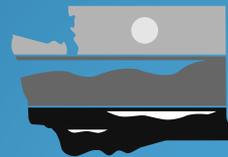


Rayonier Mill Off-Property Soil Dioxin Study Final Project Report

August 3, 2011



DEPARTMENT OF
ECOLOGY
State of Washington

Ecology Staff

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Solid Waste Program
management

Toxics Cleanup Program
management

2000

2008

2013

Interim Actions

Rayonier Mill **Upland**

Rayonier Mill **Marine**

Off-Property Soil Dioxin Study

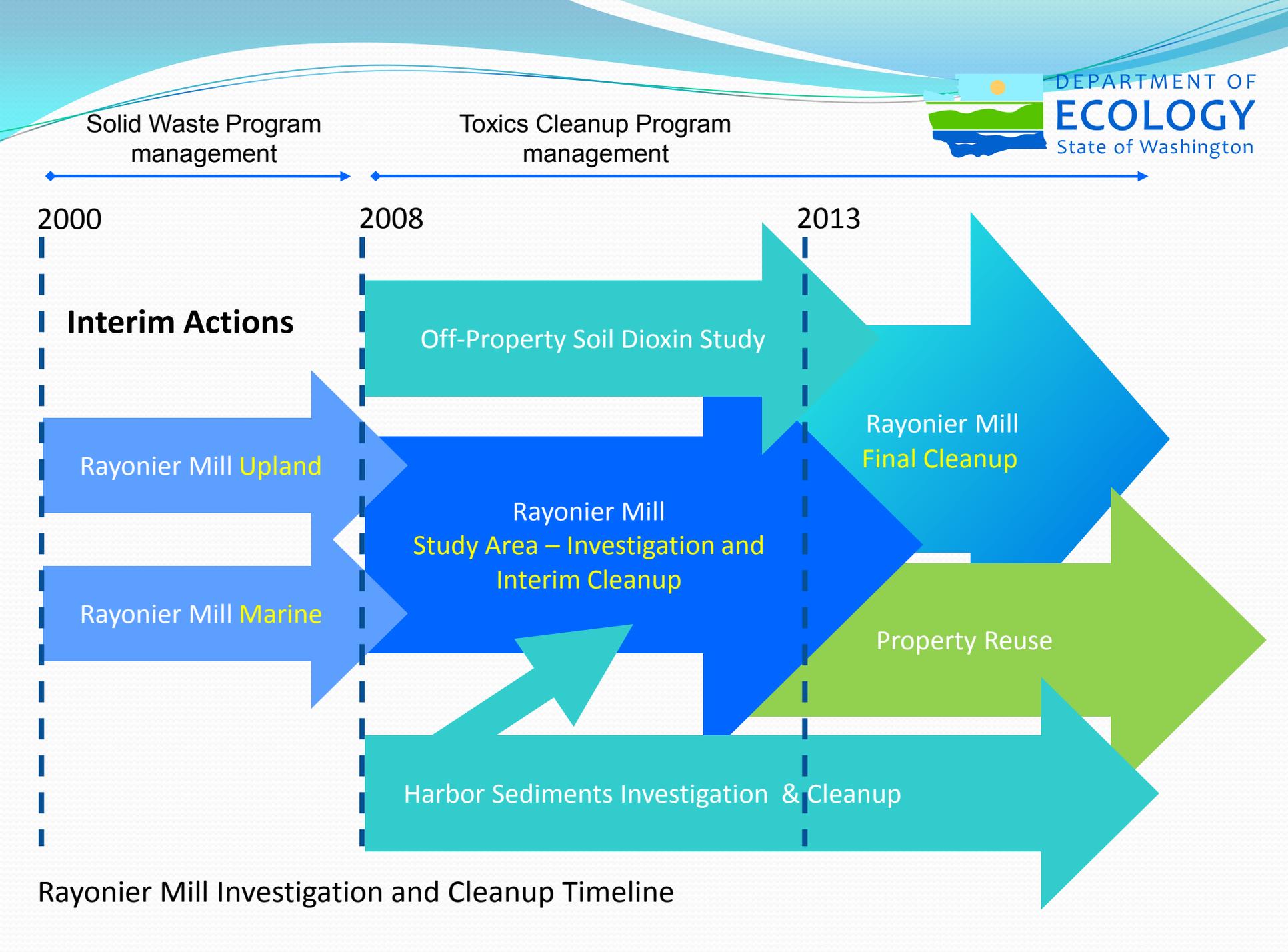
Rayonier Mill
Study Area – Investigation and
Interim Cleanup

