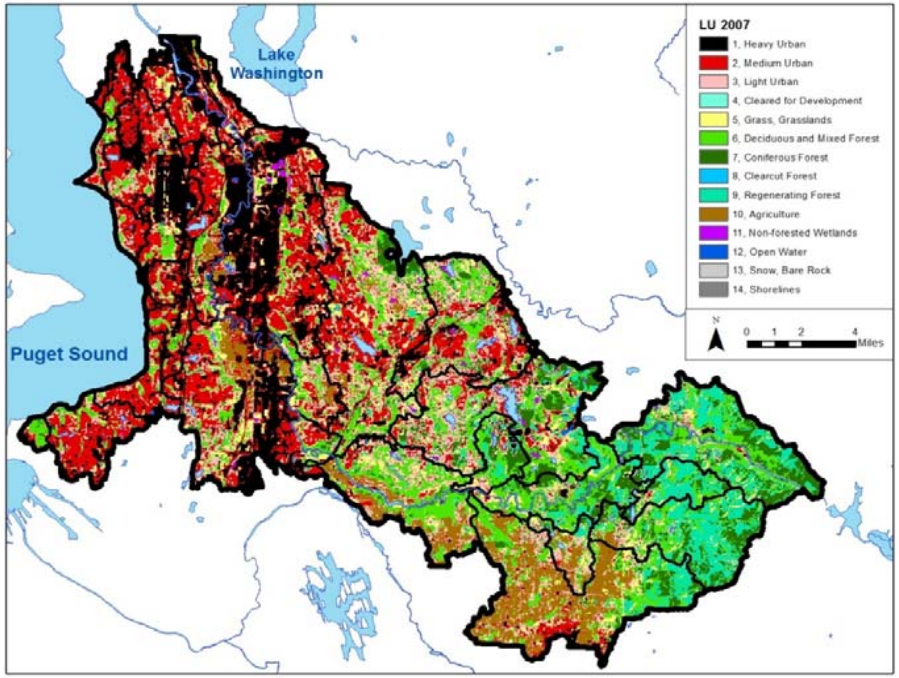
WRIA 9 Study Area



Future Development

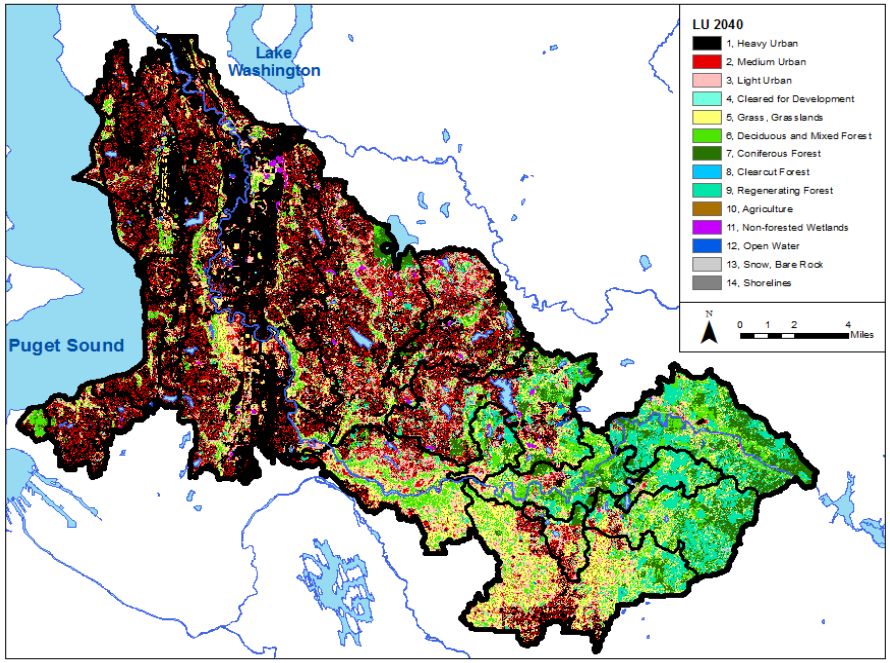
Existing Land Use

2007 Satellite-derived Land Use (UW 2007)



Simulated 2040 Future Land Use

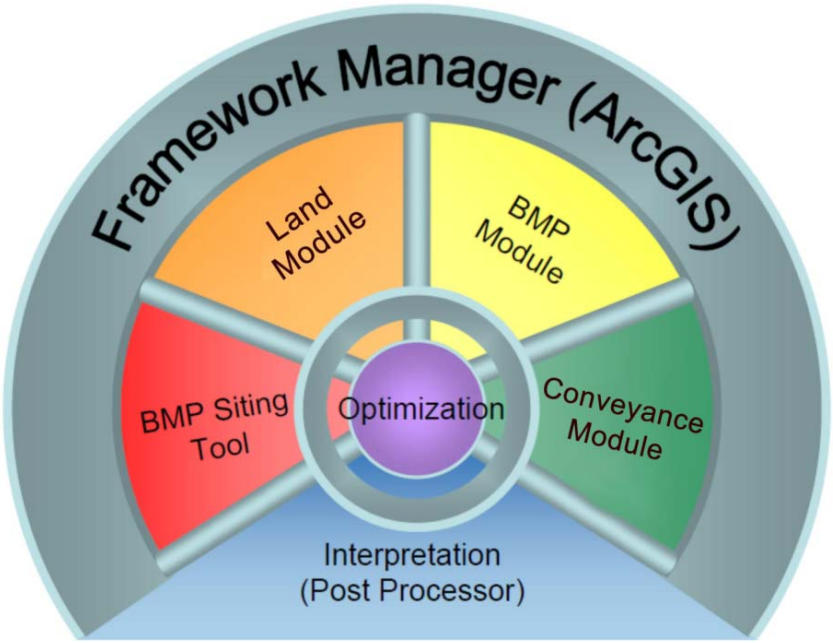
(Alberti 2009)

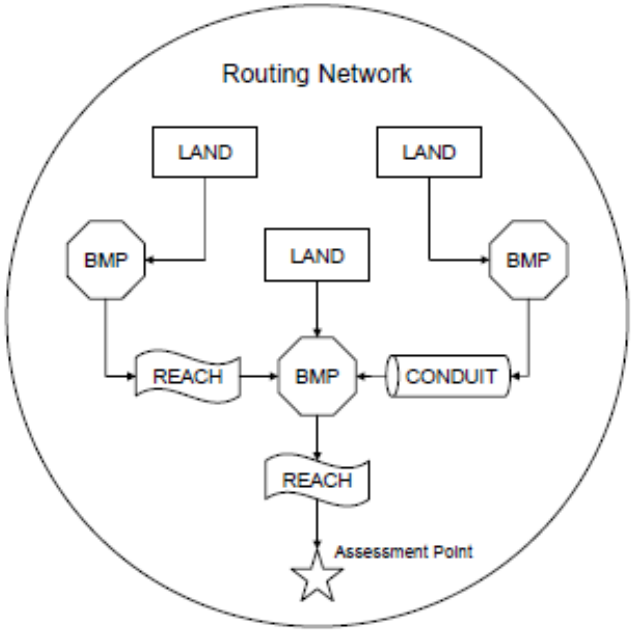


Development is projected to increase from **65% to 77%**

