

US EPA ARCHIVE DOCUMENT

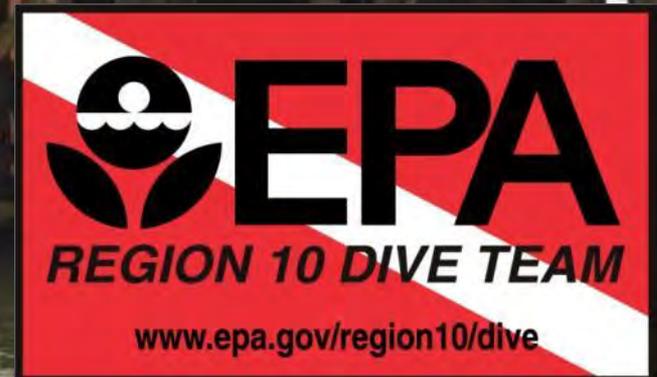
# Diving Health and Safety 201:

## Polluted water diving: Task Hazard Analyses

Sean Sheldrake, EPA  
Region 10,

Alan Humphrey, ERT

April, 2014



# Region 10 and Environmental Response Team (ERT) Units Conduct Polluted Water Dive Operations

- Support of Superfund, Clean Water Act, and Regional initiatives, through criminal and civil investigations, surveys, and sampling.
- R10 since 1968, ERT since 1978



McConnell & Trainor  
Portland Harbor, OR  
EPA Diver with used micro-plastic net



DSC01160

Quandall Terminals

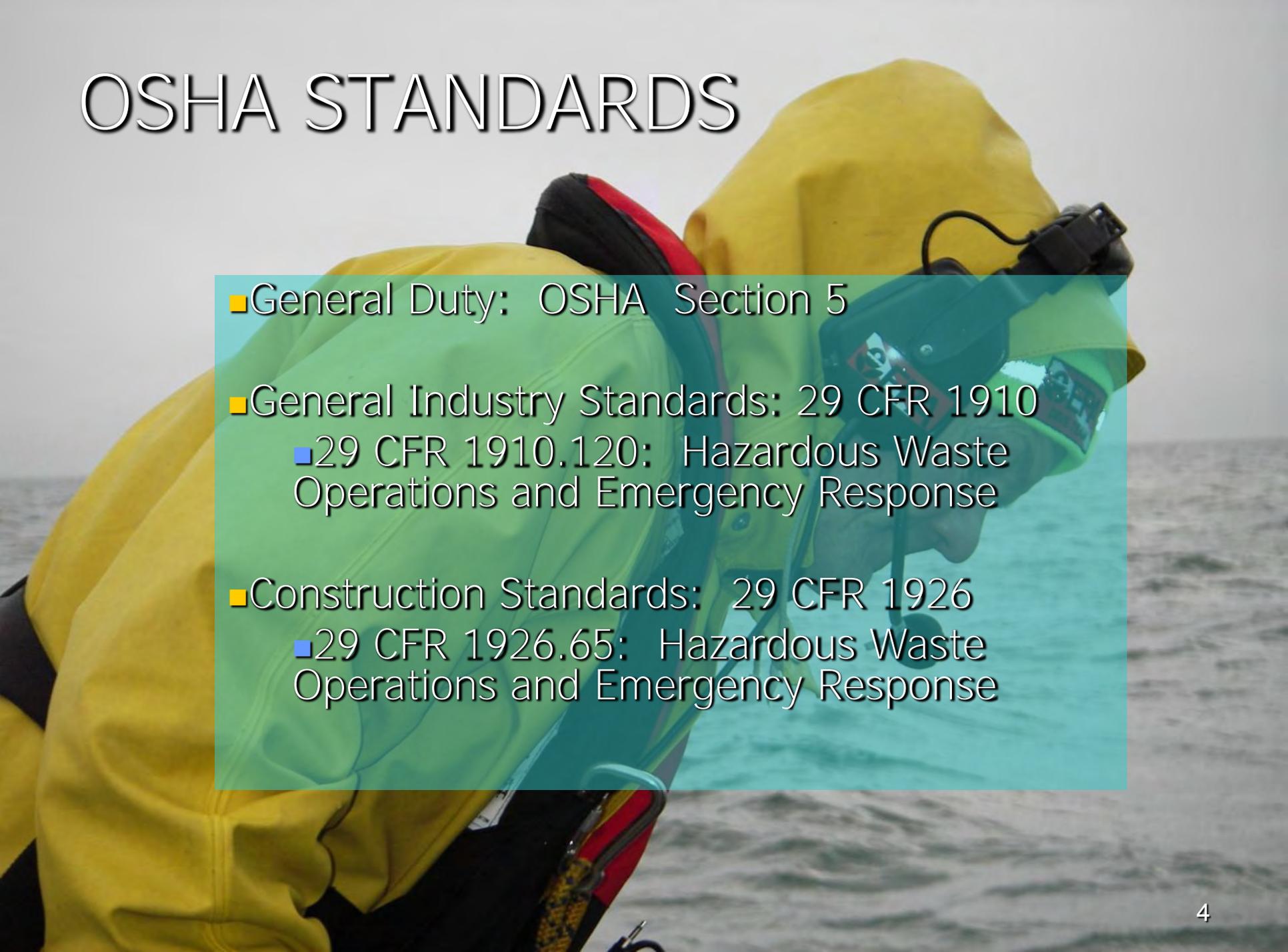
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# Discussion goals; to promote understanding of:

