Open Environmental Restoration Resource (OER2) Webinar

Environmental Background Analysis Review and Case Study of Apra Harbor Sediments, Naval Base Guam

Presented by:

NAVFAC Environmental Restoration Program

Webinar: 7

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Points of Contact

POCs

- **Kimberly.Markillie@navy.mil Presenter/Champion**
- **Tara.Meyers@navy.mil Moderator**

Logistics

- **Submit all questions via chat box throughout the presentation**
- **Presentation is being recorded**
- **Complete the webinar survey (main feedback mechanism)**

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OER2 Webinar Series

- **Why Attend?**
  - **Obtain and hear about the latest DOD and DON's policies/guidance, tools, technologies and practices to improve the ERP's efficiency**
  - **Promote innovation and share lessons learned**
  - **FEEDBACK to the ERP Leadership**
- **Who Should Attend?**
  - **ERP Community Members: RPMs, RTMs, Contractors, and other remediation practitioners who support and execute the ERP**
  - **Voluntary participation**
- **Schedule and Registration:**
  - **Every other month, 4th Wed (can be rescheduled due to holidays)**
  - **Registration link for each topic (announced via ER T2 email)**
- **Topics and Presenters:**
  - **ERP community members to submit topics (non-marketing and DON ERP-relevant) to POCs (Gunarti Coghlan – gunarti.coghlan@navy.mil or Tara Meyers - tara.meyers@navy.mil)**
  - **Selected topic will be assigned Champion to work with presenter**

Speaker Introduction

Kim Markillie is currently the Quality Assurance Manager for NAVFAC Pacific and serves as the current sediment workgroup lead. Kim has provided input on many sediment remediation projects over the last 6 years at NAVFAC Pacific. Prior to accepting her current position, she was a consultant to the DOD for over 20 years. Her particular area of expertise is in Sediment Remediation.

She currently is managing the sediment remediation project at Pearl Harbor, HI and also managed the Apra Harbor remedial investigation in Guam.

Brian Nagy is an environmental scientist for AECOM with over 8 years of experience in environmental science and over 10 years of experience in academic research. Mr. Nagy has extensive analytical experience as a former quality assurance and operations manager of a full service DoD ELAP accredited environmental laboratory, and now is the deputy project manager on a number of Navy sediments projects.

Environmental Background Analysis Review and Case Study of Apra Harbor Sediments, Naval Base Guam

Kimberly Markillie, NAVFAC Pacific
Brian Nagy, AECOM
Wendell Wen, AECOM

Presentation Outline

- **Navy and CERCLA Policy**
- **NAVFAC Guidance**
- **Apra Harbor Case Study**

Navy Policy

- **Department of the Navy (DON). 2004. *Navy Policy on the Use of Background Chemical Levels.* Memo from Chief of Naval Operations, Environmental Protection, Safety, and Occupational Health Division, to: Commander, Naval Facilities Engineering Command. 5090, Ser. N45C/N4U732212. January 30.**
  - **Clarifies Navy policy on background chemicals in the Environmental Restoration Program**
  - **Emphasizes need to differentiate between background and site-related chemicals**
- **Requirements:**
  - **Establish list of COPCs**
  - **Eliminate background chemicals from the risk assessment but document the associated risks**
  - **Don't set cleanup levels within background ranges**

CERCLA Policy

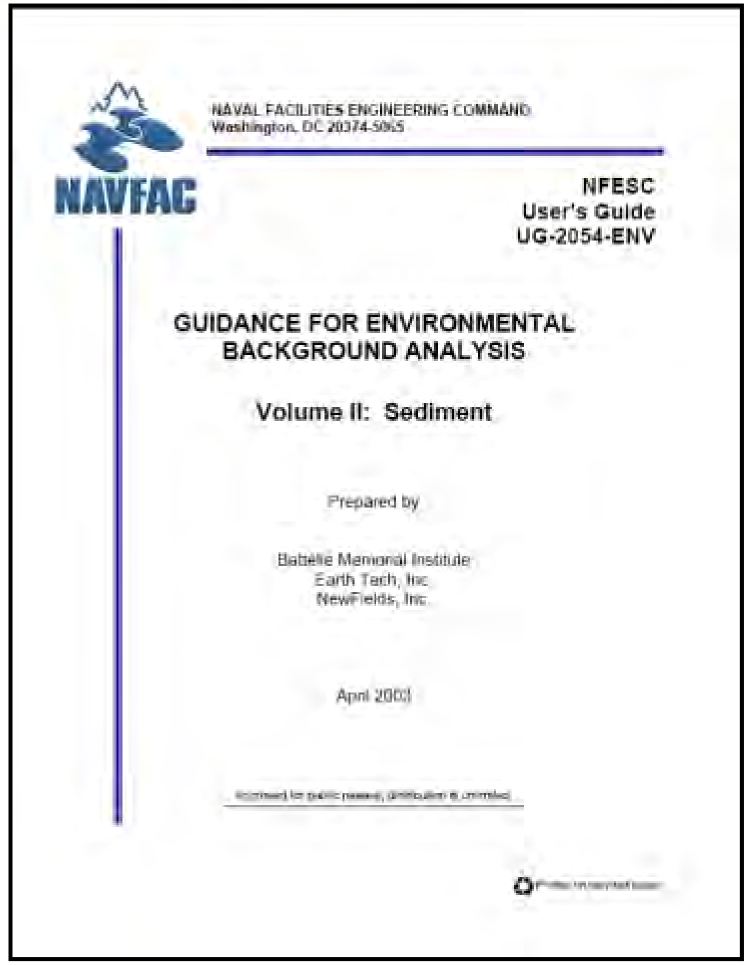
- **CERCLA precludes cleaning up background levels of naturally occurring constituents:**

  "The President shall not provide for a removal or remediation action under this section in response to a release or threat of a release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found...."

  CERCLA [42 USC §9604(a)(3)(A)]

NAVFAC Background Guidance

- **Sediment (Vol. II)**
  - **April 2003**
  - **Navy Policy on Sediment Site Investigation and Response Action**
  - **Comparative Method: Statistical Analysis**
  - **Geochemical Method: Sediment Chemistry**


NAVAL FACILITIES ENGINEERING COMMAND
Washington, DC 20374-5065

NAVFAC

NFESC
User's Guide
UG-2054-ENV

GUIDANCE FOR ENVIRONMENTAL
BACKGROUND ANALYSIS

Volume II: Sediment

Prepared by

Battelle Memorial Institute
Earth Tech, Inc.
NewFields, Inc.

April 2003

https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/Environmental/Restoration/er_pdfs/gpr/navfacesc-ev-ug-2054-env-bkgrd-seds-200304.pdf

Role of Background Analysis

- **Differentiate concentrations representing a chemical release from concentrations representing background**
- **Identify site-specific chemicals of potential concern (COPCs) for human health and ecological risk assessments**
- **Select appropriate cleanup level**

Background Analysis Process

Understand the Site

- Develop the CSM

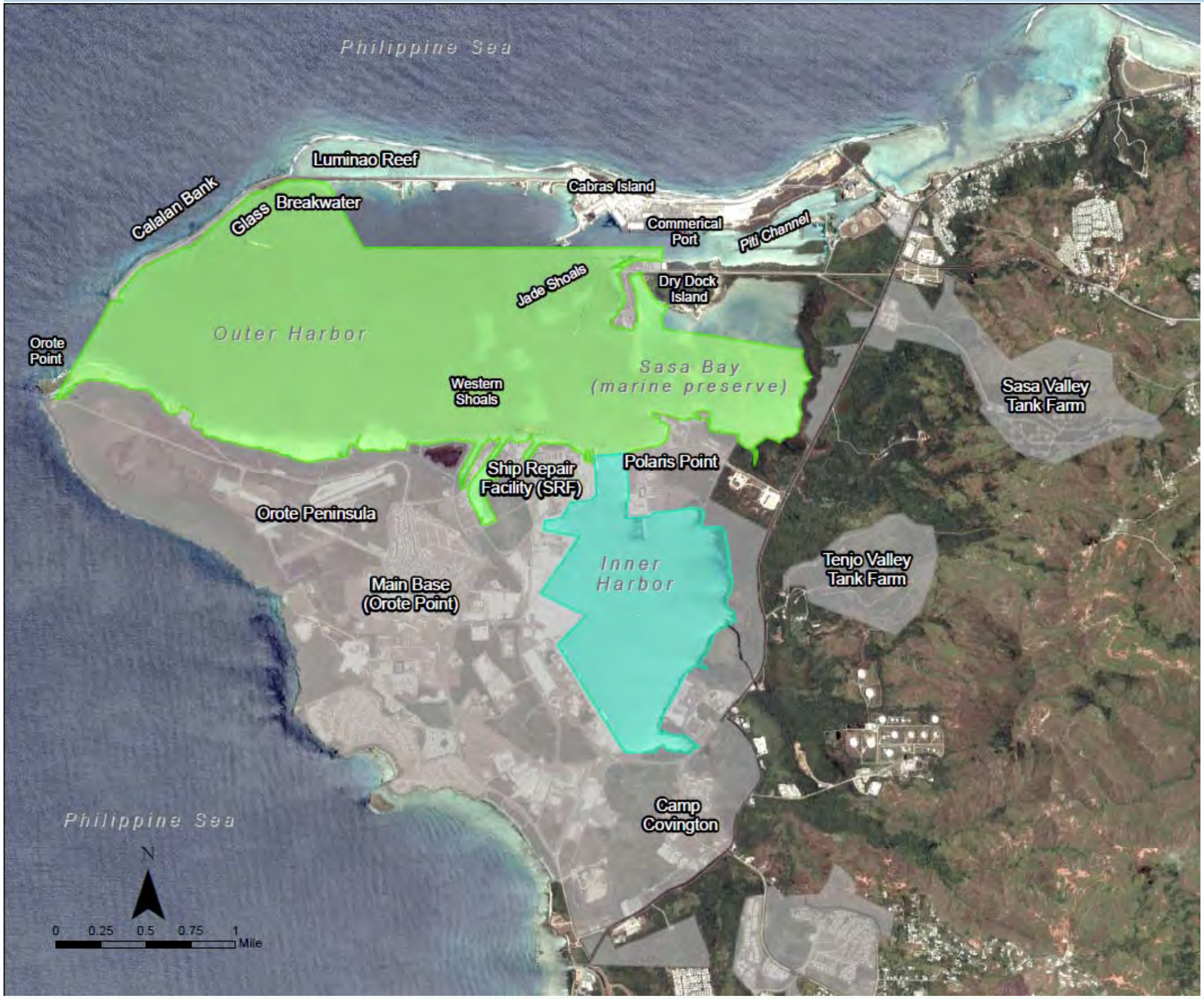
Will an EBA be needed

- EBA already completed?
- Natural sources?
- Know releases?

