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Managing ~~recontamination~~ reaccumulation in an urban waterway

Dana de Leon, City of Tacoma, WA

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Project Objectives

- Prevent the Reaccumulation ~~Recontamination~~ above sediment criteria of Thea Foss Waterway after Remediation
- Determine the Role of Stormwater in Sediment Contamination
- Use “Early Warning” Criteria to Identify Trends toward Criteria Exceedances

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Aerial View of Puyallup River Delta

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Tacoma's Source Control Strategy

- Aggressive source control efforts
- Comprehensive monitoring programs
- Modeling cumulative impacts on future sediment quality
- Evaluate need for additional source controls

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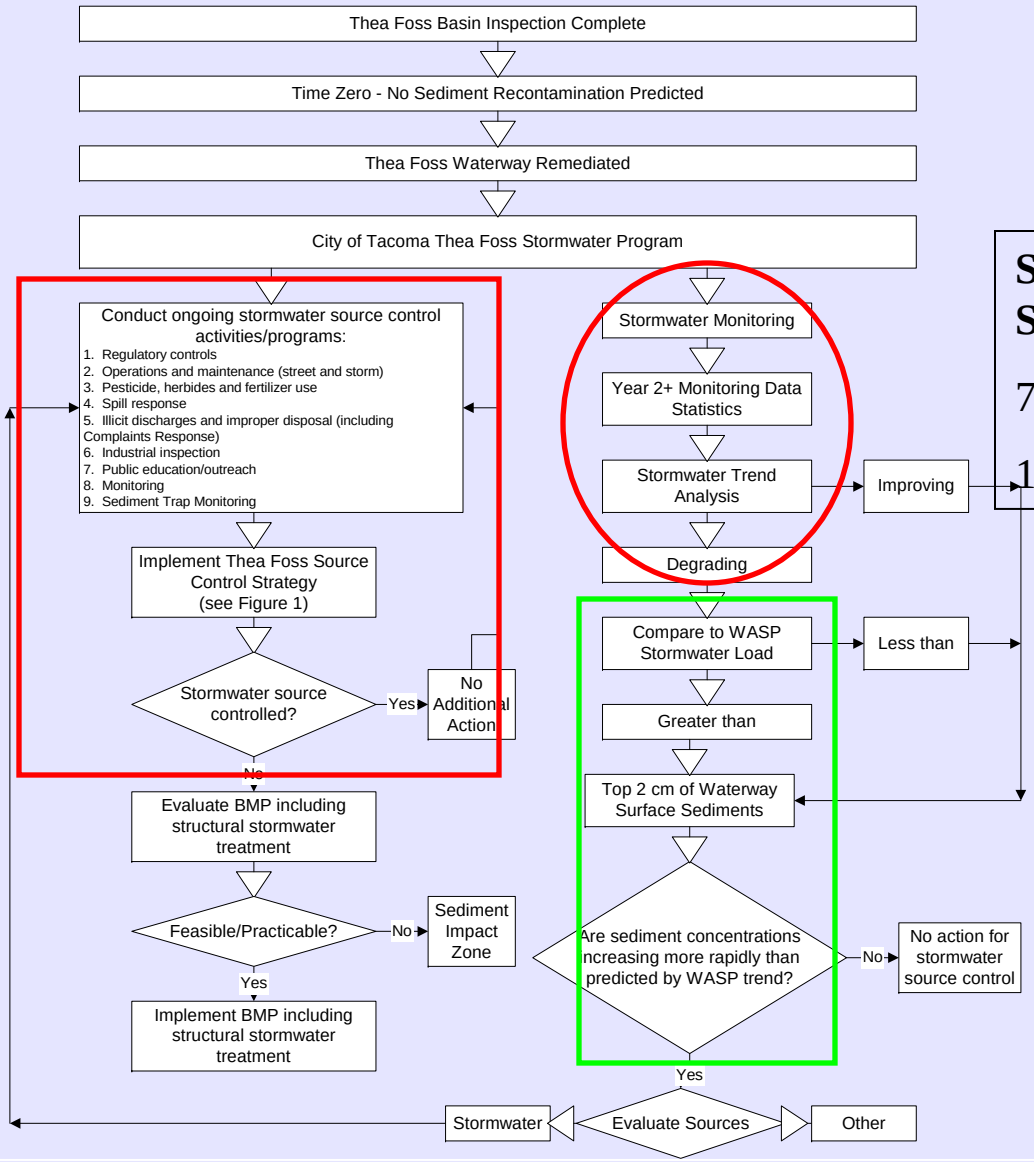
Figure 3

Thea Foss Post-Remediation Source Control Strategy



NPDES

Inspections

IDDE

Maintenance

Treatment

Source tracing

Special Studies

Storm/Storm Sediment Samples

7 outfalls

10 storms/year

Remedy OMMP

Sediment Samples

WASP Modeling

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Evaluation Strategy

1. Estuarine sediments quality <criteria?
2. Estuarine sediments quality <model projections?
3. Stormwater quality improving?
4. Additional source control required?

