

PAH Source Evaluation of Sediments in the Vicinity of Pier 39, San Francisco Bay

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Natural Spectrum

2019 Battelle Sediment Conference

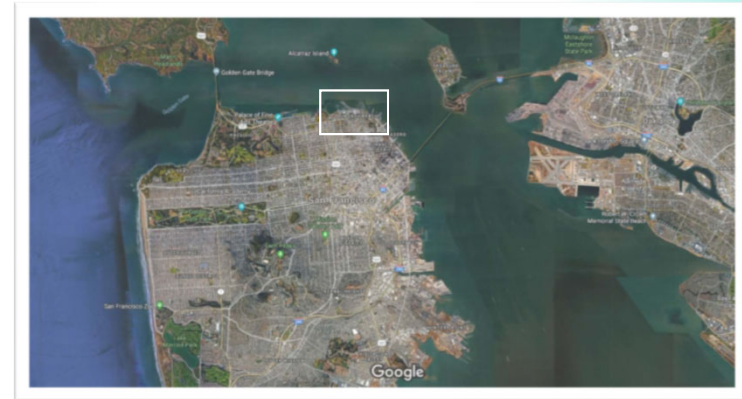
February 11-14, 2019



PAH Source Evaluation of Sediments – Vicinity of Pier 39 in San Francisco Bay

- Overview
- Evaluation Scope & Objectives
- Forensic Evaluation Process
- Definition of Potential PAH Source Signatures & Source Models
- Evaluation of Lower PAH Concentration Sediments
- Summary & Conclusions

Study Site Location



San Francisco, California

Sediment Sample Station Locations

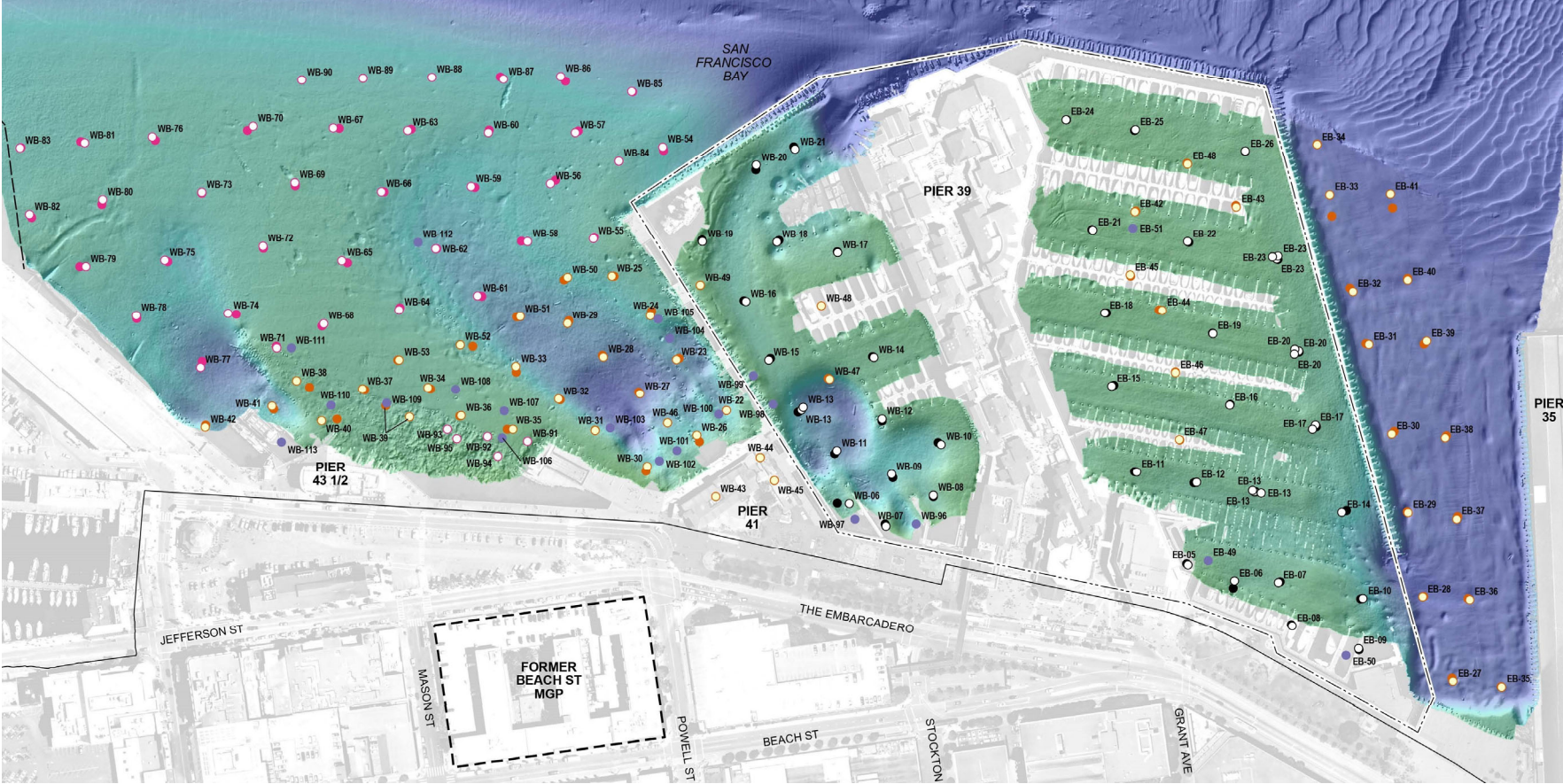


Figure provided by Haley & Aldrich, Inc.

Forensic Evaluation Objectives

- Identify high total PAH concentration pyrogenic point source areas
 - Total PAH > “ambient”
- Identify distinct compositional features of potential source signatures
- Identify presence of individual source signatures
- Identify potential nonpoint pyrogenic source signatures
 - Contribution to “nonpoint urban influence”
 - Distinguished from identified high-concentration point source pyrogenic signatures

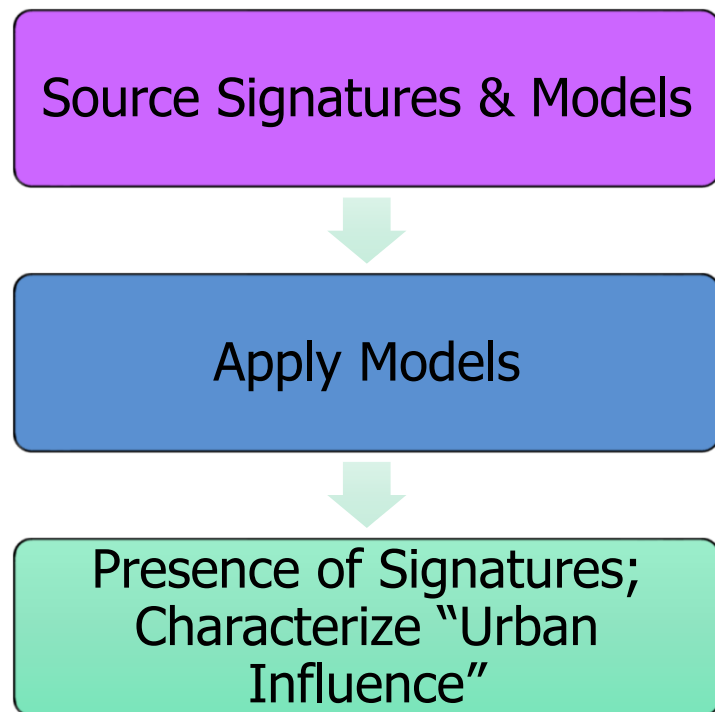
Select PAHs for Defining Ambient Conditions

- San Francisco Bay Regional Monitoring Program (RMP) PAHs
- Sum of 25 RMP PAHs = "TPAH"
- "Ambient" = 4500 µg/kg

RMP List of 25 PAHs	
Naphthalene	Benz(a)anthracene
1-Methylnaphthalene	Chrysene
2-Methylnaphthalene	Fluoranthene
2,6-Dimethylnaphthalene	Benzo(a)pyrene
2,3,5-Trimethylnaphthalene	Benzo(b)fluoranthene
Biphenyl	Benzo(e)pyrene
Acenaphthene	Dibenz(a,h)anthracene
Acenaphthylene	Pyrene
Dibenzothiophene	Perylene
1-Methylphenanthrene	Benzo(g,h,i)perylene
Anthracene	Benzo(k)fluoranthene
Phenanthrene	Indeno(1,2,3-c,d)pyrene
Fluorene	

