WRIA 9 SUSTAIN Modeling Results

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Stormwater Retrofit Planning Project for WRIA 9

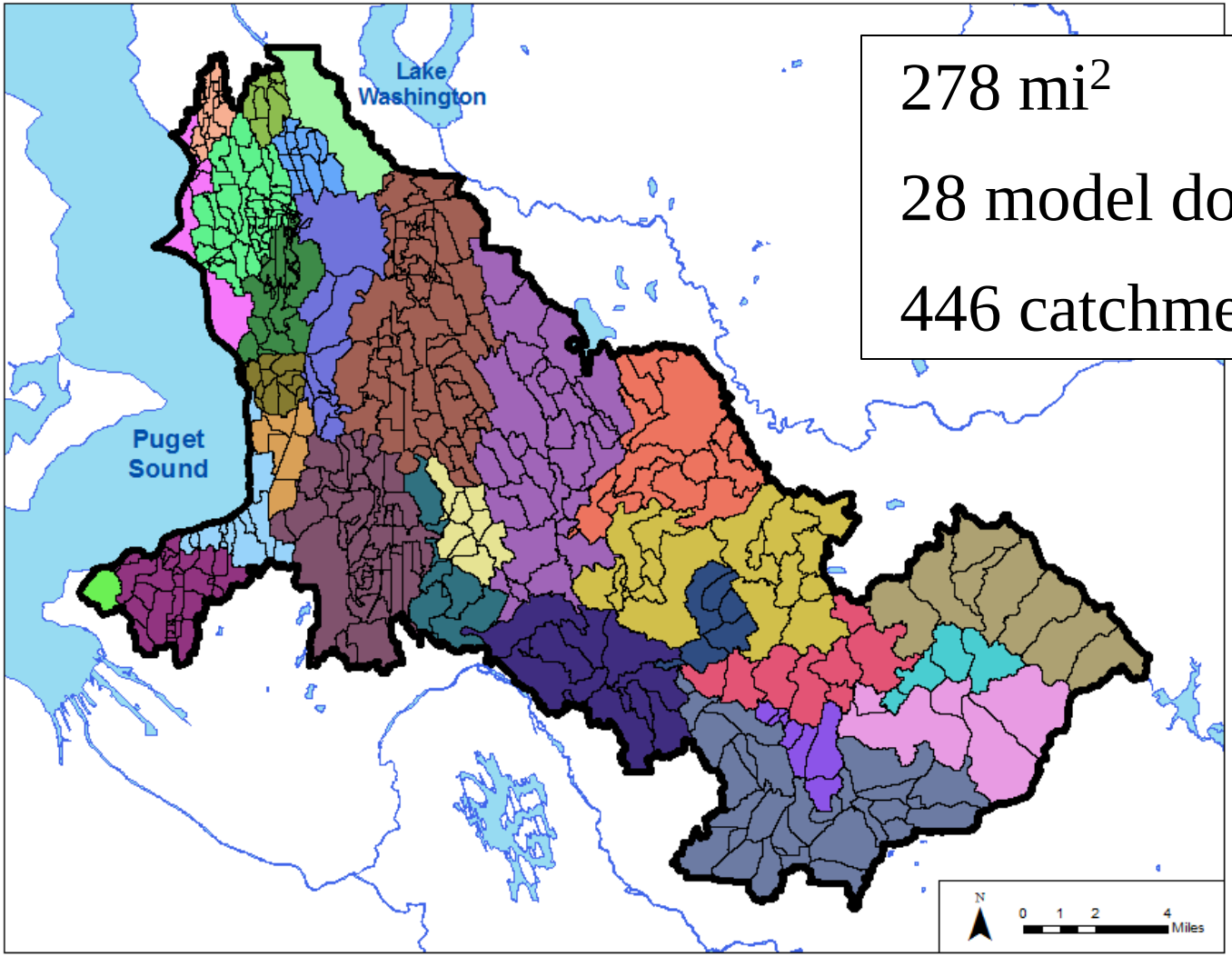
Stakeholder Workshop #4

02/27/2014

Goals and Objectives

- Model the stormwater facility needs and costs for the entire WRIA 9 study area.
- Expand on the methods developed in pilot study.
- Use the SUSTAIN model optimization to select the most cost-effective combination of BMPs to reach stormwater goals.
- Scale results to future (2040) developed conditions.
- Estimate public (vs. private) program costs considering stormwater management options.