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Monitoring Programs, 2001-2010

- Estuarine sediments monitoring
  - 0 to 10 cm: Compliance interval
  - 0 to 2 cm: “Early warning” interval
- Stormwater/baseflow monitoring
  - 7 Municipal Drains
  - 10 Storm Events/ year
  - 4 Base Flow Events/ year
- Stormwater sediments
  - 6 Municipal Drains
  - Outfall and Upline locations
  - Annual deployments

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CHEMICAL	PERCENT EXCEEDANCE	ENRICHMENT RATIO
Phenanthrene	5%	1.0-1.6
Pyrene	5%	1.0-1.8
Indenopyrene	3%	1.0-1.3
DEHP	35%	1.8-7.7

74 samples: 40 in the Head of Waterway & 34 in the remaining portion (2008).

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Modern Stormwater Trends

	Outfall Number	n	r^2	t statistic	Significance Level	Estimated % Reduction in 10 years
TSS	235	76	0.076	-2.57	99%	57%
TSS	237B	78	0.025	-1.46	93%	40%
Lead	237B	78	0.036	-1.73	96%	44%
Phenanthrene	230	72	0.116	-2.95	100%	74%
Phenanthrene	237A	78	0.127	-3.29	100%	81%
Phenanthrene	254	67	0.075	-2.37	99%	60%
Pyrene	254	67	0.340	-5.70	100%	91%
Indeno(1,2,3-c,d)pyrene	254	67	0.310	-5.36	100%	90%
DEHP	243	53	0.096	-2.32	99%	72%
DEHP	245	74	0.157	-3.59	100%	76%

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Basin-Wide Storm System Cleaning is Effective in Reducing Pollutant Loads

- In 2006, 2007 and 2008, the entire storm system was cleaned in Basins 254, 230, 235 and 237A.
- Objective: To remove residual sediments that contain legacy contamination which contaminate stormwater through resuspension.
- Tested pre- and post-cleaning stormwater data to determine statistically significant differences.