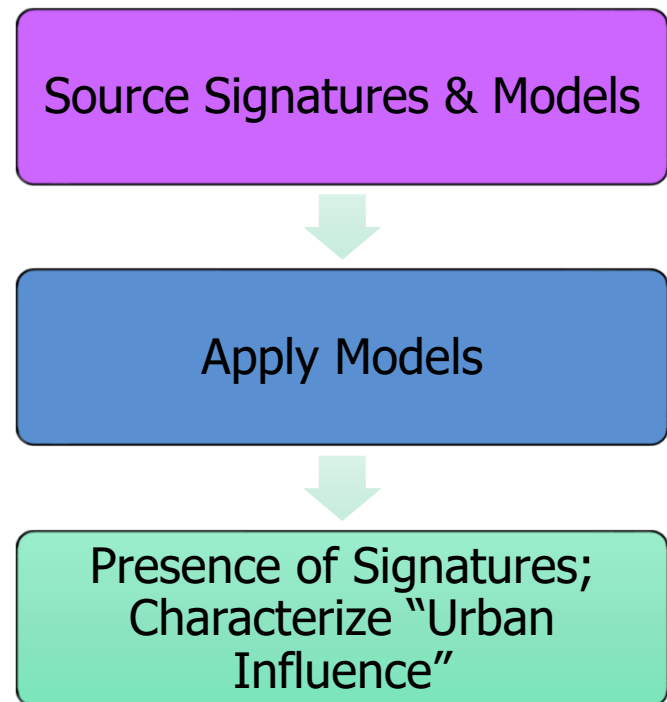
Forensic Evaluation Process - Diagnostic Source Ratio Analysis

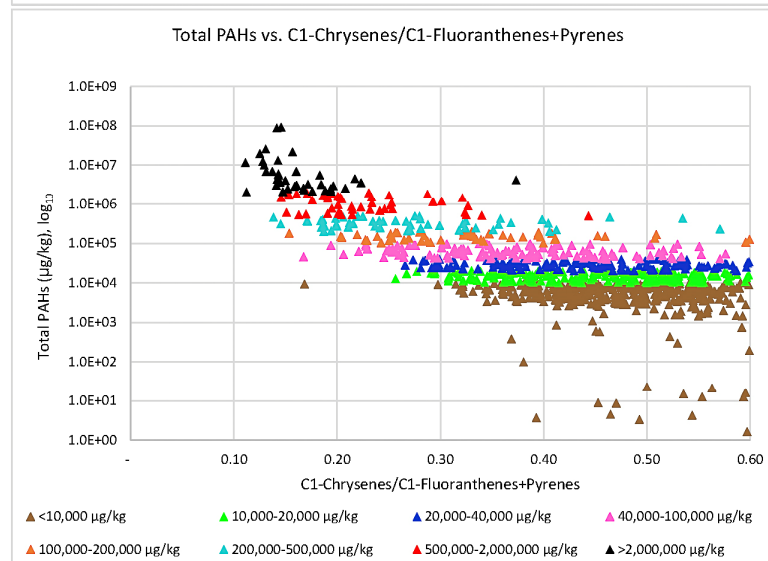
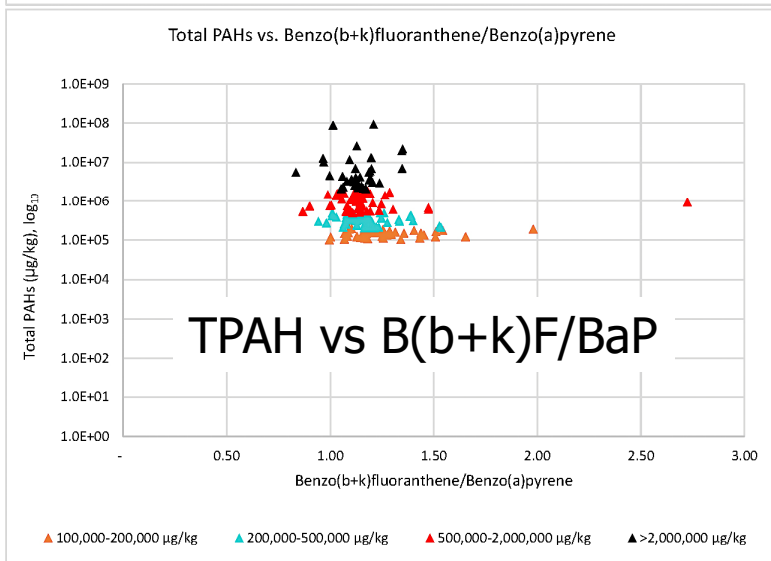
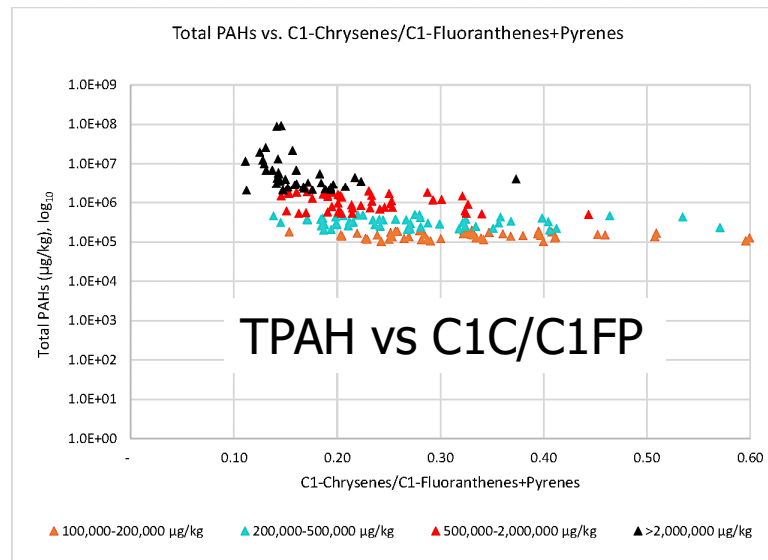
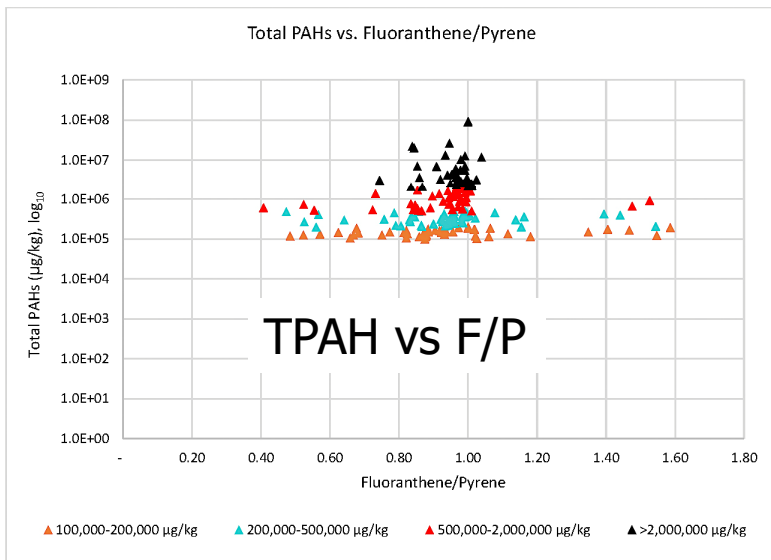
- PAHs representative of source type
 - Parent PAHs for pyrogenic sources
- Consider environmental stability
- Potential Diagnostic PAH Ratios:
 - fluoranthene/pyrene
 - benzo(b+k)fluoranthene/benzo(a)pyrene
 - C1-chrysenes/C1-fluoranthenes+pyrenes



Two Step Forensic Evaluation Process

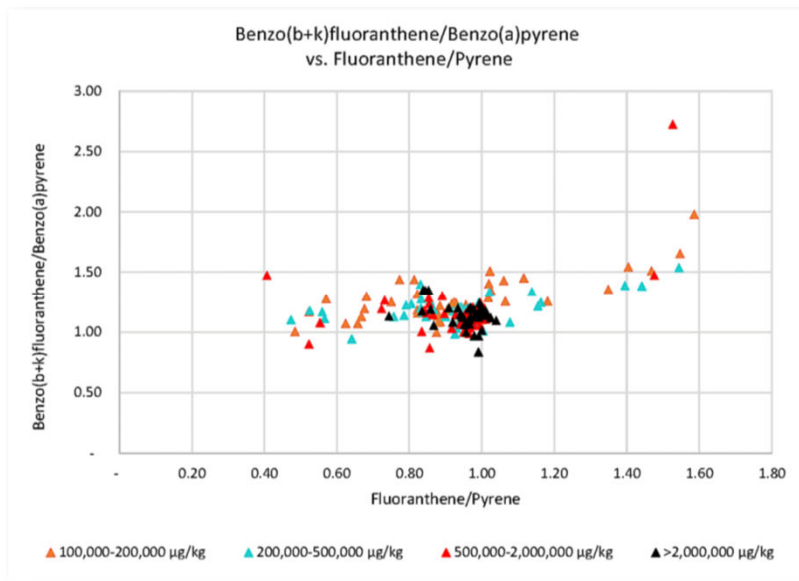
- Step 1: Sediments $\geq 100,000$ $\mu\text{g}/\text{kg}$ TPAH
 - Define most useful Source Model(s)
 - Optimized inclusion of potential point source influence, minimized influence of nonpoint source mixing
- Step 2: Sediments $< 100,000$ $\mu\text{g}/\text{kg}$ TPAH
 - Application of Source Models
 - Potential source presence
 - Characterization of "Urban Influence"