SUSTAIN: System for Urban Stormwater Treatment and Analysis INtegration

U.S. EPA model developed to assist stormwater managers in selecting cost-effective stormwater BMPs to meet watershed goals.





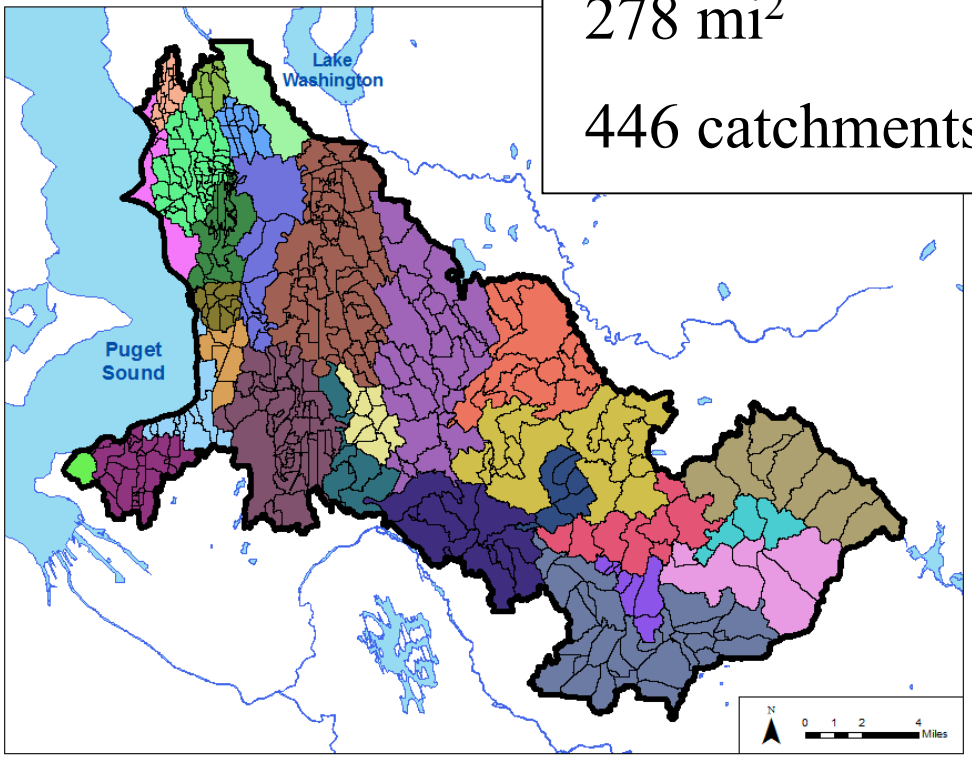
Model Inputs:
BMP Design and Cost Assumptions
Flow or water quality goals
Decision variables

