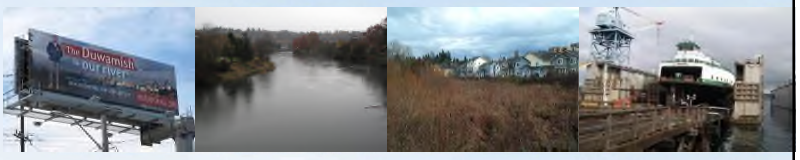
Green/Duwamish River Watershed



Pollutant Loading Assessment

Technical Advisory Committee Meeting
December 10, 2014

DEPARTMENT OF ECOLOGY
State of Washington

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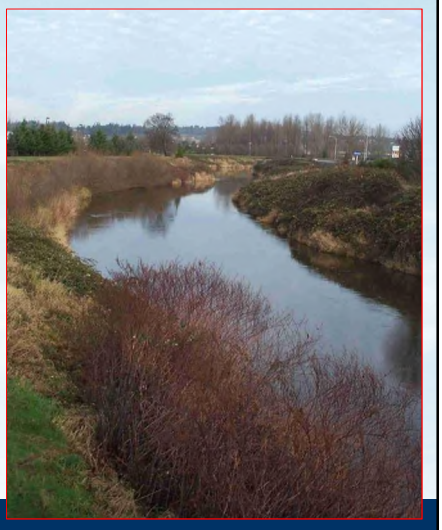
Pollutant Loading Assessment

Discussion Overview

- **Technical Approach**
  - ***Conceptual Model***
  - ***Proposed Framework***
- **Existing Information**
  - ***Data Review***
  - ***Modeling to Date***
  - ***Using the Existing Info***
  - ***Preliminary Gaps***
- **Next Steps**