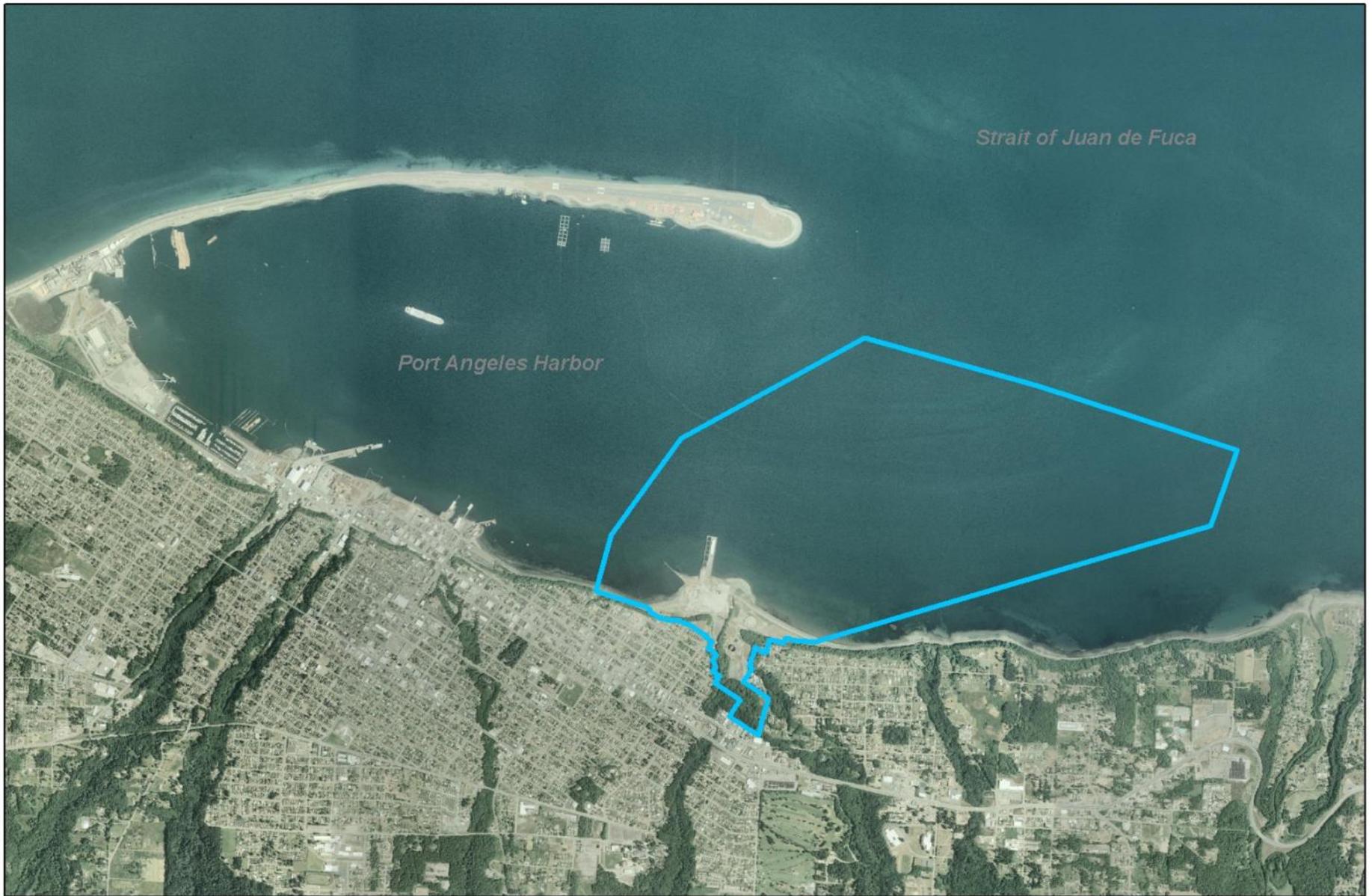
Rayonier Mill
Final Cleanup

Property Reuse

Harbor Sediments Investigation & Cleanup

Rayonier Mill Investigation and Cleanup Timeline





 Study Area boundary

Port Angeles Rayonier Mill Study Area



Agreed Order Highlights

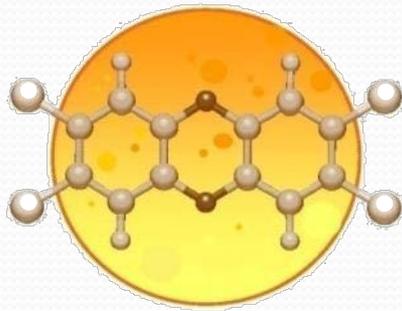
- Focus on the Study Area
- Tasks
 1. Collect additional soil and groundwater data – **Complete**
 - Technical memo - **Complete**
 2. Produce upland data summary report
 3. Produce marine data summary report
 4. Evaluate Interim Action alternatives
 5. Develop an Interim Action Plan
- Enforceable schedule over 3 years

Soil Dioxin Study Outline

- Study Design
- Sampling
- Results
- Conclusions

Off-Property Study Objectives

- Determine the magnitude of dioxin and furan concentrations in soils potentially impacted by airborne emissions from the former Rayonier Mill.
- Determine the former Rayonier Mill's contribution to measured dioxin concentrations, compared to other possible sources.



Study Limitations

This study was not designed to:

- Determine the total extent of contamination.
- Completely characterize individual properties.
- Support predicting levels on one property based on samples from another.
- Define background levels.

Study Timeline

2008

- July - Study design
- Sept. and Nov. - Data collection

2009

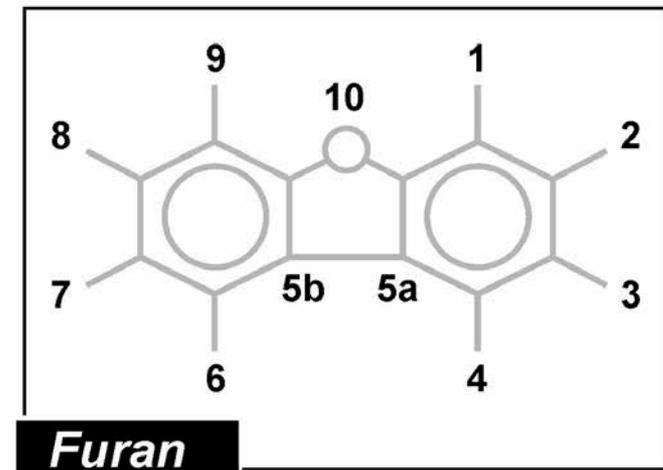
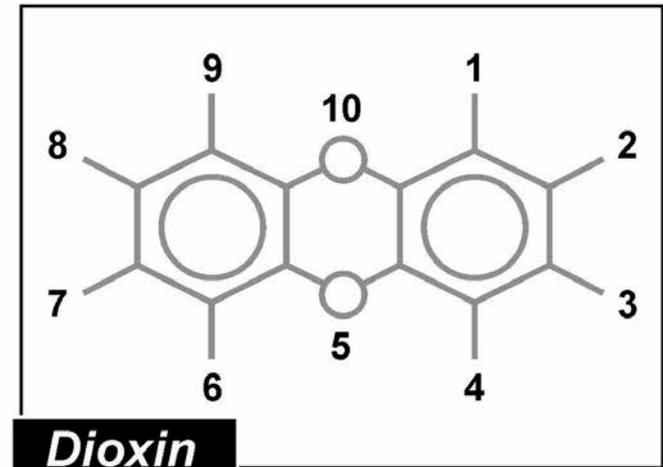
- Feb. - Preliminary results release

2011

- July – Final Project report release
- Aug 30 - Public comment period ends
- Fall – Final Report and Responsiveness Summary

Dioxins and furans?

- Family of chemicals with similar structures and biological effects
- Persist in environment and accumulate. Present worldwide
- Most people are exposed to low levels
- Exposures linked to cancer, non-cancer health effects