Source: EPA

Modeling Approach

- Model 135 hypothetical 100-acre catchments representing combinations of:
  - **5 generic land uses**
  - **3 soil types**
  - **2 slopes**
  - **3 precipitation zones**
  - **2 land costs**

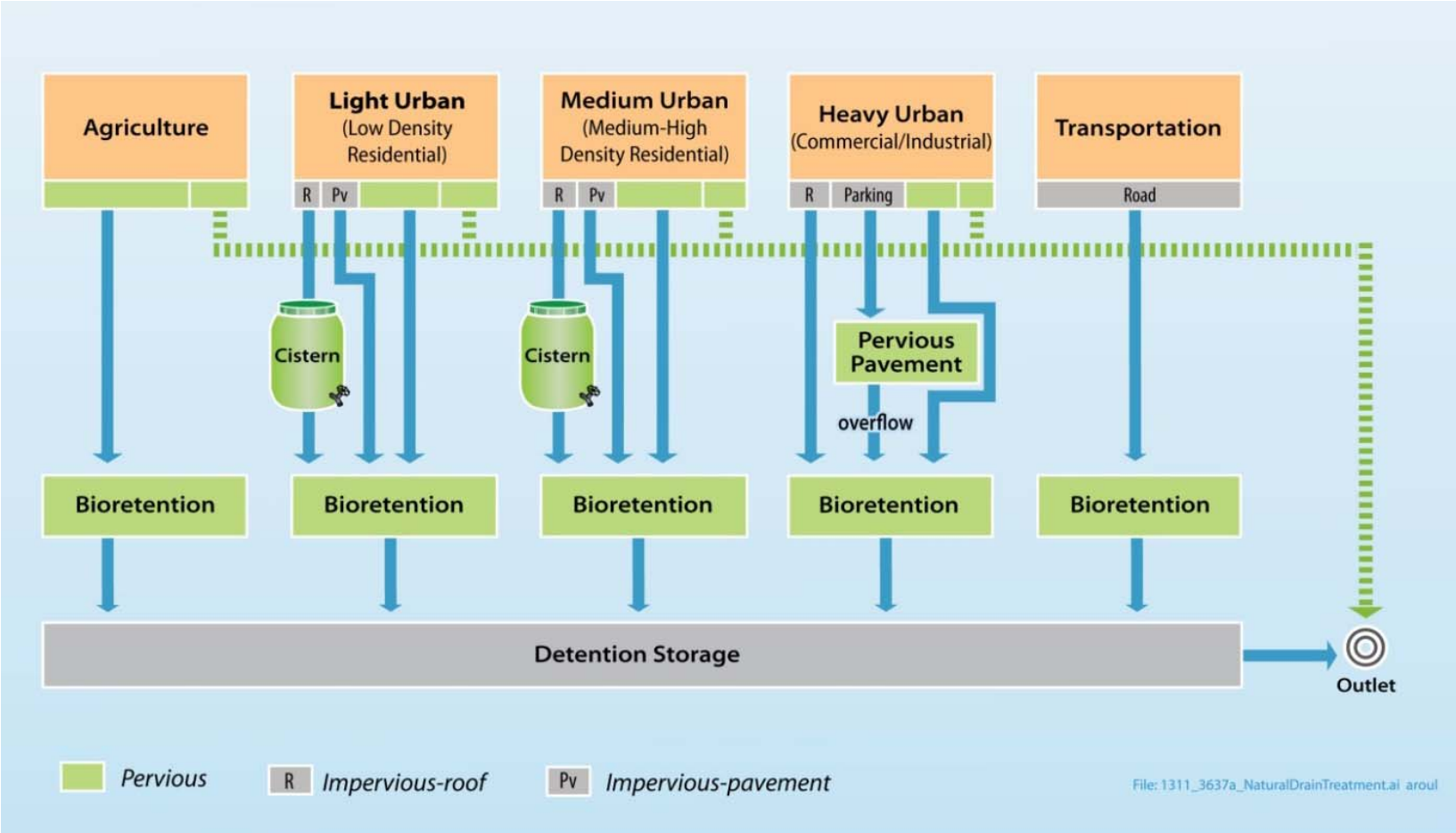
- Scale results to future land use of study area