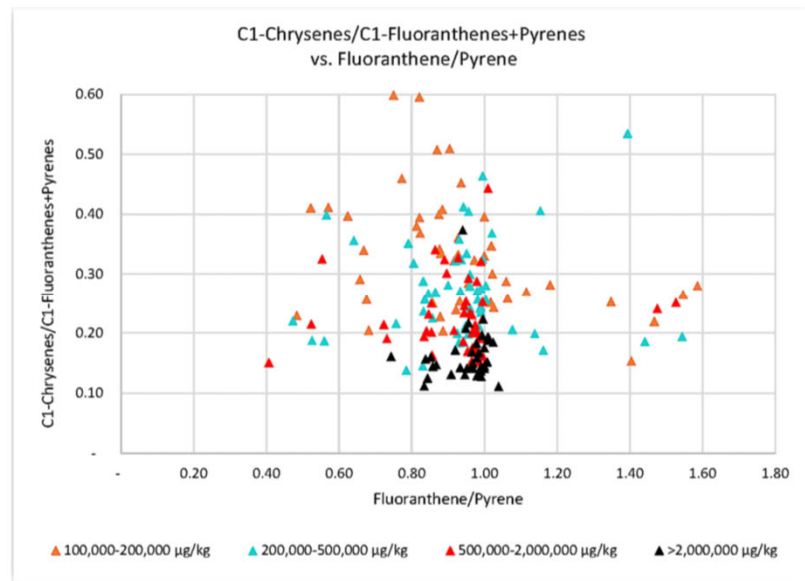


Total PAHs
versus
Diagnostic
Ratios
All Stations

Select Diagnostic Ratios for All Stations



B(b+k)F/BaP vs F/P



C1C/C1FP vs F/P

Step 1 – High TPAH Concentration Sediments

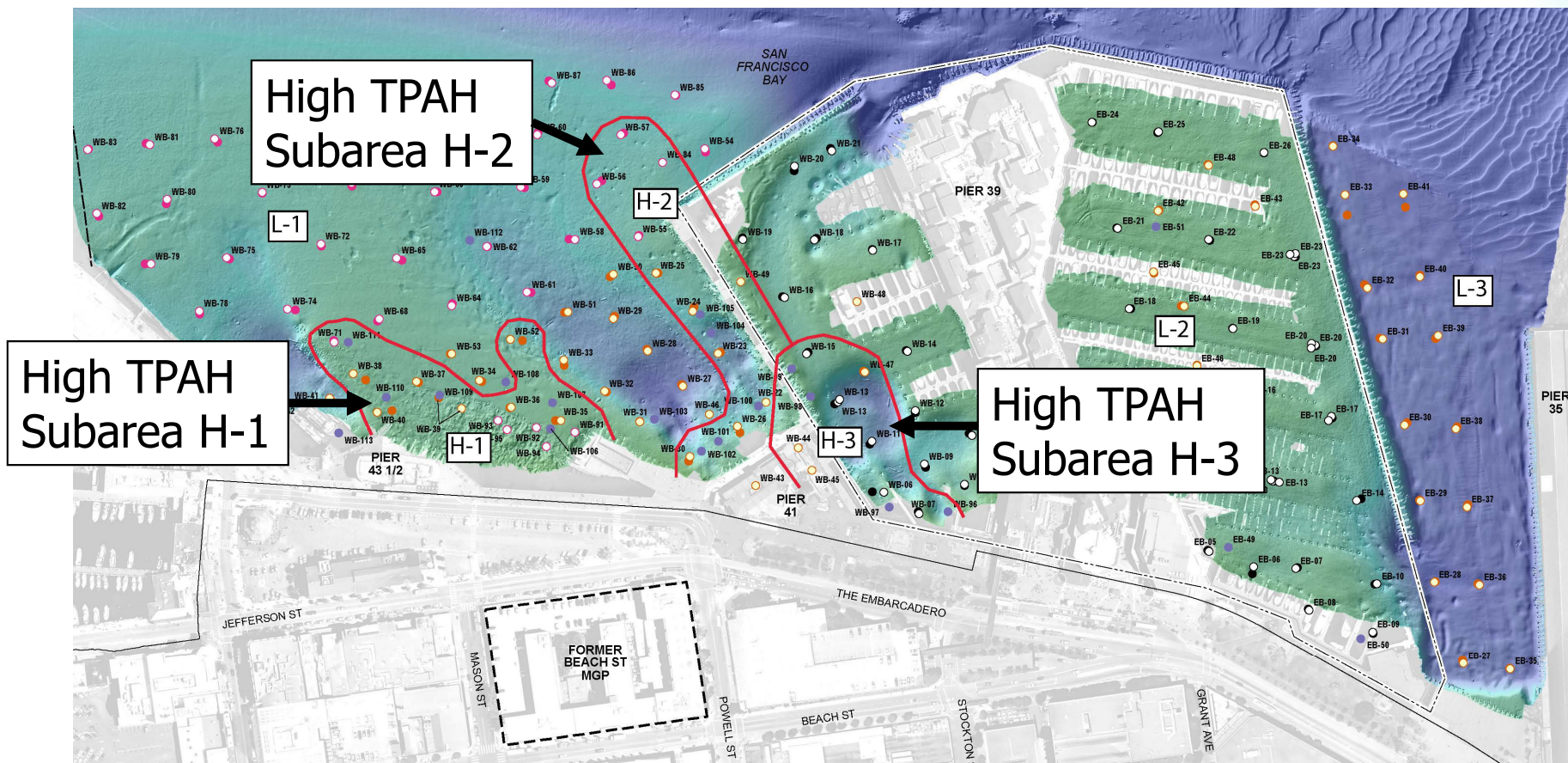
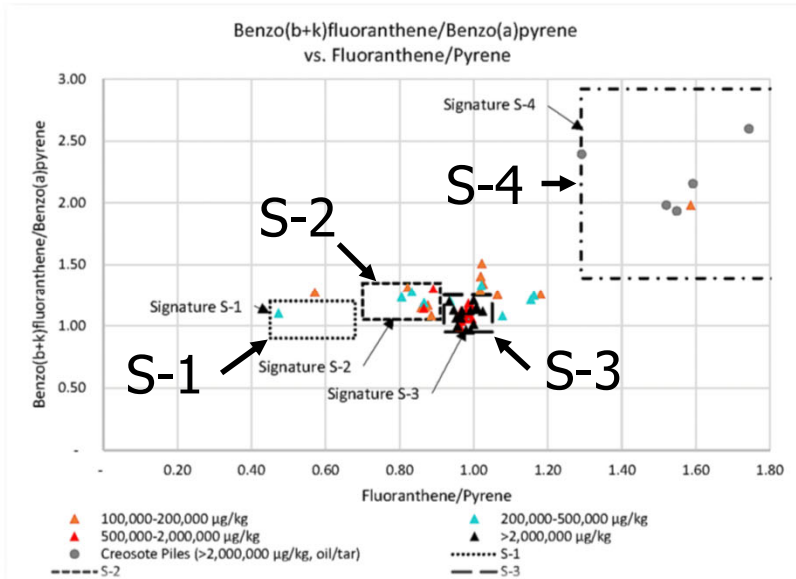
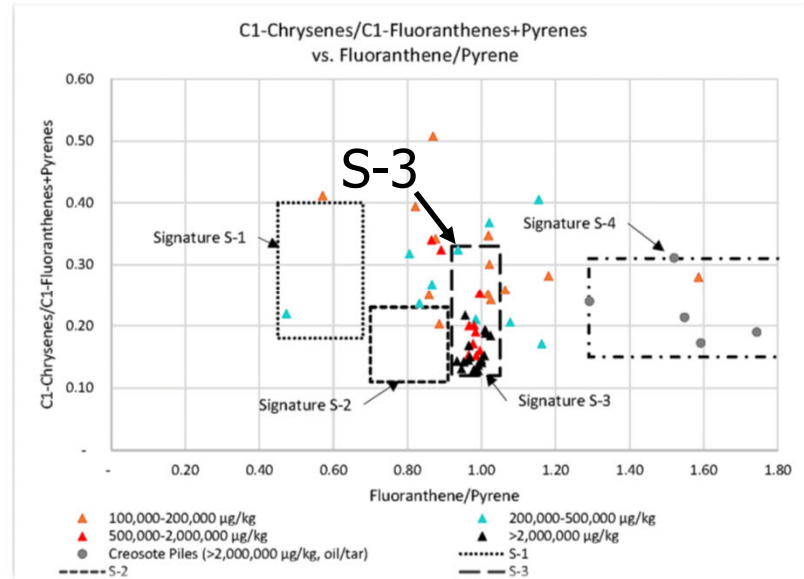


Figure provided by Haley & Aldrich, Inc.