Dioxin Sources

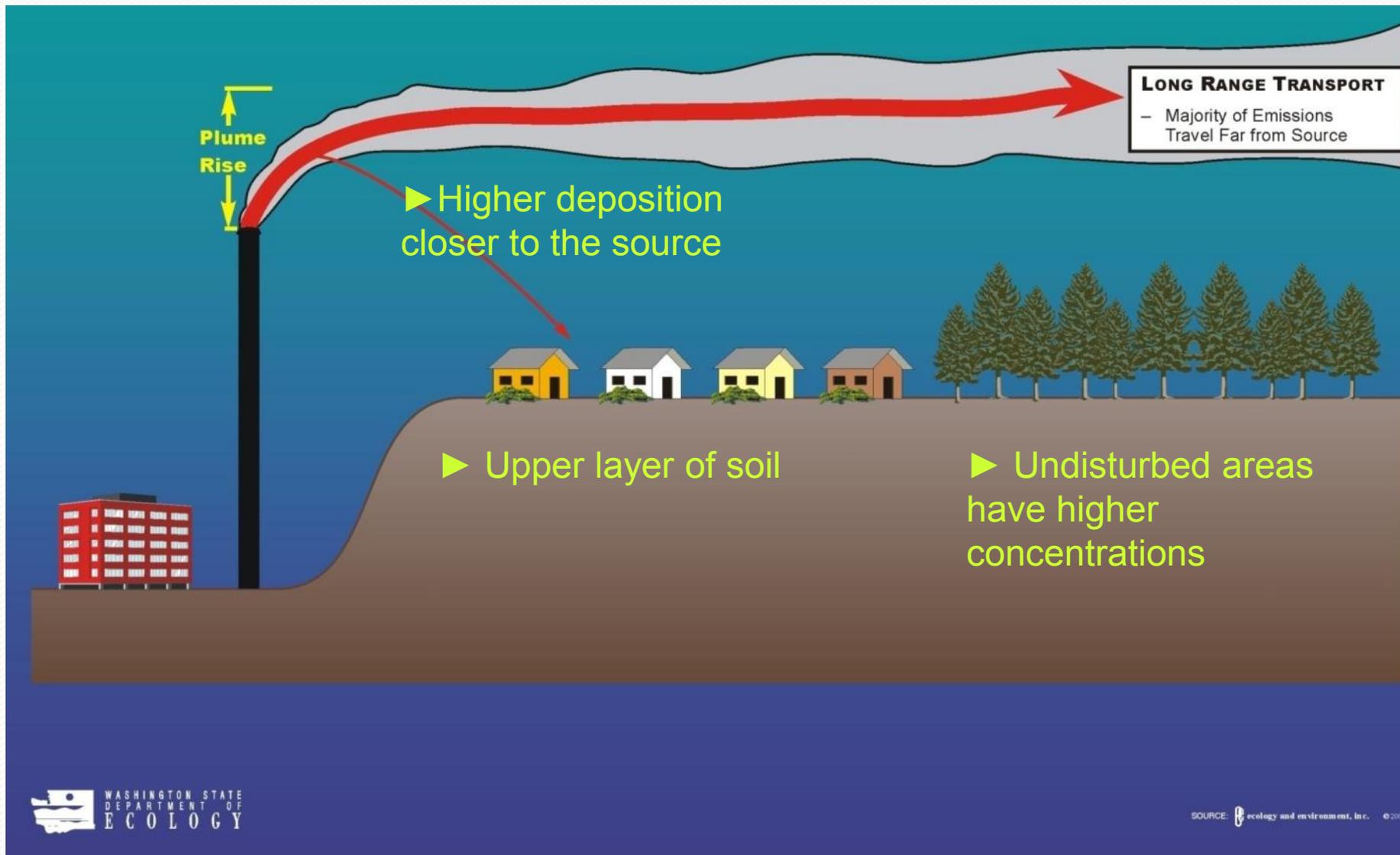
- **Point sources**
 - Incinerators, boilers
 - Pulp chlorine bleaching
 - Chemical manufacturing
- **Diffuse sources**
 - Forest fires
 - Automobile exhaust
- **Property-specific sources**
 - Chemical applications
 - Burn barrels, fireplaces
 - Ash disposal