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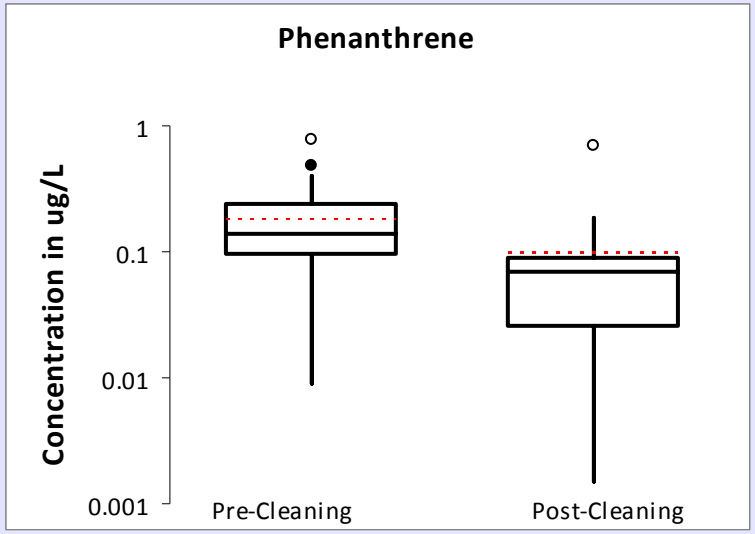
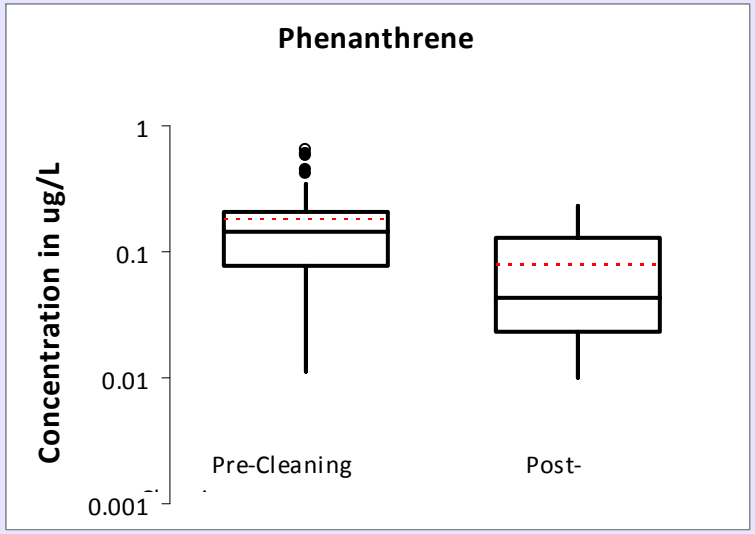
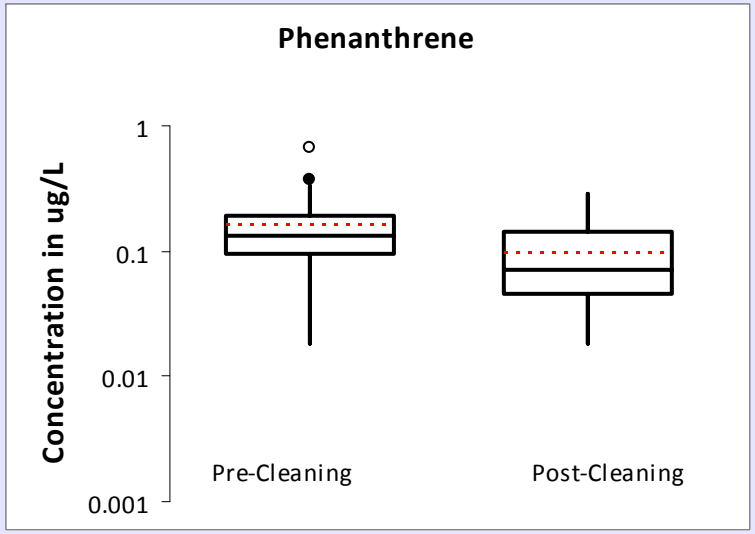
Pre- & Post-cleaning Statistically Significant Results







Lead: 26-31% reduction, 230 & 235

PAHs: 40-60% reduction, 254, 230 & 235

DEHP: 40% reduction in 235 @ 94% confidence

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Sediment WASP Model Objectives

- Improved Management of Contaminant Sources (Load Allocation)
- Development of Source Control Goals (Loading Capacity)
- “Early Warning” of Sediment Recontamination