WRIA 9 Study Area



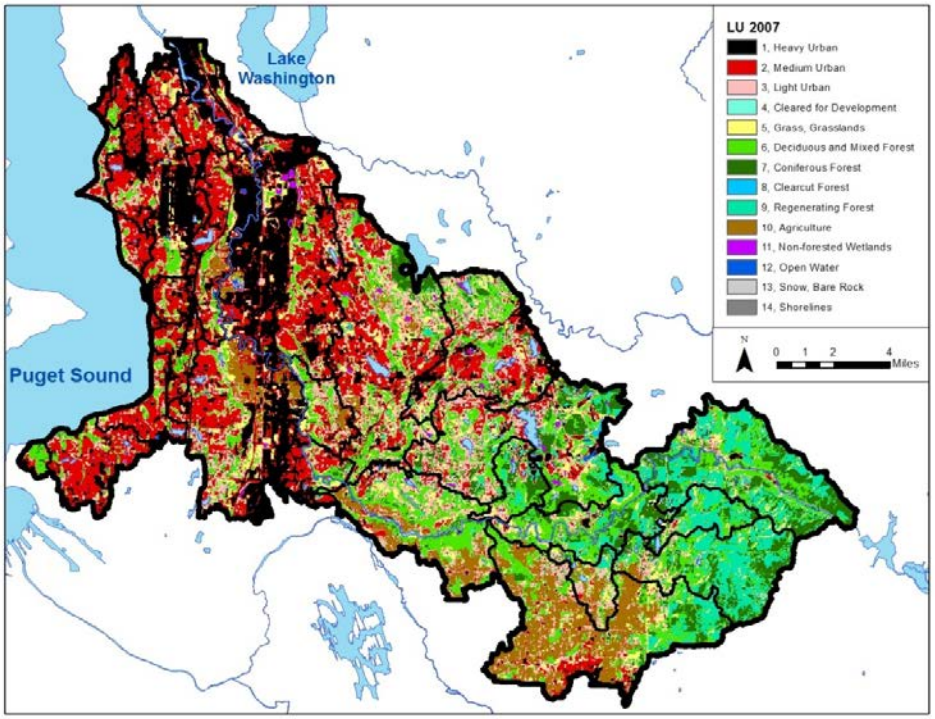
278 mi^2

28 model domains

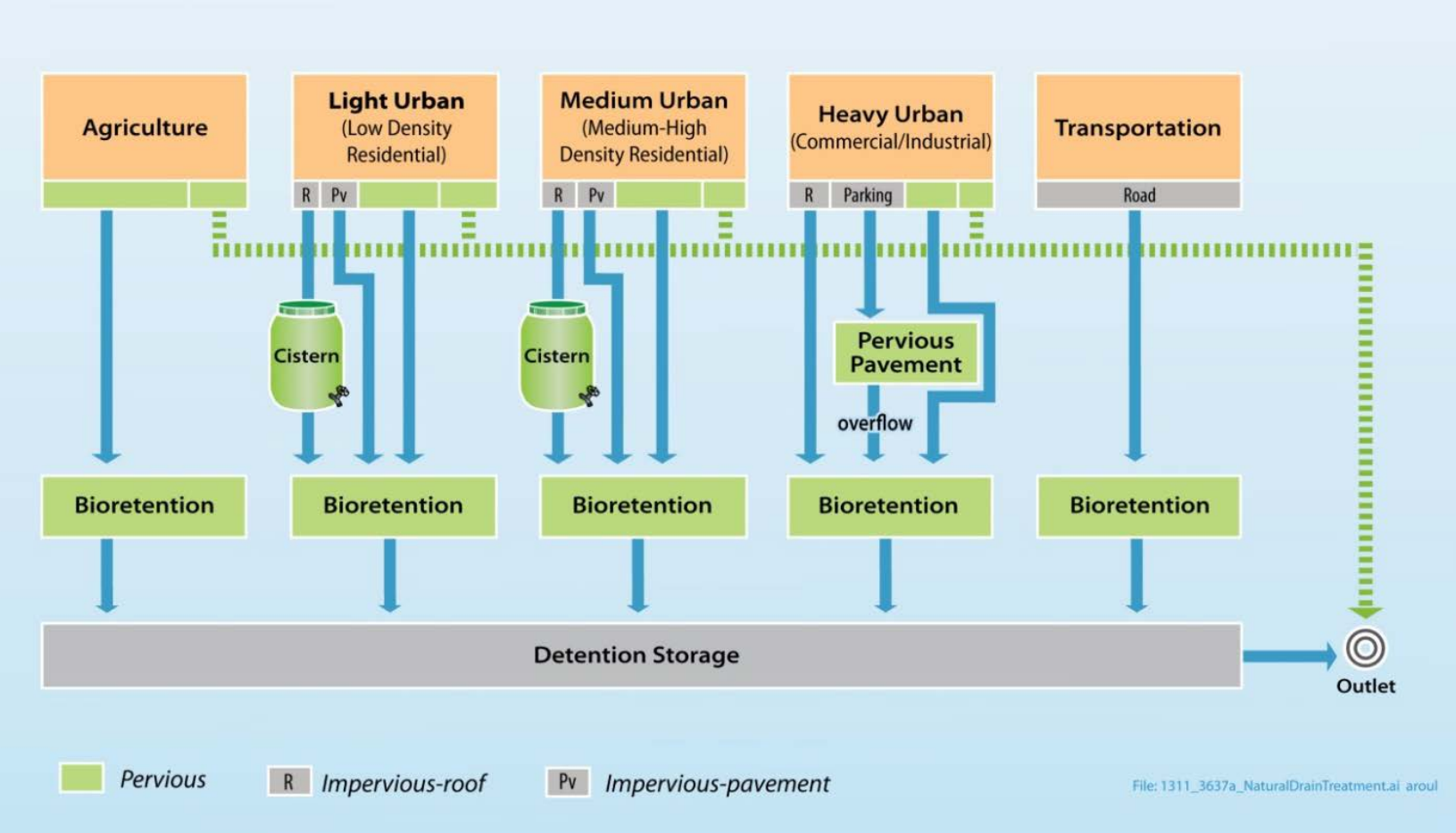
446 catchments

Modeling Approach

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



BMP Treatment Train



BMP Unit Design Assumptions

- **Cistern**
  ~3,000 gallon cistern
- **Bioretention** (rain gardens and roadside bioretention)
  100 ft^2 area
- **Porous Pavement**
  100-ft^2 area
- **Detention Pond**
  Design varies with hypothetical catchment
  Average volume of ~12,500 ft^3

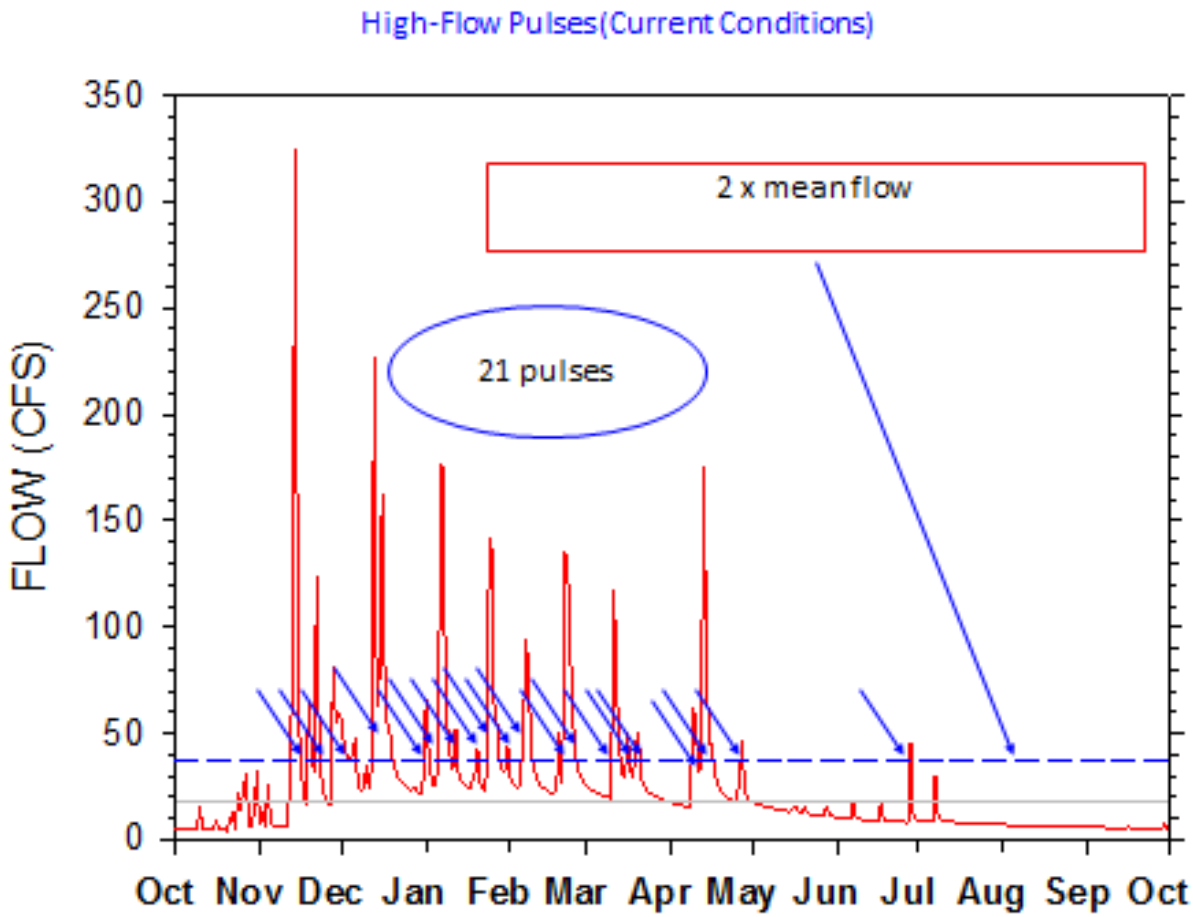
Note: units are conceptual designs and several units can be aggregated and placed at a single site

BMP Unit Cost Assumptions

- 30-year life cycle costs are presented in 2013 dollars assuming 5% real discount rate.
- Total present value costs assume construction of modeled BMP units are distributed over the 30-year period.
- **Private costs**
  - Construction and O&M of BMPs developed on private property
  - BMPs: cisterns, rain gardens, porous pavement
- **Public costs**
  - Construction and O&M of BMPs developed on public property
  - BMPs: roadside bioretention, detention ponds
  - Land costs for detention ponds
  - I&E costs of private and public facilities