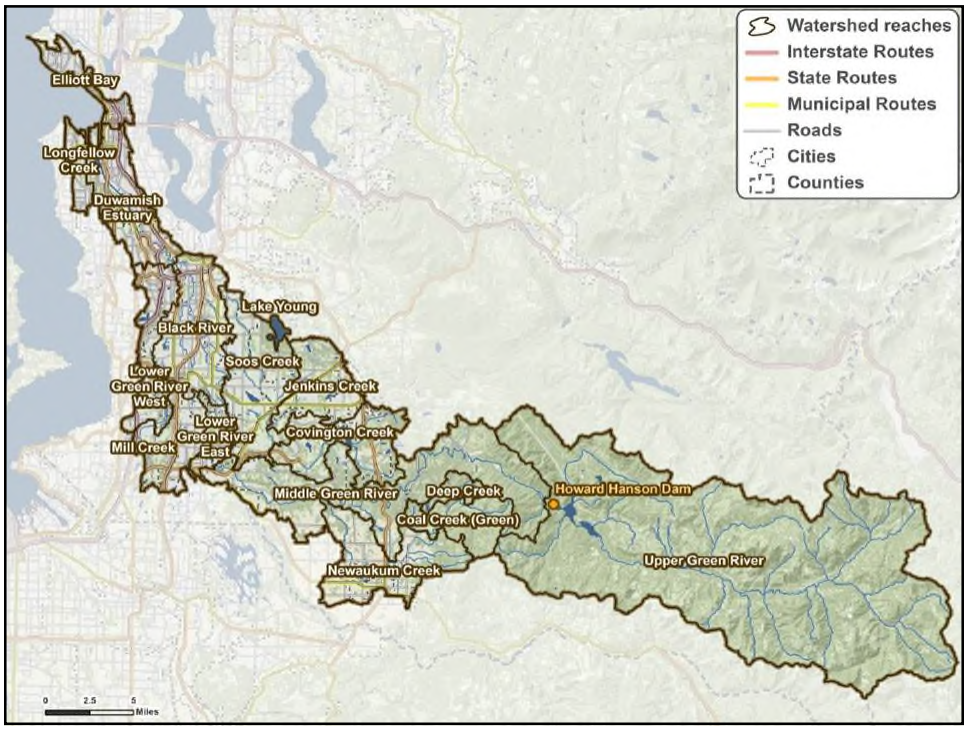


Pollutant Loading Assessment

Technical Approach

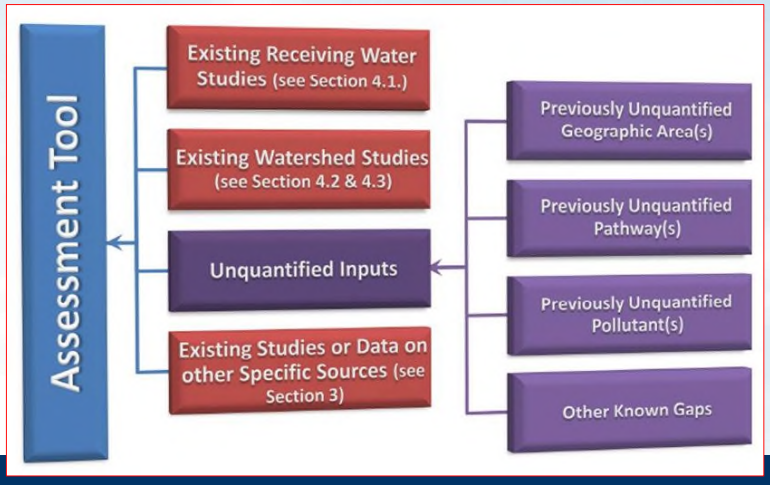
Objectives

- ***Address 303(d)-listed impairments***
- ***Link water, sediment, and tissue***
- ***Evaluate point and diffuse sources***
- ***Determine cumulative pollutant loading***
- ***Predict bioaccumulation in the food web***
- ***Predict impact of management actions***
- ***Evaluate effectiveness of cleanup & source control***



Technical Approach

Comprehensive - *builds on all available information*



Technical Approach

Comprehensive loading assessment requires

two modeling scales

- ***Watershed Level***
  - *Green / Duwamish River*
    - *Upper Green River*
    - *Middle Green River*
    - *Lower Green River*
    - *Duwamish Estuary*
- ***Receiving Water***
  - *Lower Duwamish Waterway*

needed to address different watershed processes and dynamics that occur in moving from upstream areas to downstream concerns

Conceptual Model

Major Considerations

- *Numerous Pollutants*
- *Sources*
  - *Industrial & Other Point*
  - *Natural*
  - *Diffuse*
- *Pathways*
- *Contaminant Transport*
- *Transformations*
- *Contaminant Fate*

OBSERVED RESOURCE IMPACTS AND DEGRADATION
Lower Duwamish Waterway (Sediment, Tissue, Water)
Lower and Middle Green River Watersheds (Tissue, Water)
Upper Green River Watersheds (Water)

CONCEPTUAL MODEL
INDUSTRIAL AND OTHER POINT SOURCES
Composition and Characteristics of Industrial, CSO's, Agricultural, Stormwater Sources

NATURAL AND DIFFUSE SOURCES
Atmospheric Deposition (wet/dry), and Urban, Agricultural, and Natural Land Uses

CONTAMINANT TRANSPORT
Pathways and Migration

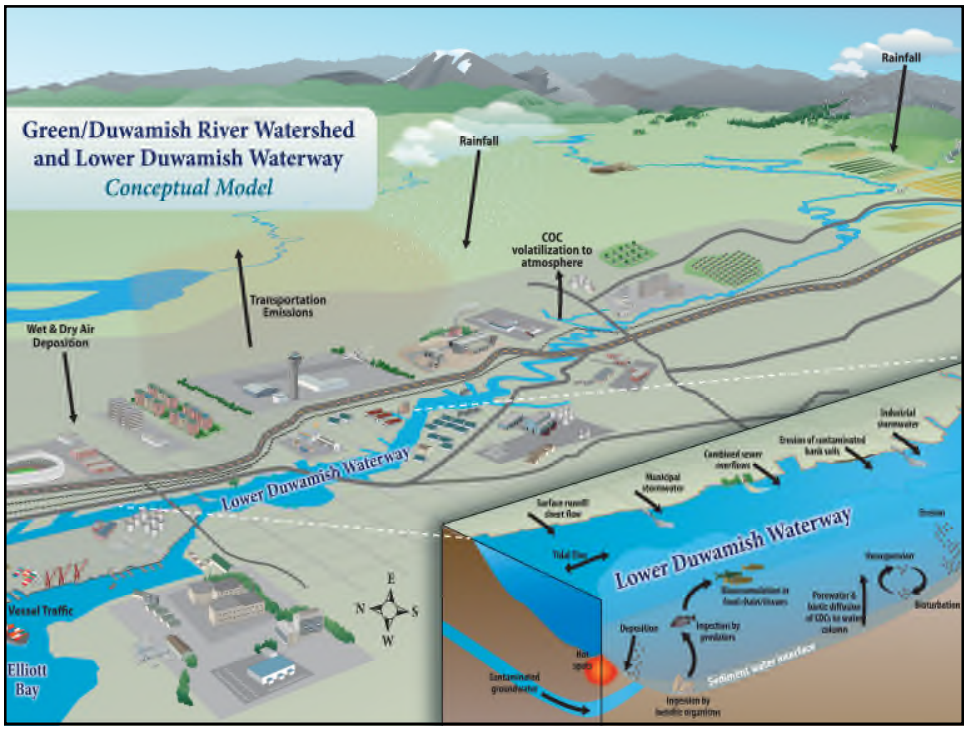
CONTAMINANT TRANSFORMATIONS
Potential Physical, Chemical, and Biological Transformations along with Interactions of Major Ions, Dioxins, PCBs, Metals, Pesticides, and Nutrients in Environmental Media

CONTAMINANT FATE
End-Points Along Pathways to Soils, Surface Water, Wetlands, Sediments, Tissues, and Shallow/Deep Groundwater