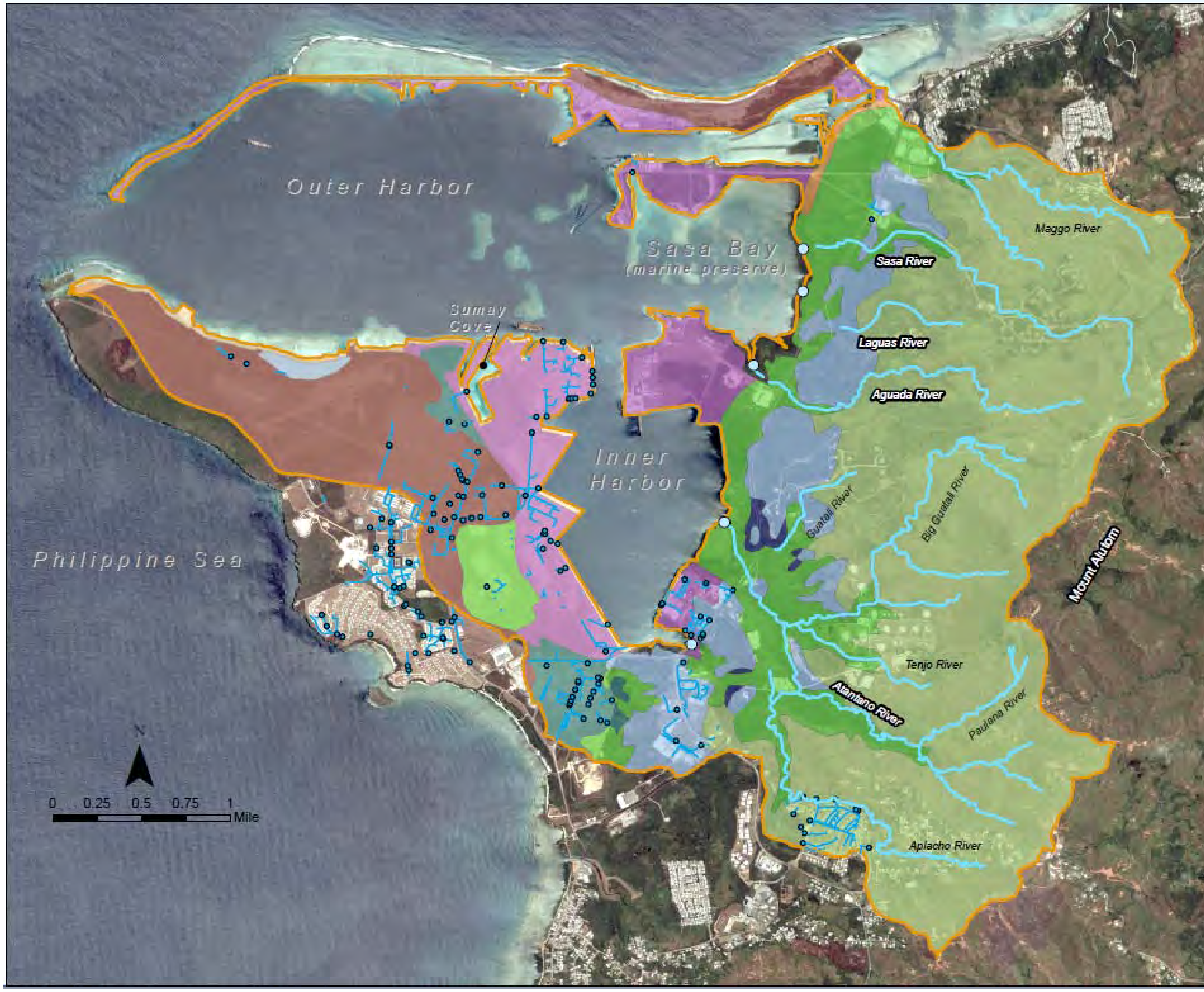
DQO in the WP

- Sample locations
- Metals to analyze for

Case Study: Apra Harbor, Naval Base Guam



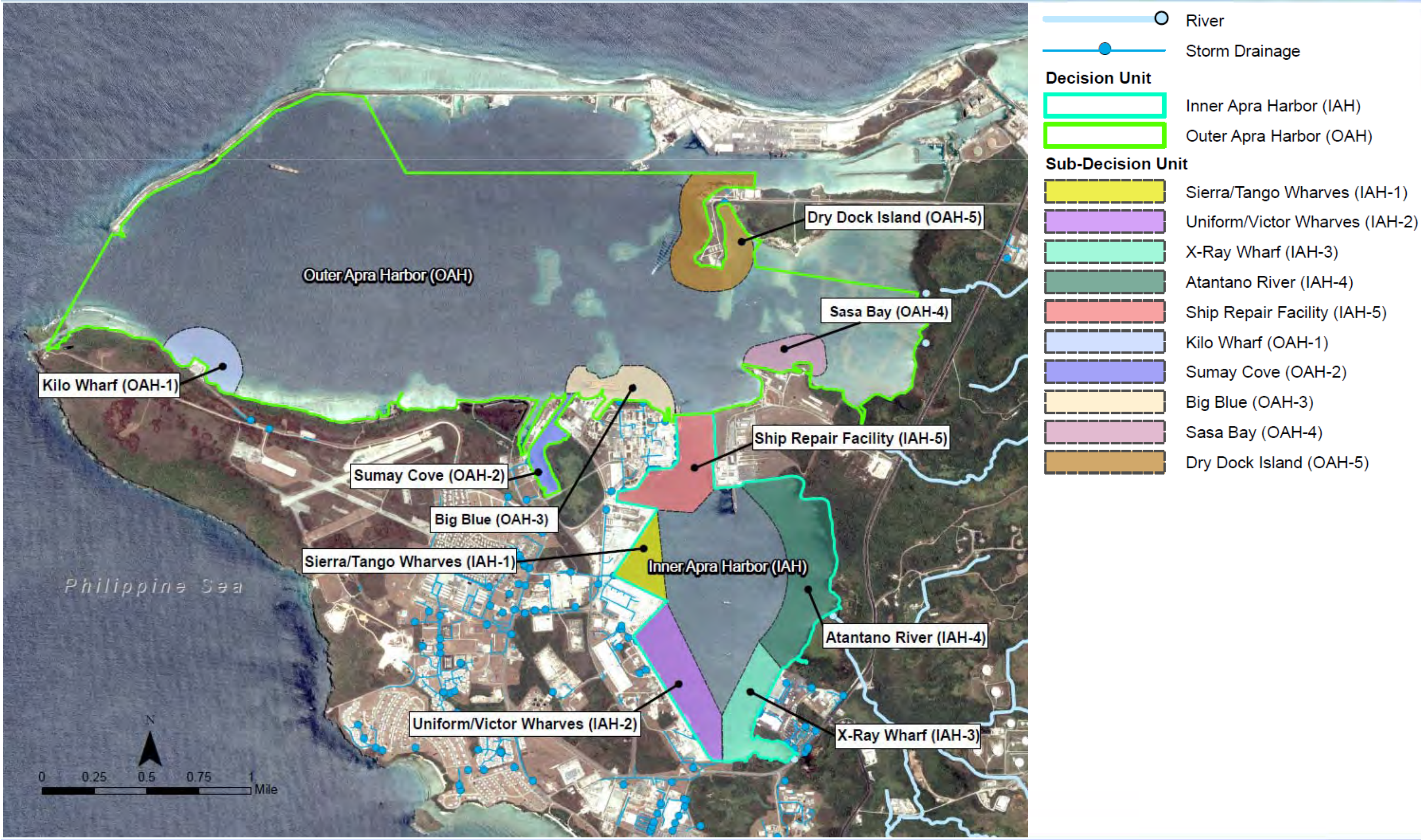
Site Location: Geology and Watershed



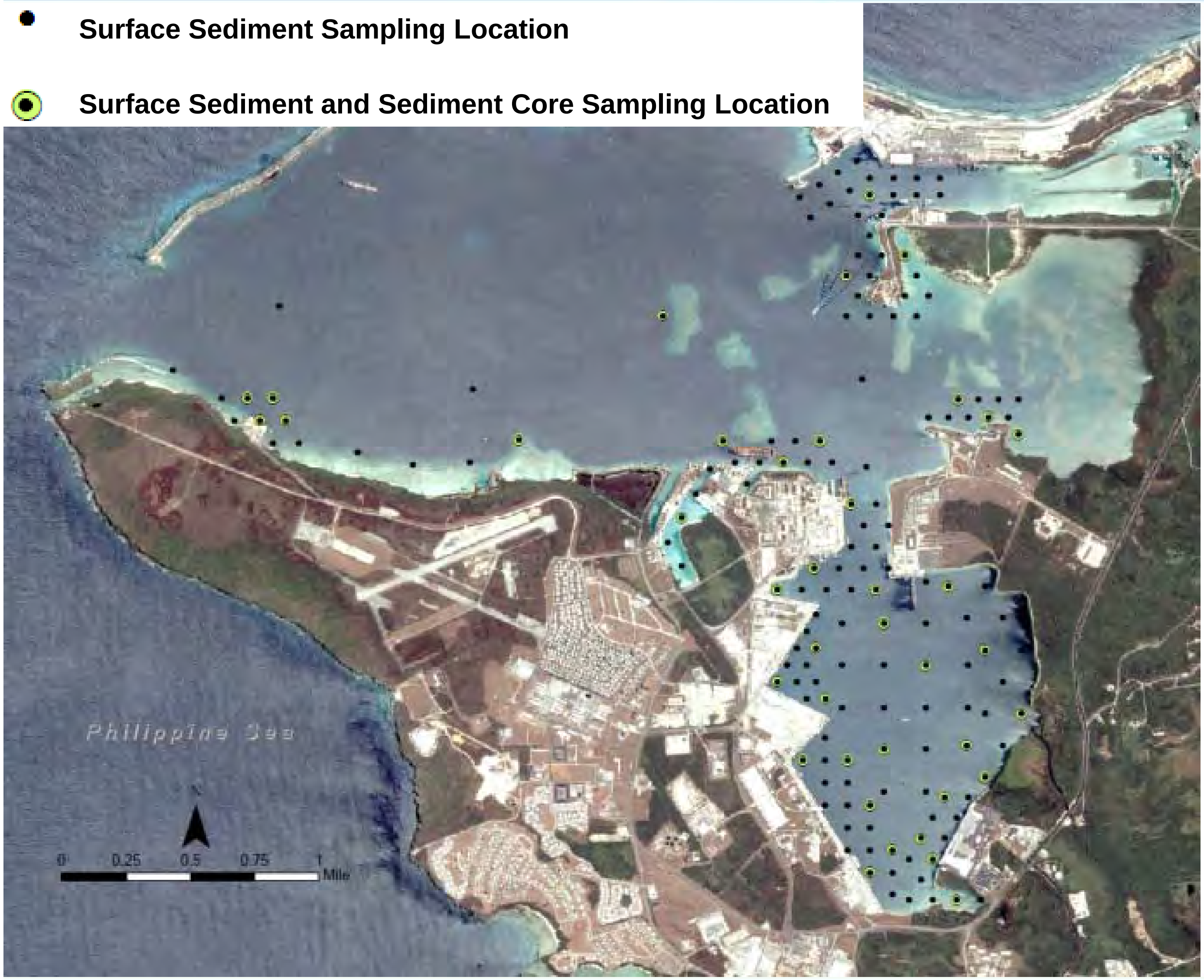
- River
- Storm Drainage
- Apra Watershed

