Sediment-bound Contaminants Resiliency and Response

—Hurricane Sandy—

Region II Regional Response Team meeting

June 13, 2018

Shawn Fisher
U.S. Geological Survey, New York Water Science Center

USGS
science for a changing world

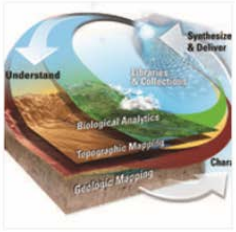
U.S. Geological Survey

- Established in 1879

- Agency under Department of the Interior
  - Sister agencies include NPS, FWS, BLM, OEM, BIA

USGS Mission Areas

Climate and Land Use Change



Core Science Systems

Ecosystems

Energy and Minerals

Environmental Health

Natural Hazards

Water

USGS Regions

- Water Science Center in every state and Puerto Rico
- Other science offices and research labs throughout the country
- HQ in Reston, VA

USGS WMA Mission Statement

…to collect, analyze, and disseminate the impartial hydrologic data and information needed to wisely manage resources

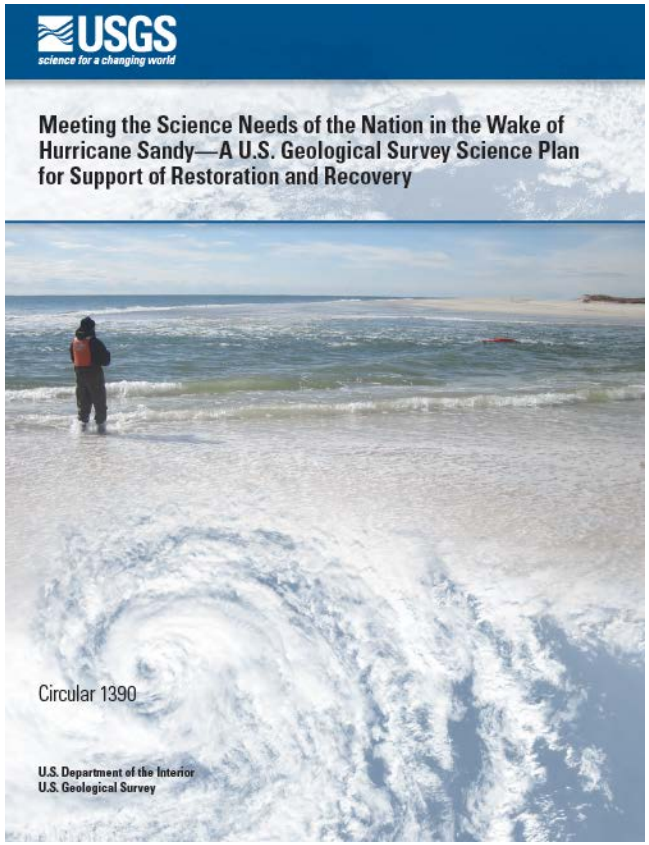
…to protect life and property

Outline

- Summary of work conducted during Hurricane Sandy and the lead up to the SCoRR pilot study
- SCoRR study objectives and operations
- Developing a decision support tool
- Field and analytical methods
- Data generated from the 2015 regional assessment
- Expanding SCoRR

USGS Hurricane Sandy Response

Science Themes



http://pubs.usgs.gov/circ/1390

1. Coastal topography and bathymetry
2. Impacts to coastal beaches and barriers
3. Impacts of storm surge including disturbed estuarine and bay hydrology
4. Impacts of environmental quality and persisting contaminant exposures
5. Impact to coastal ecosystems, habitats, and fish and wildlife

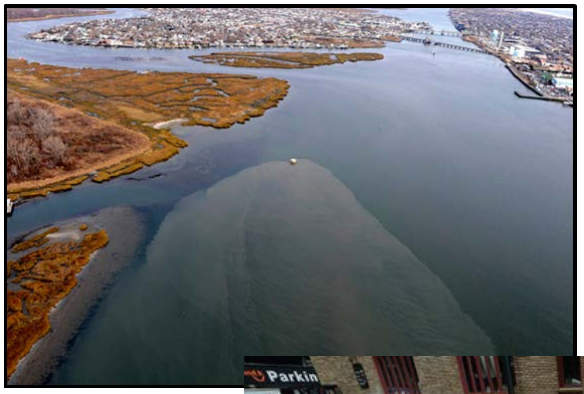
USGS
science for a changing world

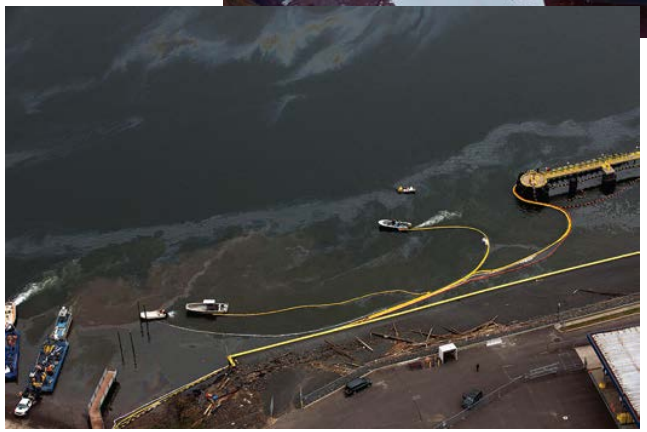
Round 1

THEME 4: IMPACTS OF ENVIRONMENTAL QUALITY AND PERSISTING CONTAMINANT EXPOSURES

Impacts on the Built Environment

- Flooding led to infrastructure failure
  - Wastewater treatment
  - Petroleum production and containment
  - Transportation
  - Utility generation and supply
- Failure that leads to release of contaminants from these sources can threaten human and ecological health into the future





USGS
science for a changing world

Compromised Wastewater Treatment Systems

- Centralized systems
  - Assessed bed sediment
  - Selected regions with greatest municipal wastewater infrastructure failure and historical data
  - Correlate chemical and bacteriological data with contaminant-discharge (or spill) information
- On-site systems
  - Assessed shallow groundwater
  - Selected regions based on seasonal use and septic density
  - Results of groundwater samples to be correlated based on on-site system densities

USGS
science for a changing world

Impacts of Environmental Quality and Persisting Contaminant Exposures

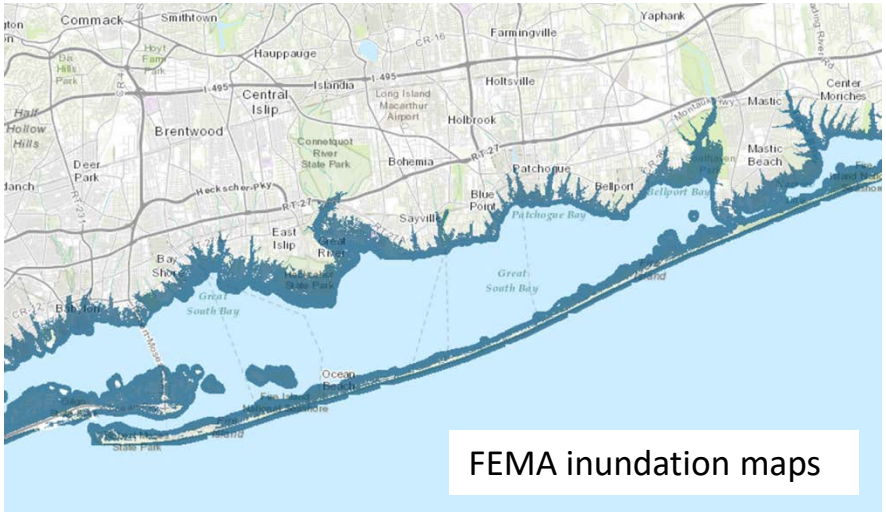
- Main Objectives:
  1. Evaluate potential ecological health impacts associated with exposure to sediment-associated contaminants mobilized by Hurricane Sandy
  2. Correlate sources and receptors with persistence of mobilized contaminants