POLLUTANT LOADING ASSESSMENT TECHNICAL APPROACH

DATABASE ASSEMBLY
Existing Data Types, Sediment, Ambient WQ, Air Quality, Tissue, Physical, Hydrodynamics, Discharge, Sediment Transport, Ongoing Studies

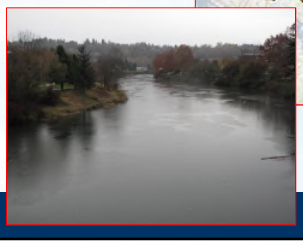
MODELING TOOL DEVELOPMENT
Watershed and Water Body Goals
Sediment Targets, Biota and Fish Goals
Receiving Water Studies and Previous Modeling
Watershed Studies
Specific Sources / Unquantified Inputs
Modeling Framework



Conceptual Model

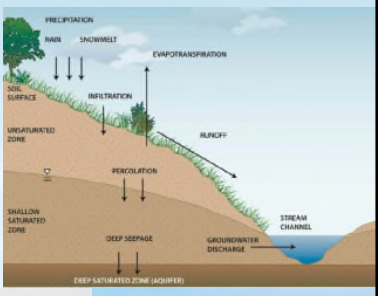
Green-Duwamish Watershed

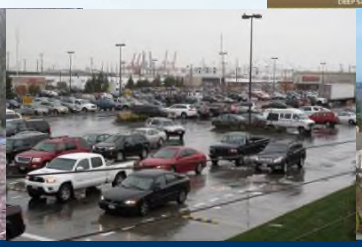
- **Considerations**
  - ***Spatial Extent***
  - ***Hydrologic Processes***
  - ***Pollutant Processes***
  - ***Sources***
  - ***Pathways***



Hydrologic Processes

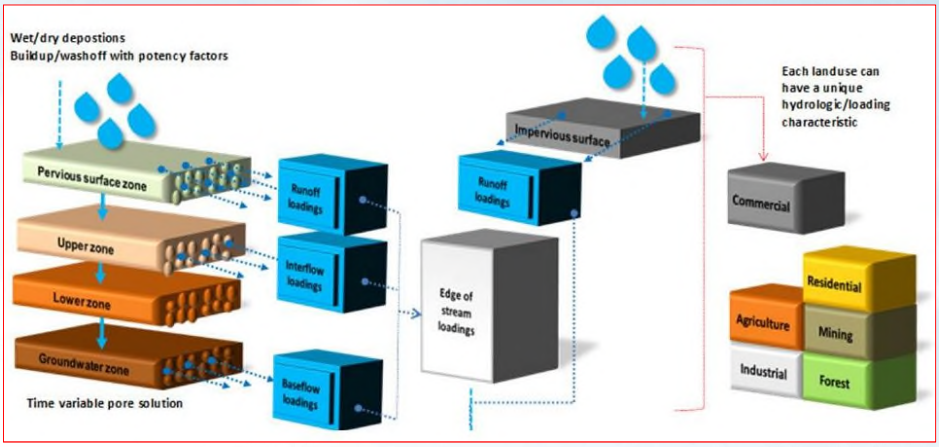
- **Key mechanisms**
- **Hydrologic Response Units provide connection to influence of landscape**





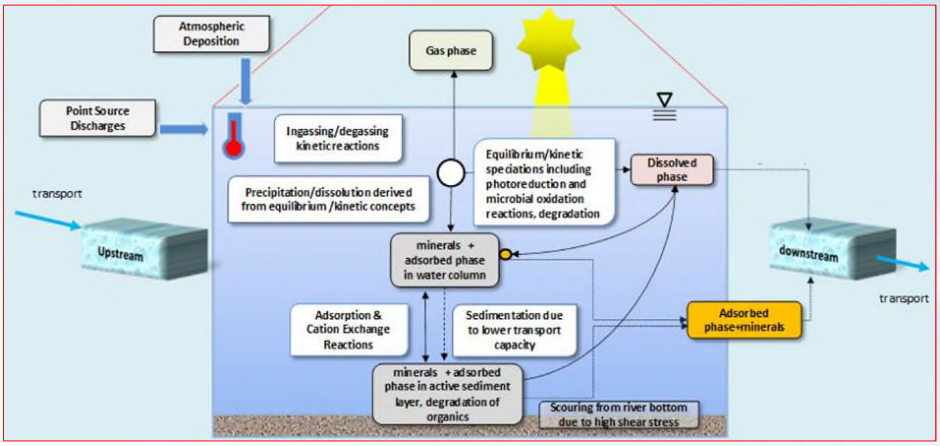
Pollutant Processes

Loading Mechanisms



Pollutant Processes

Transformation Mechanisms



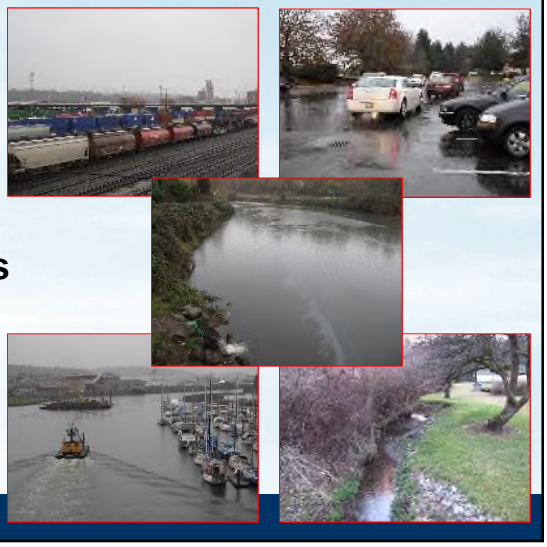
Sources and Pathways

Source Examples

- *Industrial processes*
- *Building materials*
- *Combustion activities*
- *Spills*