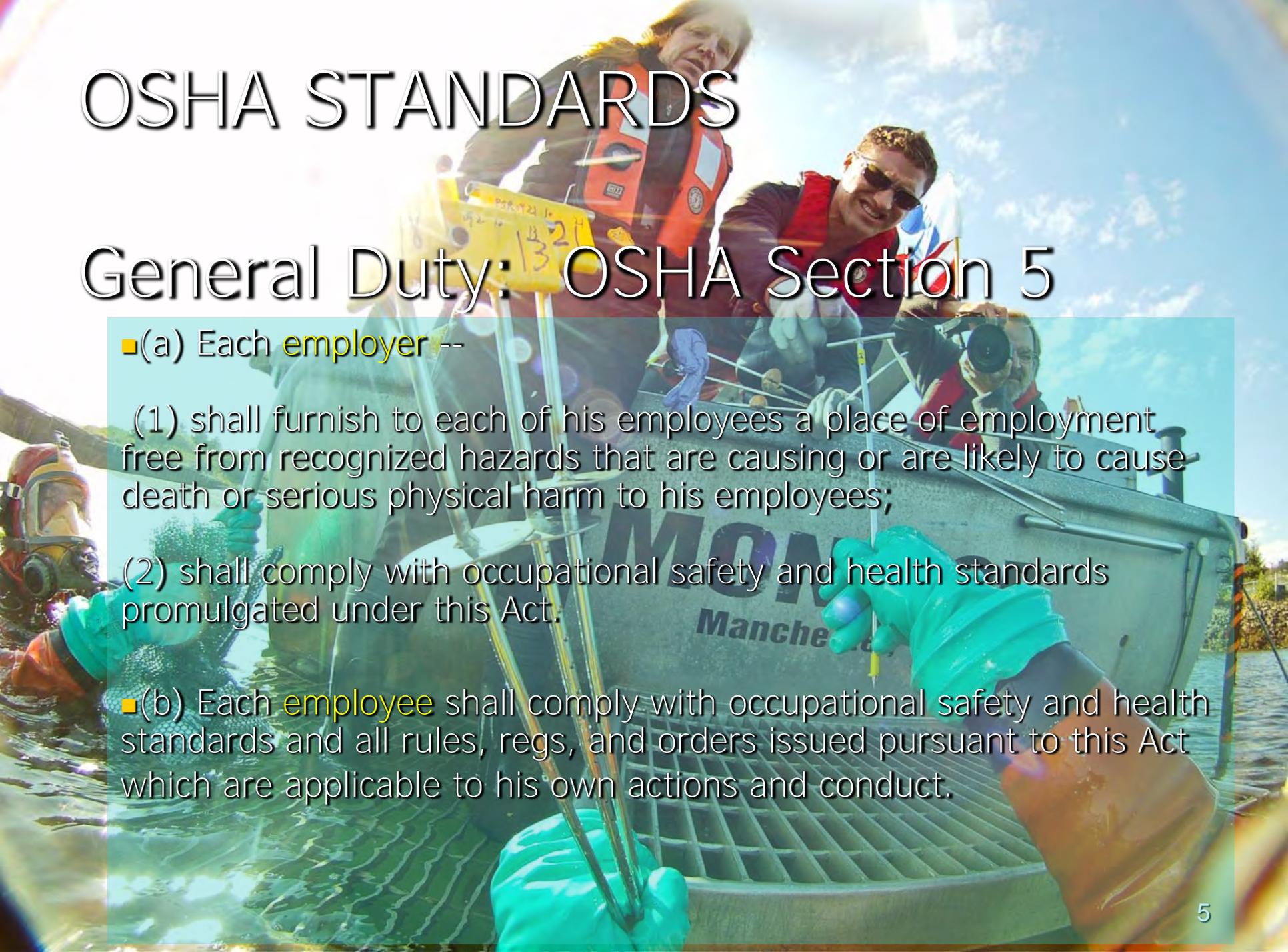
- Basic OSHA employer requirements, OSHA HAZWOPER requirements;
- Water quality in harbor areas;
- Dive planning tools;
- Task Hazard Analyses for dive plans; and
- Case Studies