- Key Tasks:
  1. Define a relevant study area
  2. Compile pertinent historical contaminant data
  3. Conduct reconnaissance sampling of sediments, young of the year blue fish and mussels within priority estuaries
  4. Conduct targeted sampling of areas impacted by compromised wastewater treatment plants and on-site systems

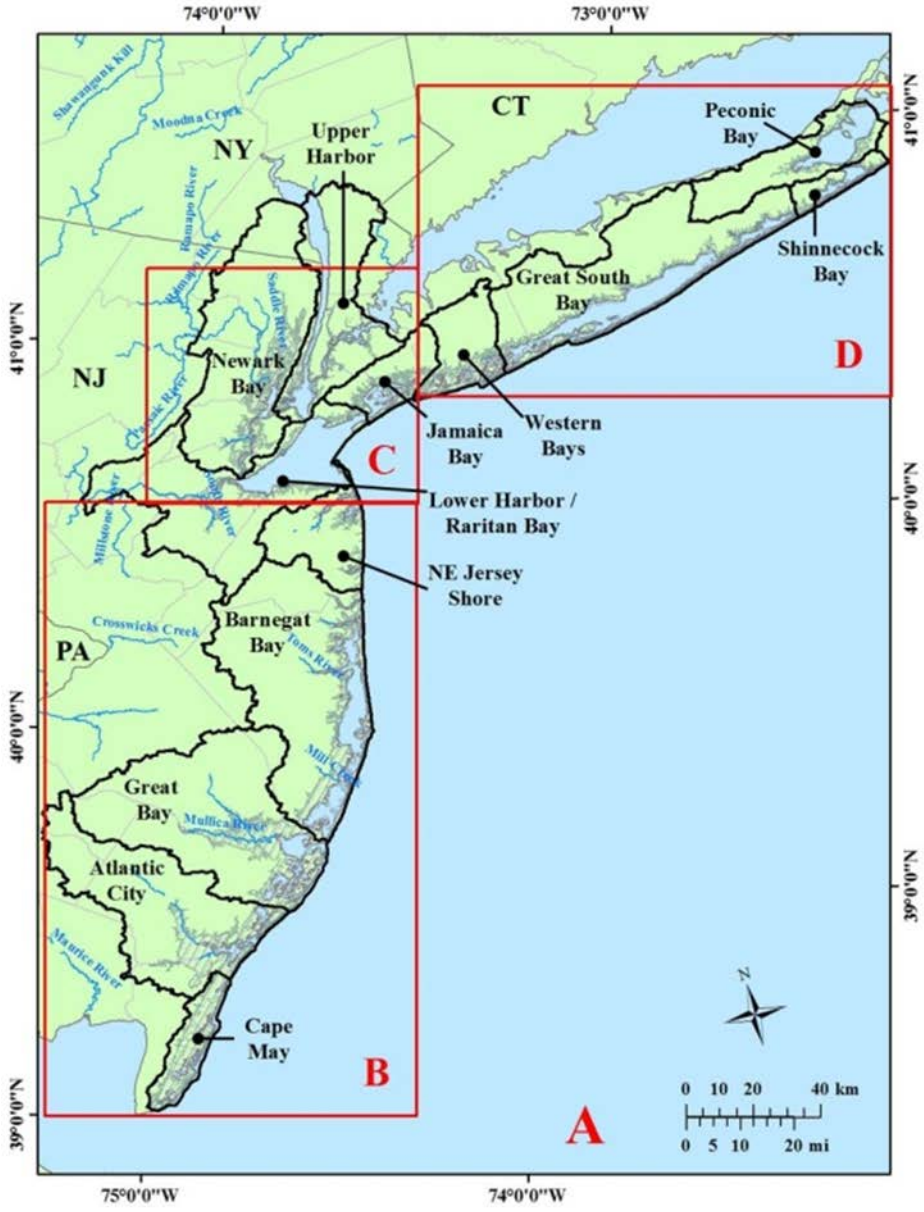
USGS science for a changing world

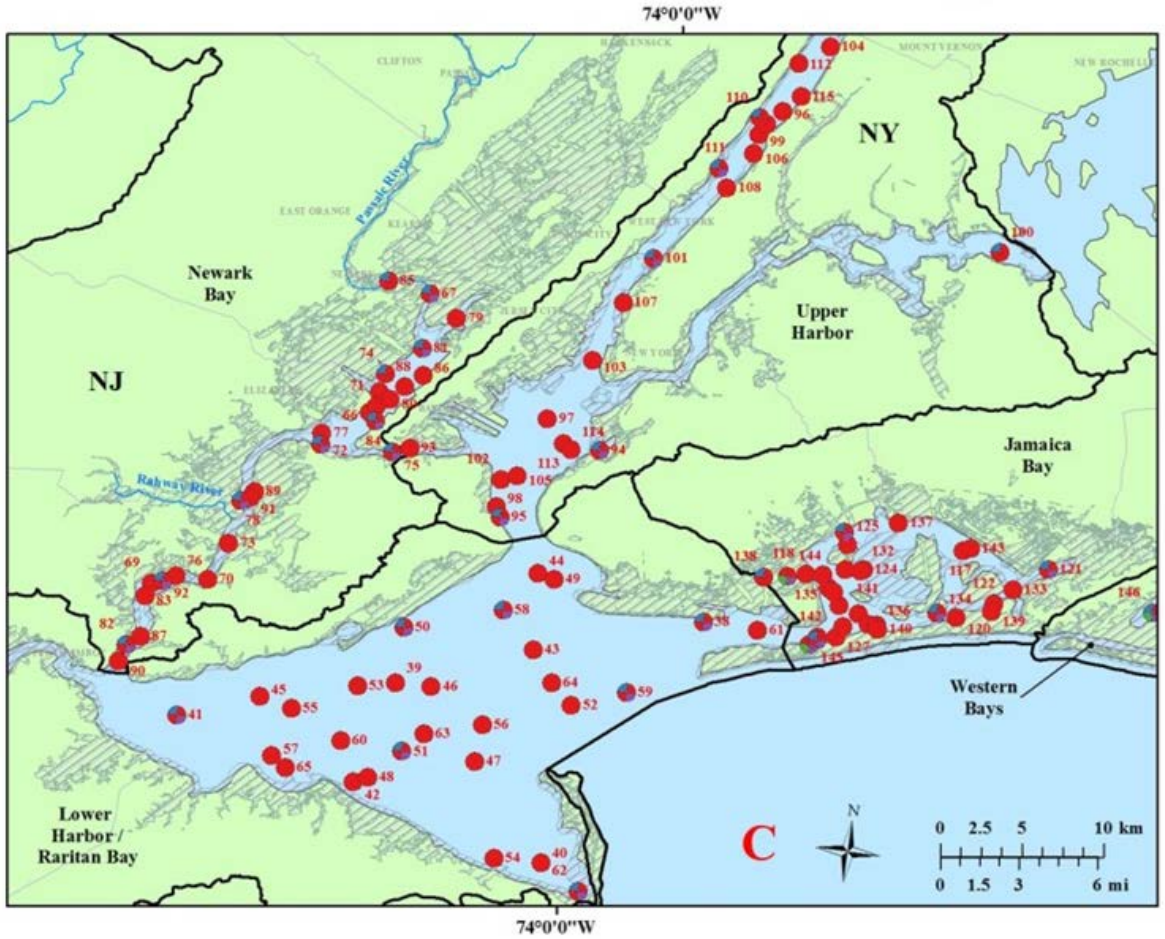
See http://pubs.usgs.gov/fs/2013/3091/ for more details.