Source Models for High TPAH Subarea H-1

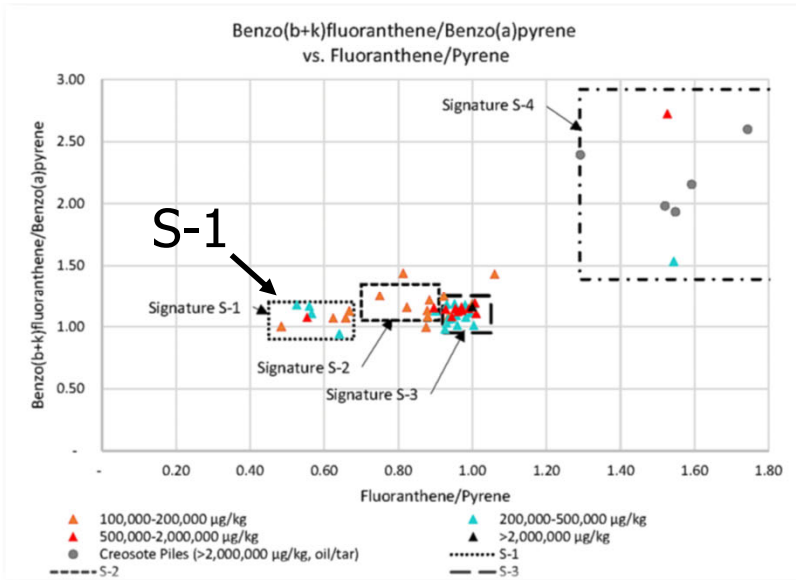


B(b+k)F/BaP vs F/P

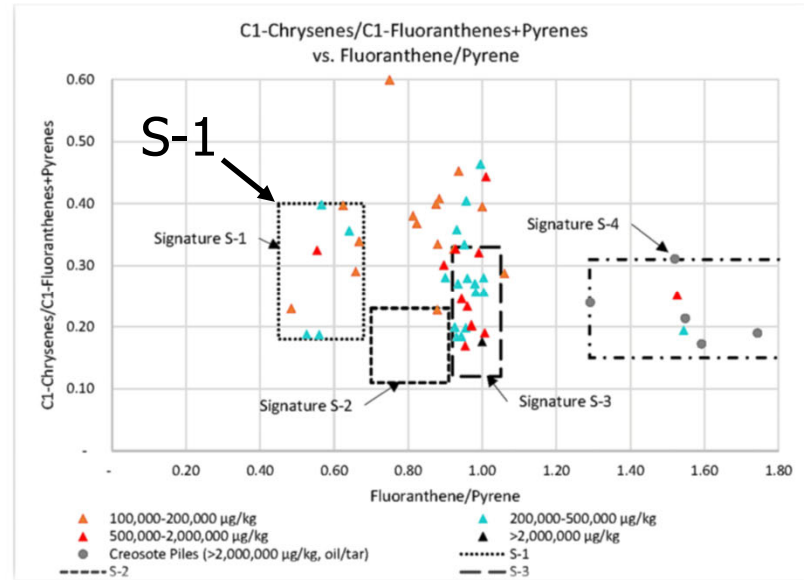


C1C/C1FP vs F/P

Source Models for High TPAH Subarea H-2

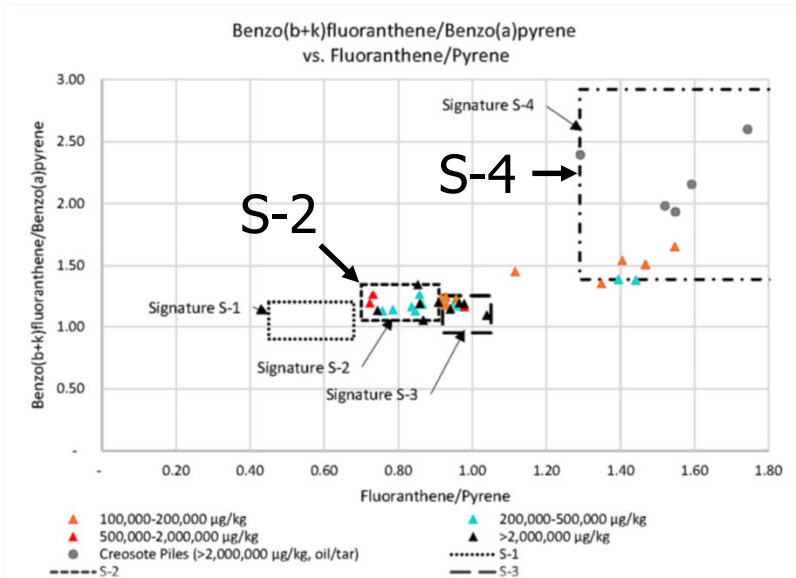


B(b+k)F/BaP vs F/P

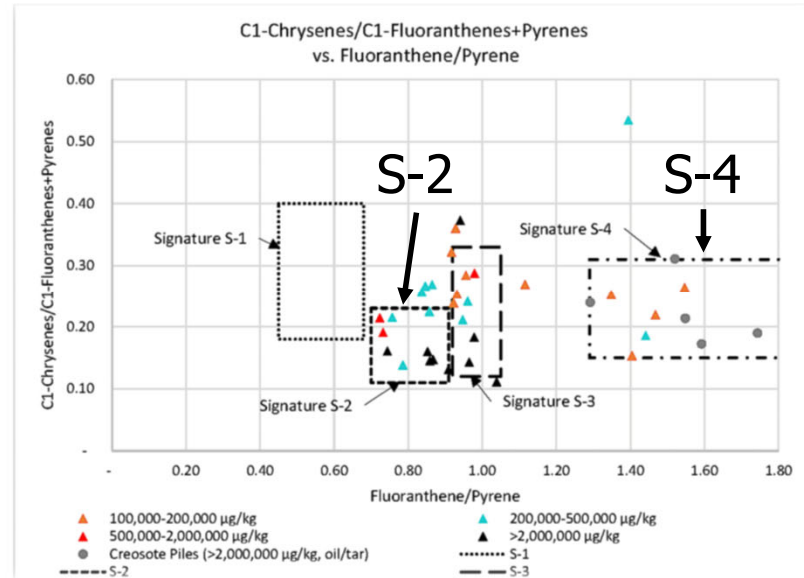


C1C/C1FP vs F/P