- **Artificial Fill** – Dredged material*
- **Alluvium** – Alluvial clay deposits
- **Beach Deposits** – Beach sand and gravel
- **Hagatna Argillaceous Member** – Fossiliferous detrital limestone
- **Reef Facies** – Limestone of reef origin
- **Alutom Formation** – Conglomerates, sandstones and sandy limestones
- **Alifan Limestone** – Recrystallized limestone
- **Talisay Member** – Clay and clayey conglomerate

Site Location: Decision Units Associated with Potential Land Sources



Sediment Sampling Locations at Apra Harbor



- **178 Surface Sediment Samples**
  - **93 Inner Harbor**
  - **85 Outer Harbor**
- **204 Subsurface Sediment Samples**
  - **129 Inner Harbor**
  - **75 Outer Harbor**
- **382 samples**
- **21 target metals**
- **3 reference metals**

Background Analysis Required for Apra Harbor

- Screening level exceedances observed in sediment
- Preliminary risk evaluation indicates risk from metals
- Preliminary data evaluation suggests naturally occurring metals from streams
- Follow Navy policy/guidance and EPA guidance to conduct an Environmental Background Analysis (EBA)

Overall Background Analysis Approaches

- **CSM (watershed, geology, streams, past activities)**
- **Data evaluation (guidance and exceedances)**
- **Spatial distribution (maps and figures)**
- **Combined univariate plot analysis (location, depth, qualifiers, particle size distribution, cumulative probability plot)**
- **Geochemical association (correlation matrix, linear regression)**
- **Multiple lines of evidence**

Spatial Distribution: Aluminum

River

2014 Surface Sediment Sampling Location

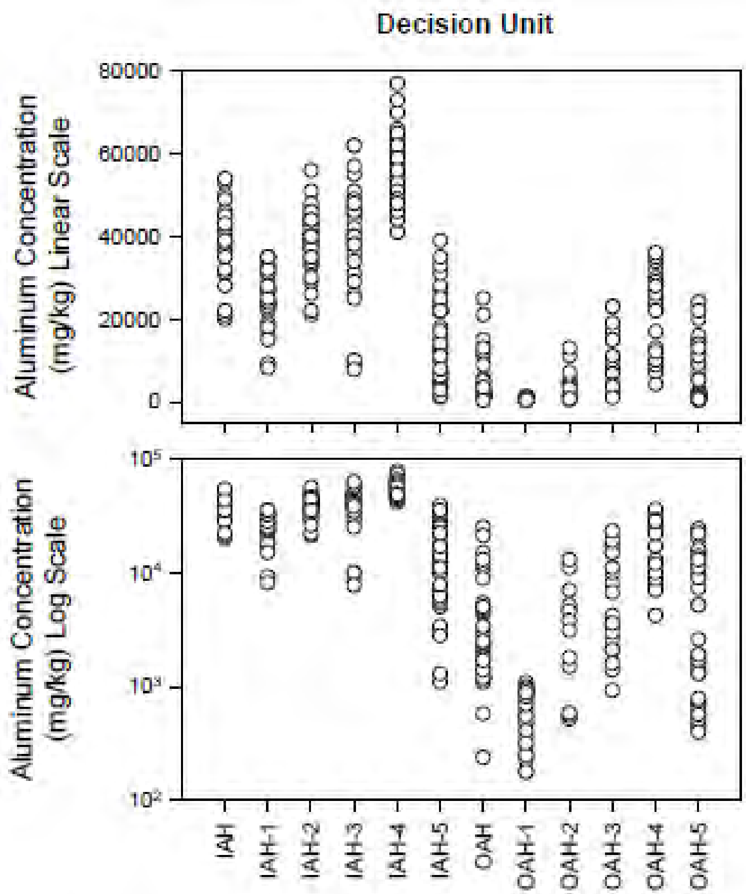
• with Detection Concentration

Aluminum (mg/kg)

- < 1,800
- 1,800 - 3,600
- 3,601 - 9,000
- 9,001 - 18,000
- 18,001 - 27,000
- 27,001 - 36,000
- 36,001 - 45,000
- 45,001 - 54,000
- 54,001 - 64,000

Screening Level 18,000 mg/kg

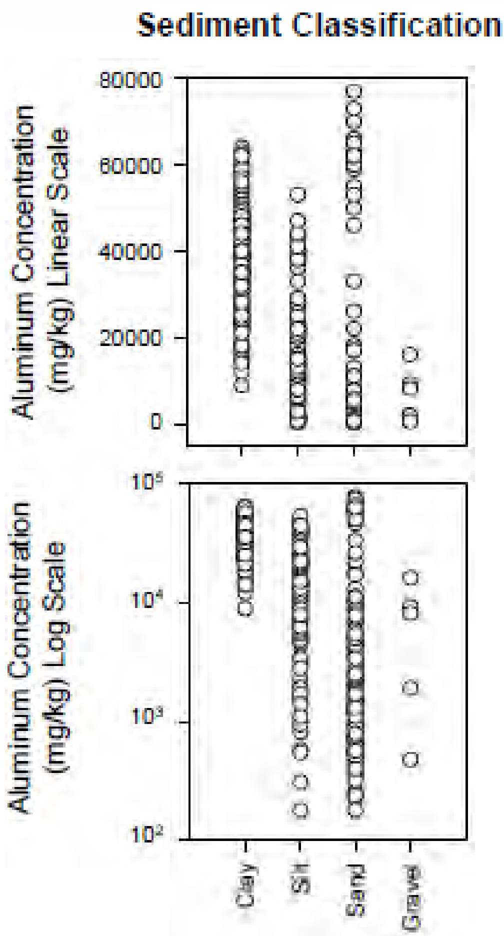
Spatial Distribution Plot



Aluminum

- **Spatial Distribution Plot**
  - **Concentrations vary by location**
  - **Some locations expected to be mostly background**
    - **IAH-4**
    - **OAH-4**
  - **Some locations expected to have contamination**
    - **IAH-5**

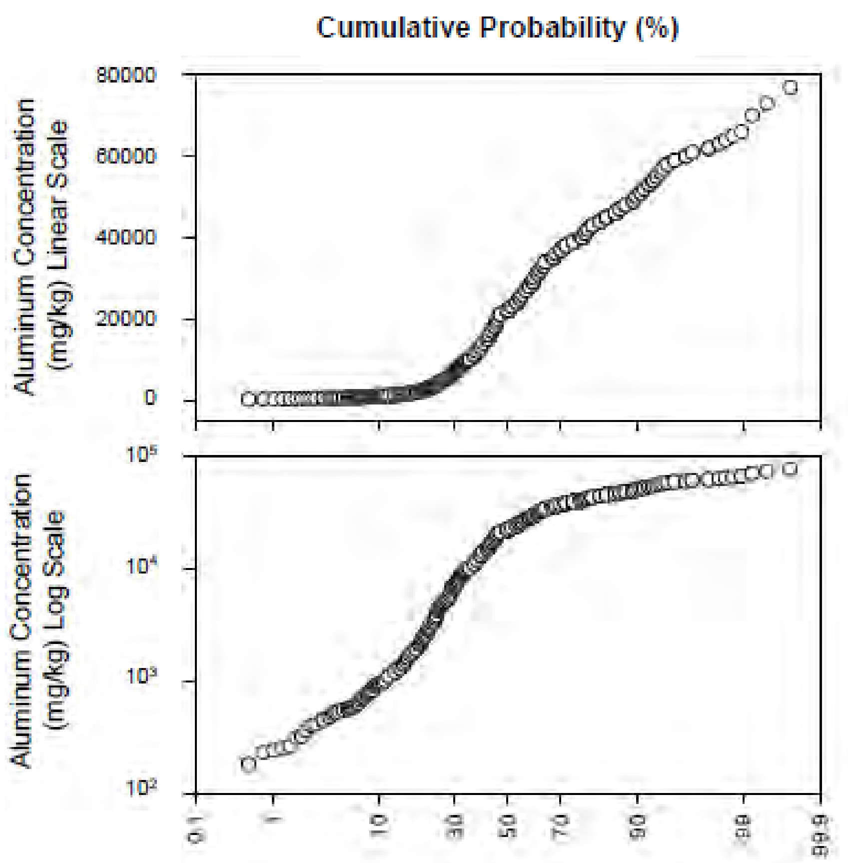
Sediment Type and Classification Plot



Aluminum

- **Sediment Classification**
  - **Clay**
  - **Silt**
  - **Sand**
  - **Gravel**
- **Naturally occurring metals tend to be enriched in clay due to surface area**
- **Contaminant releases can be anywhere**