278 mi^2

446 catchments

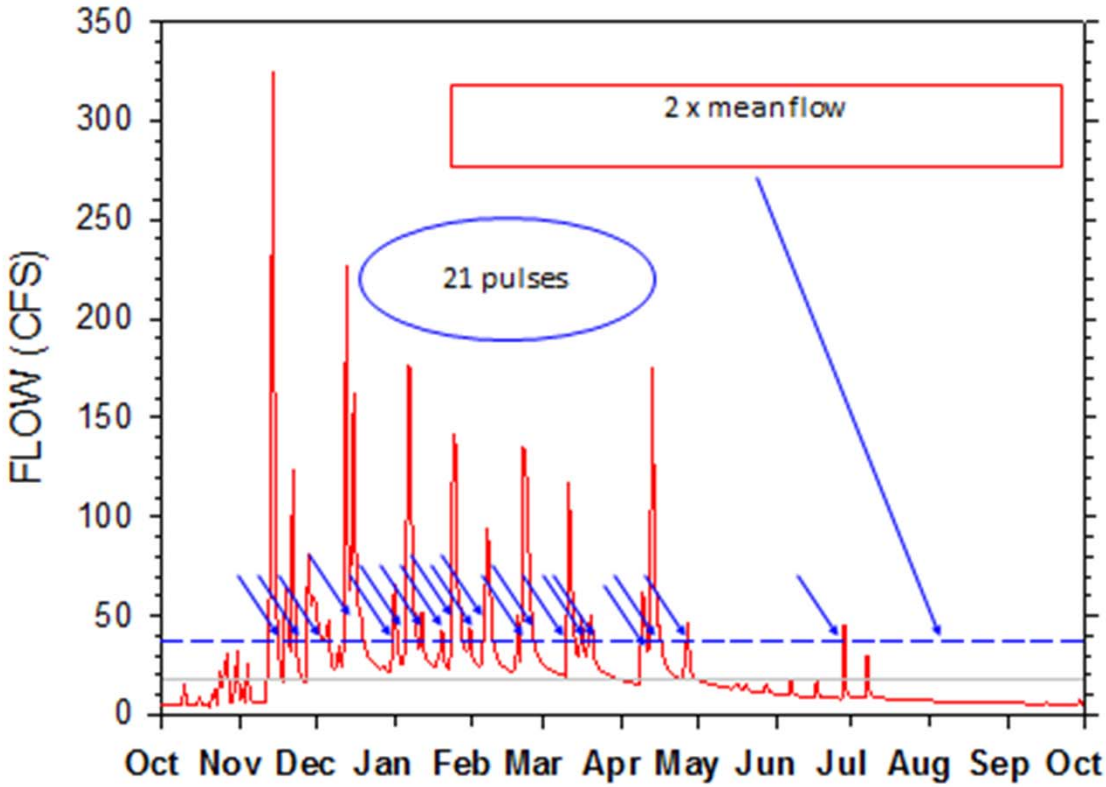
BMP Treatment Train



BMP Unit Design and Cost Assumptions

- Develop conceptual BMP unit designs
- 30-year life cycle costs assuming 5% real discount rate:
  - **Capital** : design, permitting, and construction
  - **Operation and Maintenance** (O&M)
  - **Inspection and enforcement** (I&E)
  - **Land acquisition cost**
- Construction of modeled BMP units are distributed over the 30-year period.

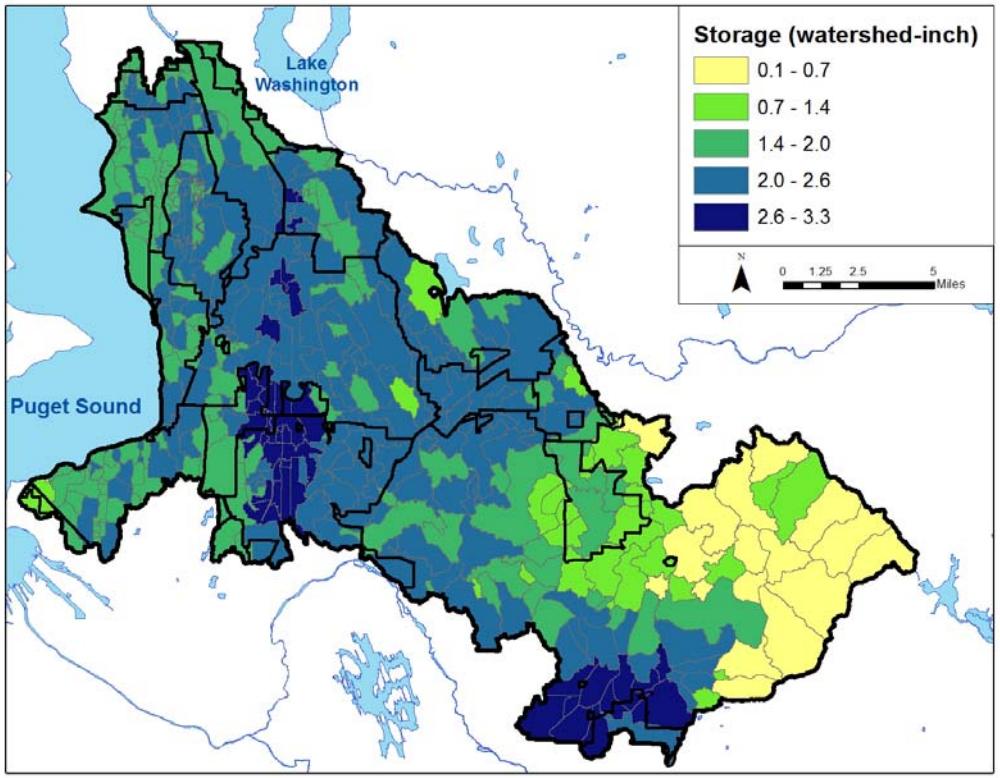
SUSTAIN Optimization Target:
Reduce Stream Flashiness