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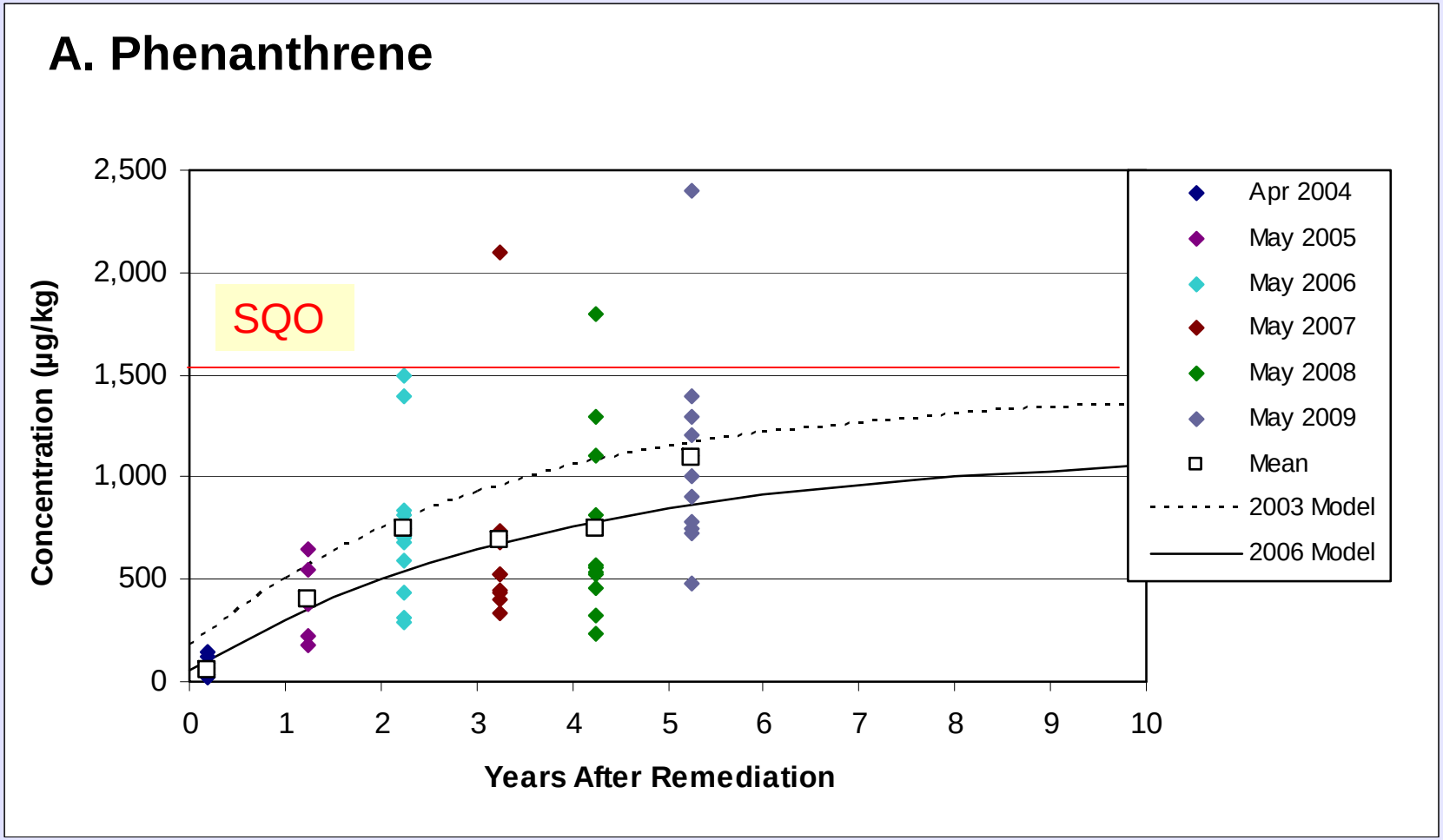
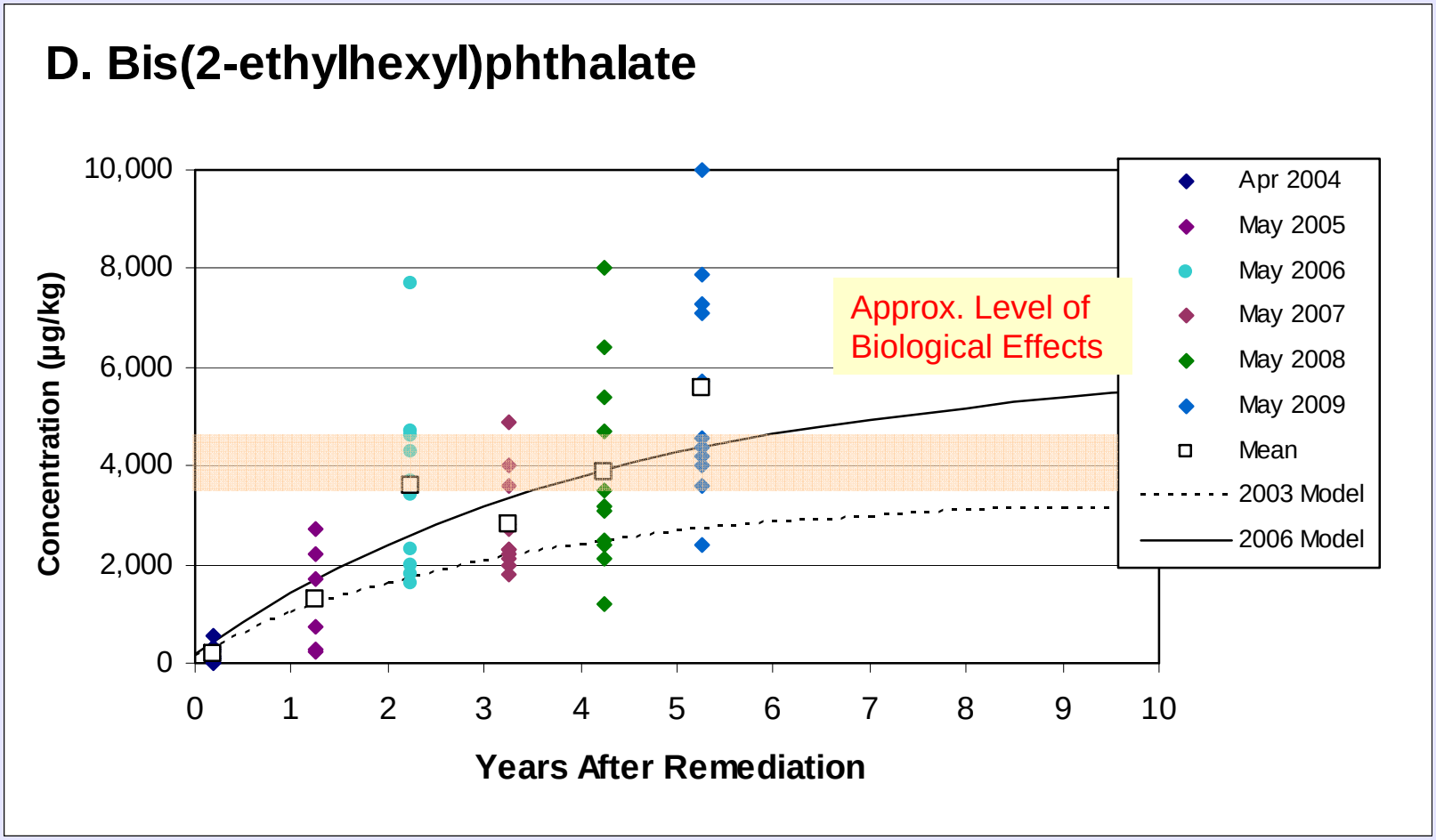
Predicted versus Observed Sediment Concentrations: Phenanthrene