Pathway Examples

- *Stormwater*
- *Air deposition*
- *Volatilization*
- *Resuspension*

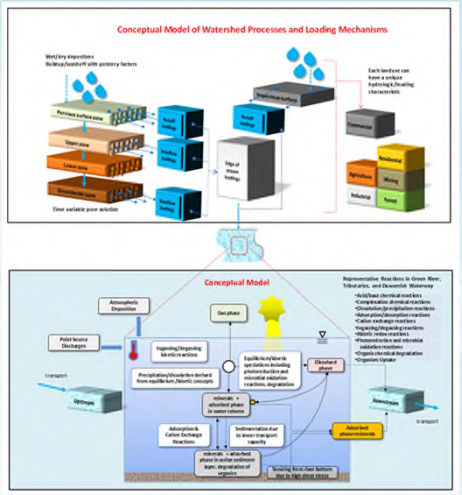


Conceptual Model

Integrated Approach

- *Hydrology incorporated*
- *Sources & pathways evaluated*
- *Transformations examined*

  (e.g., cycling between various phases)

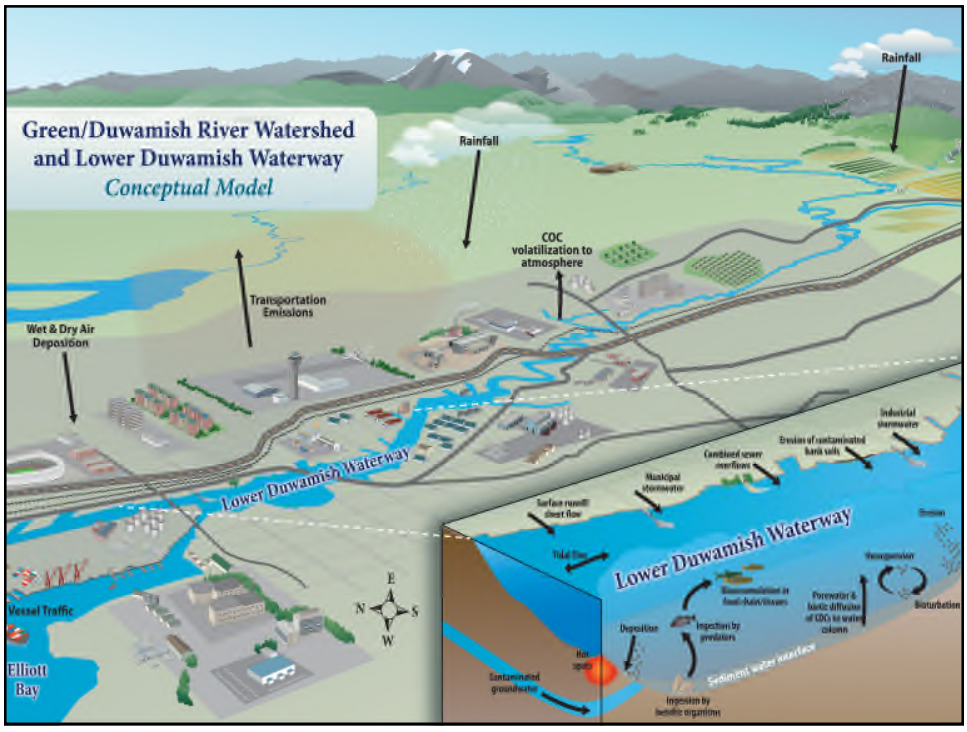


Conceptual Model

Lower Duwamish Waterway

- **Build on existing information**
  - ***LDW Group Conceptual Site Model describes:***
    - *Major pathways*
    - *Historical wastes*
    - *Source id & control efforts*