High Pulse Count (HPC): Number of times mean daily flows ≥ high-flow threshold set at 2 X long-term mean daily flow rate

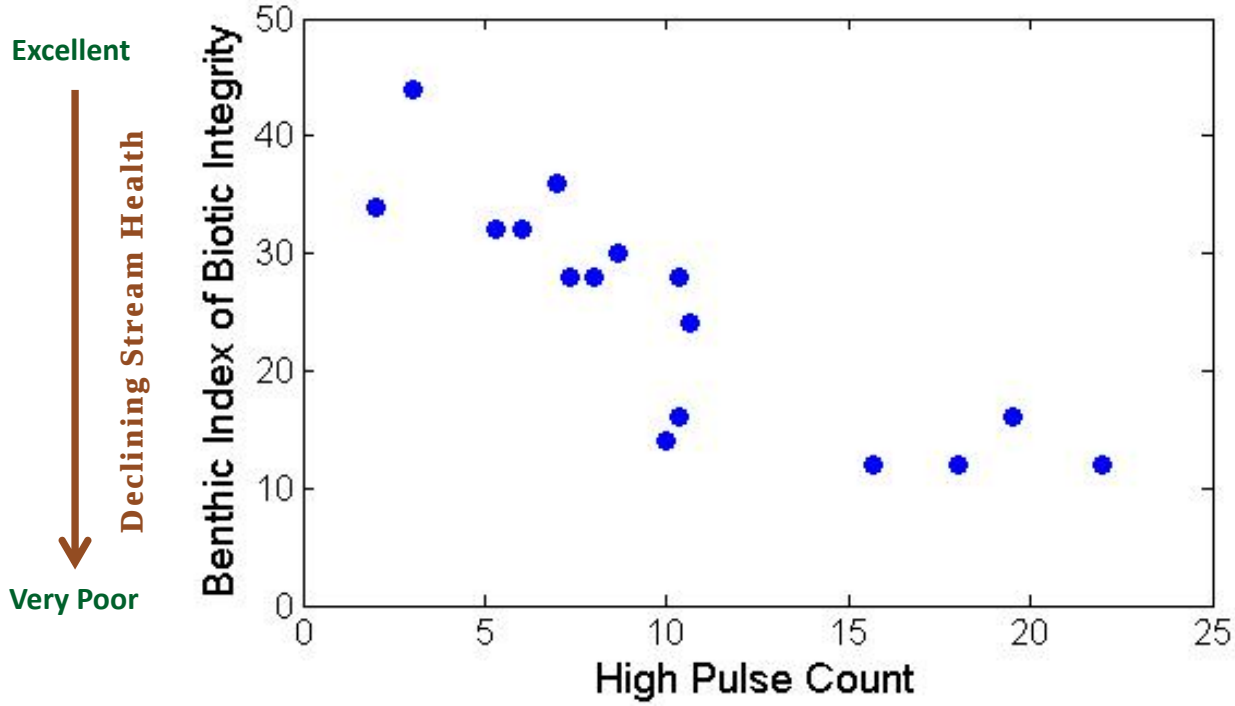
Stormwater Facilities: Storage needed

- **Results:** Cost-effective combinations of cisterns, rain gardens, roadside bioretention, detention ponds
- **2.5 inches** of flow control needed for future development
- Adjusted for 10% increase in storage to mitigate climate change impacts.