Predicted versus Observed Sediment Concentrations: DEHP



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Work Plan Development

Timeline: Matrix vs Conc. vs Activity

Spatial Analyses used to Focus Source Control Efforts

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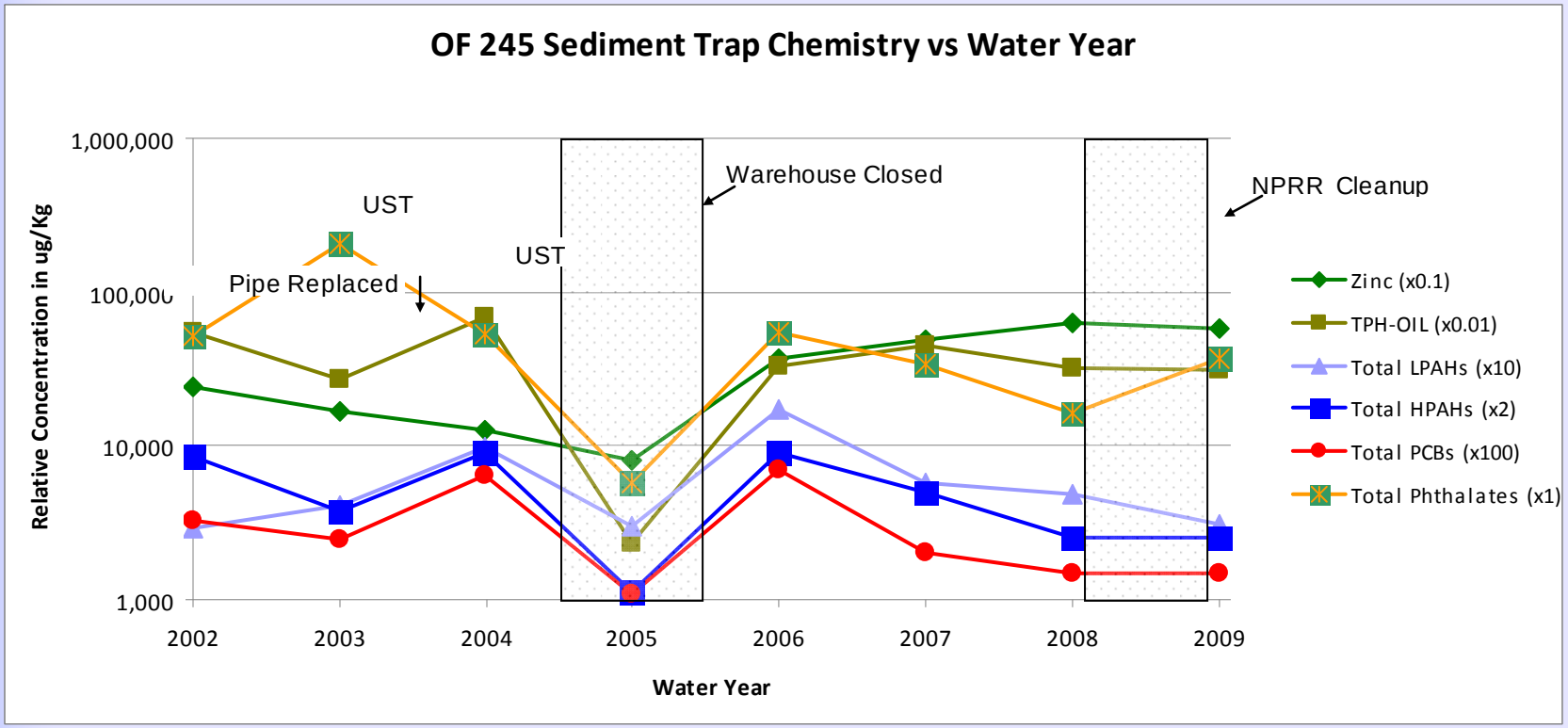