# OSHA STANDARDS



- General Duty: OSHA Section 5
- General Industry Standards: 29 CFR 1910
  - 29 CFR 1910.120: Hazardous Waste Operations and Emergency Response
- Construction Standards: 29 CFR 1926
  - 29 CFR 1926.65: Hazardous Waste Operations and Emergency Response

# OSHA STANDARDS

A background image showing a boat crew in safety gear. A man in a red life vest and sunglasses is smiling. A woman in a red life vest is holding a yellow sign with the number '1321'. A diver in a red and black wetsuit is visible in the water. The boat has 'MONACO' and 'Manche' written on it.

## General Duty: OSHA Section 5

### ■(a) Each employer --

(1) shall furnish to each of his employees a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

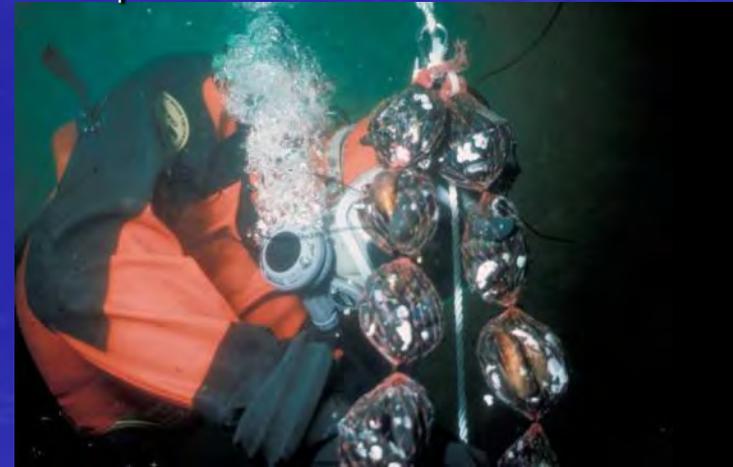
(2) shall comply with occupational safety and health standards promulgated under this Act.

### ■(b) Each employee shall comply with occupational safety and health standards and all rules, regs, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

# OSHA STANDARDS

## 29 CFR 1910.120- hazardous waste site operations

- Each employer shall establish a written health and safety program that provides for SOPs and site-specific health and safety plans (HASPs)
- Site-specific HASPs shall provide –
  - A comprehensive workplan; and
  - Organizational structure
- Organizational structure shall provide—
  - General supervisor with responsibility and authority to direct all hazardous waste operations; and
  - Site safety and health supervisor with authority to implement the HASP and to verify compliance.