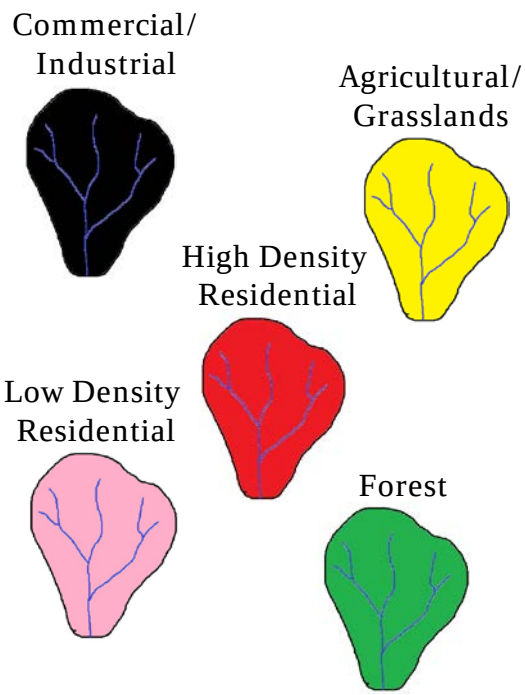
SUSTAIN Optimization

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



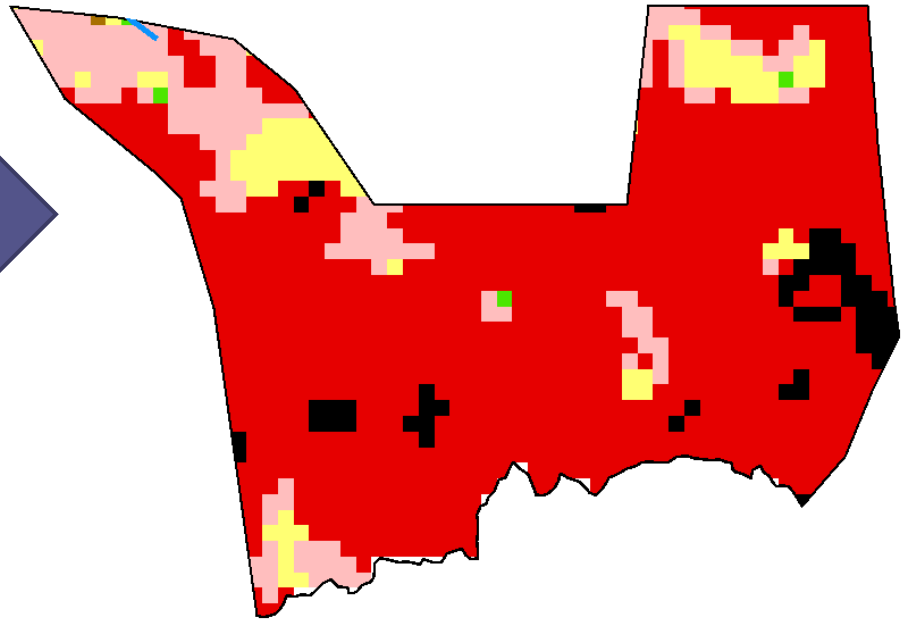
Scaling SUSTAIN results to Study Area

SUSTAIN Modeled Hypothetical Catchments



Scale

Newaukum Creek Subcatchment



Stormwater Management Options

- **Scaled hypothetical catchment results to future (2040) land use of study area**
- **<u>Three stormwater management options</u>:**

a) Required stormwater management occurring with new and redevelopment

b) Stormwater retrofit of roads and highways

c) Stormwater retrofit of remaining developed area

(a) + (b) + (c) = Full Stormwater Management

Results: Number of BMP units

	(a)	(b)	(c)
BMP Units	New and Redevelop-ment	Roads and Highways Retrofit	Remaining Development Retrofit
Cisterns	21,000	-	13,000
Rain Gardens	1,700,000	-	950,000
Roadside Bioretention	-	190,000	-
Detention Ponds	46,000	5,000	25,000

Results: Storage Volume of BMP Units

Full Stormwater Management [(a)+(b)+(c)]:

BMP Unit	Volume (acre-ft)	Storage (inches)
Cisterns	310	0.03
Rain Gardens	9,700	0.90
Roadside Bioretention	700	0.06
Detention Ponds	20,000	1.80