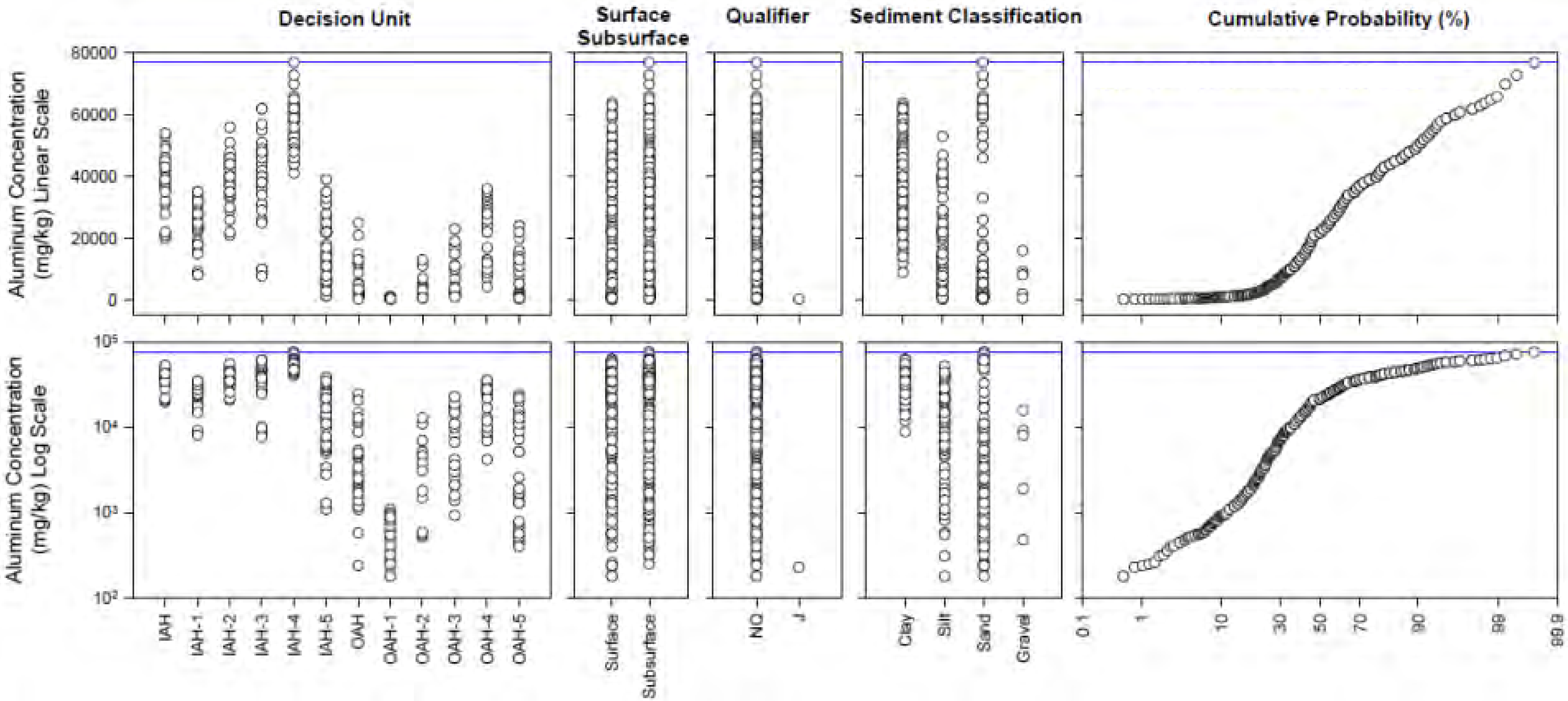
Cumulative Probability Plot



Aluminum

- **Cumulative probability**
  - **Normal distribution**
  - **Log-normal distribution**
- **Inflection point shows possible "break" between naturally occurring concentrations and contaminate releases**
- **No observable inflection point indicates all background**

Combined Univariate Plots



Aluminum **77,000 mg/kg**

Association between Chromium and Nickel in Different Rocks

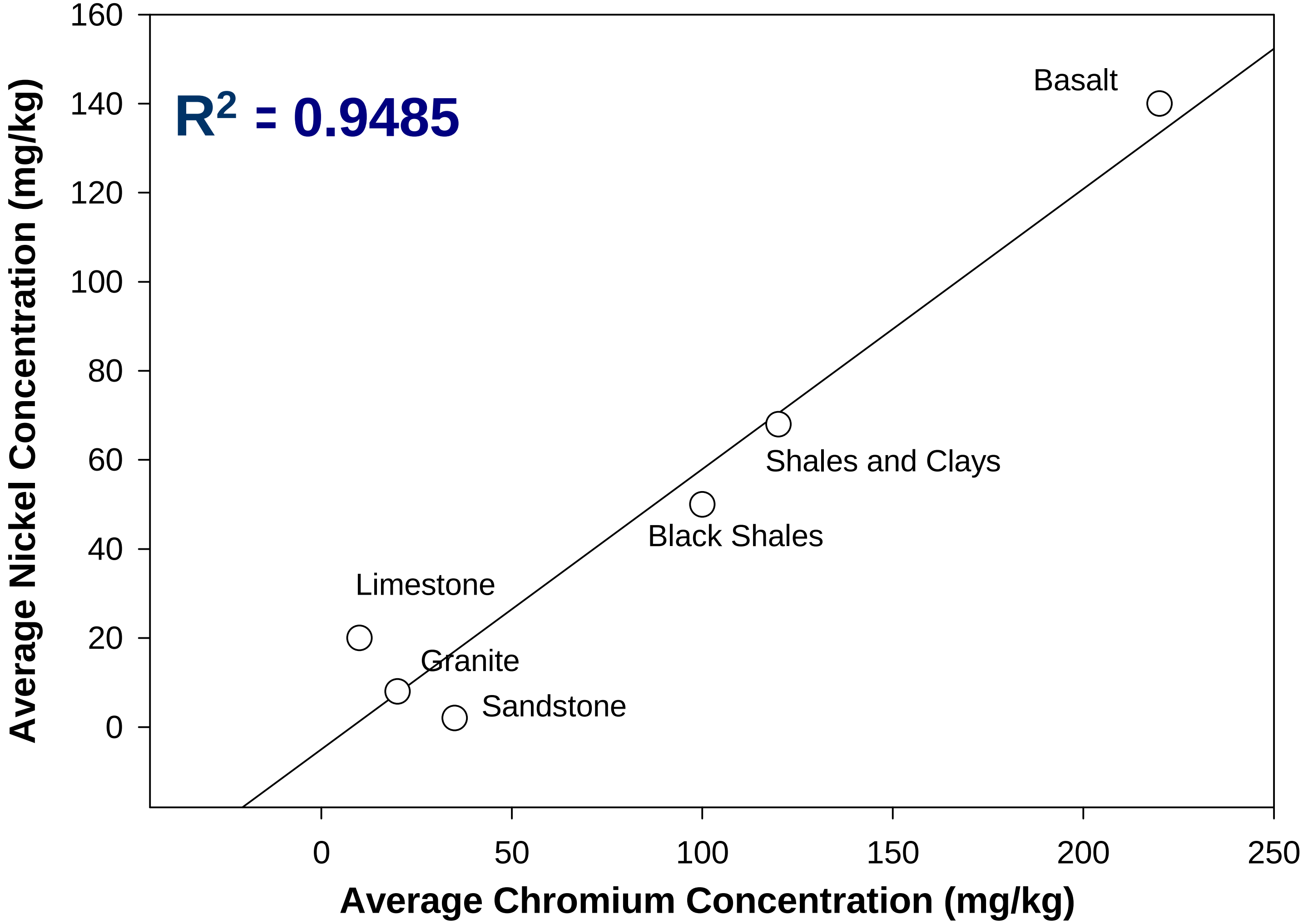
Chromium/nickel concentrations in different rocks

Name	Chromium		Nickel		Average Cr/Ni Concentration Ratio
	Average	Range	Average	Range	
Basaltic igneous	220	40–600	140	45–410	1.6
Granitic igneous	20	2–90	8	2–20	2.5
Shales and clays	120	30–590	68	20–250	1.8
Black shales	100	26–1,000	50	10–500	2.0
Limestone	10	—	20	—	0.5
Sandstone	35	—	2	—	17.5

Source: Alloway (1990, Table 7-2).

From *Guidance for Env. Background Analysis: Soil,* Table A-10 (NAVFAC 2002)