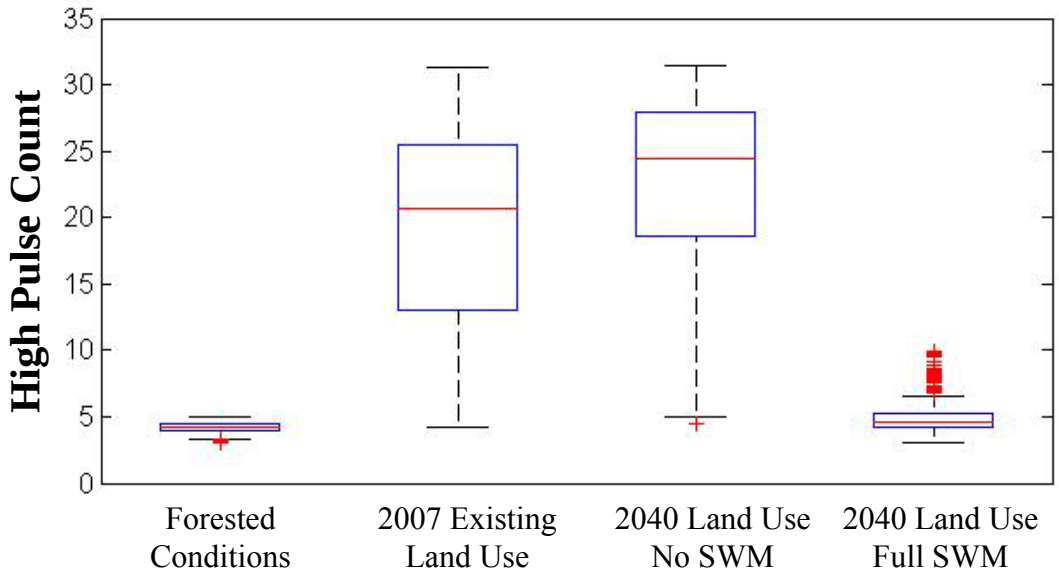


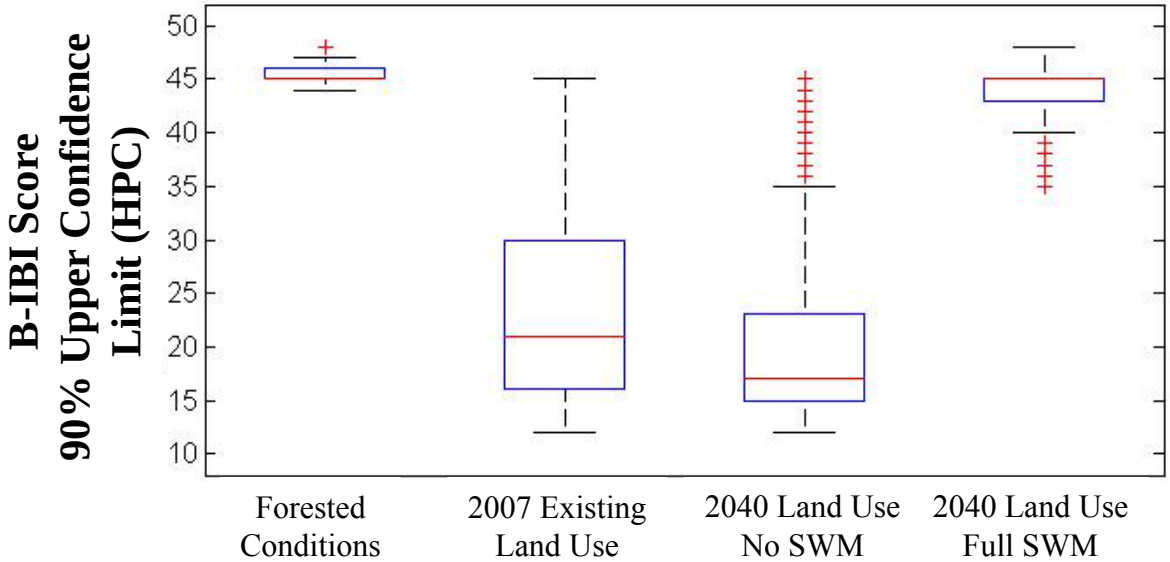
BMP Effectiveness:
Improvement in Biological Health

- King County data set from 16 flow and B-IBI stream stations (*DeGasperi et al. 2009*)
- Logistic regression equation provide probabilistic estimates of improvement in B-IBI scores based on improvement in HPC (*Horner 2013*)