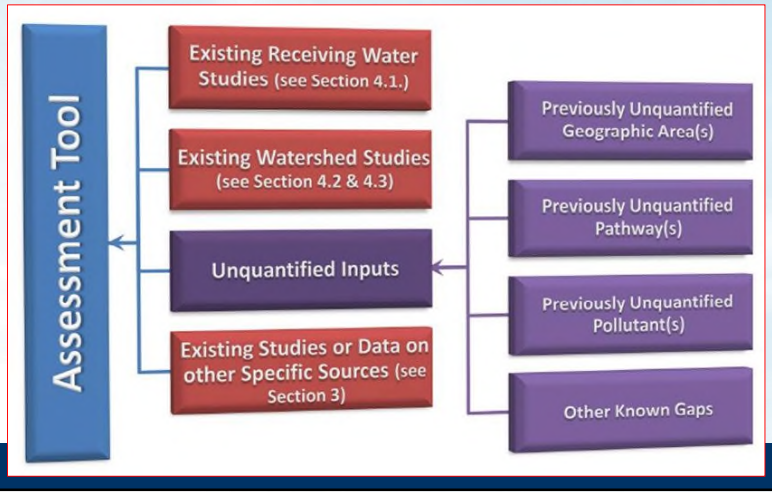
- **Proposed PLA approach**
  - ***Stronger linkage to upstream inputs***
  - ***Additional pollutant transformation & fate***



Technical Approach

Proposed Framework

Comprehensive -- ***builds on all available information***

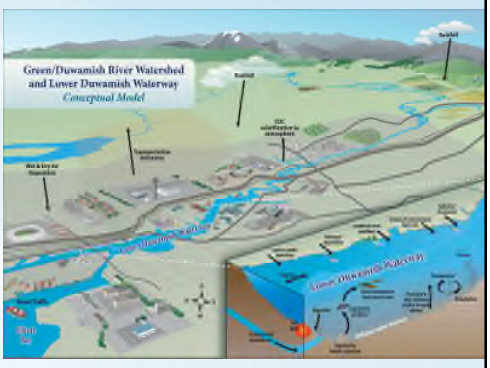


Technical Approach

Modeling Framework

Considerations

- ***Technical Criteria***
  - *Physical domain*
  - *Time periods*
  - *Source contributions*
  - *Constituents*
- ***Regulatory Criteria***
- ***User Criteria***



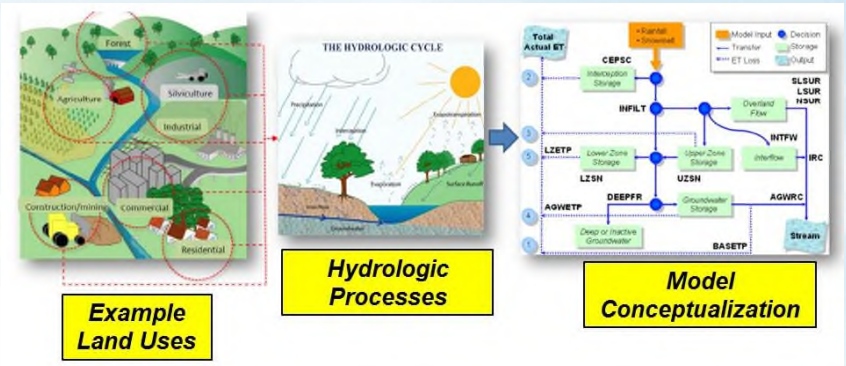
Modeling Framework

Watershed Representation

- ***Desired model features***
  - *variety of pollutants*
  - *mixed land uses*
  - *rainfall events*
  - *stormwater flow patterns*
  - *water storage features*
  - *pollutant transport*

Watershed Representation

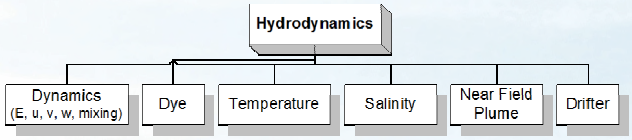
- **Loading Simulation Program in C++ (LSPC)**
  - ***Historic use by King County (as Hydrologic Simulation Program – Fortran or HSPF)***



Receiving Water Representation

- ***Desired Model Features***
  - *couple with watershed model*
  - *tidal hydrodynamics*
  - *sediment and contaminant transport*
  - *account for pollutant fate*

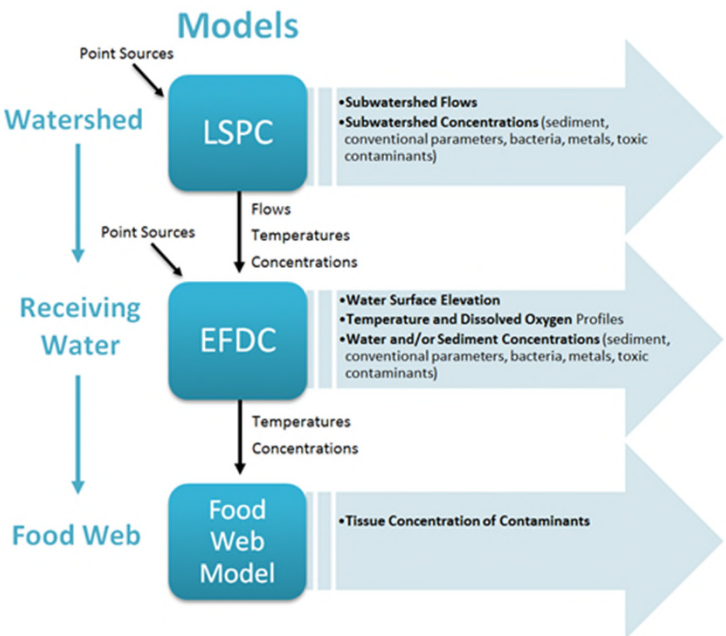
- ***Environmental Fluid Dynamics Code (EFDC) - used for several LDW evaluations***