Source Models for High TPAH Subarea H-3



B(b+k)F/BaP vs F/P



C1C/C1FP vs F/P

Step 2 – Lower TPAH Sediments

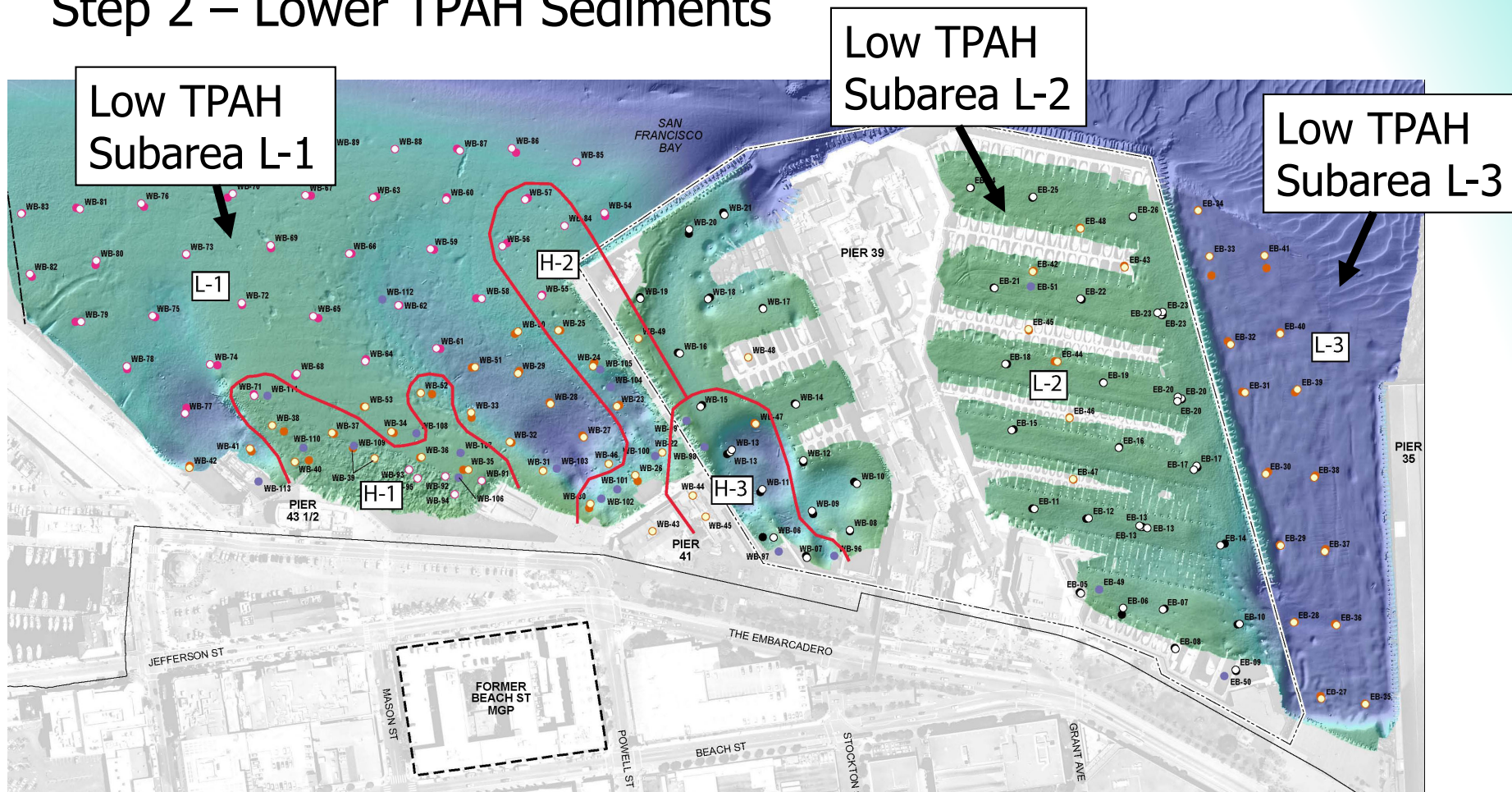
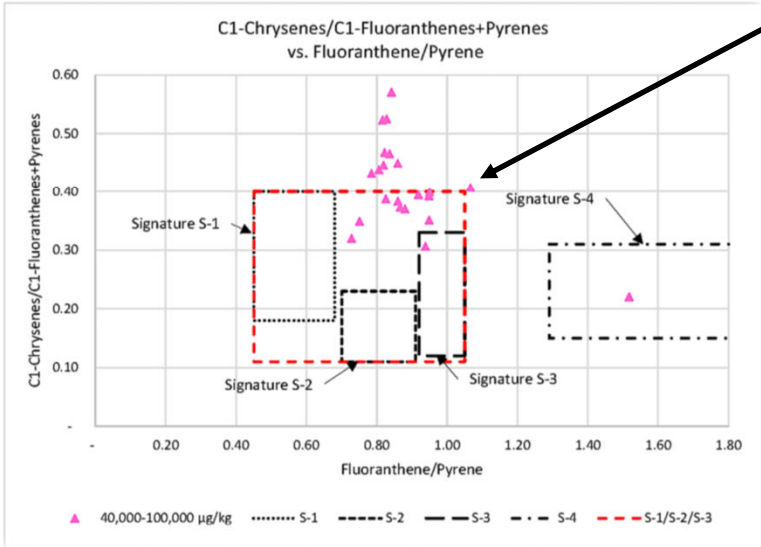
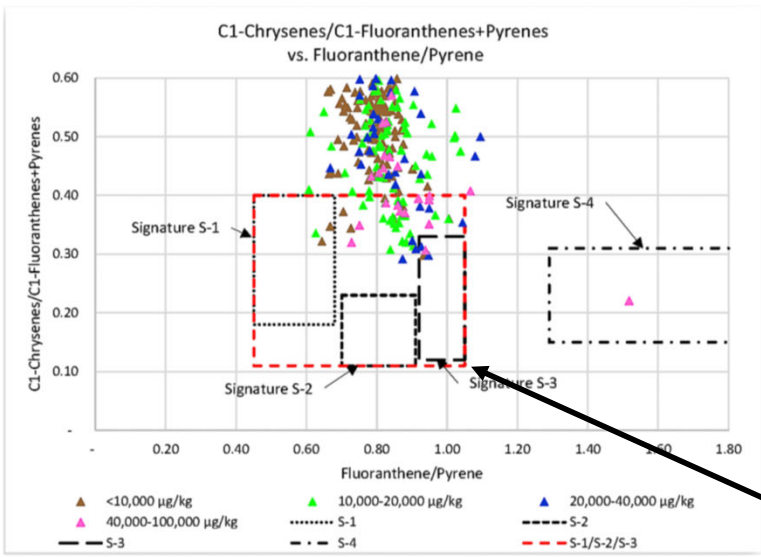
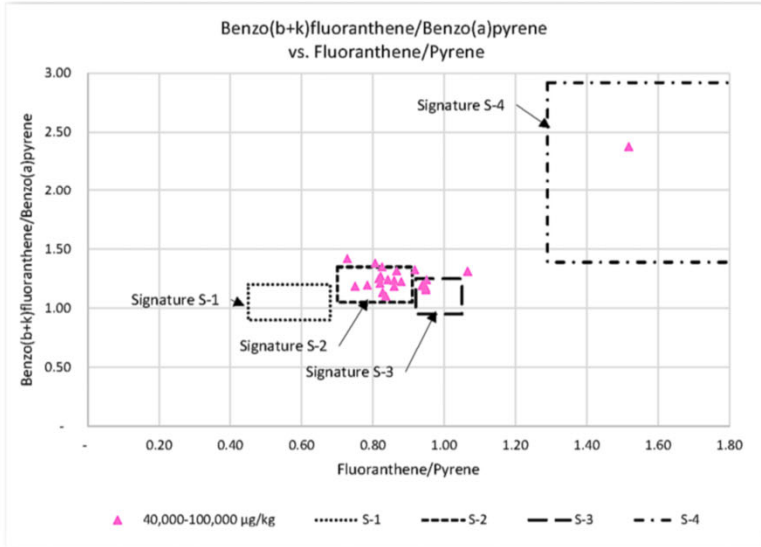
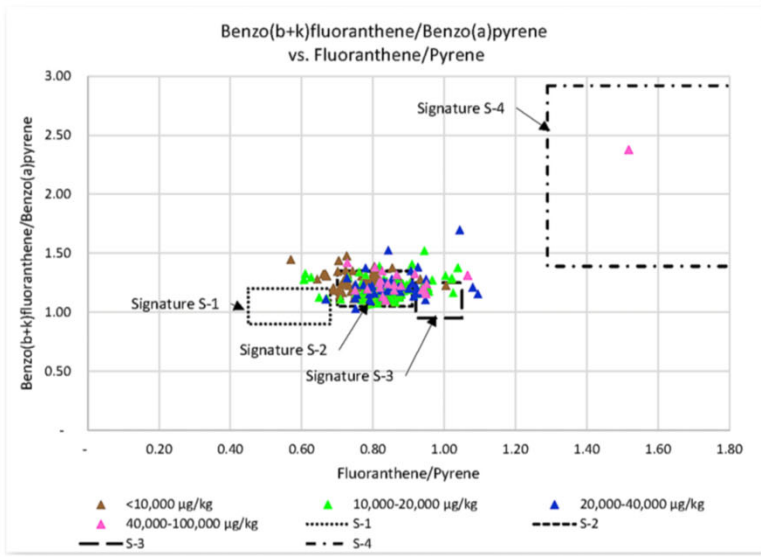