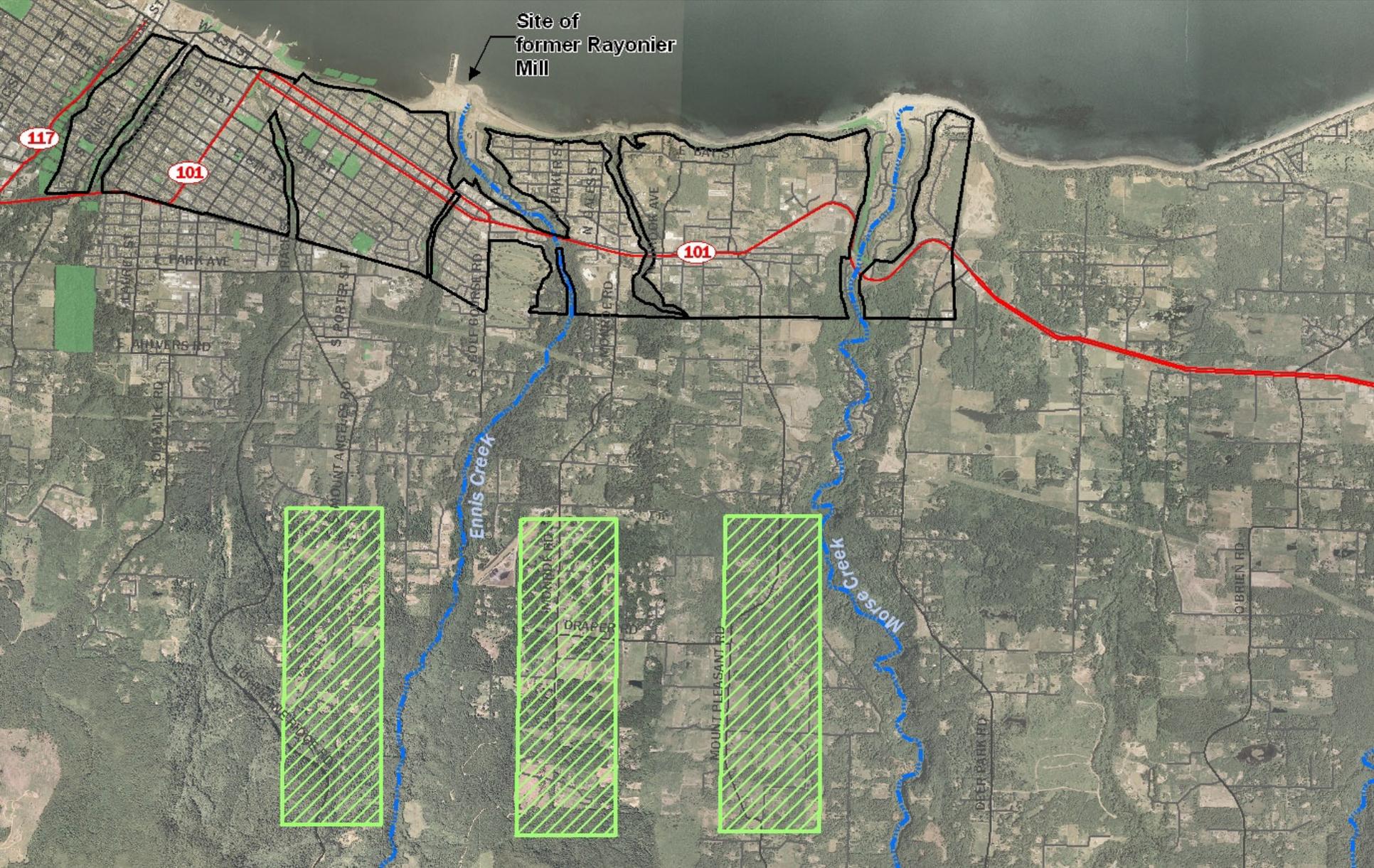
Potential Dioxin Point Sources



Dioxin Emissions



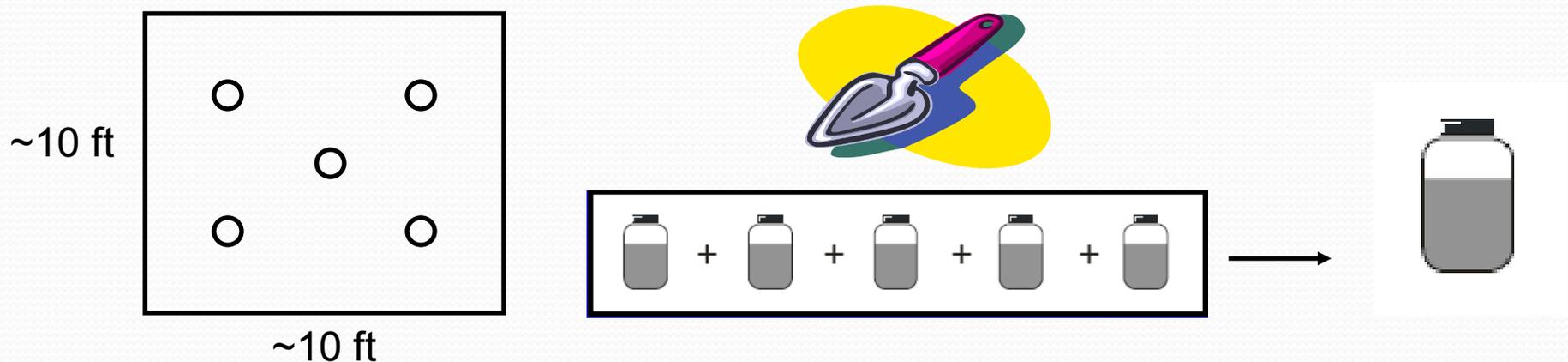
Upslope Samples



Soil Sampling

After a property was selected, the sampling team collected:

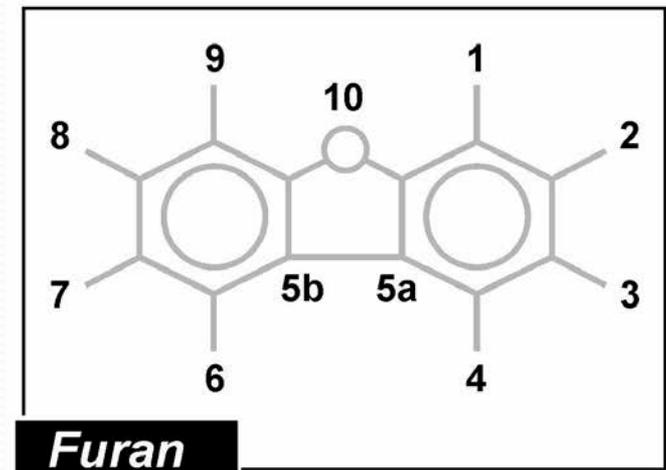
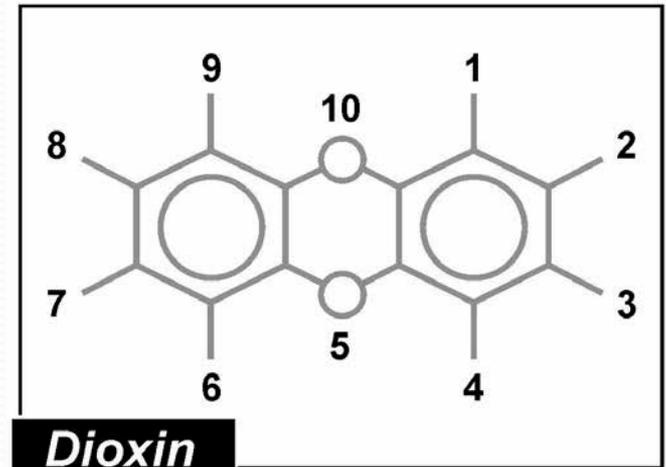
- Five samples from 3 inch deep holes
- Mixed the five samples into one “composite”





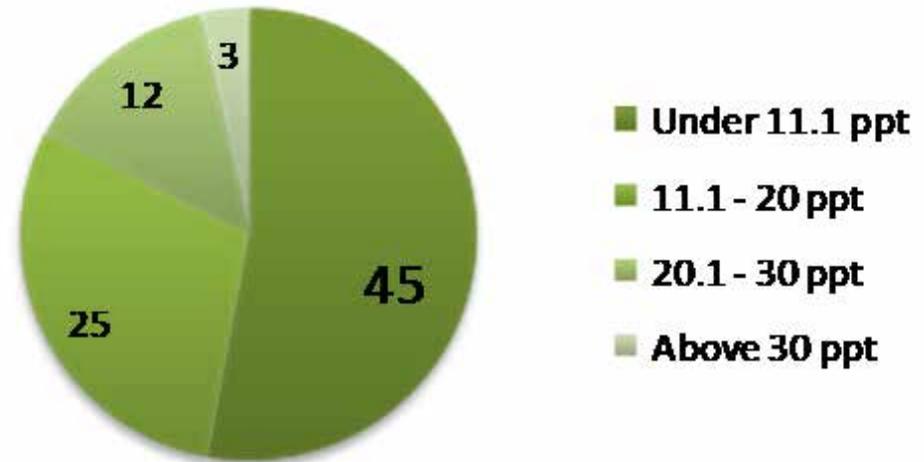
TEQs – Measuring dioxins

- 210 different dioxins and furans, 17 most toxic reported
- Concentrations are multiplied by a scaling factor based on comparison to the most toxic one
- All 17 together = Toxic equivalent concentration (TEQ)



Basic Findings

- 85 total samples
 - 60 grid (residential)
 - 14 forested
 - 2 road
 - 9 upslope



- 40 of 85 samples exceeded 11.1 ppt
- 11.1 ppt is the “Method B” direct contact value for protection of human health