Study Area



FEMA inundation maps




74°0'0"W
NY
NJ
Newark Bay
Upper Harbor
Jamaica Bay
Western Bays
Lower Harbor / Raritan Bay
Passaic River
Rahway River
C
N
0 2.5 5 10 km
0 1.5 3 6 mi
74°0'0"W

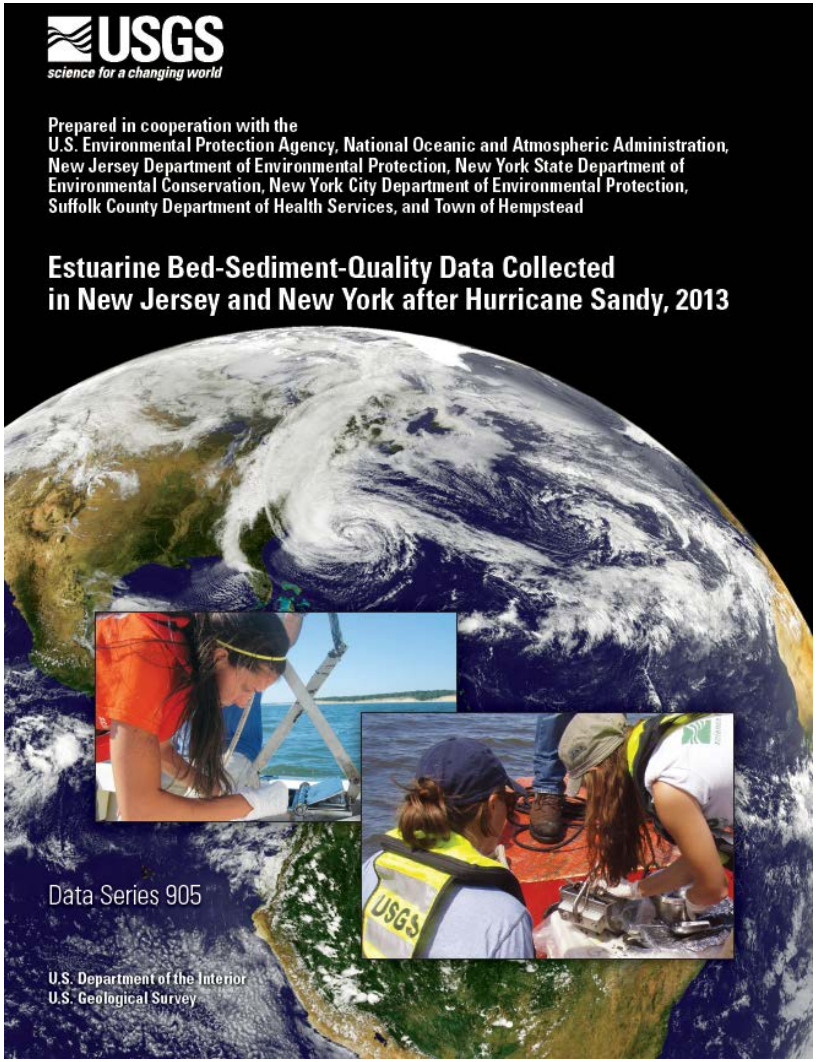

Jamaica Bay


Sandy Hook


Upper Harbor

Data Release

- Data from all Round 1 NY/NJ sediment studies
  - Data collection and analysis methods detailed
  - 38 tables consisting of physical, chemical, and toxicological results
- Regional bed sediment chemistry data, along with focused studies, interpreted in special issue of Marine Pollution Bulletin in 2016 (vol. 107)



http://pubs.usgs.gov/ds/0905/

Round 2

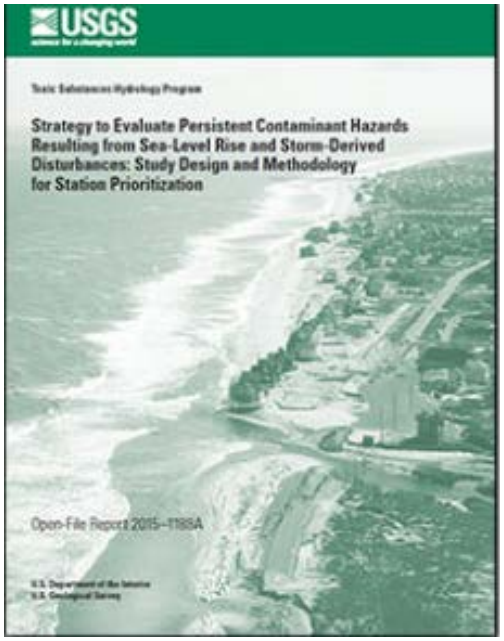
SEDIMENT-BOUND CONTAMINANT RESILIENCY AND RESPONSE

USGS
science for a changing world

Sediment-bound Contaminant Resiliency and Response (SCoRR)

USGS Strategy to Evaluate Persistent Contaminant Hazards Resulting from Sea-level Rise and Storm-derived Disturbances

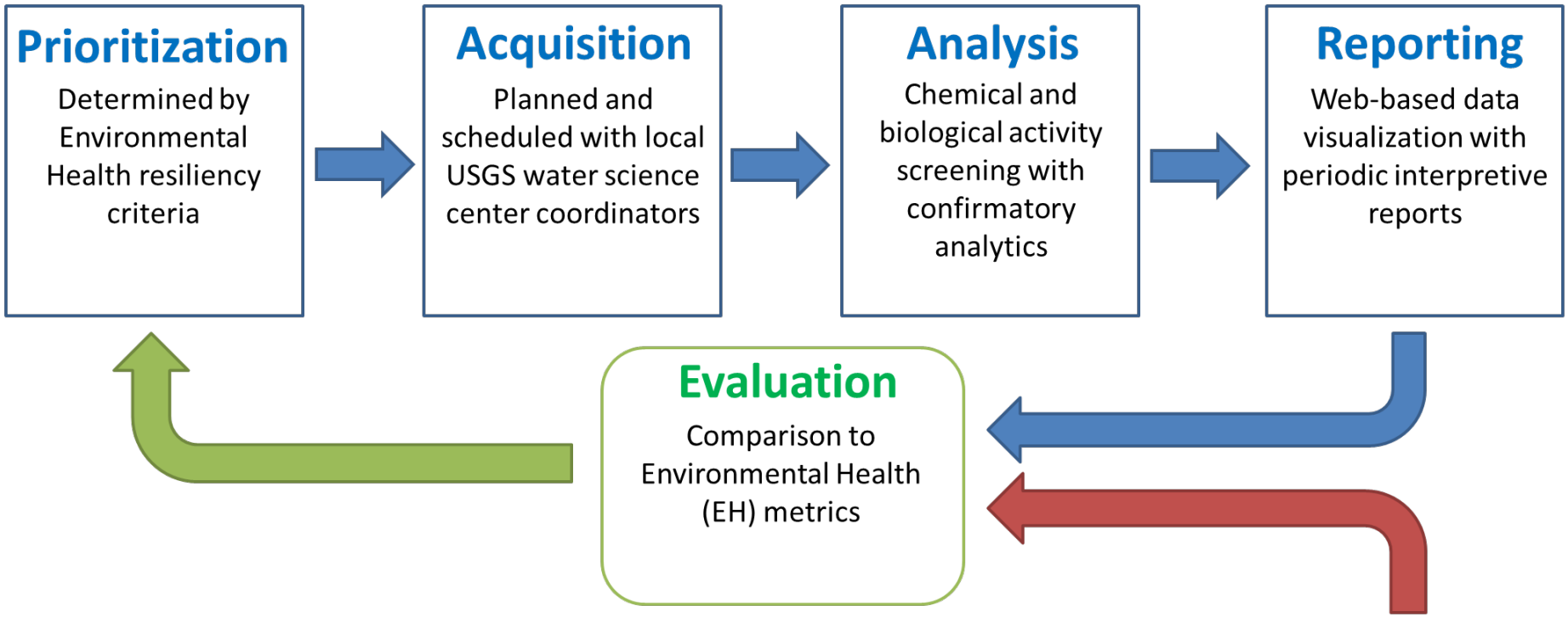
- Motivation:
  1. Lack of baseline contaminant data proximal to receptors and mitigation efforts
  2. Sea-level rise and future storms could adversely impact environmental health
- Objectives:
  1. Develop and deliver a strategy to assess SLR and storm-derived changes in contaminant threats to humans and ecosystems.
  2. Demonstrate the strategy by conducting a pilot implementation in the Northeastern U.S.
  3. Deliver interpretive products that map, measure, and evaluate vulnerability from contaminant threats