2.8 inches of flow control for development in study area

$$\text{storage} = \frac{\text{volume of facilities}}{\text{developed area}}$$

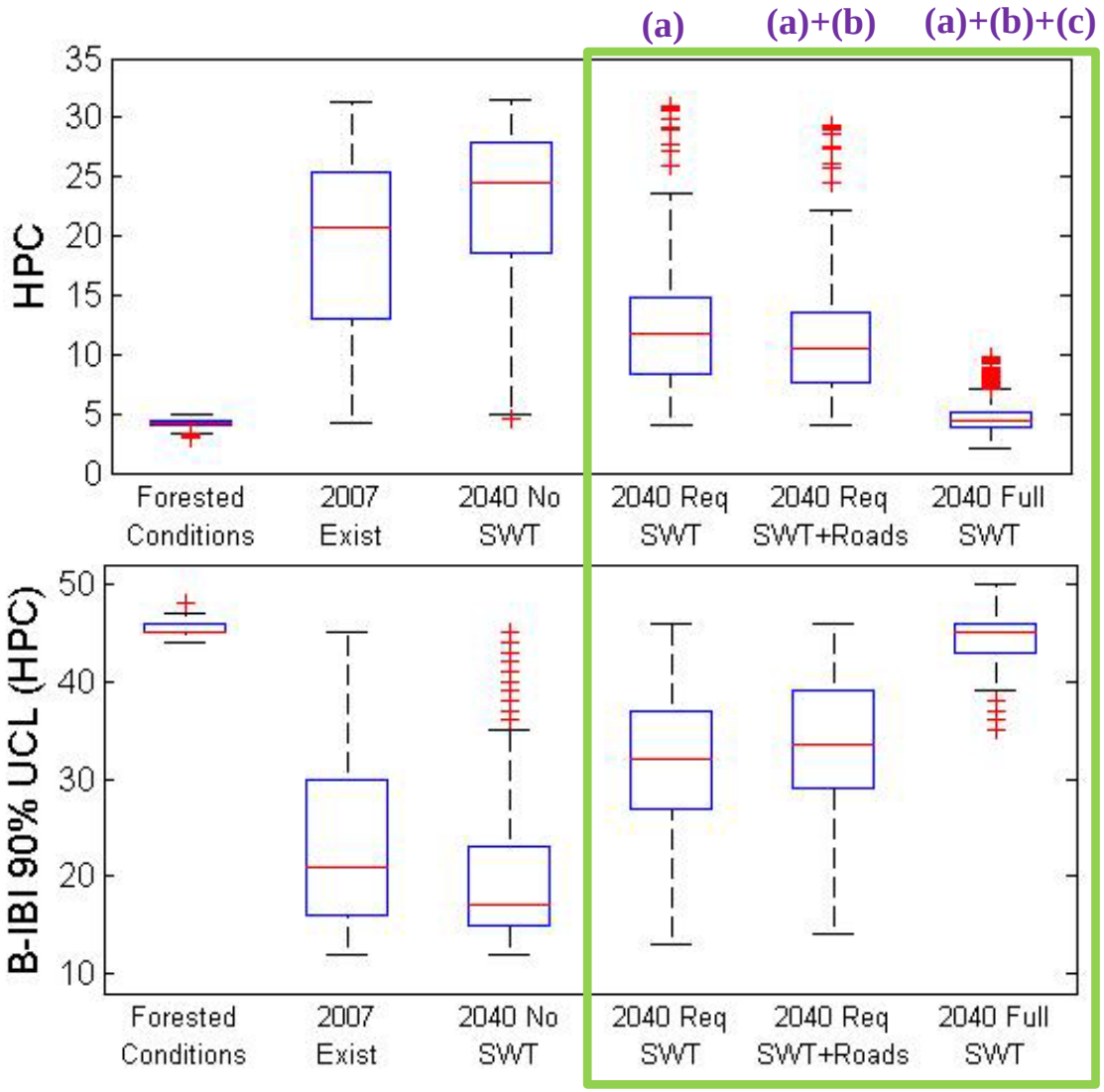
Biological Health

Benthic Index of Biotic Integrity (B-IBI) Biological Condition Categories

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/

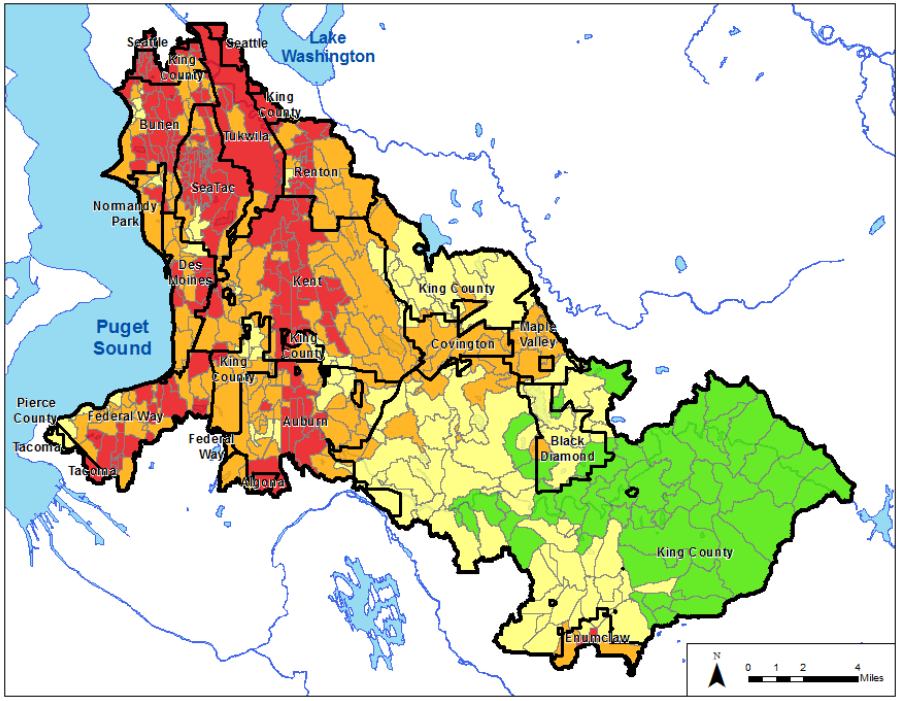
Potential Improvement in Hydrologic Indicators and B-IBI Scores