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Stormwater Source Tracing

	230	235	237A	237B	243	245	254
TSS	-3	2	-3	-1	0	2	3
Lead	2	6	-4	-4	3	-4	1
Zinc	-1	3	-2	-6	-2	4	4
Bis(2-eh)phthalate	4	5	-2	-2	-2	-1	-2
Phenanthrene	2	2	0	-3	-3	0	2
Pyrene	2	3	3	-3	-4	-4	3
Indeno(123-cd)pyrene	2	1	2	1	-2	-5	1

Lower Concentrations	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	Higher Concentrations

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Storm Sediment Source Tracing

Water Years 1-8	230	235	237A	237B	243	245
Lead	3	0	-1	-2	4	-4
Mercury	2	-1	-1	-2	4	-2
Zinc	3	0	-1	-2	1	-1
TPH-OIL	1	0	0	-2	1	0
DDT	No significant differences					
Phenanthrene	1	1	1	1	1	-5
Indeno(1,2,3-cd)pyrene	3	-1	2	1	0	-5
Pyrene	1	1	1	1	1	-5
Total PCBs	4	-1	-1	-2	2	-2
DEHP	2	0	0	-1	1	-2
Butylbenzylphthalate	-2	-2	-2	-2	4	4
Total Phthalates	1	0	-1	-3	1	2

Lower Concentrations	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	Higher Concentrations

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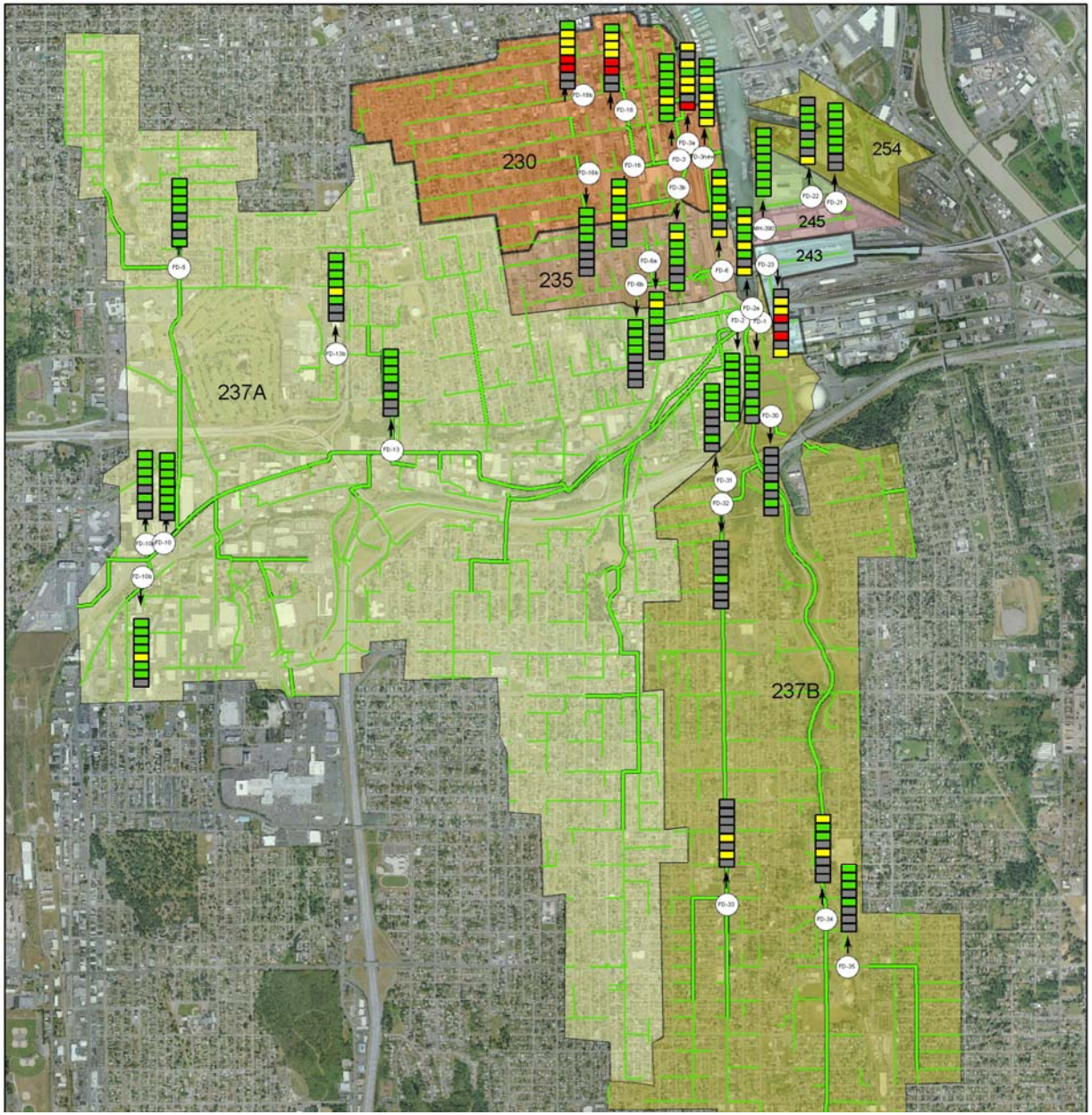
Mercury Figure 2-1a