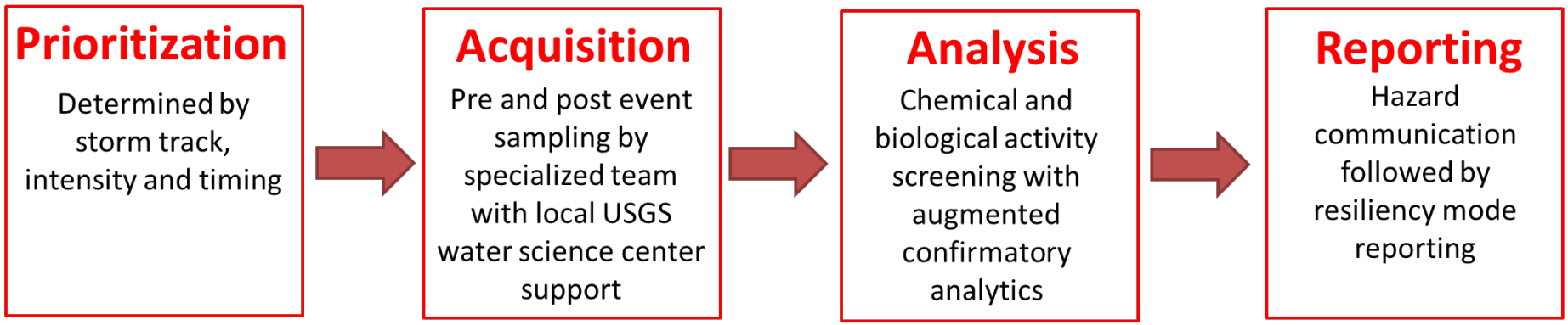


USGS science for a changing world

https://pubs.er.usgs.gov/publication/ofr20151188A

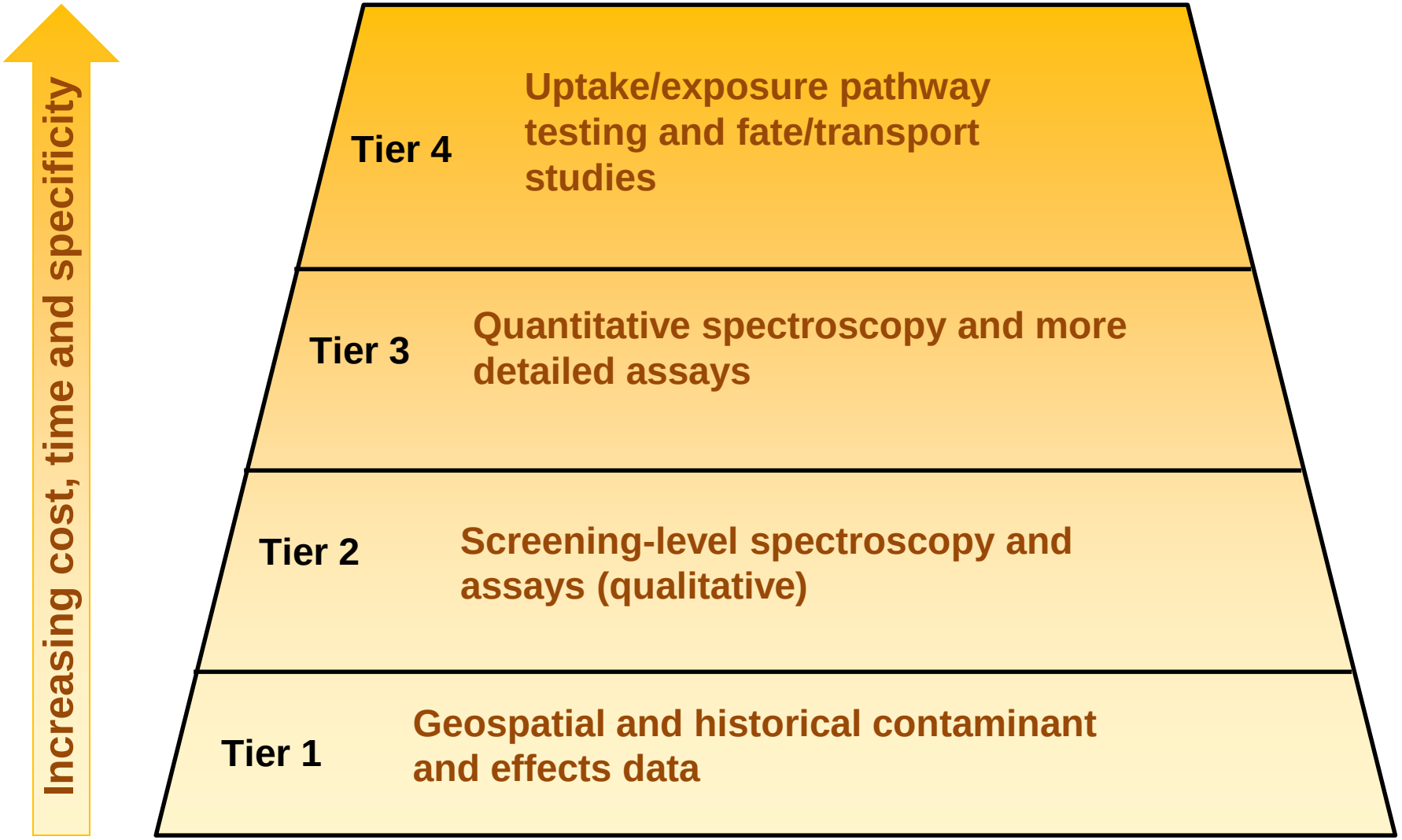
Resiliency Mode: Definition of Baseline





Response Mode: Determine Post-Event Changes

Analytical Approach

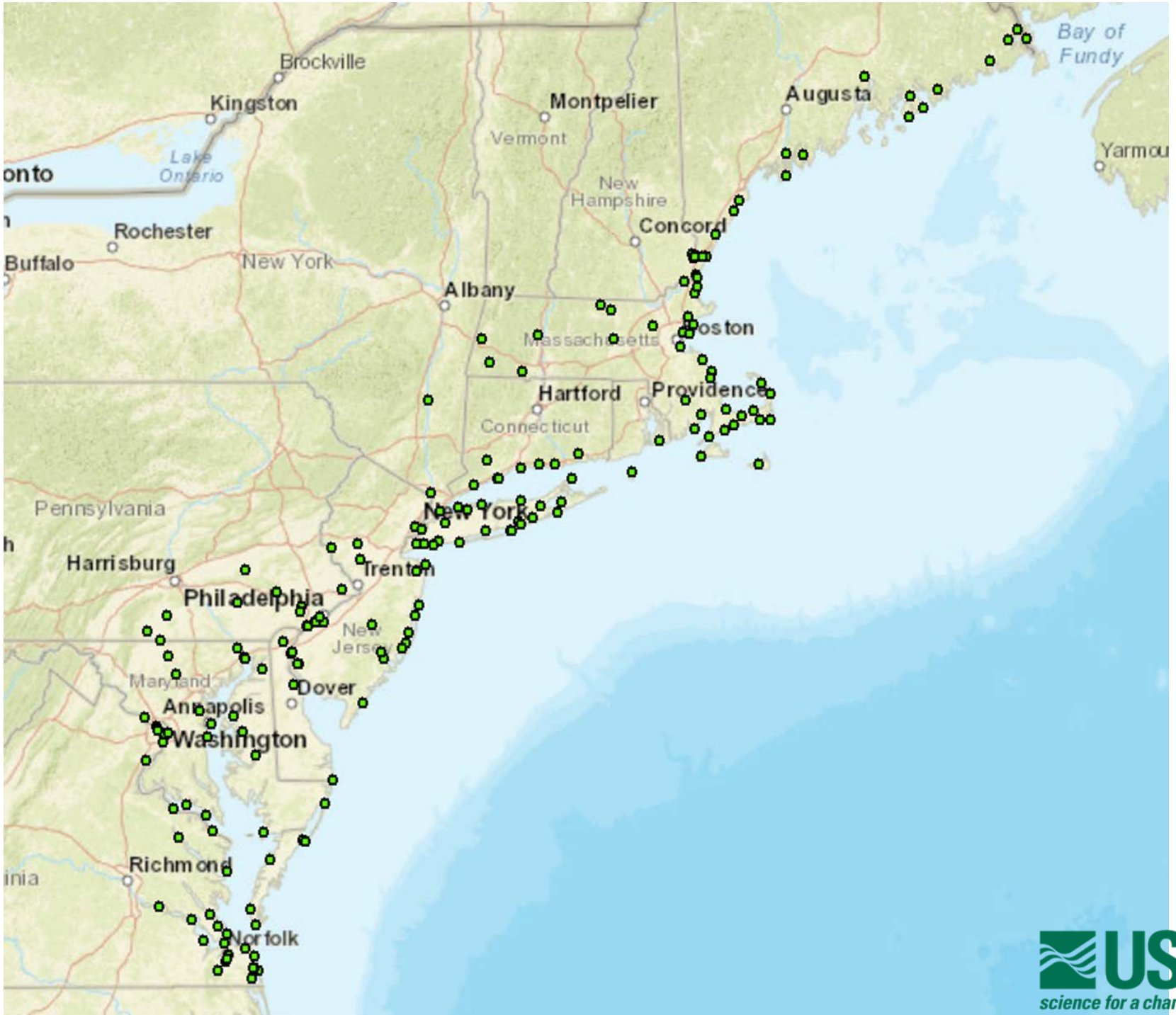


USGS
science for a changing world

Geospatial: Downloaded data

- Base data
  - Sampling Locations* [east coast]
  - NLCD 2011 [national]
  - NLUD 2010 [national]
  - NHD and NHD+ [national]
  - WBD HUCs [national]
  - State and county boundaries [national]
  - SSURGO [county]
  - Hurricane Sandy Surge Extent [NY and NJ]
- Receptors
  - Coastal Barrier Resource System [national]
  - Critical Habitats [national]
  - National Wetlands Inventory [national]
  - National Wildlife Refuge System [national]
  - Protected Areas Database [national]
  - National Inventory of Dams [national]
- Contaminants
  - Combined Sewer Overflows [NY and NJ]
  - Bulk Storage Facilities [NY and NJ]