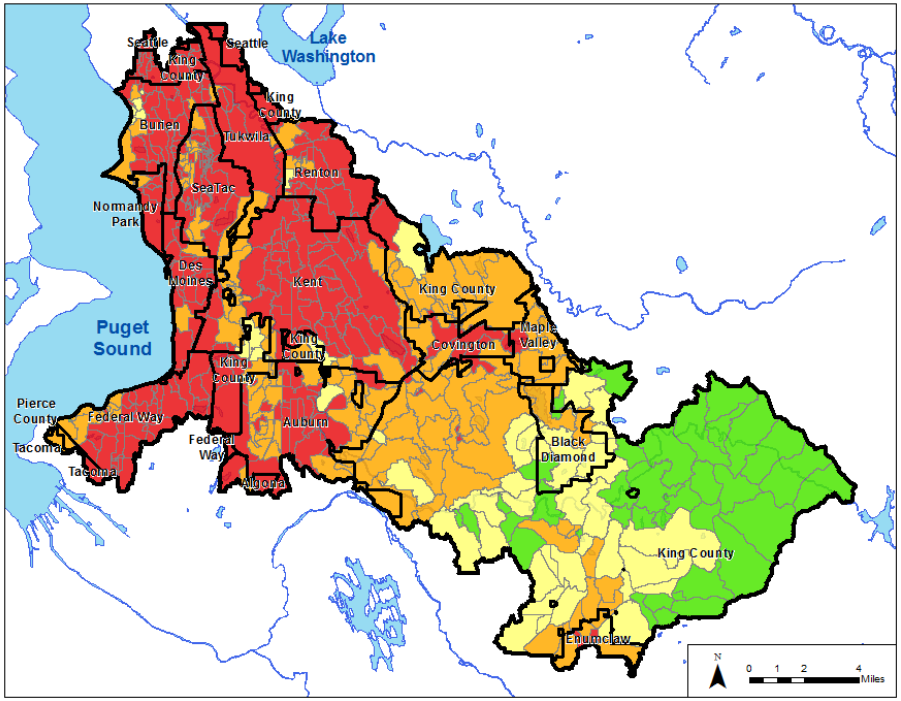
*Results for 446 catchments of study area

Potential B-IBI Scores: No Stormwater Management

2007 Existing Land Use



2040 Land Use



Biological Condition	B-IBI Range
Excellent	46 - 50
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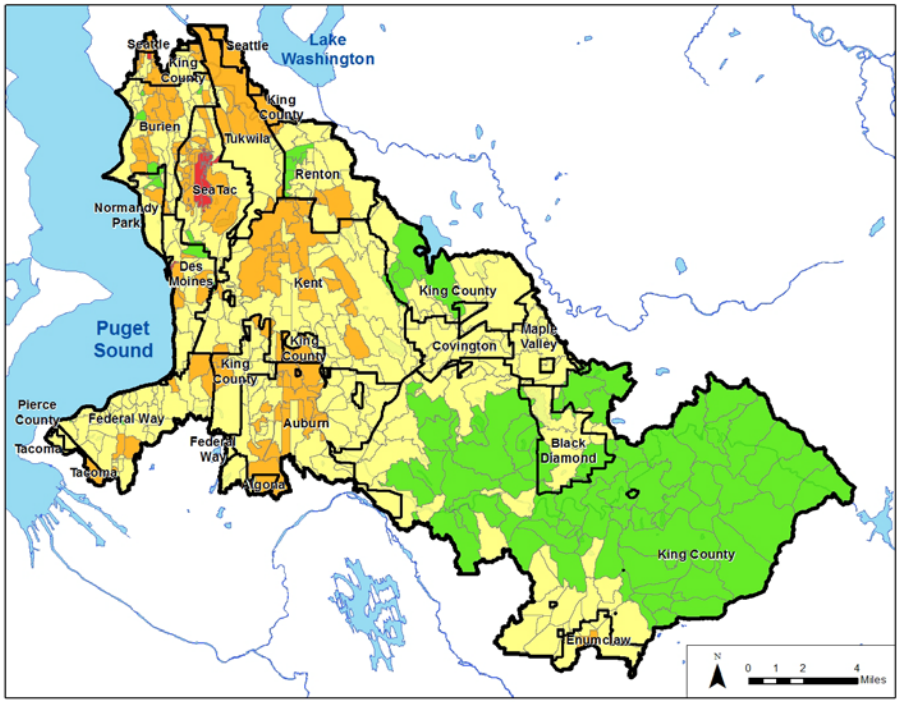
Potential B-IBI Improvement