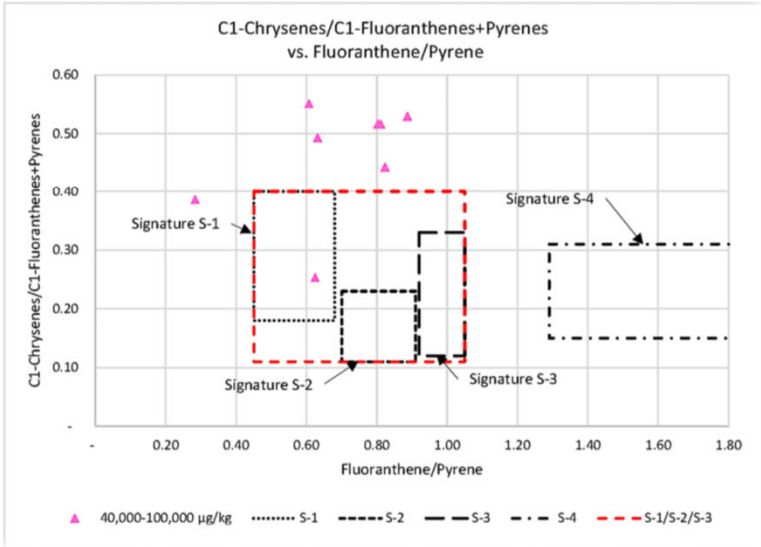
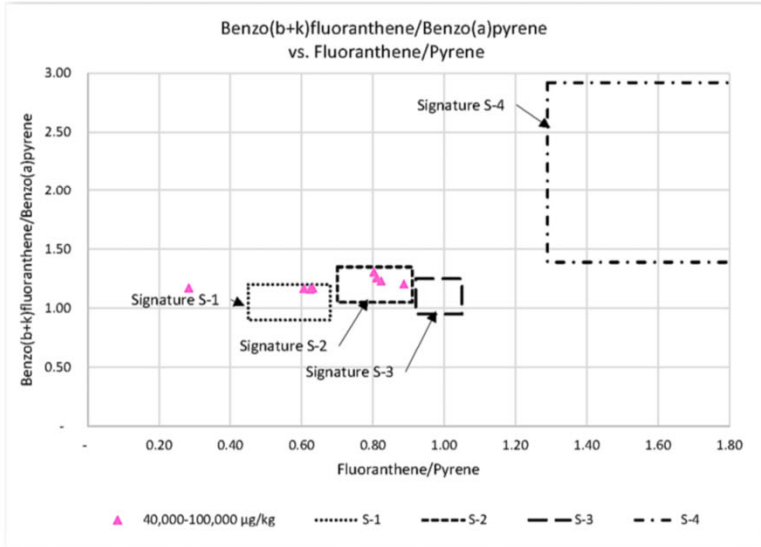
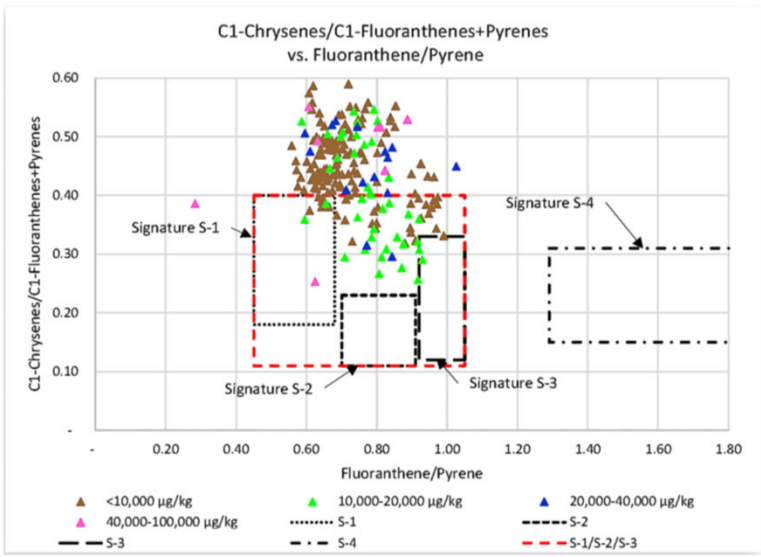
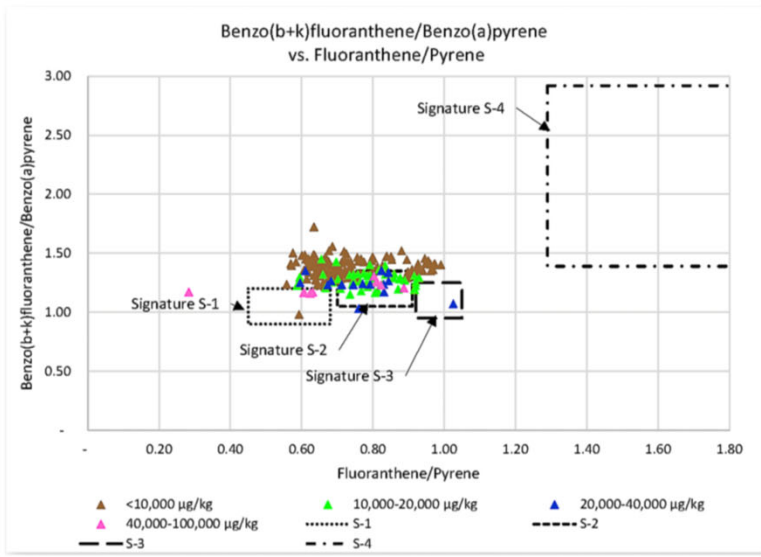
Figure provided by Haley & Aldrich, Inc.

Source Models for Low TPAH Subarea L-1

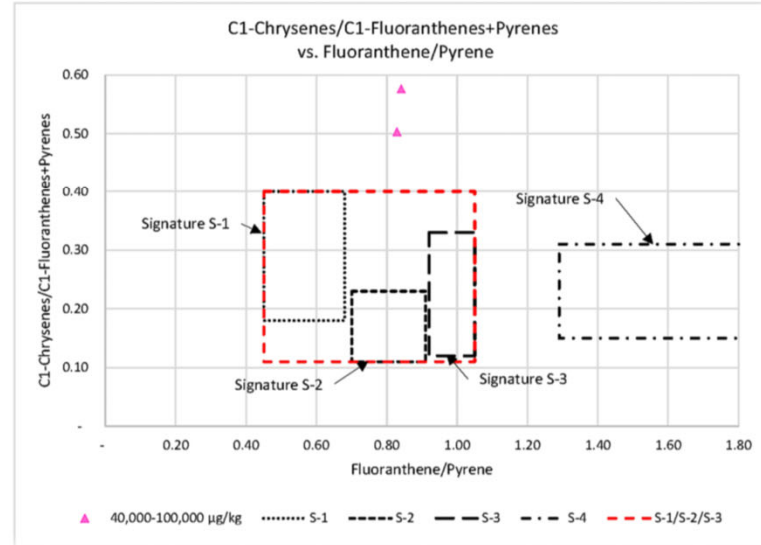
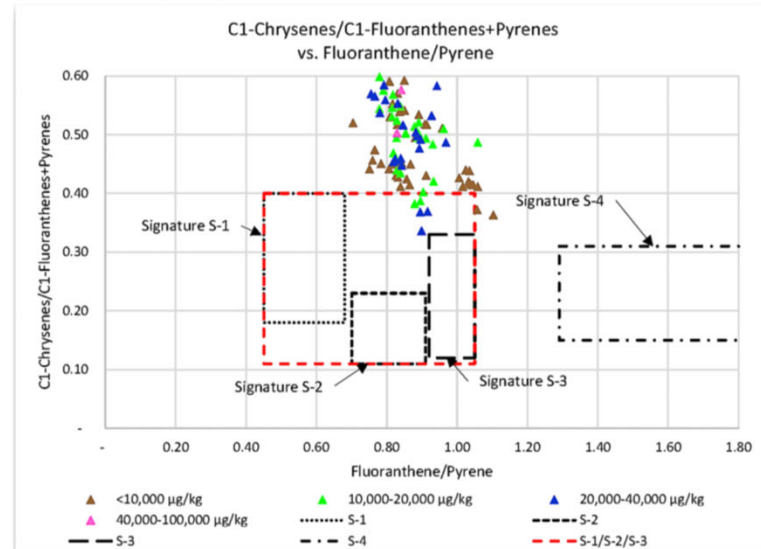
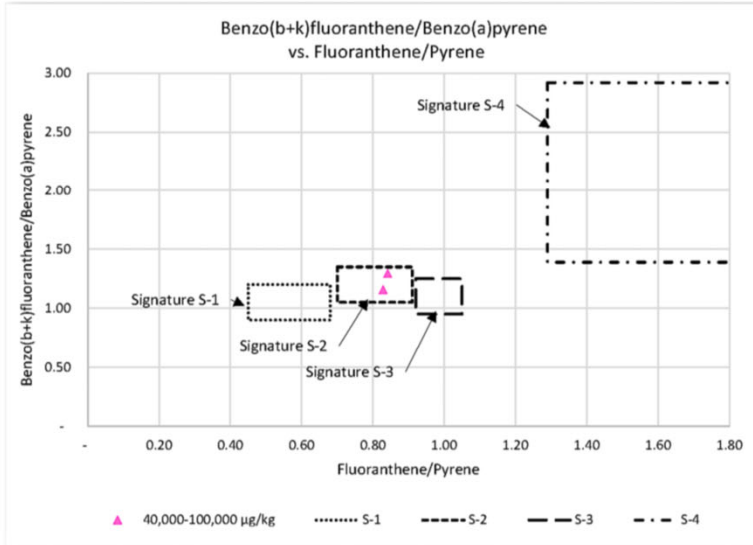
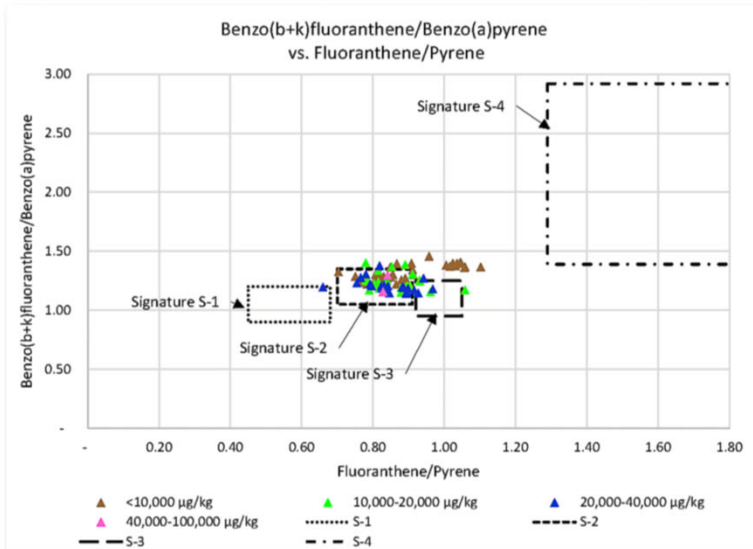