Potential Improvement in Hydrologic Indicators and B-IBI Scores

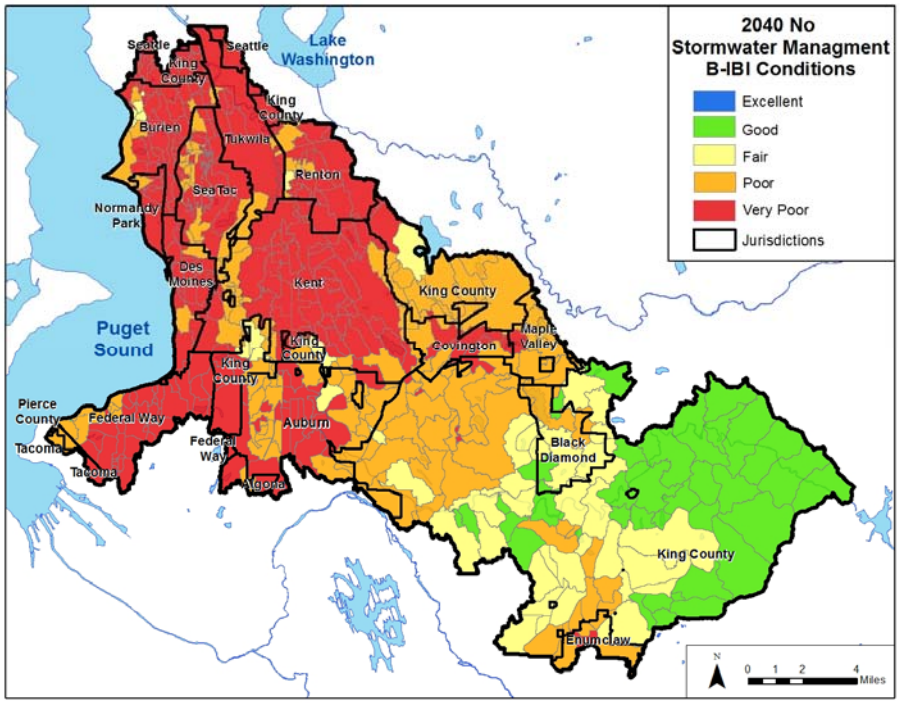




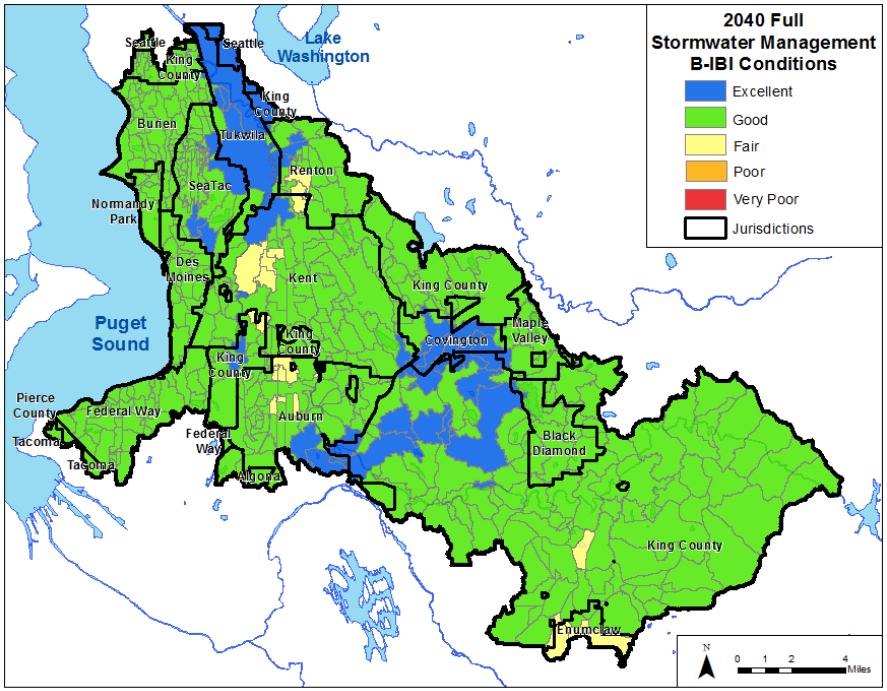
*Results for 446 catchments of study area

Potential B-IBI Improvement

2040 Land Use
No Stormwater Management



2040 Land Use
Full Stormwater Management



Biological Condition	B-IBI Range
Excellent	46 - 50
Good	38 - 44
Fair	28 - 36
Poor	18 - 26
Very Poor	10 - 16

Source: http://pugetsoundstreambenthos.org/

How will modeled stormwater infrastructure be implemented across the landscape?