Strong Association (R^2) between Chromium and Nickel in Different Rocks



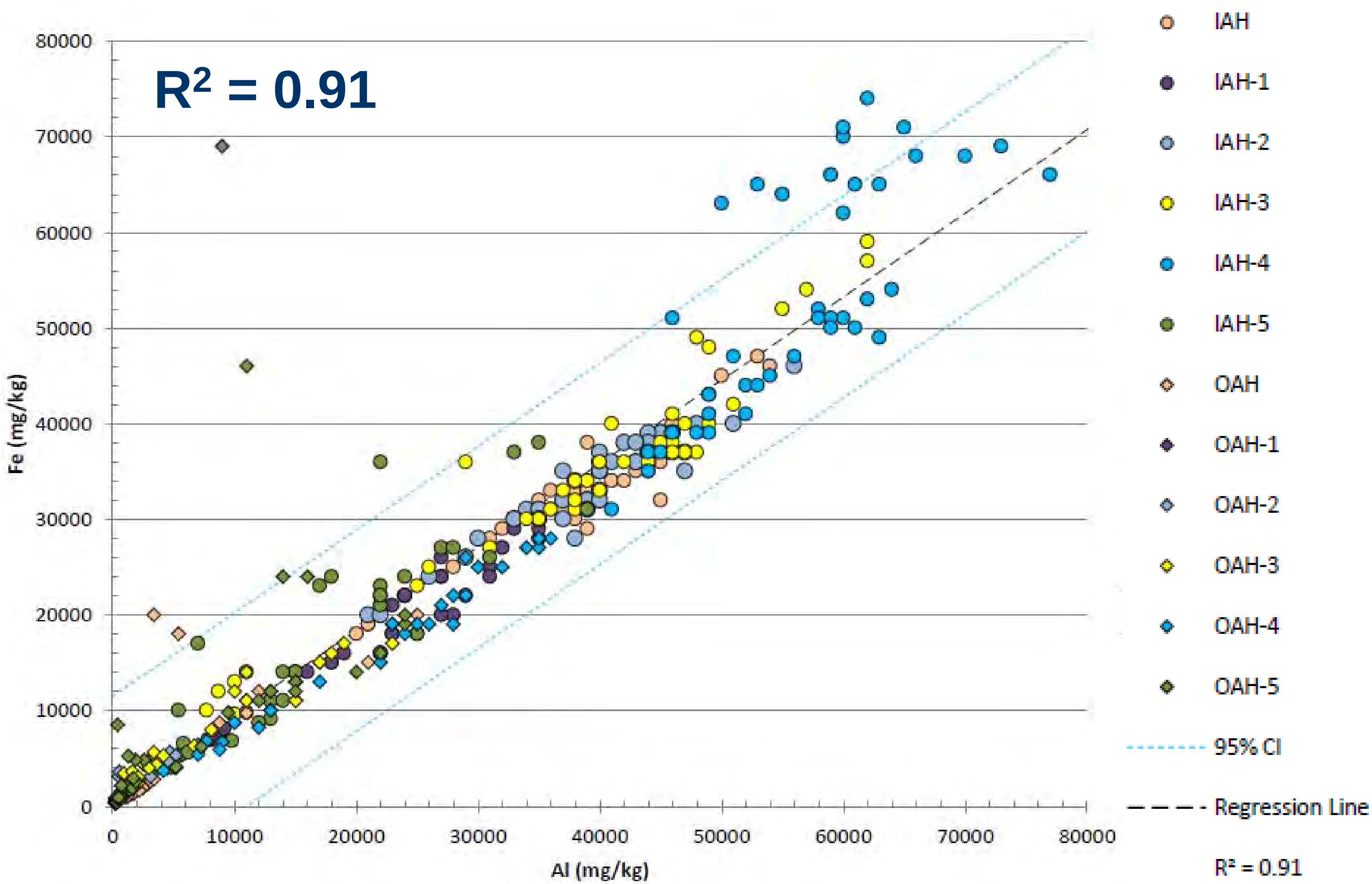
Geochemical Association Background

- **R (correlation coefficient)**
- **R^2 (coefficient of determination)**
- **Describe the population and identify possible outliers**
- **Confidence interval (95%)**

Correlation Matrix – Apra Harbor Sediment

	Al	Sb	As	Ba	Be	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	Sn	V	Zn
Al	1.00																							
Sb	0.00	1.00																						
As	0.63	0.28	1.00																					
Ba	0.18	0.36	0.02	1.00																				
Be	0.89	0.15	0.56	0.45	1.00																			
Cd	-0.05	0.50	0.09	0.20	-0.01	1.00																		
Ca	-0.92	-0.10	-0.57	-0.26	-0.88	-0.02	1.00																	
Cr	0.14	0.33	0.12	0.32	0.31	0.09	-0.32	1.00																
Co	0.93	0.05	0.55	0.36	0.88	0.07	-0.90	0.18	1.00															
Cu	0.14	0.75	0.32	0.44	0.29	0.81	-0.24	0.36	0.22	1.00														
Fe	0.95	0.14	0.68	0.30	0.89	0.14	-0.92	0.20	0.97	0.33	1.00													
Pb	-0.02	0.70	0.17	0.38	0.14	0.79	-0.14	0.62	0.07	0.89	0.16	1.00												
Mg	0.77	0.10	0.47	0.18	0.72	0.07	-0.66	0.13	0.66	0.26	0.72	0.11	1.00											
Mn	0.93	0.04	0.67	0.12	0.82	-0.01	-0.83	0.14	0.82	0.19	0.88	0.02	0.73	1.00										
Hg	-0.01	0.65	0.21	0.26	0.08	0.78	-0.05	0.23	0.05	0.81	0.14	0.78	0.15	0.04	1.00									
Ni	0.83	0.26	0.56	0.51	0.96	0.06	-0.86	0.48	0.85	0.40	0.87	0.30	0.69	0.77	0.17	1.00								
K	0.98	-0.02	0.63	0.21	0.87	-0.05	-0.91	0.13	0.95	0.12	0.96	-0.04	0.73	0.89	-0.02	0.81	1.00							
Se	0.41	0.14	0.33	0.01	0.36	0.08	-0.30	0.04	0.29	0.16	0.36	0.10	0.39	0.46	0.14	0.32	0.38	1.00						
Ag	0.22	0.47	0.22	0.33	0.36	0.18	-0.23	0.26	0.21	0.43	0.26	0.38	0.27	0.24	0.38	0.40	0.17	0.21	1.00					
Na	0.86	0.00	0.64	-0.01	0.71	-0.04	-0.74	0.06	0.69	0.13	0.78	-0.02	0.74	0.88	0.03	0.64	0.84	0.42	0.15	1.00				
Tl	0.39	0.36	0.35	0.06	0.38	0.06	-0.33	0.13	0.27	0.24	0.36	0.20	0.43	0.43	0.35	0.39	0.37	0.38	0.47	0.49	1.00			
Sn	0.09	0.64	0.26	0.26	0.14	0.92	-0.14	0.18	0.16	0.91	0.26	0.84	0.22	0.15	0.83	0.22	0.07	0.19	0.34	0.14	0.28	1.00		
V	0.98	0.01	0.61	0.24	0.90	-0.03	-0.92	0.15	0.96	0.16	0.97	-0.01	0.74	0.90	0.00	0.85	0.98	0.36	0.21	0.82	0.36	0.09	1.00	
Zn	-0.03	0.54	0.12	0.24	0.03	0.99	-0.06	0.21	0.09	0.85	0.16	0.85	0.09	0.01	0.78	0.12	-0.04	0.07	0.19	-0.03	0.04	0.93	-0.01	1.00

Iron vs. Aluminum: Geochemical Association



Putting It All Together

- **Multiple lines of evidence**
  - **Data distribution with an understanding of the historical land use**
  - **Spatial distribution as related to the geology and watershed**
  - **Combined plots**
  - **Geochemical association**

Vanadium: Spatial Distribution

River

2014 Surface Sediment Sampling Location

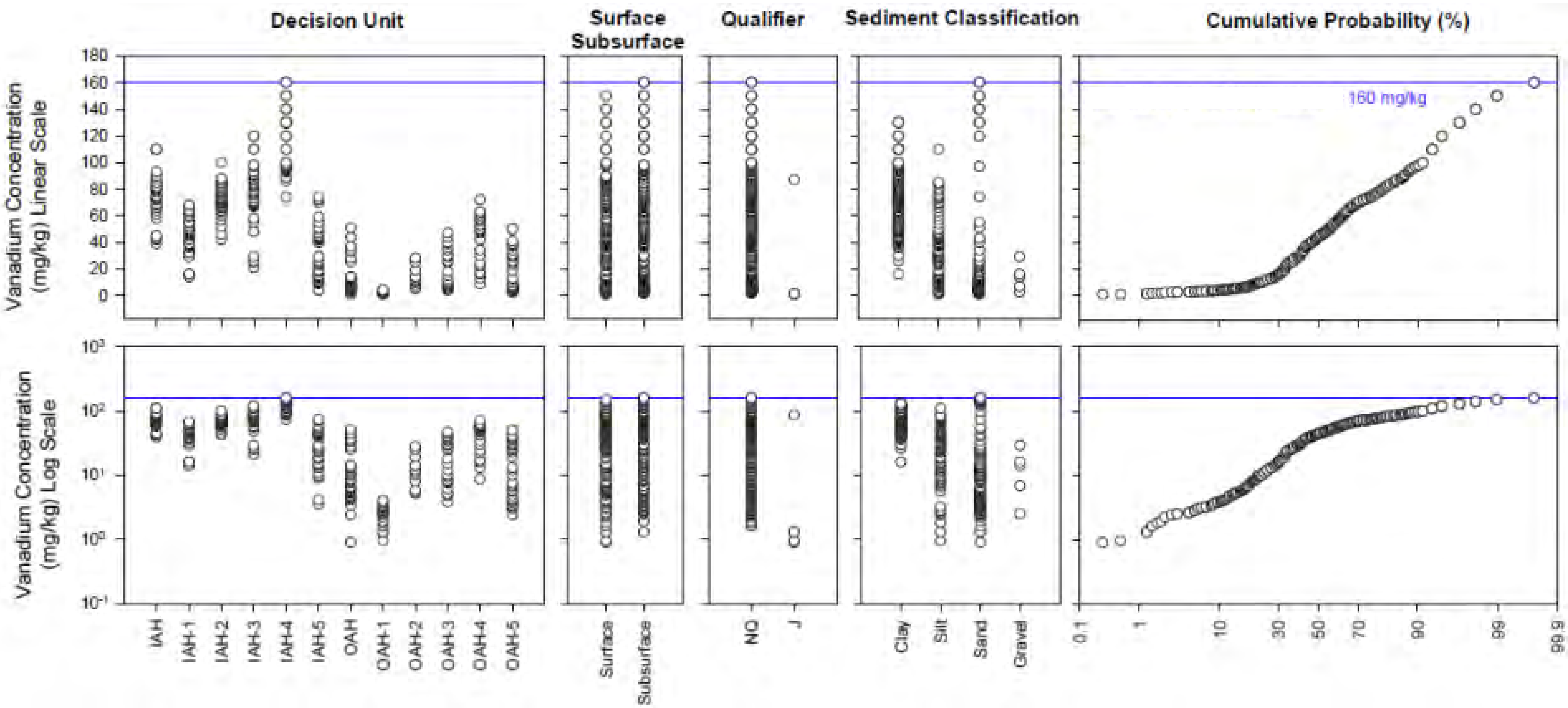
• with Detection Concentration

Vanadium (mg/kg)