Modeling Framework

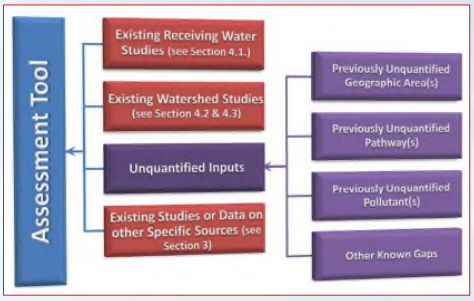
Food Web / Bioaccumulation Representation

- ***Desired model features***
  - *ability to link contaminant levels in the water column and sediment to contaminant levels in aquatic life*
- ***Arnot and Gobas Food Web Model (FWM) - used for several LDW evaluations***



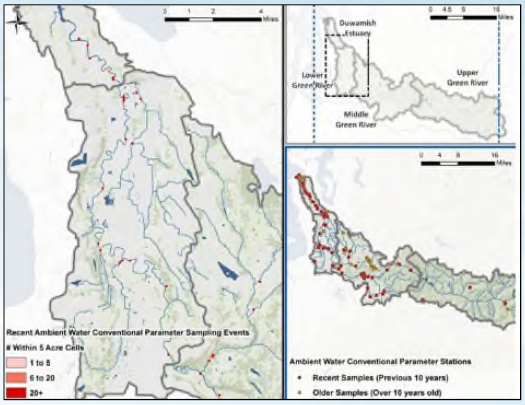
Existing Data

- **<u>Objective</u>: Identify and evaluate information needed to support:**
  - ***Source assessment***
  - ***Model development***
- **Data Types**
  - ***Water***
  - ***Sediment***
  - ***Tissue***
  - ***Other***



Existing Data

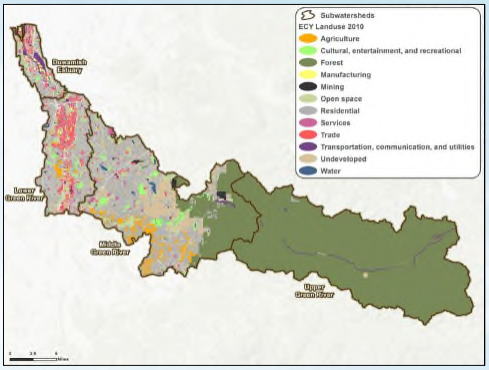
- **Water Quality**
  - *Ambient surface*
  - *Point source*
  - *Groundwater*
- **Sediment Quality**
  - *Ambient surface*
  - *Point Source*
  - *Subsurface*



SAMPLE DATA ASSESSMENT MAP

Existing Data

- **Tissue** *(fish/shellfish)*
- **Other**
  - *Air Quality*
  - *Physical*
  - *Streamflow*
  - *Meteorological*
  - *Hydrodynamic*
  - *Sediment Distribution*



SAMPLE PHYSICAL DATA

Existing Data

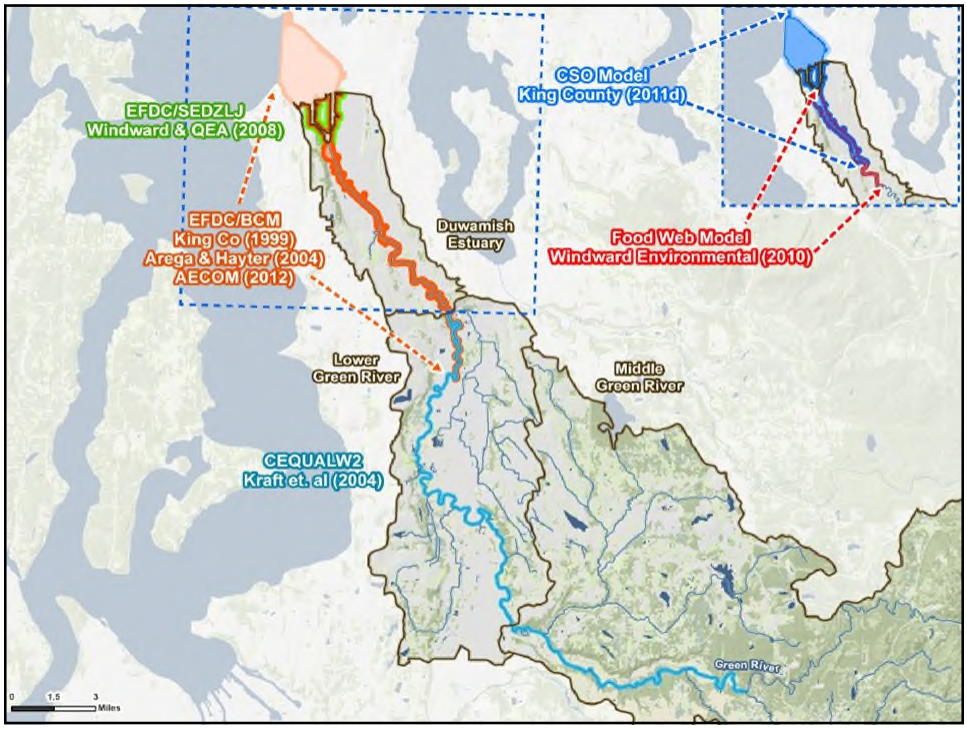
- **Data Sources Examined**
  - *Ecology's Environmental Information Management System (EIM)*
  - *LDW Sherlock Data Base*
  - *LDW RI/FS Studies*
  - *EPA STORET*
  - *USGS NWIS*
  - *Ecology's Permit & Reporting Information System (PARIS)*