Thea Foss Waterway - Sediment Trap Data Results



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Next Steps in Source Control

- Ongoing business inspections/ Work Plan
- Additional sampling to verify modeling and assess trends.
- Basin-wide upland model to assess a menu of stormwater maintenance & treatment scenarios that will minimize impacts on waterway from stormwater discharges.

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Conclusions

- PAHs appear to be largely under control in waterway sediments with current source control efforts and stormwater source loads
- DEHP is well above SQOs and remains a stormwater source control priority
- Other sources (marinas, atmospheric, coal tar) also need to be monitored with additional controls in place as available or necessary

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Manage Phthalate Reaccumulation Using Site-Specific O&M Plans

- Source control program to ID and control potential point sources
- Acknowledge atmospheric deposition will cause reaccumulation
- Monitor to predict extent and concentrations in exceedence area at equilibrium
- Consider site-specific triggers for actions: extent and concentrations of reaccumulation, association with other contaminants, ecological priorities and beneficial uses of the area

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Contacts and Website

- Dana de Leon, P.E. 253-502-2109
  ddeleon@cityoftacoma.org
- Mary Henley, P.E. 253-502-2113
  mhenley@cityoftacoma.org
- Todd Thornburg, 503-670-1108
  tthornburg@anchorqea.com
- Annual Source Control and Stormwater Reports:
  http://www.cityoftacoma.org/Page.aspx?hid=14413
- Thea Foss Waterway Cleanup Reports:
  http://www.cityoftacoma.org/Page.aspx?hid=939

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Phthalate Work Group Conclusions

- EPA, Ecology, Various Municipalities
- Ubiquitous Phthalate Sources:
  Air -> Stormwater -> Sediment pathway
- Significant in urban, impervious watersheds
- Expect sediment build-up in quiescent areas, to exceed SMS criteria re benthic toxicity – minimal concern up the food chain
- Manage phthalate reaccumulation at cleanup sites using site-specific O&M plans

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Reaccumulation Prevented?

- Yes –
  - continue monitoring and source control programs.
- No –
  - Look at all sources and reduce loads to the extent practicable.
  - Additional source control
    - BMPs: Basin Cleaning, Street Sweeping, etc.
    - Stormwater Treatment
    - Low Impact Development (gradual turnover process)

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Recontamination Evaluation 2009 Conclusions

- PAHs appear to be largely under control in waterway sediments, assuming no future changes in source loads
- DEHP is well above SQOs and occasionally above biological effects levels in the head of the waterway; DEHP remains a stormwater source control priority
- Organic carbon explains much of the observed local heterogeneity in sediment quality
- WASP model predictions show excellent agreement with sediment quality monitoring trends, confirming its value as a predictive tool