Four Lines of Evidence

Magnitude

Spatial
Patterns

Chemical
Patterns

Mass Balance



Magnitude – Urban Soils

	Port Angeles Grid	WA Urban	Denver	Utah	Australia Urban	Norway
Median	11.87	2.74	2.17	0.90	4.18	1.51
75 th Percentile	17.45	5.92	7.92	1.83	10.74	2.30
High	76.26	21.55	42.71	4.47	45.33	12.13
Low	1.13	0.73	0.21	0.32	0.11	0.16



Magnitude – Non-Urban Soils

	PA Forest	PA Upslope	PA Road	WA forest	WA open land	US Rural
Median	10.61	1.82	5.27	3.49	1.47	0.94
75 th Percentile	25.58	2.37	6.50	5.60	2.31	2.32
High	40.46	5.54	6.50	6.67	5.18	11.69
Low	4.02	0.80	4.04	1.18	0.69	0.21

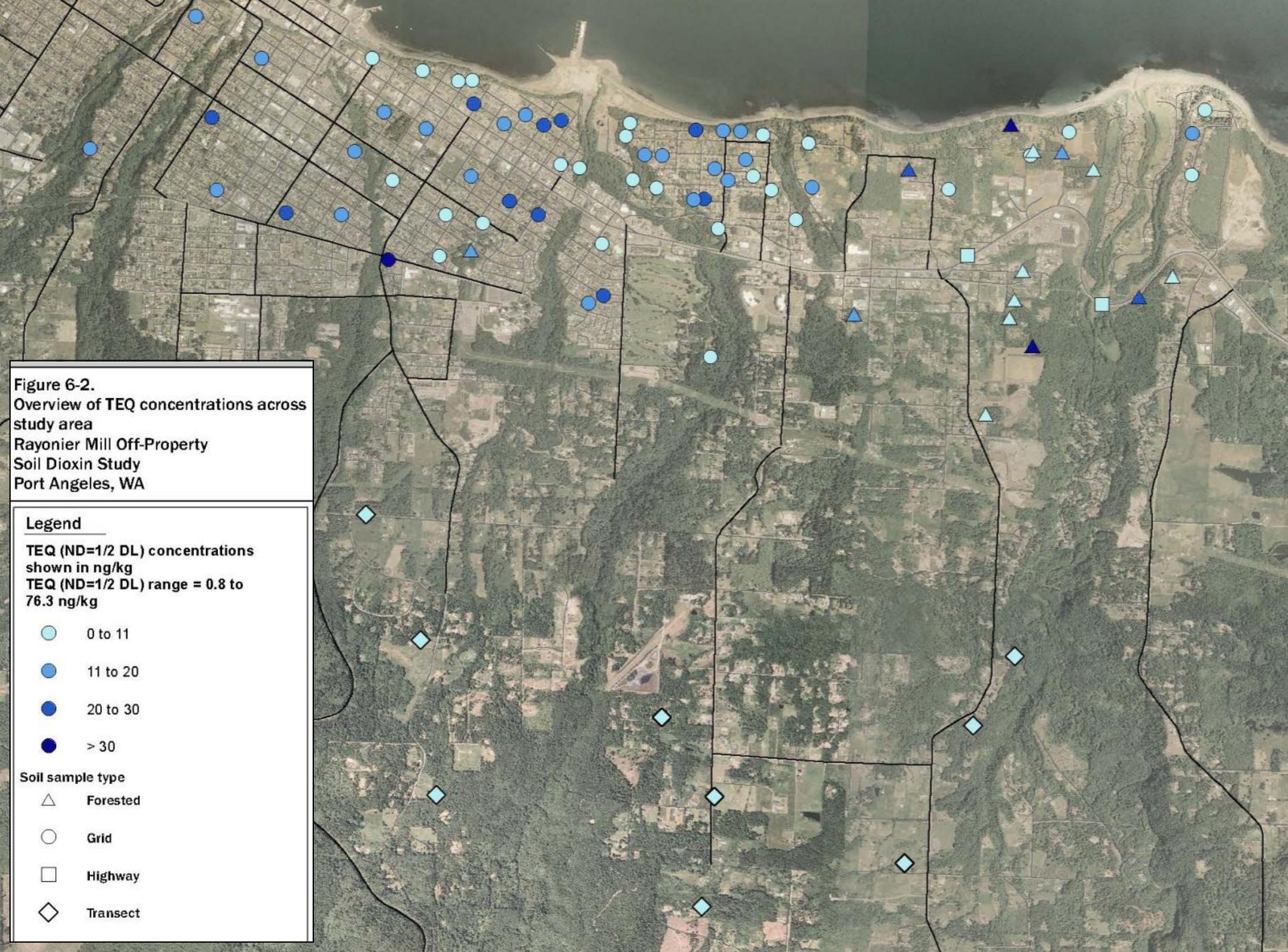


Figure 6-2.
Overview of TEQ concentrations across
study area
Rayonier Mill Off-Property
Soil Dioxin Study
Port Angeles, WA

Legend

TEQ (ND=1/2 DL) concentrations
shown in ng/kg
TEQ (ND=1/2 DL) range = 0.8 to
76.3 ng/kg

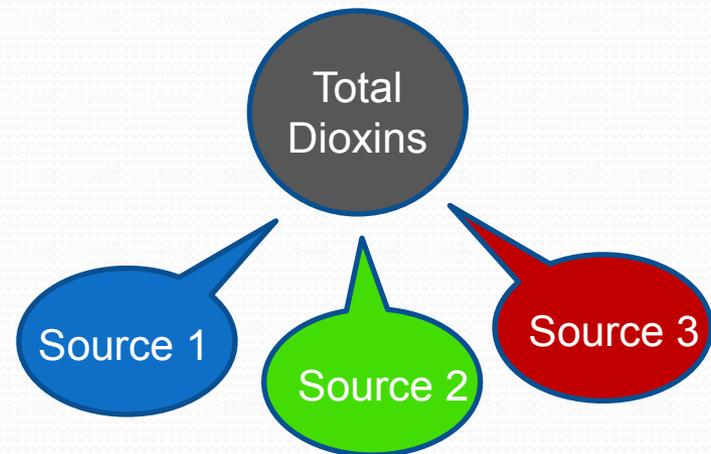
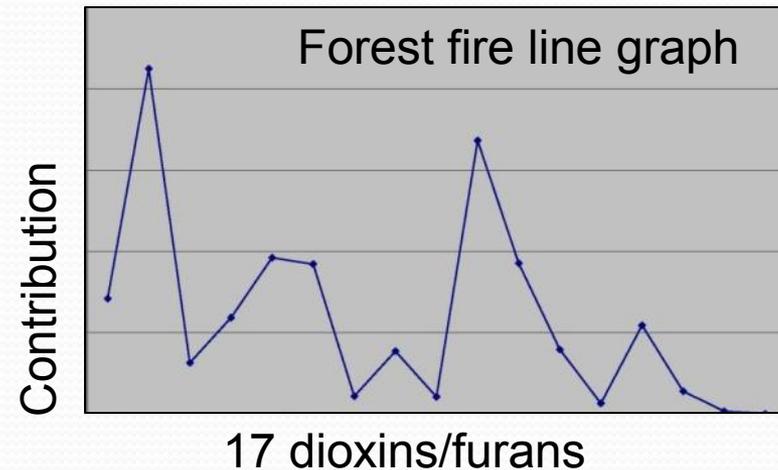
- 0 to 11
- 11 to 20
- 20 to 30
- > 30