Existing Models

- **Receiving Water** *(EFDC)*
  - *King County (1999)*
  - *Arega & Hayter (2004), Hayter (2006)*
  - *Windward & QEA (2008), QEA (2008)*
  - *AECOM (2012)*
  - *King County (2011)*
- **Receiving Water** *(CE-QUAL-W2 -- Kraft et al., 2004)*
- **Watershed** *(HSPF -- Aqua Terra & King County, 2003)*
- **Food Web** *(Windward, 2010)*

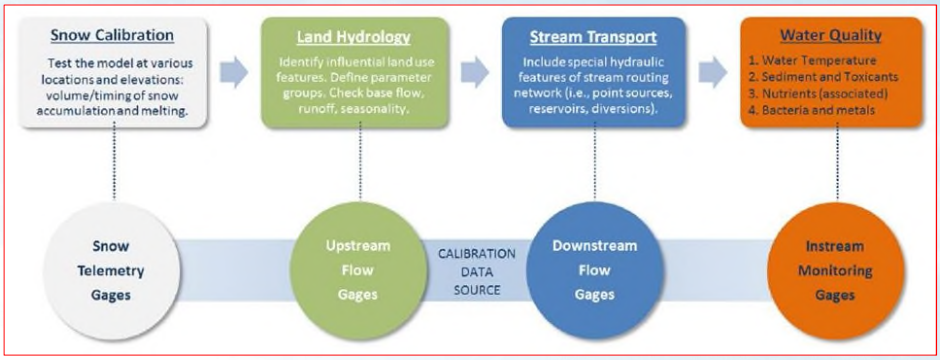
Refer to Table 4-1 for summary of:

- *Study*
- *Modeling tool*
- *Sources represented*
- *Pathways addressed*
- *Parameters assessed*



Using the Existing Info

Watershed Model



Using the Existing Info

Receiving Water Model

Data Usage

Data Type	Source Assessment	Watershed Model		Receiving Water Model[1]		Food Web Model	
		Configuration	Calibration/ Validation	Configuration	Calibration/ Validation	Configuration	Calibration/ Validation
Ambient Surface Water Quality	•		•	•	•		
Point Source Water Quality[2]	•	•	•	•			
Groundwater Quality	•	•		•	•		
Ambient Surface Sediment Quality	•		•	•	•		
Point Source Solids/Sediment Quality[2]	•	•	•	•			
Ambient Subsurface Sediment Quality	•			•	•		
Tissue Quality	•	•		•	•	•	•
Air Quality	•	•		•	•		
Physical	•	•		•			
Streamflow			•	•	•		
Meteorological		•		•			
Hydrodynamic				•	•		
Sediment Distribution	•	•		•	•		
Bank Samples			•		•		

Data Collection Efforts

Ongoing Studies

- **Watershed**
  - ***Ecology Green River Loading with USGS***
  - ***King County Studies***
  - ***WRIA 9 Activities***
- **Lower Duwamish Waterway**
  - ***Sediment cleanup and source control studies***
- **Stormwater Management & Drainage Planning**
  - ***Municipal and industrial stormwater data***
- **Flood Studies**

Technical Approach

Preliminary Gaps

- **Ambient Water Quality**
  - ***Lower Duwamish Waterway***
  - ***Green/Duwamish River Watershed***
- **Additional Observations**
  - ***Point source data***
  - ***Data to support estimates of diffuse source loads***