  - Hazardous Spills [NY]
  - EPA FRS and TRI [national]
  - Inundated Business Locations [NY and NJ]

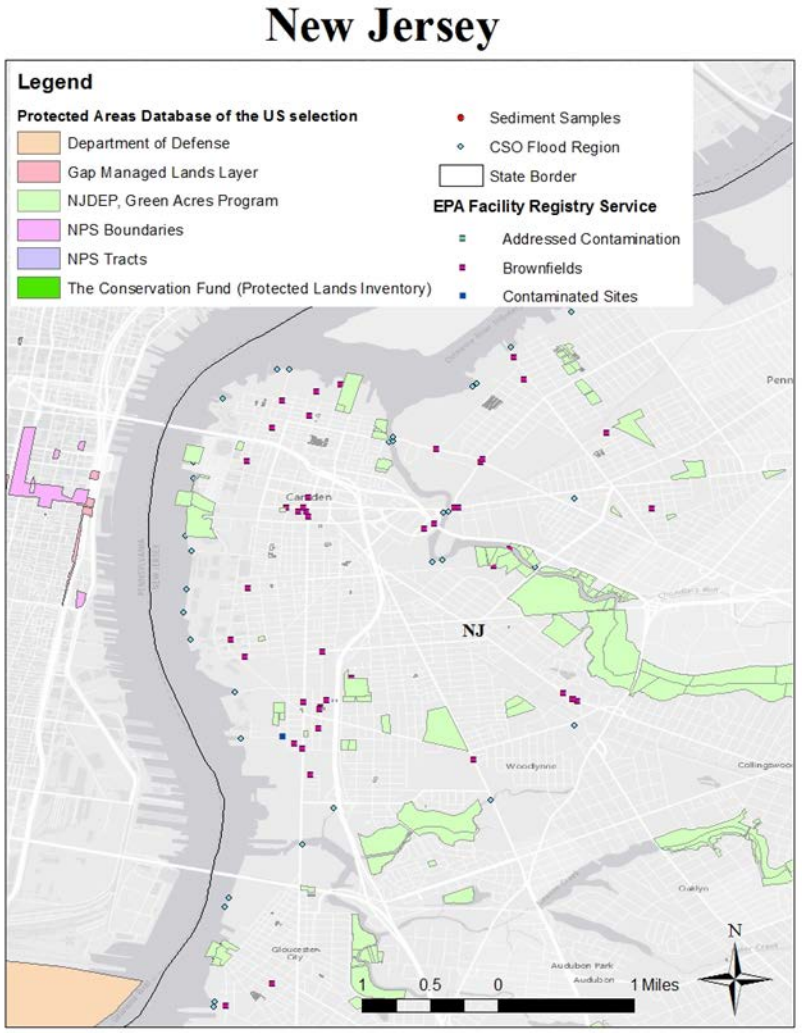
USGS
science for a changing world



USGS
science for a changing world

Vulnerability and Priority Ranking

- Method to condense and summarize geospatial data, assigned to sampling locations
- Literature review of existing sediment-focused risk/vulnerability and hazard assessments
- Iterative refinements as new data sources are identified and processed

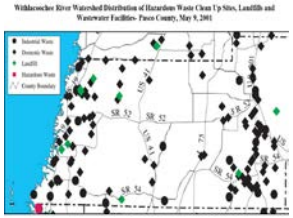


Vulnerability Rank

Vulnerability of receptor(s) can be determined at the following scales

- Hazard/contaminant/discrete receptor
- Site/community and regional levels
- Vulnerability could be defined by physical site characteristics, system level perturbation or hierarchical filters between systems (i.e. open system vs. less open), proximity to exposure of contaminant, or biogeochemical or physiographic characteristics.