Soil sample type

- △ Forested
- Grid
- Highway
- ◇ Transect

Chemometrics

- Dioxins from different sources have different chemical patterns
- Most soil samples contain dioxins from multiple sources
- Mathematical unmixing into source profiles and contributions from each source
- Several hundred profiles used for interpretation





Chemical Patterns

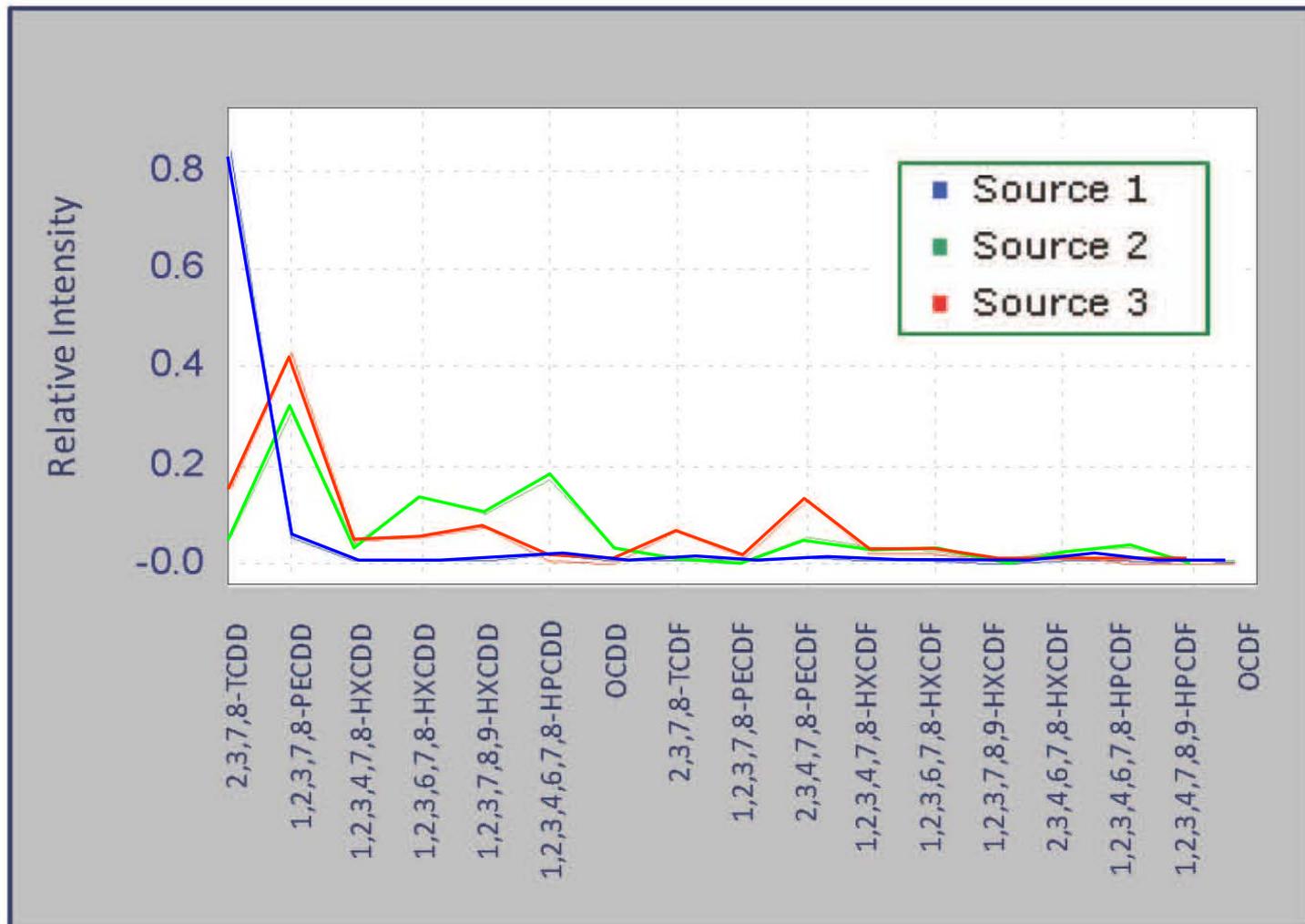
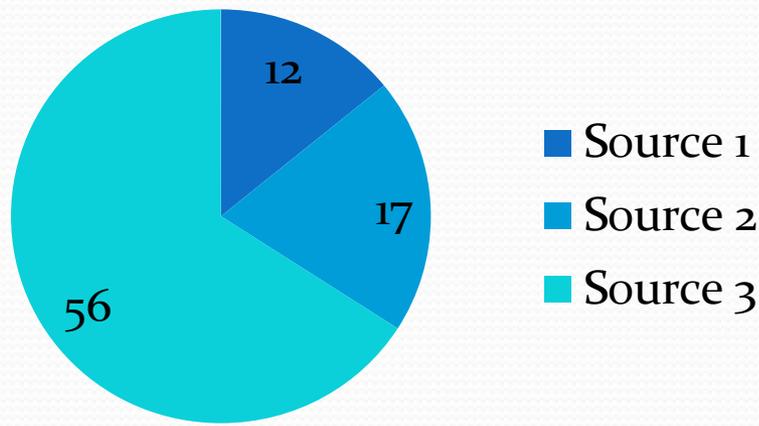


Figure 8-10 Unmixing model source profiles

Source Increment Magnitudes

- # of Samples with largest part from each source:



- Without source 3, sources 1 and 2 are similar to other urban soils
- Source 3 dominates most forest samples

SOURCE 1: tire burning, herbicide

Figure 8-18.
Unmixing model Source 1 TEQ
increments
Rayonier Mill Off-Property
Soil Dioxin Study
Port Angeles, WA.