Table 3-4. Detailed summary of ambient surface water quality data

Parameter Group	Count by Subwatershed								Recent Data (within last 10 years)		All Data	
	Duwamish Estuary		Lower Green River		Middle Green River		Upper Green River					
	Station	Sampling Events	Station	Sampling Events	Station	Sampling Events	Station	Sampling Events	Station	Sampling Events	Station	Sampling Events
Alkylated PAHs	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	10	413	10	144	11	87	0	0	17	245	31	644
Bacteria	20	603	20	534	45	852	2	10	54	1,288	87	1,999
Conventional	64	2,676	32	3,207	72	9,813	8	3,738	121	14,076	121	14,076
Dioxin/Furan	0	0	0	0	0	0	0	0	0	0	0	0
Metals	9	486	9	344	12	355	2	28	12	486	32	1,213
Organometals	0	0	0	0	0	0	0	0	0	0	0	0
Other SVOCs	10	120	2	4	2	3	0	0	2	4	14	127
PAHs	11	245	4	37	4	30	0	0	9	98	19	312
PBBs	0	0	0	0	0	0	0	0	0	0	0	0
PBDE	0	0	0	0	0	0	0	0	0	0	0	0
PCBs	12	43	3	26	3	28	0	0	18	97	18	97
Pesticides	2	89	2	5	4	11	0	0	3	93	8	105
Petroleum	1	23	1	2	1	2	0	0	1	2	3	27
Phthalates	8	94	0	0	0	0	0	0	0	0	8	94
VOCs	1	24	1	2	1	2	0	0	1	2	3	28

Notes: Gray shaded parameter cells represent primary human health risk drivers. Orange shaded cells have no data. Cream/yellow shaded cells have limited data.

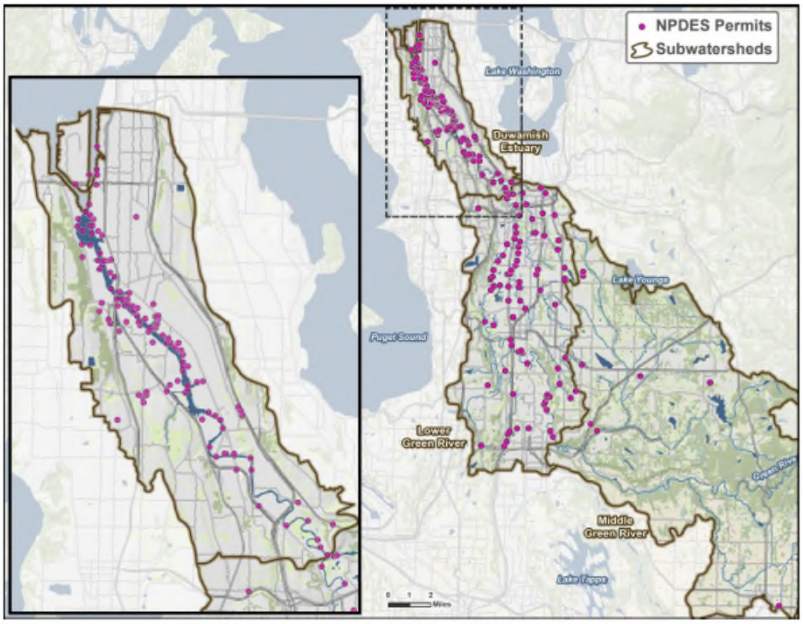


Figure 3-2. Permitted discharges near the LDW and the Green/Duwamish River watershed

Preliminary Gaps

Lower Duwamish Waterway

Parameter Group	Air	Ambient Surface Sediment	Ambient Surface Water	Point Source Solids/Sediment	Point Source Water	Groundwater	Ambient Subsurface Sediment	Tissue
Alkylated PAHs	•		•	•	•	•	•	
Arsenic								
Bacteria	•	•		•	•	•	•	•
Conventional	•							
Dioxin/Furan			•		•	•		•
Metals								
Organometals	•		•	•	•	•		
Other SVOCs	•							
PAHs								
PBBs	•	•	•	•	•	•	•	•
PBDE	•	•	•	•	•	•	•	•
PCBs								
Pesticides	•							
Petroleum	•		•		•			•
Phthalates	•							
VOCs	•		•					•

Notes: Gray shaded parameter cells represent primary human health risk drivers. A dot indicates less than 25 samples in the LDW representing a potential parameter data gap for this data set.

Preliminary Gaps

Green/Duwamish Watershed

Parameter Group	Air	Ambient Surface Sediment	Ambient Surface Water	Point Source Solids/Sediment	Point Source Water	Groundwater	Ambient Subsurface Sediment	Tissue
Alkylated PAHs	•	•	•	•	•	•	•	•
Arsenic	•			•	•	•	•	•
Bacteria	•	•		•	•	•	•	•
Conventional				•	•		•	•
Dioxin/Furan	•	•	•	•	•	•	•	•
Metals	•			•	•		•	•
Organometals	•	•	•	•	•	•	•	•
Other SVOCs	•		•	•	•	•	•	•
PAHs	•			•	•		•	•
PBBs	•	•	•	•	•	•	•	•
PBDE	•	•	•	•	•	•	•	•
PCBs				•	•	•	•	•
Pesticides	•		•	•	•	•	•	•
Petroleum	•	•	•	•	•		•	•
Phthalates	•		•	•	•	•	•	•
VOCs	•	•	•	•	•		•	•

Notes: Gray shaded parameter cells represent primary human health risk drivers. A dot indicates less than 25 samples in the LDW representing a potential parameter data gap for this data set.