Expanded source boundary

Source Models for Low TPAH Subarea L-2



Source Models for Low TPAH Subarea L-3



Summary & Conclusions

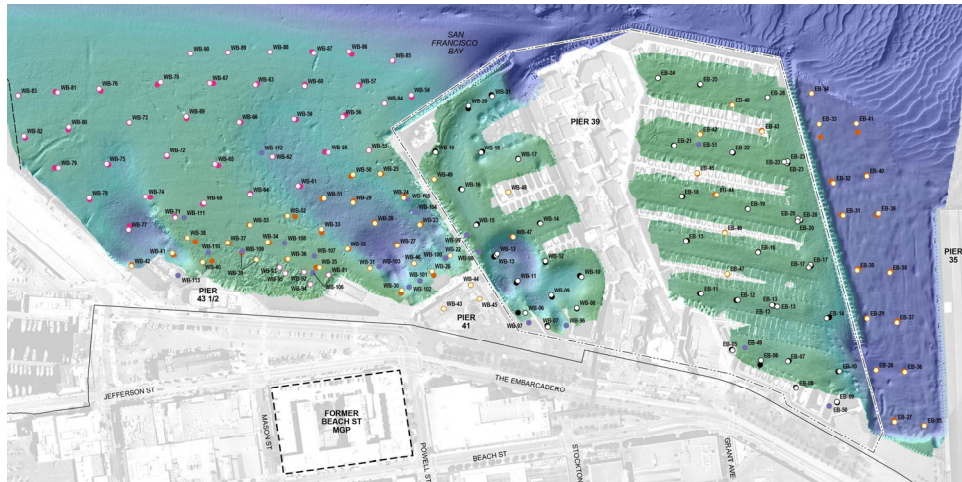
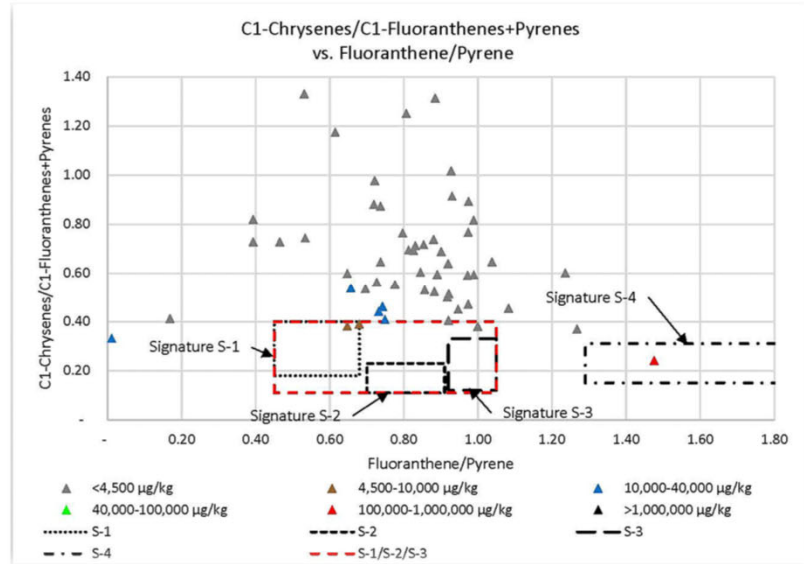
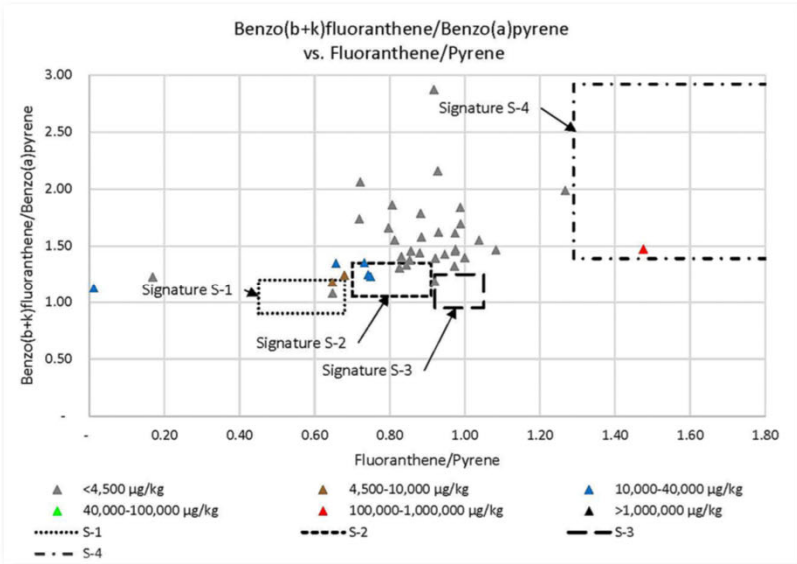
- Four distinct source signatures evidenced in high PAH concentration sediments for specific subareas
 - Three pyrogenic signatures (S-1, S-2 & S-3) likely consistent with historical MGP sources
 - One signature (S-4) was related to creosote
- A fifth “urban influence” PAH signature predominates lower PAH concentration sediments in three relatively large subareas
- Upland subsurface soils from shoreline and adjacent to former MGP facility footprint do not exhibit significant potential source correlations (S-1 to S-4)

Thank You for Attending
Any Questions?