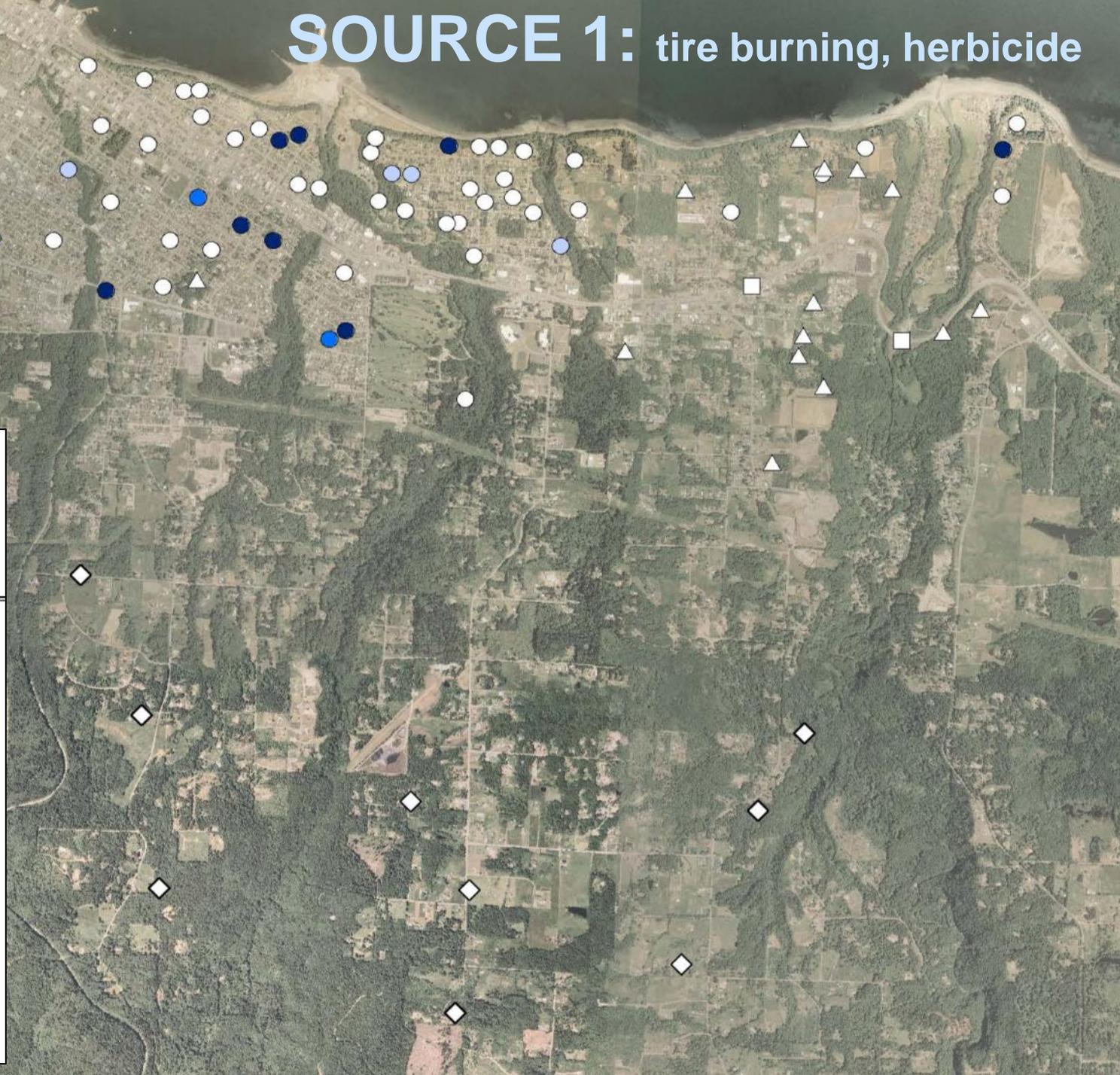
Legend

TEQ (ND = 1/2 DL) concentrations
shown in ng/kg

- 0 to 3
- 3 to 7
- 7 to 11
- > 11

Soil sample type

- △ Forested
- Grid
- Highway
- ◇ Transect



SOURCE 2: urban soils, vehicle emissions, hog fuel boilers

Figure 8-19.
Unmixing model Source 2 TEQ
increments
Rayonier Mill Off-Property
Soil Dioxin Study
Port Angeles, WA