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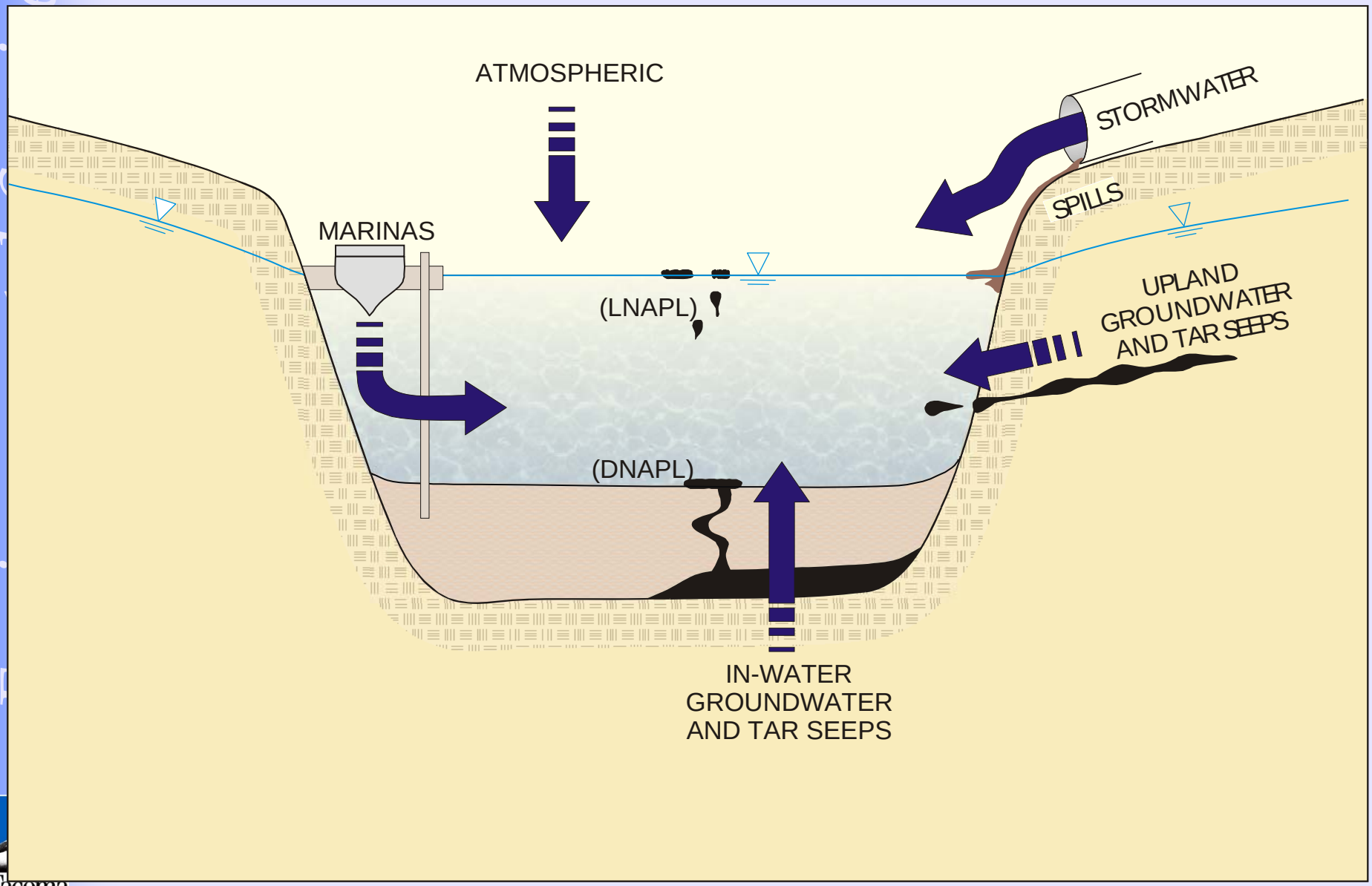
Potential Pollutant Sources



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Tacoma's Source Control Efforts

- Public education
- Storm system maintenance/cleaning
- Business inspections & spill/compliant response
- Illicit Discharge Detection and Elimination investigations
- Stormwater Management Manual & Ordinance: Development/redevelopment standards for water quantity and quality

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Other Source Control Efforts

- Atmospheric Deposition Study
- Studies to evaluate structural treatment technologies – Vaults, Pervious Pavement, Bioinfiltration, Bioswales.
- Basin-wide Storm System Cleaning
- Targeted business inspections.

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