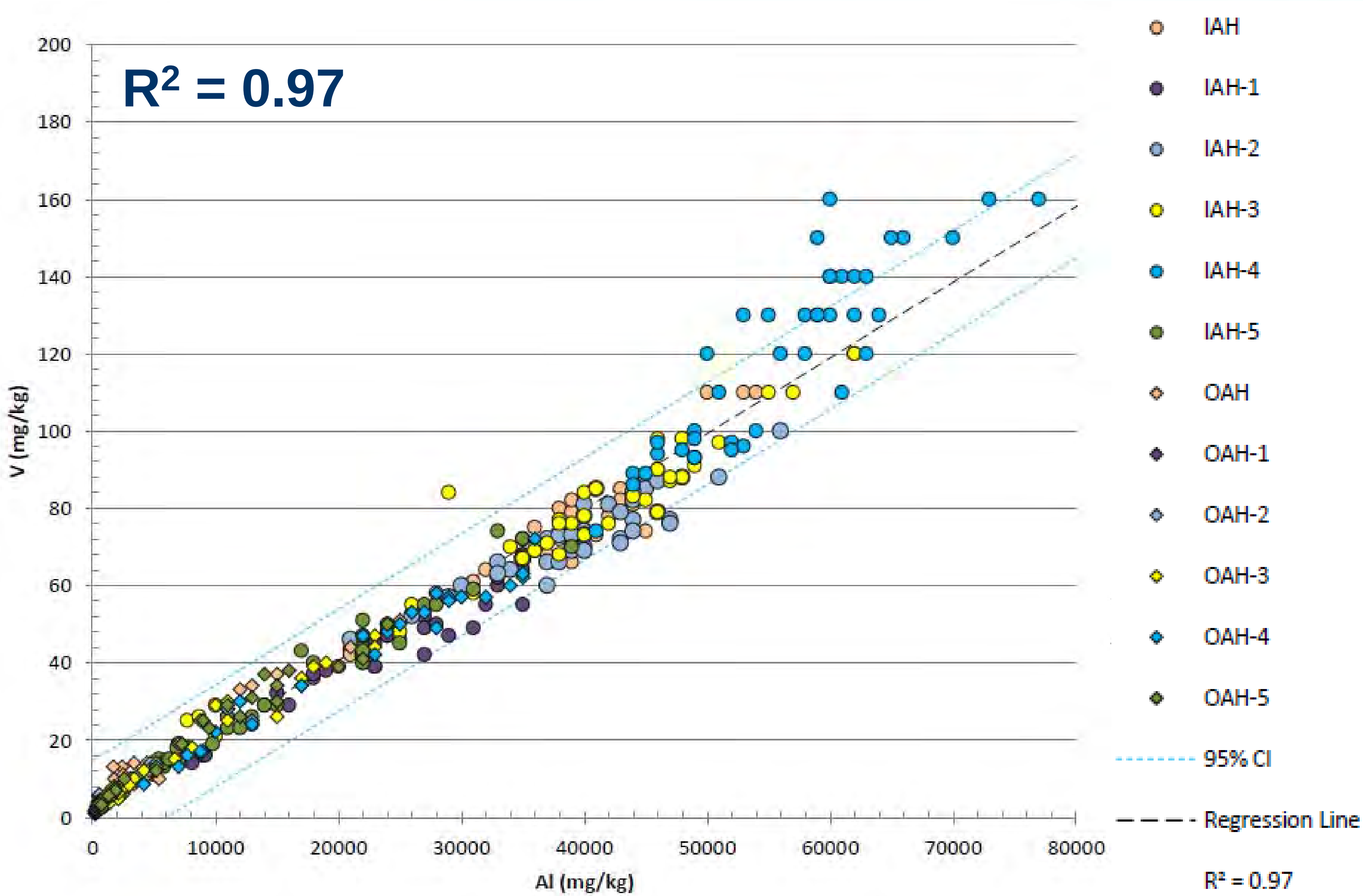
- < 28.50
- 28.50 - 42.75
- 42.76 - 57.00
- 57.01 - 71.25
- 71.26 - 85.50
- 85.51 - 99.75
- 99.76 - 114.0
- 114.01 - 142.5
- 142.51 - 150.0

Screening Level 57 mg/kg

Vanadium: Univariate Plots



Vanadium vs. Aluminum: Geochemical Association



Nickel: Spatial Distribution

River

2014 Surface Sediment Sampling Location

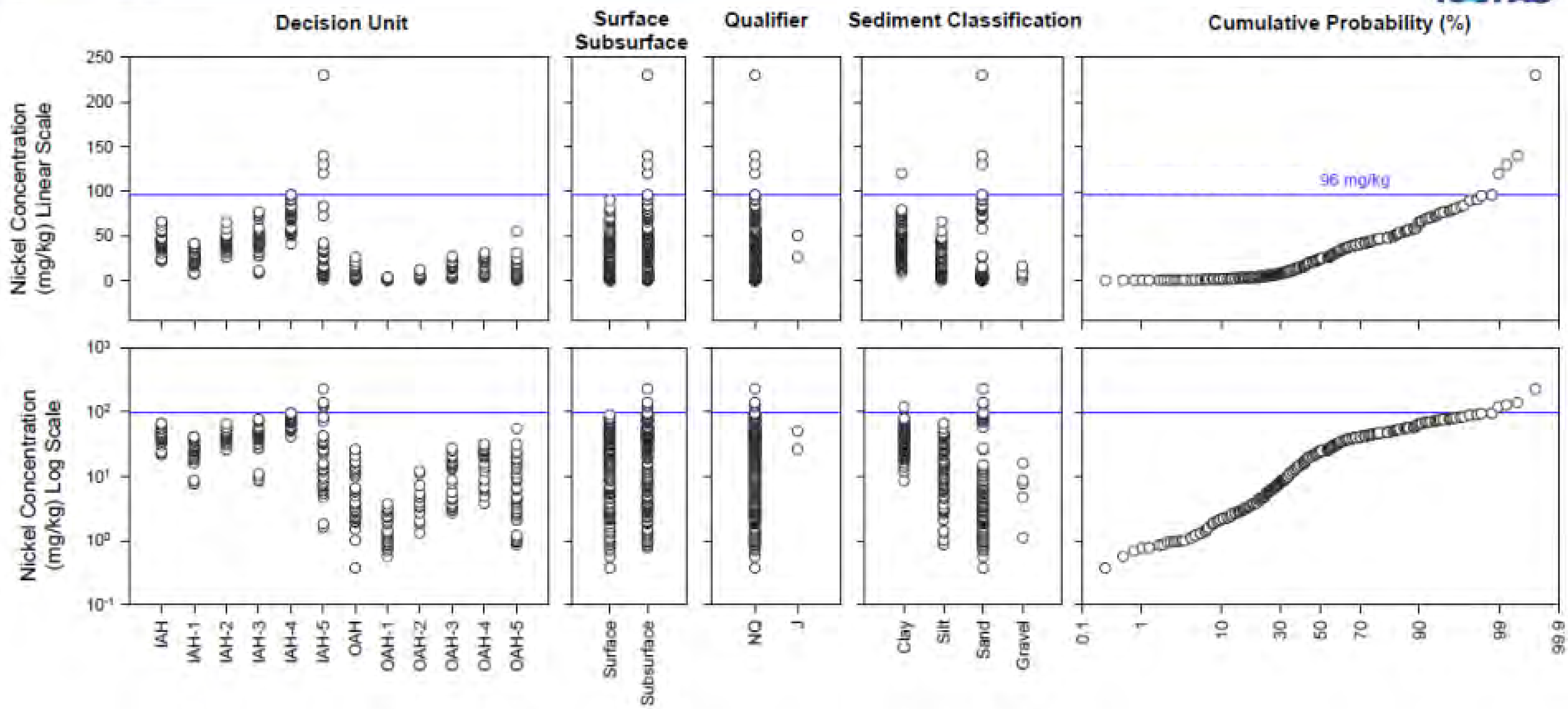
• with Detection Concentration

Nickel (mg/kg)

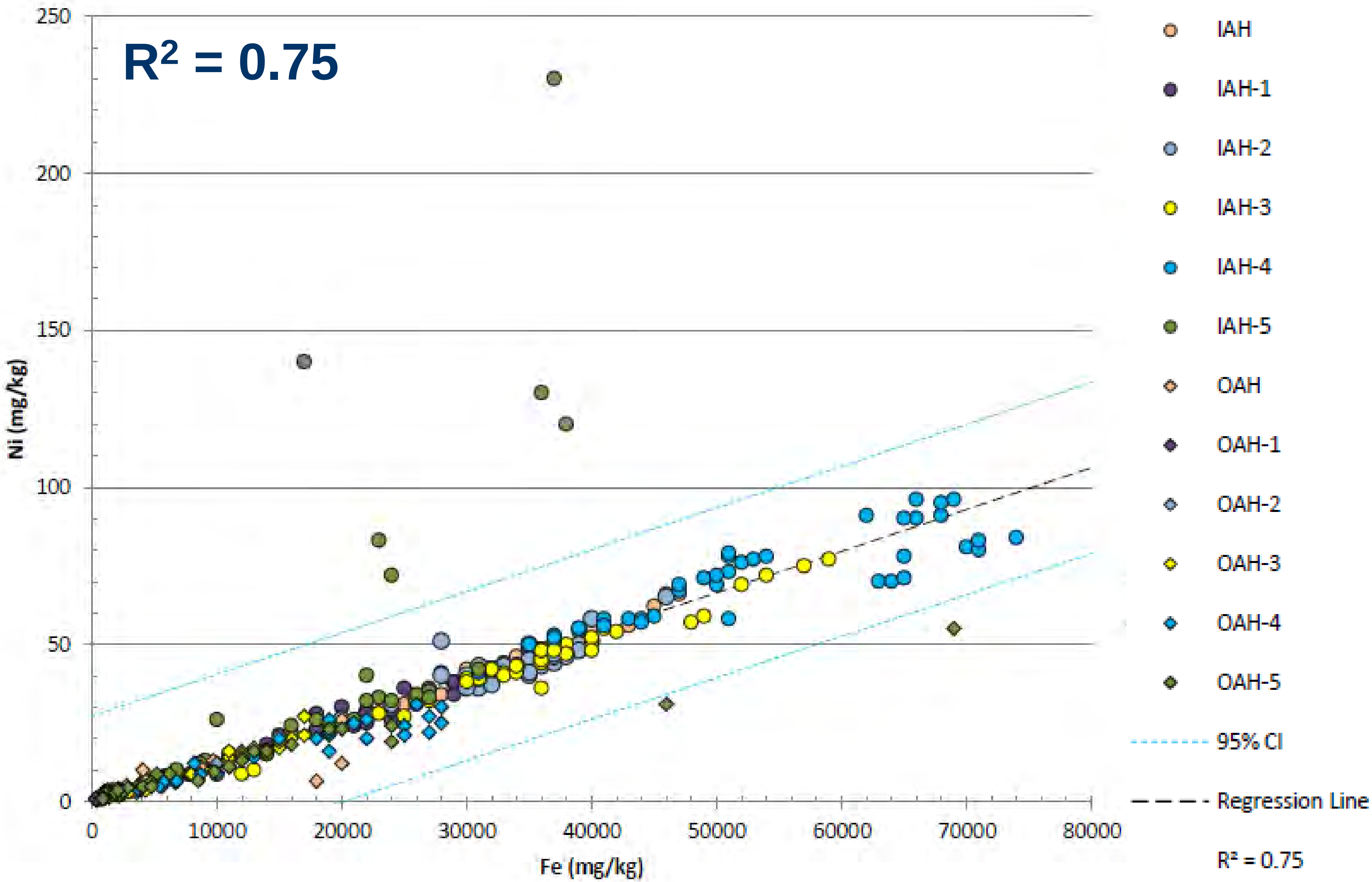
- < 5.23
- 5.23 - 10.5
- 10.46 - 15.7
- 15.69 - 20.9
- 20.91 - 31.4
- 31.36 - 41.8
- 41.81 - 62.7
- 62.71 - 83.6
- 83.61 - 90.0