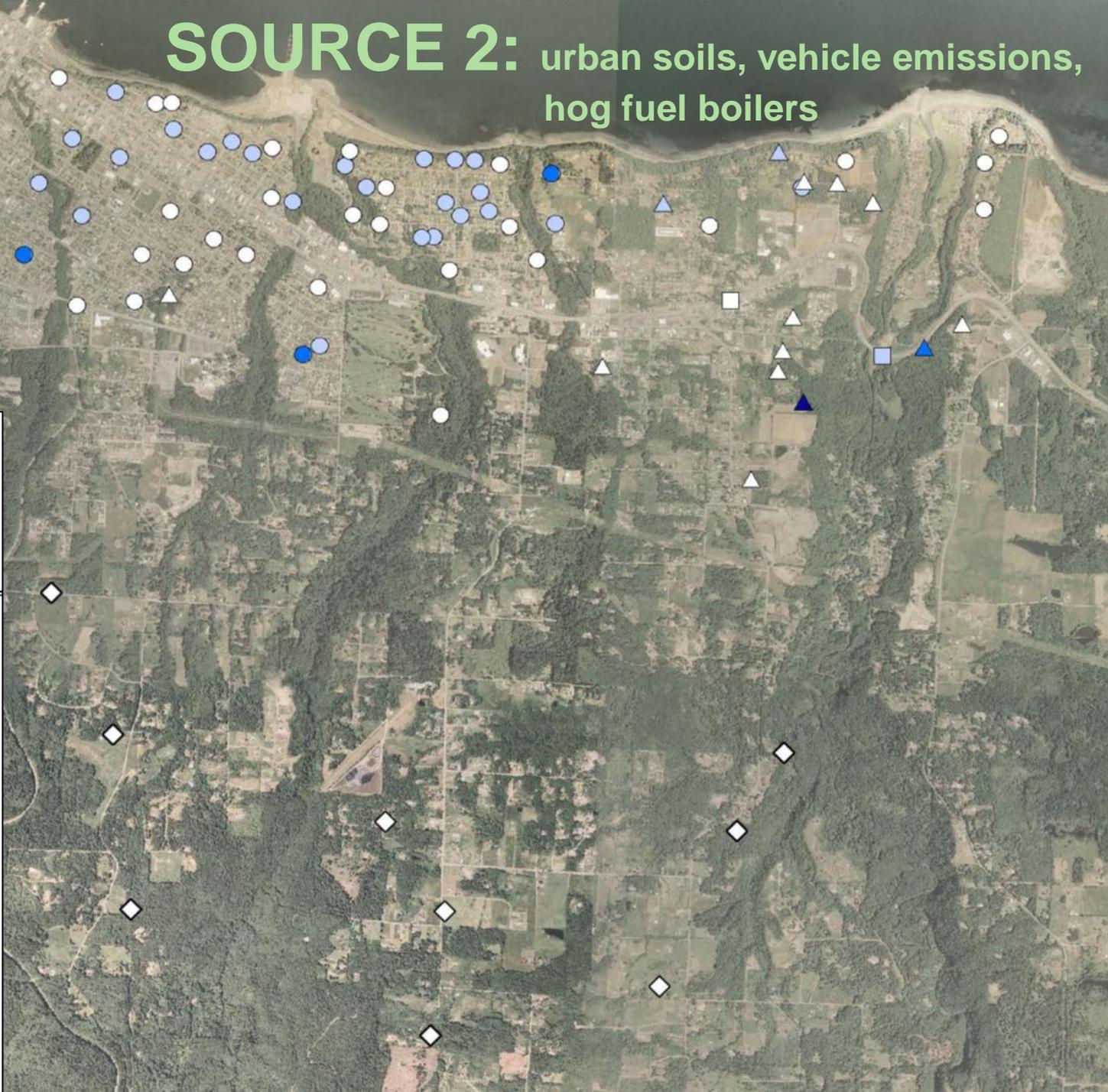
Legend

TEQ (ND = 1/2 DL) concentrations
shown in ng/kg

- 0 to 3
- 3 to 7
- 7 to 11
- > 11

Soil sample type

- △ Forested
- Grid
- Highway
- ◇ Transect



SOURCE 3: hog fuel boiler

Figure 8-20.
Unmixing model Source 3 TEQ
increments
Rayonier Mill Off-Property
Soil Dioxin Study
Port Angeles, WA

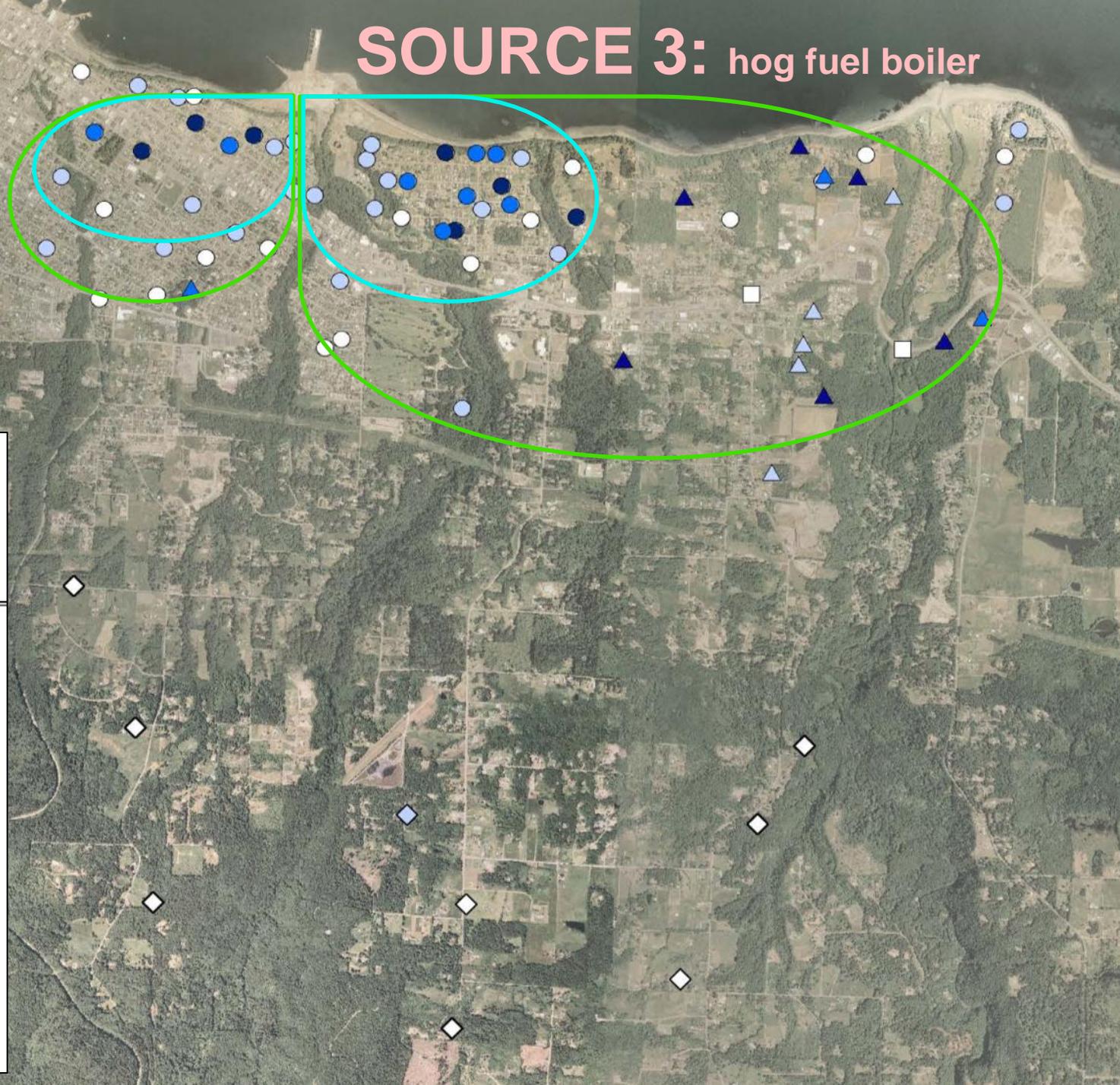
Legend

TEQ (ND = 1/2 DL) concentrations
shown in ng/kg

- 0 to 3
- 3 to 7
- 7 to 11
- > 11

Soil sample type

- △ Forested
- Grid
- Highway
- ◇ Transect



Mass Balance

- Rayonier's hog fuel boiler (HFB) appears to have produced enough dioxin emissions to account for what is found in the soil from Source 3
- Medical waste incinerator not a credible source based on similar medical waste facilities
- Other HFBs located further west may have contributed to Source 3 in our study area, but contributions are expected to be limited due to distance

Ecology Conclusions

- Dioxin/furan soil concentrations appear higher than other available urban studies
- Rayonier's emissions impacted soils outside the Rayonier property
- Additional evaluation needed to determine extent
- Actions may be needed



Next Steps

Ecology is concentrating on the Rayonier Mill Study Area and Agreed Order

Completing the Port Angeles Harbor investigation is a high priority

Work on developing next steps for off-property areas with Rayonier as time and resources permit

Questions and Answers