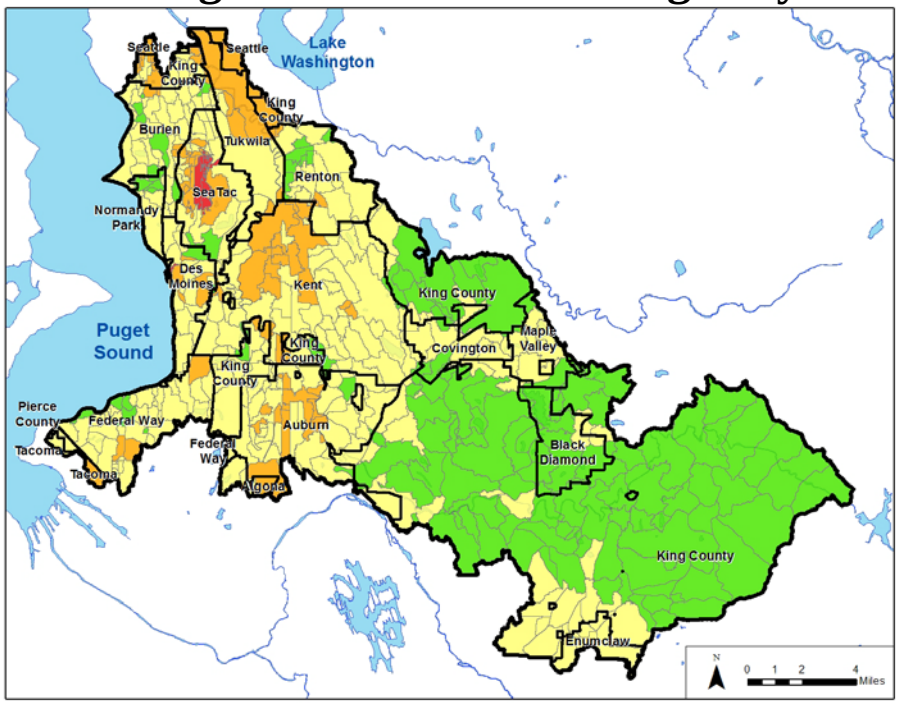
(a)

2040 Required Stormwater Management



(a)+(b)

2040 Required Stormwater Management+ Roads and Highways



Biological Condition	B-IBI Range
Excellent	46 - 50
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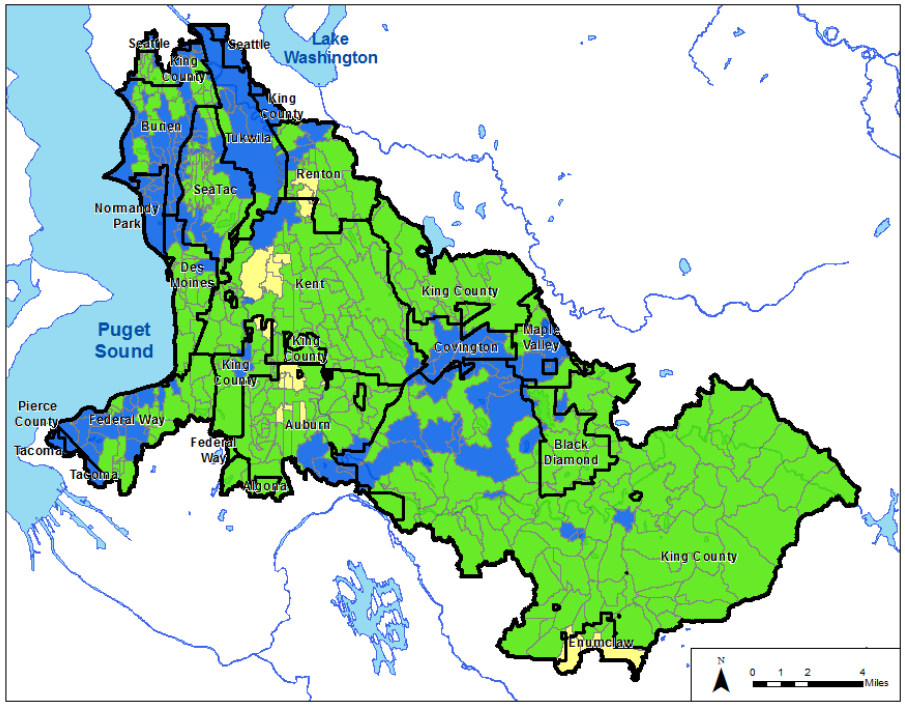
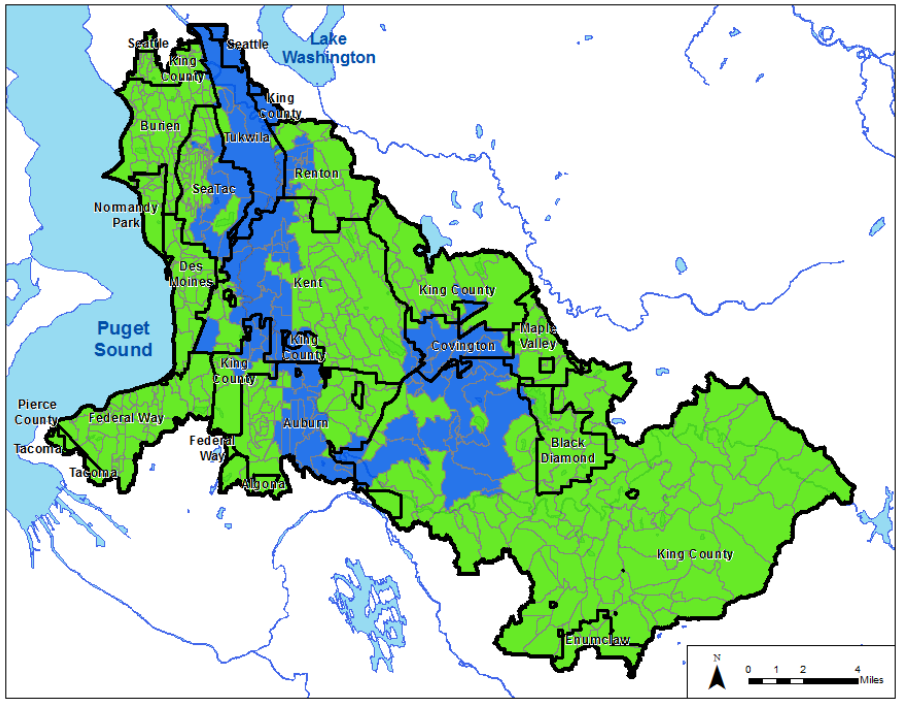
Potential B-IBI Improvement