- Assume new and redevelopment builds on-site facilities
- Assume public funds used to build everything else
- Compare 30 and 100 year planning horizons
- Look at WRIA 9 and Puget Sound

Full Stormwater Treatment in 30 years

- ~50% of landscape is projected to be new or redevelopment and require stormwater facilities in the next 30 years
- Public stormwater program to build remaining facilities:
  1. build regional facilities
  2. retrofit all roads and highways
  3. Retrofit all other non-forested lands not redeveloped within the next 30 years
  4. Operate and maintain public facilities and inspect private facilities

100-year Public Stormwater Program

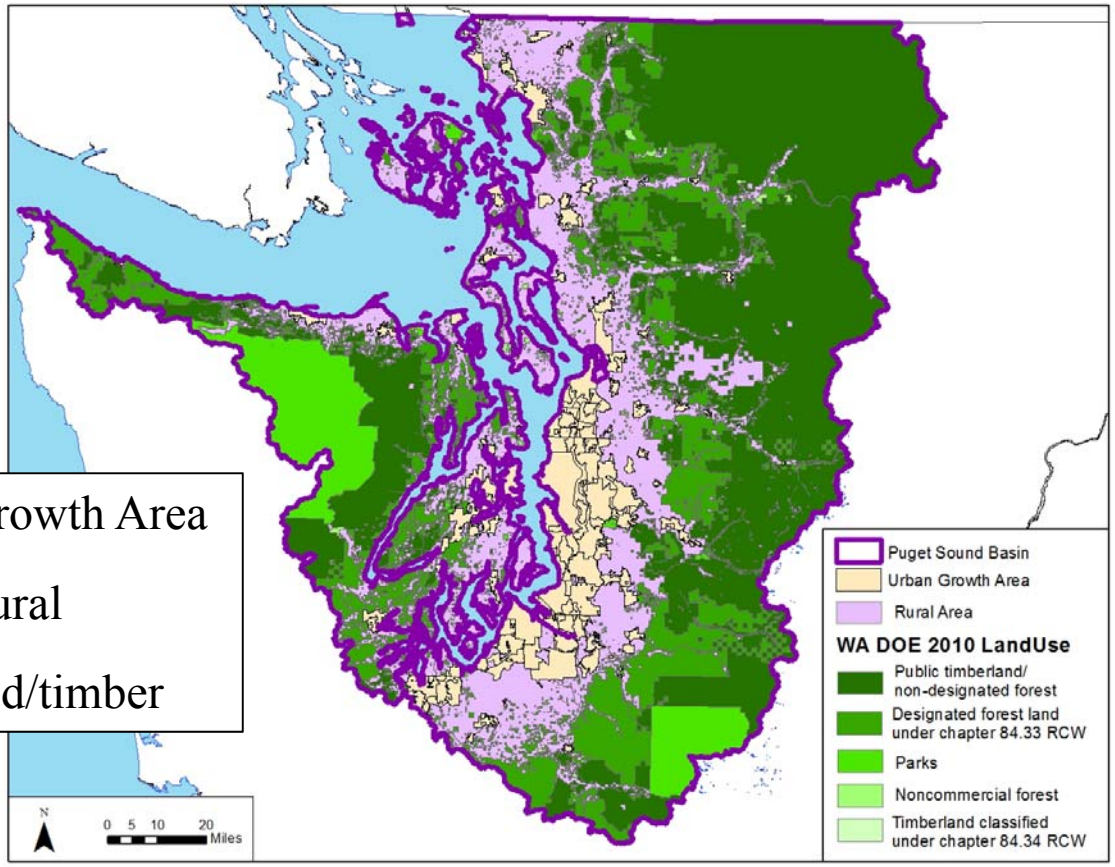
- New and redevelopment rate: 1.6% per year
- Facilities would be built over entire project area except roads and highways in next 100 years
- **100 year stormwater program:** Focus on building regional facilities and road and highway facilities

Annual Public Stormwater Program Costs: WRIA 9 Project Area

	Annual Capital Costs		Annual Operating Costs*	
	30-year	100-year	30-year	100-year
WRIA 9 Project Area	$210M	$46M	$650M	$540M

*Operating costs include O&M and I&E costs. Value reflects annual operating costs after all necessary facilities are built.

Extrapolation to Puget Sound Basin



10% Urban Growth Area

24% rural

67% forested/timber

Estimate stormwater facilities cost range for Puget sound by scaling urban and rural costs associated with low and high land costs of WRIA 9 project area.

Annual Public Stormwater Program Costs: Puget Sound Basin

	Annual Capital Costs		Annual Operating Costs*	
	30-year	100-year	30-year	100-year
Puget Sound basin	$4.3B	$650M	$13B	$11B

*Operating costs include O&M and I&E costs. Value reflects annual operating costs after all necessary facilities are built.

Conclusions:
Policy and Planning Horizon

- Will stormwater requirements trigger necessary facilities during new and redevelopment?
- How aggressively do public programs build facilities?
- How long in the future do we aim for success?

Questions?

For more details: King County's WRIA 9 Retrofit Project
http://www.kingcounty.gov/services/environment/watersheds/green-river/stormwater-retrofit-project.aspx

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Acknowledgements, thank you!

- King County: Jeff Burkey, Curtis DeGasperi, and Jim Simmonds
- University of Washington: Dr. Rich Horner and Dr. Erkan Istanbulluoglu
- Funding provided by: U.S. Environmental Protection Agency
- Project Management Team and Stakeholders