Prioritizing Contaminants and Receptors



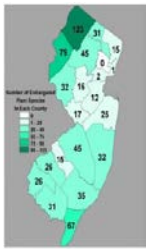
REGIONAL SCALE

Contaminant Sources

HAZARD SCALE

SITE/COMMUNITY SCALE

Human/ecological receptor SCALE



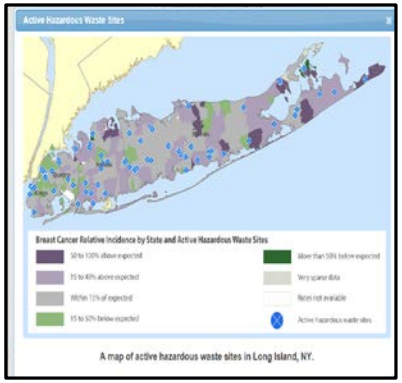
Receptors

REGIONAL SCALE

Prioritization

Site selection

e.g., Parks



e.g., Hazardous Waste Sites

SITE/COMMUNITY SCALE

USGS science for a changing world

Prioritize and collect samples

- Established field protocols based on national methods (including USGS National Field Manual)
- Streamlined the sample collection and processing procedure
- Field data were collected on a portable, app-based form that automatically populated metadata and prompted for pictures—all data uploaded to cloud storage prior to processing

https://pubs.er.usgs.gov/publication/ofr20151188B

Tier 2 – Field data/metadata

	A	B	C	D	E	F	G	H	I	J	K	L
1	SCoRR_Site_ID	State	Sample_Date	Sample_Start_Time	Field_Crew_Coordinator	Field_Crew	Latitude	Longitude	GPS_Accuracy_m	Location_Notes	Site_Photo_1	Site_Photo
119	NJ-02748	NJ	20150826	0938	XXX	JCohl/CSouche	39.699129	-74.20297	3.0545218	Wetlands near A	144059643746(	144059645
120	NJ-02765	NJ	20150826	1056	XXX	JCohl/CSouche	39.650514	-74.25206	3.048	Ponar sample alc	144060128319	144060129
121	NJ-03043	NJ	20150824	1636	XXX	JCohl/CSouche	39.614768	-75.53364	3.0844061	Small stream dee	144051559798(	144051560
122	NJ-03043	NJ	20150824	1654	XXX	JCohl/CSouche	39.614786	-75.53364	3.0583634	Deep in reeds. M	144051547110	144051549
123	NJ-03043	NJ	20150824	1702	XXX	JCohl/CSouche	39.614859	-75.53377	3.055553	Deep into reeds.	144051850169	144051851
124	NJ-03043	NJ	20150824	1713	XXX	JCohl/CSouche	39.614898	-75.53364	3.188703	Deep in reeds fo	144052040379	144052042
125	NJ-03043	NJ	20150824	1720	XXX	JCohl/CSouche	39.614982	-75.534	3.048	Deep in reeds	144052361643	144052362
126	NJ-03043	NJ	20150824	1725	XXX	JCohl/CSouche	39.614784	-75.53428	3.863207	Deep in reeds	144052582690	144052584
127	NJ-03060	NJ	20150824	1103	XXX	JCohl/CSouche	39.609547	-74.49129	3.048	Had to sample lo	144042869811	144042871
128	NY-00386	NY	20150803	1143	XXX	SCF, RJW	40.575981	-74.08226	3	NYC Parks park E	143863635809	143863637
129	NY-00396	NY	20150831	1055	XXX	Ijf	40.595655	-73.5866	4.942963	North side of cha	144103316494	144103317
130	NY-00402	NY	20150818	1136	XXX	RJW,JED	40.609889	-73.81967	3.716767	South on cross b	143991920365	143991821
131	NY-00526	NY	20150817	1238	XXX	JED,RJW	40.854102	-72.44504	3.048	Point is about 40	143982987420	143982989
132	NY-00563	NY	20150903	1028	XXX	Ijf	40.916701	-72.63882	4.9168863	East side of bridg	144129436103	144129437
133	NY-00811	NY	20151014	1439	XXX	Ijf kcm	41.836509	-73.94062	3.048	Off of foot bridg	144484820477	144484822
134	NY-00811	NY	20151014	1444	XXX	Ijf kcm	41.836509	-73.94062	3.048	Off of foot bridge on trail NE of marina		
135	NY-01332	NY	20150825	1024	XXX	IJF; Jill P.(NPS i	40.693618	-72.98597	3.048	East of Watch Hil	144051323330	144051324
136	NY-01346	NY	20151014	0919	XXX	Kcm ijf	40.885588	-73.49154	3.048	Marsh off of trail	144482888588	144482889
137	NY-02211	NY	20151015	0842	XXX	Kc ijf	41.033693	-73.91302	3.048	Marsh bordering	144491332528	144491334
138	NY-02211	NY	20151015	0847	XXX	Kc ijf	41.033693	-73.91302	3.048	Marsh bordering	144491332528	144491334
139	NY-02623	NY	20150921	1347	XXX	IJF KC	40.81296	-72.72821	3.0518866	Just to the west	144285775082	144285777
140	NY-02635	NY	20151001	0941	XXX	Ijf kmc	40.926076	-73.32503	4.9602847	Marsh behind cra	144370707974	144370710
141	NY-02635	NY	20151001	0946	XXX	Ijf kmc	40.926076	-73.32503	4.9602847	Marsh behind crab meadow beach parking		
142	NY-02636	NY	20150827	1119	XXX	Ijf & kc	40.6929	-73.27088	3.048	West marsh off a	144068912193(	144068914

SCoRR_Resiliency_field_data2015 | SCoRR_Response_field_data2015

USGS
science for a changing world

Tier 2 – Chemistry

- Sediment TOC
  - Percent organic/inorganic carbon
  - Organic contaminant sorption
- FTIR spectroscopy – organic/inorganic functional group analysis, cluster analysis
- LC/UV-VIS/Fluorescence – detection of colored compounds and organo-metallic complexes (e.g. organic pigments, PAHs, reactive dyes and tracers)

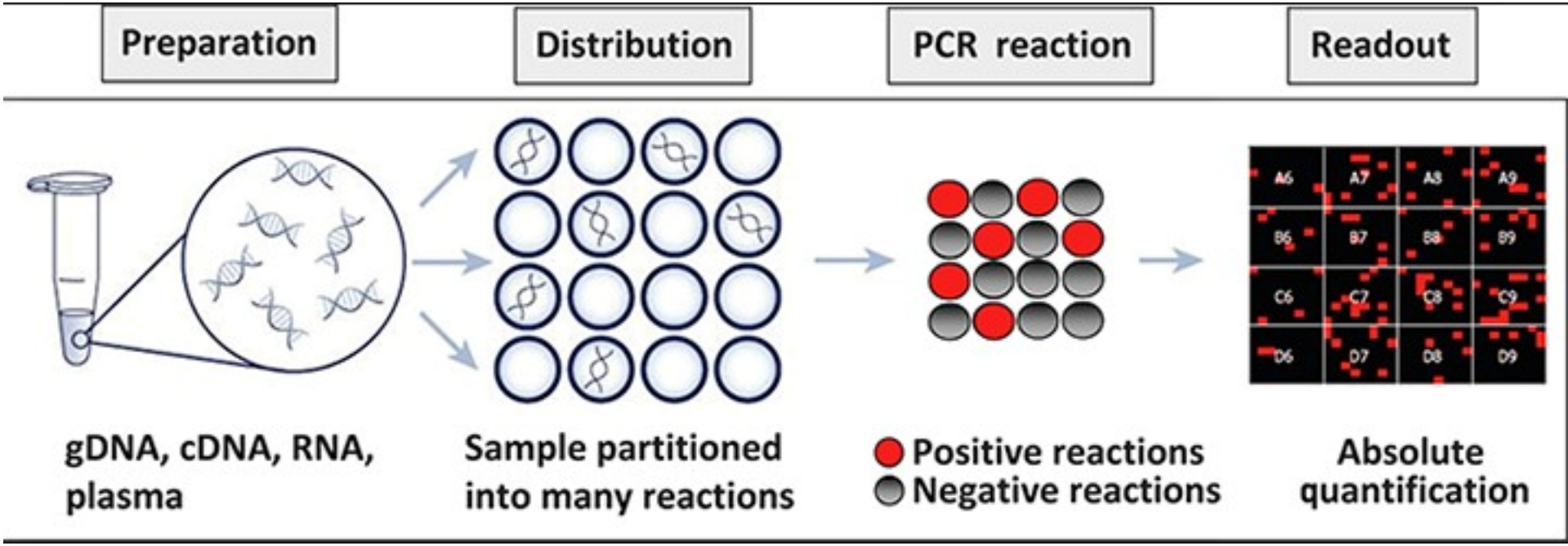
USGS
science for a changing world

Tier 2 – Soil/sediment microbiology

- Genetic markers for bacteria, fungi, and viruses
- Amplification and analysis via PCR
- Bacteria populations in soils typically range from 10^6 to 10^9 cells/gram as determined via direct count assay
- Virus populations are typically1 to 2 logs less than the bacteria populations (opposite of aquatic environments)
- Antibiotic resistance of bacteria present in soils and sediment was also tested