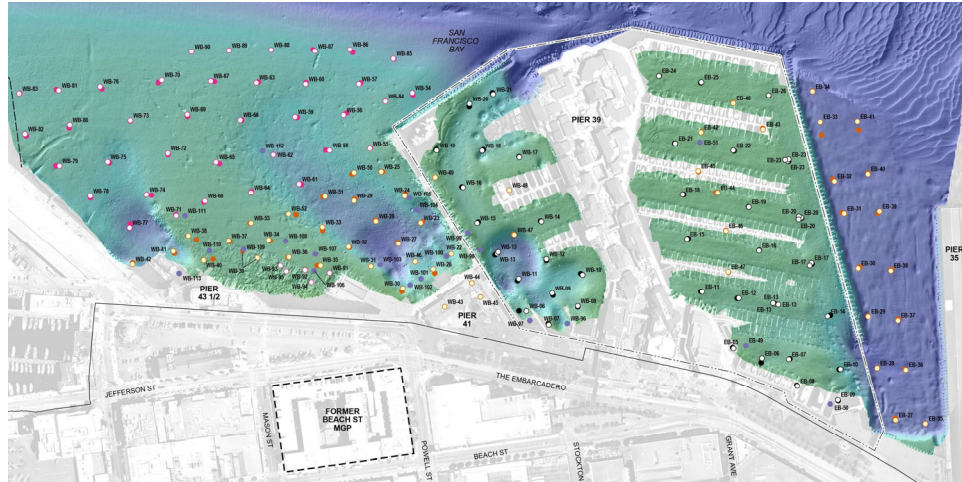
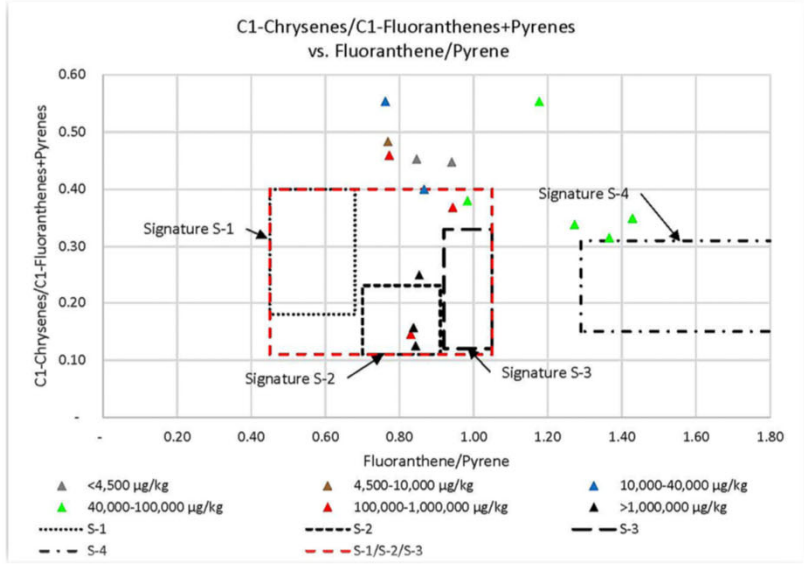
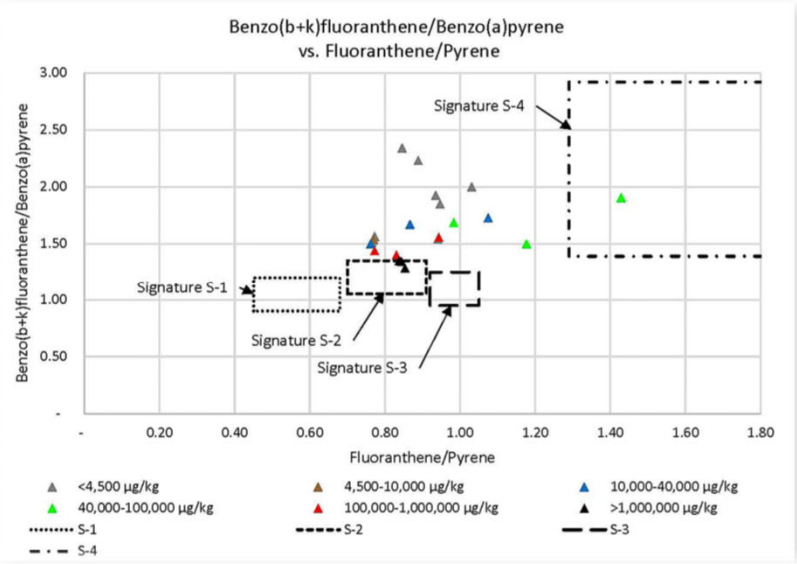
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Source Models for Shoreline Soils



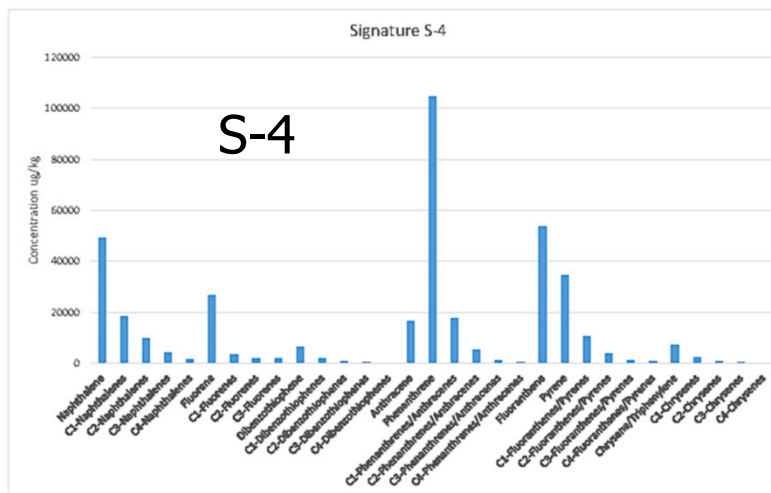
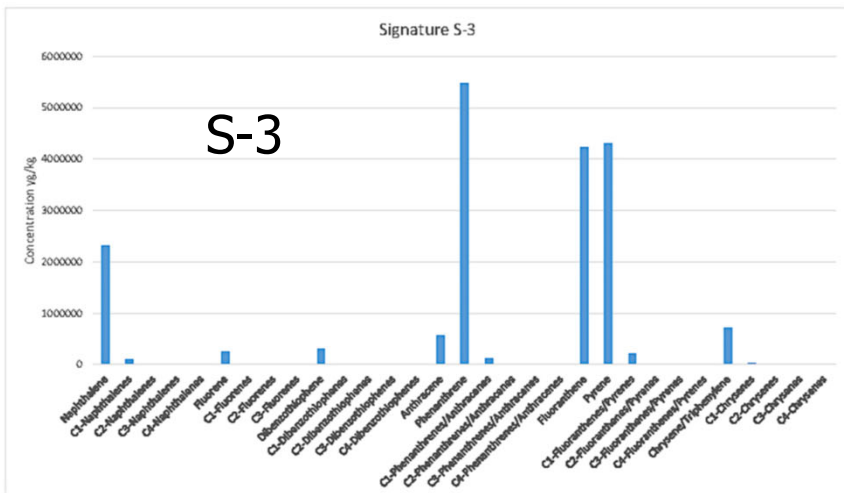
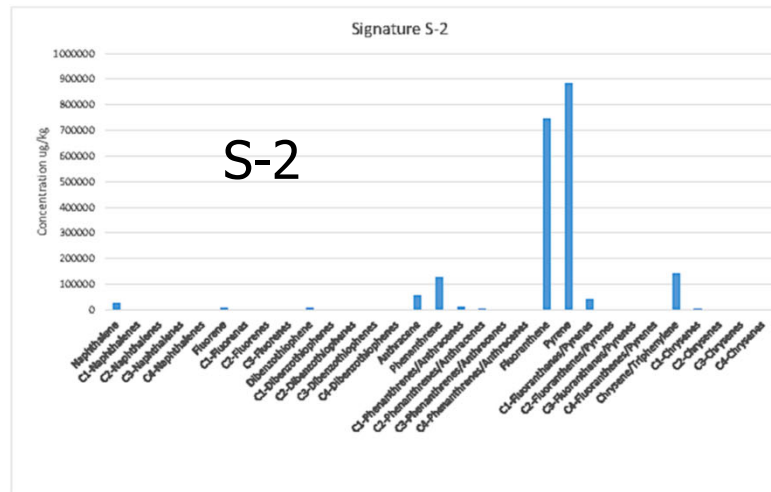
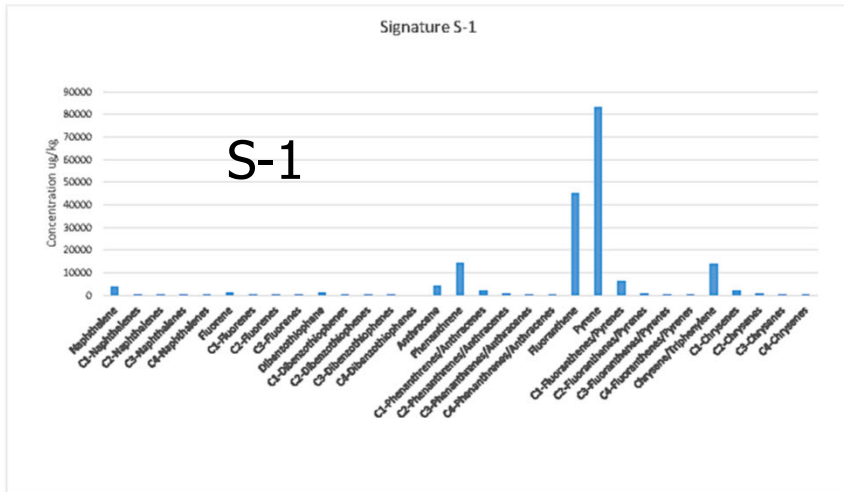
Backup Slide #1

Source Models for Beach St. Upland Soils



Backup Slide #2

Source Signatures PAH Profiles



Backup Slide #3