Screening Level 20.9 mg/kg

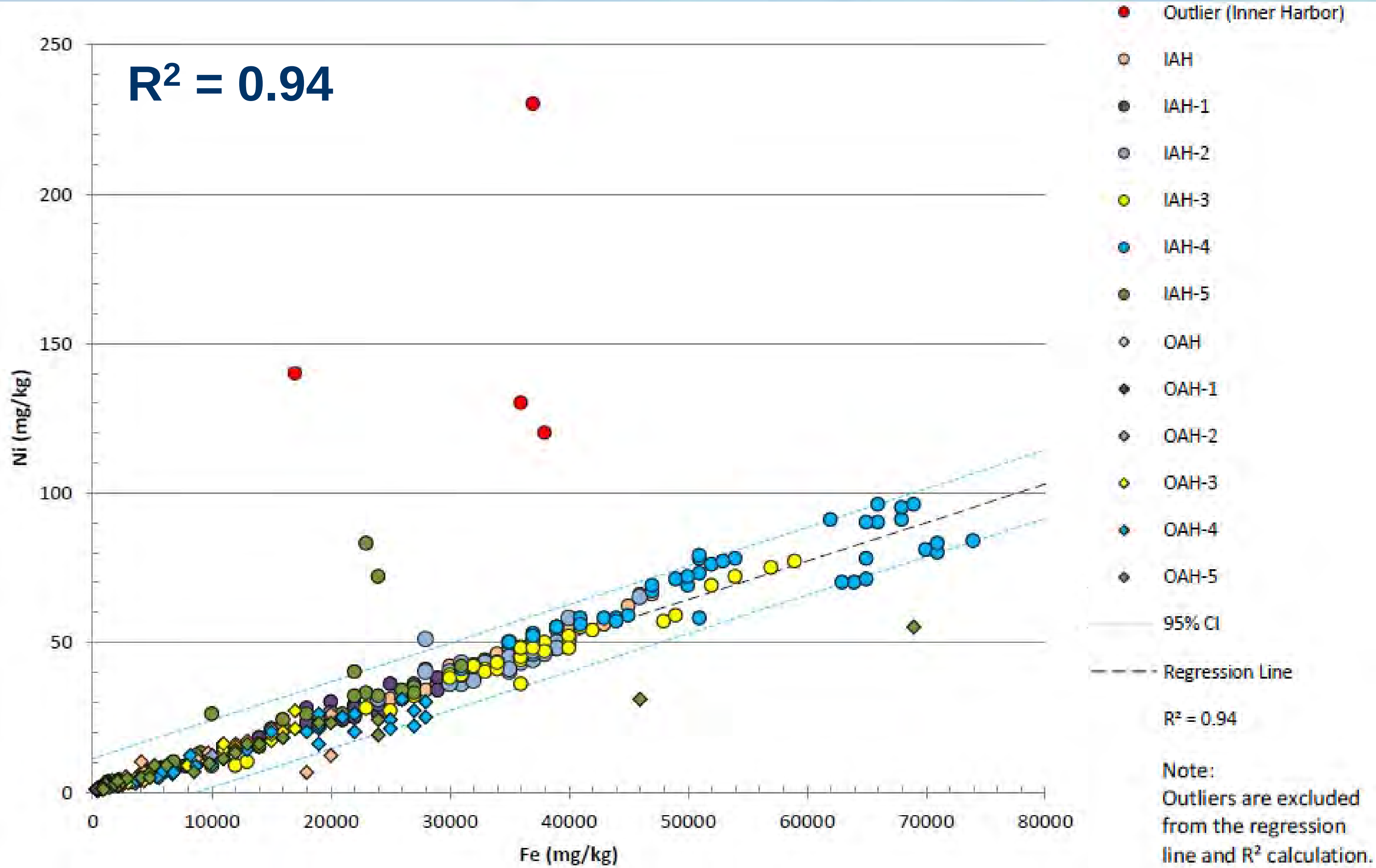
Nickle: Univariate Plots



Nickel vs. Iron: Geochemical Association



Nickel vs. Iron: Geochemical Association



Chromium: Spatial Distribution

River

2014 Surface Sediment Sampling Location

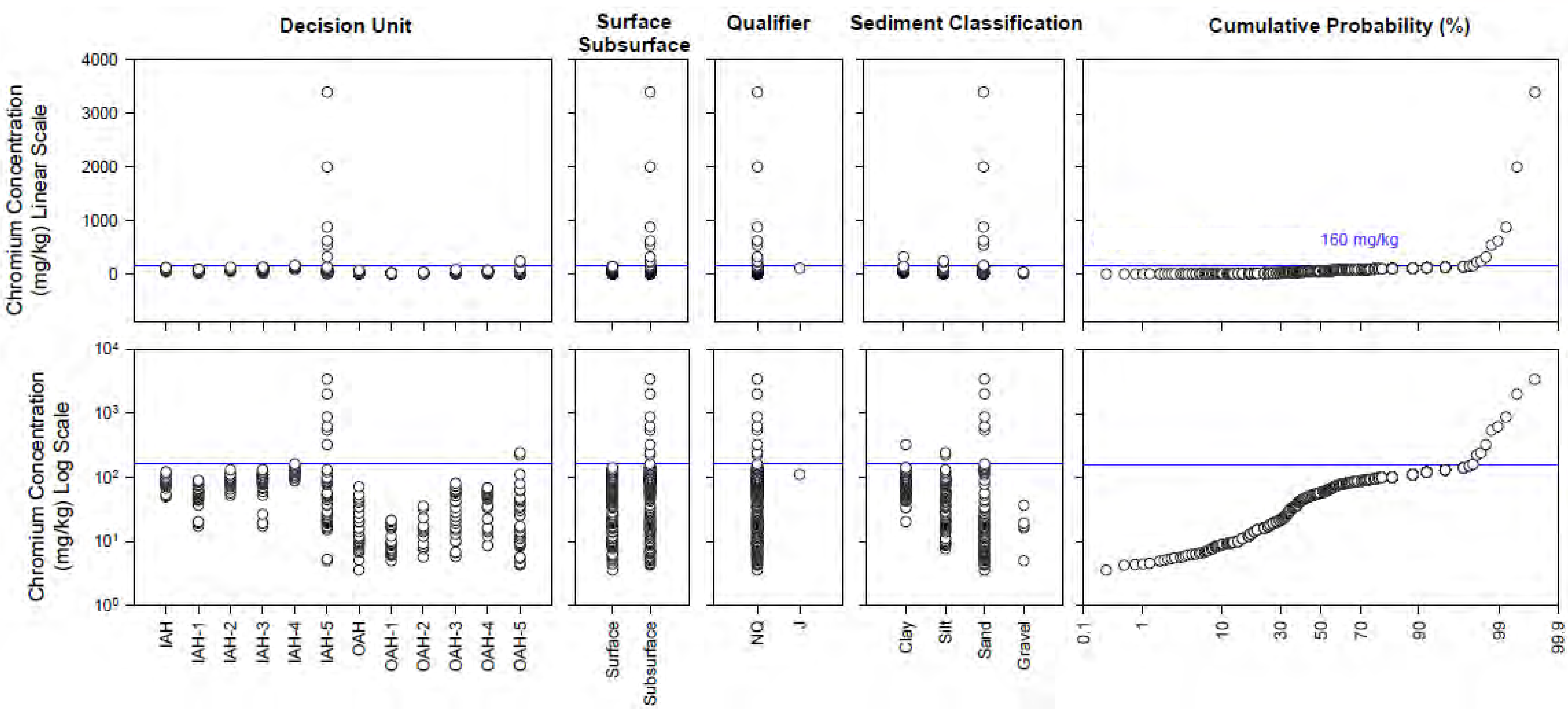
- with Detection Concentration

Chromium (mg/kg)