USGS
science for a changing world

Digital Polymerase Chain Reaction



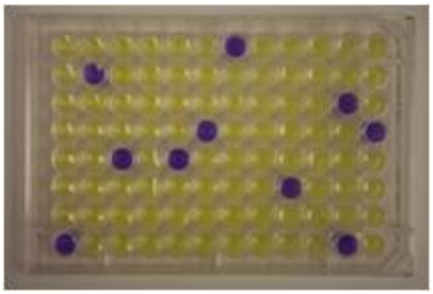
Tier 2 – Bioassays

Whole cell bioassays for the detection of bioactive analytes

Sediment extract

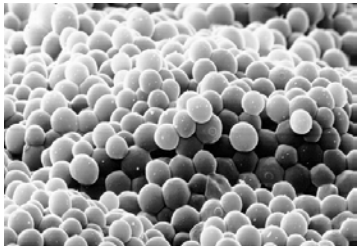
Whole sediment

Salmonella-based



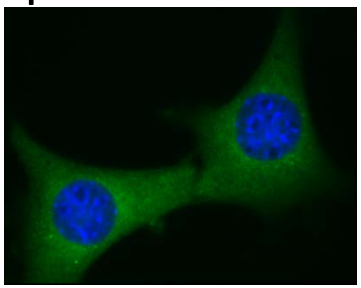
- Genotoxicity
- Mutagenicity
- Cytotoxicity

Yeast/ tetrahymena



- Bioreporter (metals/ steroid hormones)
- Phagocytosis
- Cytotoxicity

Reporter Cell line



- Luciferase-based NR reporter
- Nuclear translocation assays
- Gene expression (CYP1A/ MTT

Select Datasets and Reports

- Analytical inorganic chemistry results for samples collected for the Sediment-Bound Contaminant Resiliency and Response Strategy pilot study, northeastern United States, 2015
  - Bill Benzel

- Matrix inhibition PCR and Microtox® 81.9% screening assay analytical results for samples collected for the Sediment-Bound Contaminant Resiliency and Response Strategy pilot study, northeastern United States, 2015
  - Luke Iwanowicz

- The presence of antibiotic resistance genes in coastal soil and sediment samples from the eastern seaboard of the United States
  - Dale Griffin (soon to be released)

https://www.sciencebase.gov/ → search term → ***SCORR***

Future research and monitoring

EXPANDING SCORR

USGS
science for a changing world

Expanding SCoRR

- Include additional metrics in the decision support tool (2019), including those affecting proximity to potential source

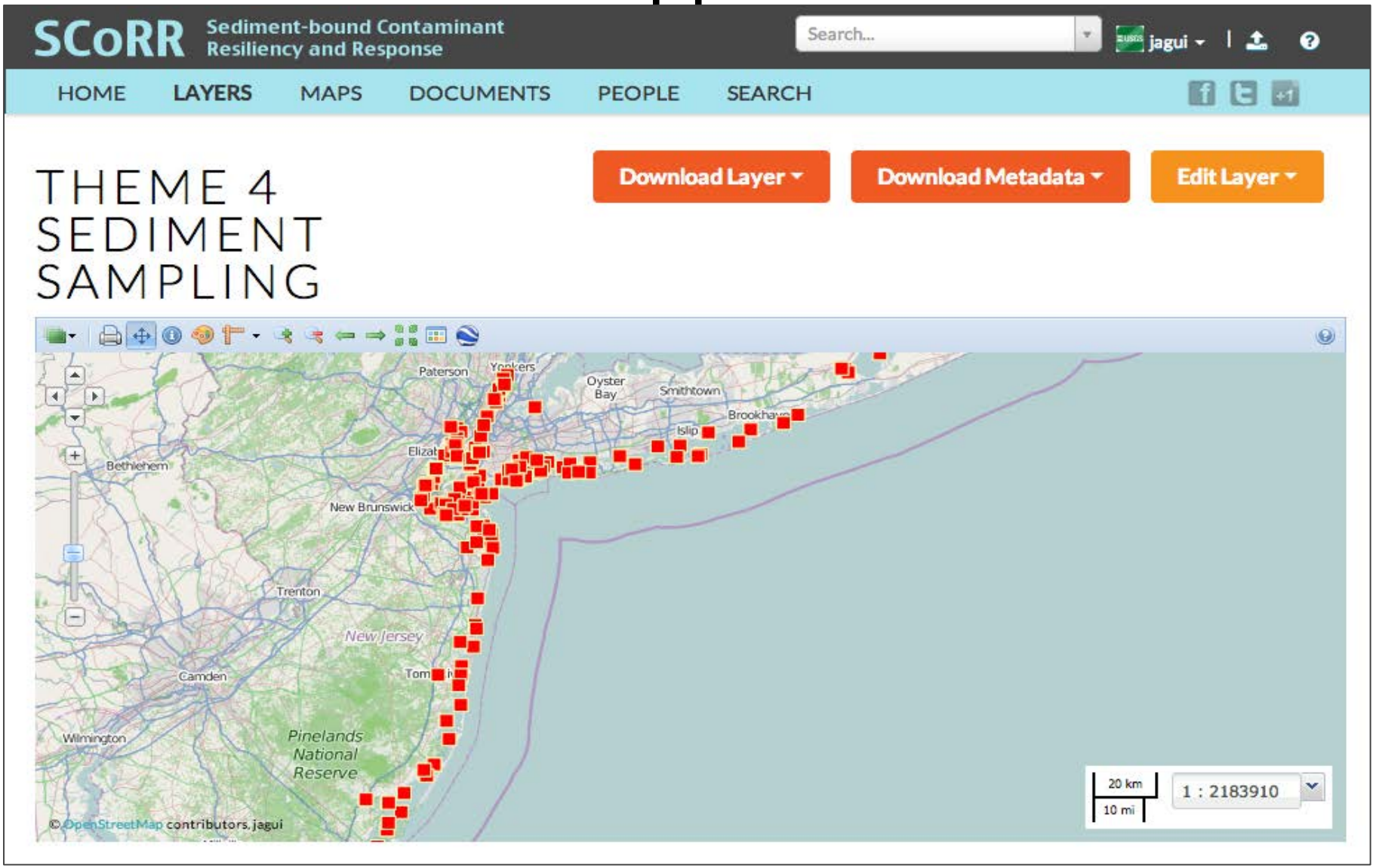
- Redevelop monitoring network for consistent sediment sampling (in coordination with other Federal agencies; State, Tribal, and local health agencies; and emergency managers)

- Expand screening methods for bed sediment analysis, including rapid-result analytics, in situ data collection, and coupling with existing remote sensing techniques