(a)+(b)+(c)

2040 Full Stormwater Management



Fully-Forested



Biological Condition	B-IBI Range
Excellent	46 - 50
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Potential Improvement in Water Quality Indicators

- TSS concentrations modeled in SUSTAIN and scaled to study area considering stormwater management options.
- Extrapolate to turbidity, copper and zinc concentrations.
- Low risk of exceeding turbidity, dissolved copper and dissolved zinc water quality standards.

Cost Results: Required Stormwater Management with New and Redevelopment (a)

2040 Required Stormwater Management with new and redevelopment (a)			
BMP Type	Capital ($M)	O&M ($M)	I&E ($M)
Cisterns	$18	-	$11
Rain Gardens	$1,900	$1,200	$2,200
Roadside Bio	-	-	-
Detention Ponds	$1,600	$21	-

30-yr life cycle costs presented in 2013 dollars assuming a 5% real discount rate

Public Stormwater Program Cost: $3.9 billion

Cost Results: Stormwater Retrofit of Roads and Highways (b)

Stormwater Retrofit of Roads and Highways (b)			
BMP Type	Capital ($M)	O&M ($M)	I&E ($M)
Cisterns	-	-	-
Rain Gardens	-	-	-
Roadside Bio	$210	$130	$200
Detention Ponds	$180	$2	-

30-yr life cycle costs presented in 2013 dollars assuming a 5% real discount rate

Public Stormwater Program Cost: $0.7 billion

Cost Results: Stormwater Retrofit of Remaining Developed Land (c)

Stormwater Retrofit of remaining development (c)			
BMP Type	Capital ($M)	O&M ($M)	I&E ($M)
Cisterns	$11	-	$7
Rain Gardens	$1,000	$640	$1,300
Roadside Bio	-	-	-
Detention Ponds	$870	$11	-

30-yr life cycle costs presented in 2013 dollars assuming a 5% real discount rate

Public Stormwater Program Cost: $3.8 billion

Summary of Total Potential Public Stormwater Program Costs

		Total Cost ($M)	Total Cost ($M/mi^2)
(a)	Required Management	$3,900	$14
(a)+(b)	Required Management + Roads and Highways	$4,600	$17
(a)+(b)+(c)	Full Management	$8,400	$30

30-yr life cycle costs presented in 2013 dollars assuming a 5% real discount rate

Conclusions

- Modeled 2007 existing and 2040 developed conditions predict degradation in biological health with no stormwater management.
- Full stormwater management improved biological health close to that of forested conditions.
- Low risk of exceeding turbidity, dissolved copper and dissolved zinc water quality standards.
- Although roads and highways make up a small portion of the study area, retrofit of this area is important to improve flow and water quality to conditions supportive of biological health.
- Public stormwater program total present value 30-yr life cycle costs range from $3.9B to $8.4B.

Round Table Questions:

- How useful is the info for general planning purposes?
- Do the results generally make sense to you?
- How will you use the results?