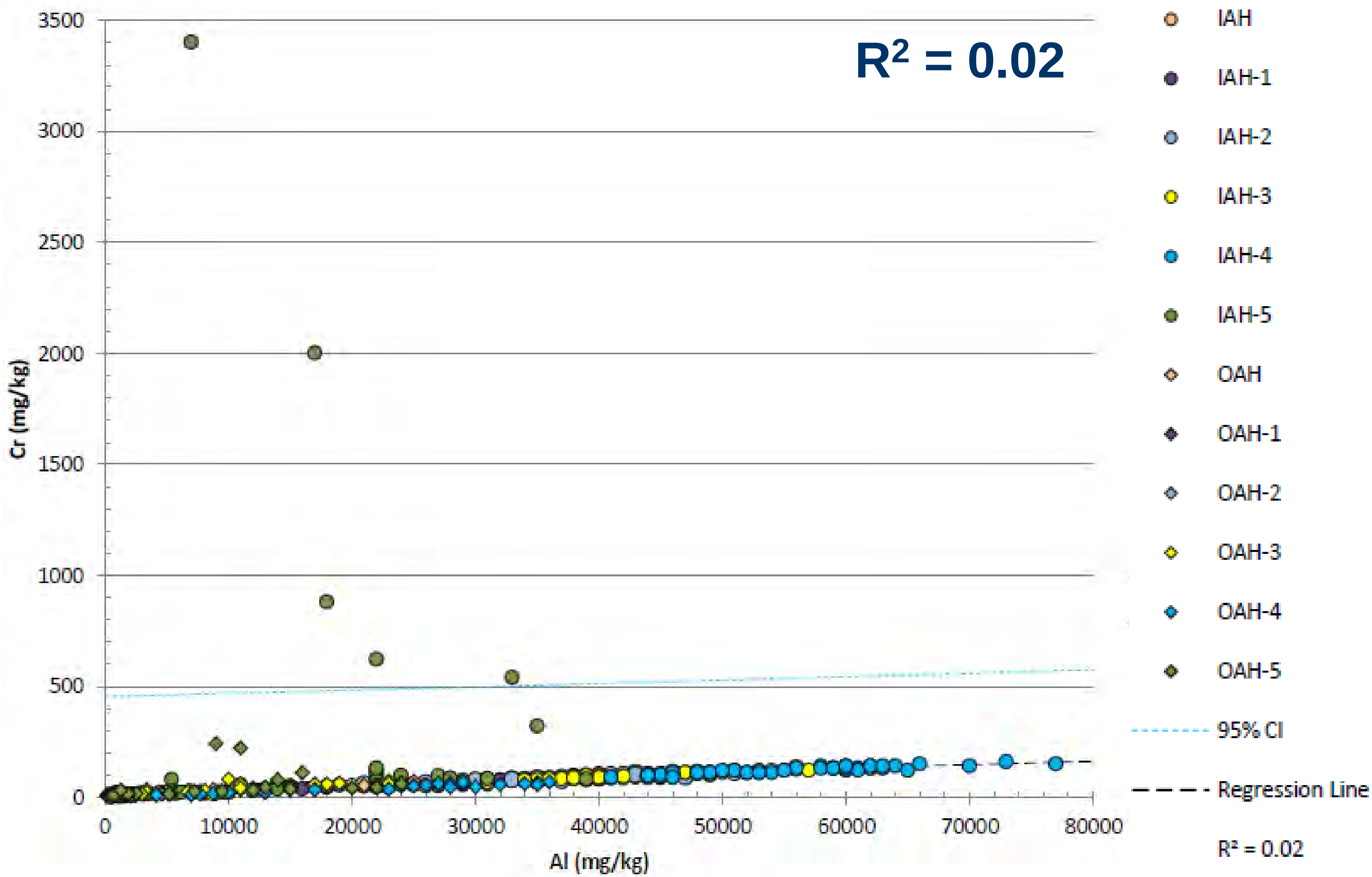
- < 15.5
- 15.50 - 31.0
- 31.01 - 46.5
- 46.51 - 62.0
- 62.01 - 77.5
- 77.51 - 93.0
- 93.01 - 108.5
- 108.51 - 124
- 124.01 - 140

Screening Level 62 mg/kg

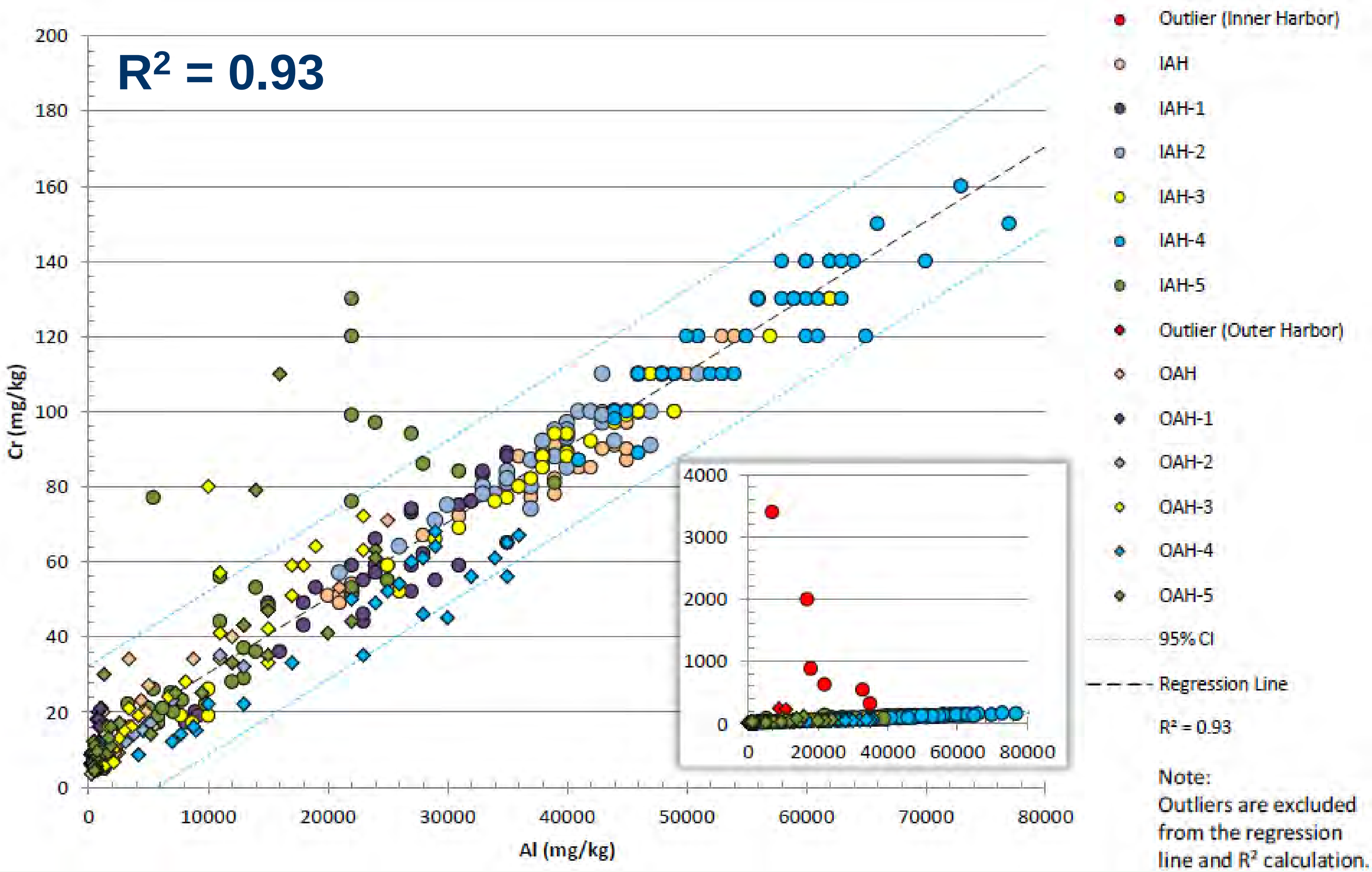
Chromium: Univariate Plots



Chromium vs. Aluminum: Geochemical Association



Chromium vs. Aluminum: Geochemical Association



Background Estimate

Target Constituent	EBA Dataset Range	Background				
		Range (min–max)	Mode	MBC	95th Percentile	Recommended Background Concentration
Aluminum (Al)	**180–77,000**	**180–77,000**	**22,000**	**77,000**	**59,000**	**77,000**
Antimony (Sb)	0.16 J – 13	0.16–6.7	0.33	5.3	2.95	**5.3**
Arsenic (As)	0.79–26	0.79–26	11	23	15	**23**
Barium (Ba)	1.8–230	1.8–230	5.7	84	15	**84**
Beryllium (Be)	0.014 J – 0.88	0.014–0.88	0.18	0.41	0.31	**0.41**
Cadmium (Cd)	0.026 J – 26	0.026–26	0.11	1.2	0.43	**1.2**
Calcium (Ca)	3,700–460,000	3,700–460,000	290,000	460,000	320,000	**460,000**
Chromium (Cr)	**3.5–3,400**	**3.5–3,400**	**110**	**160**	**130**	**160**
Cobalt (Co)	0.076 J – 41	0.076–41	12	41	25.1	**41**
Copper (Cu)	0.52–1,300	0.52–1,300	36	100	91	**100**
Iron (Fe)	**300–74,000**	**300–74,000**	**36,000**	**74,000**	**53,950**	**74,000**
Lead (Pb)	0.24–1,100	0.24–1,100	31	60	46	**60**
Magnesium (Mg)	2,900–25,000	2,900–25,000	18,000	25,000	22,000	**25,000**
Manganese (Mn)	7.4–1,000	7.4–1,000	440	1,000	770	**1,000**
Mercury (Hg)	0.011 J – 9	0.011–9	0.14	0.54	0.45	**0.54**
Nickel (Ni)	**0.37–230**	**0.37–230**	**48**	**96**	**76**	**96**
Potassium (K)	82 J – 7,000	82–7,000	2,900	7,000	4,800	**7,000**
Selenium (Se)	0.069 J – 0.58	0.069–0.58	0.35	0.58	0.42	**0.58**
Silver (Ag)	0.024 J – 1.2	0.024–1.2	0.11	0.61	0.36	**0.61**
Sodium (Na)	3,900–30,000	3,900–30,000	16,000	30,000	25,000	**30,000**
Thallium (Tl)	0.051 J – 0.66	0.051–0.66	0.12	0.2	0.17	**0.2**
Tin (Sn)	1.2 J – 86	1.2–86	1.9	15	7.2	**15**
Vanadium (V)	**0.892 J – 160**	**0.89–160**	**130**	**160**	**90.5**	**160**
Zinc (Zn)	1.1 J – 12,000	1.1–12,000	110	350	160	**350**

Resources

- **General**
  - **NAVFAC Environmental Restoration and BRAC**

    https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/ev/erb.html
- **Navy Policy and NAVFAC EBA Guidance**

  https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/ev/erb/gpr.html
- **CSM Development**
  - **Terrestrial/Groundwater**

    https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/Environmental/Restoration/er_pdfs/c/navfacesc-ev-cklst-csm-terrestrial-20130114.pdf
  - **Sediment/Surface Water**

    https://www.navfac.navy.mil/content/dam/navfac/Specialty%20Centers/Engineering%20and%20Expeditionary%20Warfare%20Center/Environmental/Restoration/er_pdfs/c/navfacesc-ev-cklst-csm-sediment-20130114.pdf

Questions

Wrap Up

- **Please complete the feedback questionnaire at the end of this webinar. We are counting on your feedback to make this webinar series relevant!**

- **Next OER2 Webinar Info….**

Title: *Historical Radiological Assessments - The What, Why and How for Navy Remedial Project Managers*

Presenter: Jan Nielsen (NAVFAC LANT)

Date: November 18th, 2015

Time: 11:00-12:00 PDT

- **Thank you for participating!**