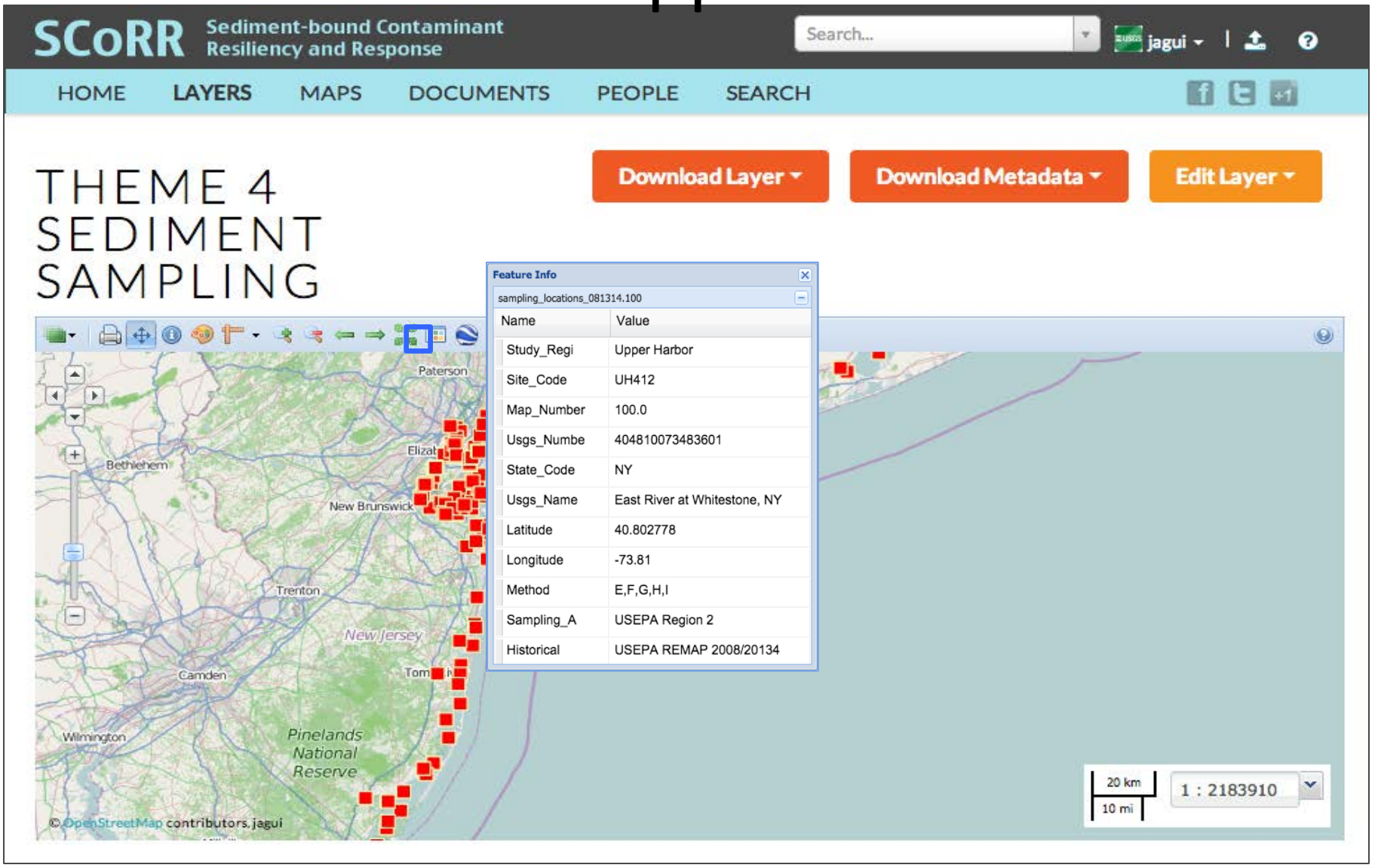
- Improve online mapper interface

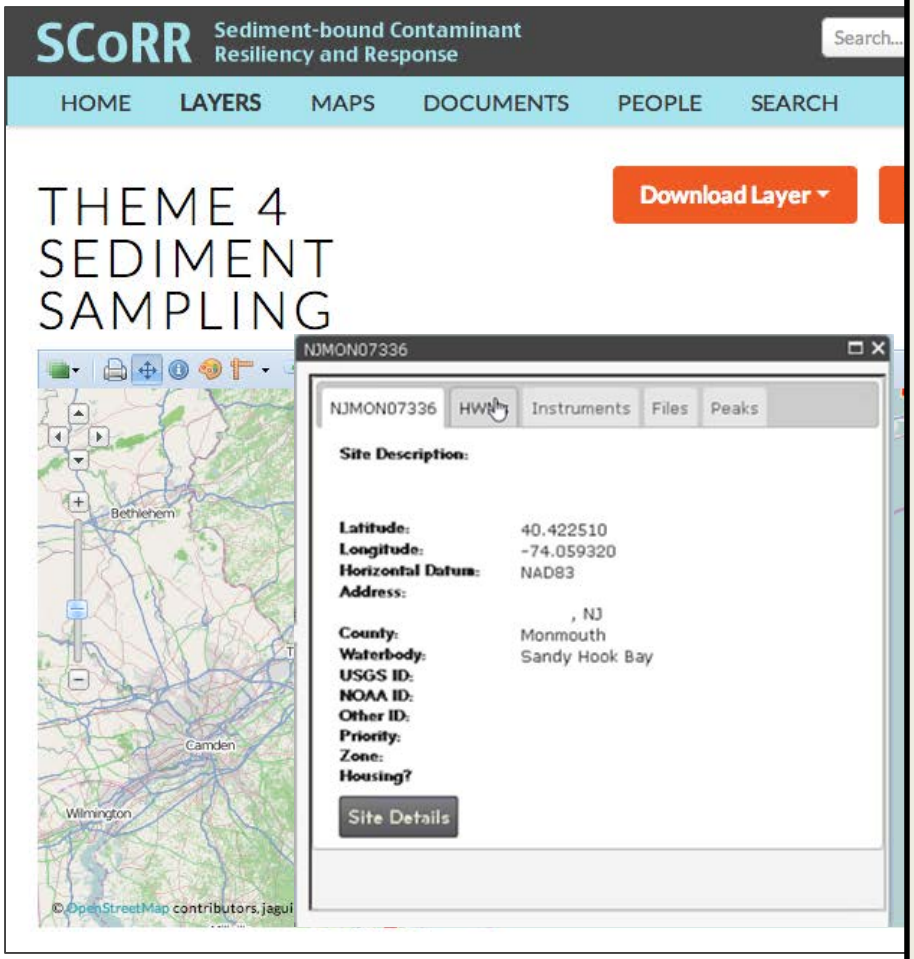
USGS
science for a changing world

Example of potential improvements to SCoRR mapper online



Example of potential improvements to SCoRR mapper online





UH412

Latitude: 40.8028 **Longitude:** -73.8100

Map Number: 100
USGS Number: 404810073483601
USGS Name: East River at Whitestone, NY
State Code: NY
Sampling Methods:

E – Wastewater and Hormone
F - X-ray fluorescence
G – Fourier-transform infared spectroscopy
H - Protein phosphatase 2A
I - Endocrine disruptors

Sampling Agency: EPA Region 2
Associated historical data: 4EPA REMAP 2008/2013
Vulnerability Ranking: XX
Priority Ranking: Medium

Link to Site Data

Thank you

Project lead:

Tim Reilly (NJ) – tjreilly@usgs.gov

Maps and decision support tool:

Dan Jones (UT) – dkjones@usgs.gov

Network Coordinator:

Shawn Fisher (NY) – scfisher@usgs.gov

Analytics

Inorganics:

Bill Benzel (CO) – wbenzel@usgs.gov

Organics:

Keith Loftin (KS) – kloftin@usgs.gov

Pathogens:

Dale Griffin (FL) – dgriffin@usgs.gov

Bioassays:

Luke Iwanowicz (WV) – liwanowicz@usgs.gov

USGS science for a changing world

https://toxics.usgs.gov/scorr/