# What is a “polluted water” dive?

- Federal dive programs define polluted water in many different ways.
- EPA defines polluted water as anything that could: make a diver sick (now or later), increase their risk of cancer, or cause any other undesirable outcome for the diver, tender, or other persons that may contact the site workers or equipment.
- EPA assumes that water column concentrations of contaminants can change rapidly

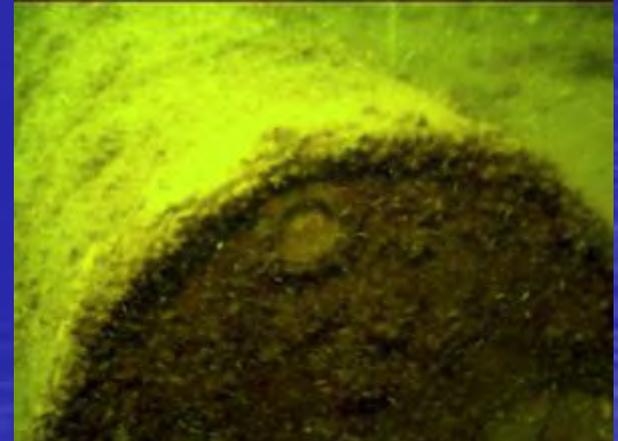
# Site Hazards

- Known vs. Unknown (Unanticipated) Sources
- Physical Hazards
- Biological Hazards
- Chemical Hazards



# Chemical Contaminants

- Metals
- Volatile Organic Compounds (VOCs)
- Polychlorinated Biphenyls (PCBs)
- Dioxins
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Pesticides/Herbicides



# Chemical Contaminants

## Chemical Properties

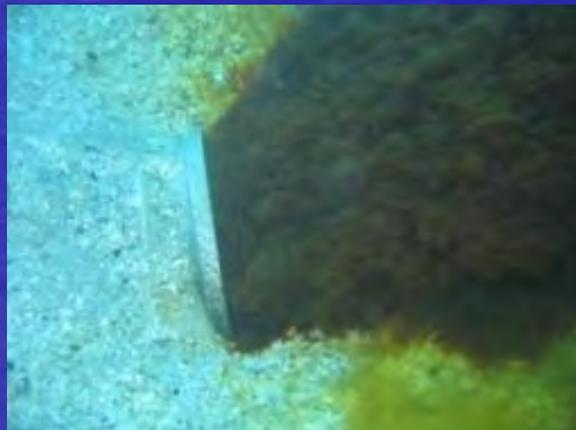
- Water-borne/Water Soluble Contaminants
- Non-Soluble
- Contaminant Density
  - Floaters (Gas, Some Oils)
  - Sinkers (PCBs, Metals)
- Adherence to Sediments
- Persistent Contaminants
- Releases
- Water Reactive



# Chemical Contaminants

## Routes of Exposure

- Inhalation
- Ingestion
  - Full Face Mask/Helmet
- Skin Contact
  - Dry Suit



# Chemical Contaminants

## CAMEO Chemicals

Chemical Datasheet

[Add to MyChemicals](#)

[Print Friendly Page](#)

### ARTICLES CONTAINING POLYCHLORINATED BIPHENYLS (PCB)



[Chemical Identifiers](#) | [Hazards](#) | [Response Recommendations](#) | [Physical Properties](#) | [Regulatory Information](#) | [Alternate Chemical Names](#)

#### Chemical Identifiers

[What is this information?](#)

UN/NA Number	CAS Number	CHRIS Code
<a href="#">2315</a>	11096-82-5	
	11097-69-1	<a href="#">PCB</a>
	11104-28-2	
	11141-16-5	
	12672-29-6	
	12674-11-2	
	1336-36-3	
	<del>53469-21-9</del>	

**NFPA 704:** Red 1 -- Flammability: Must be preheated to burn  
Blue 2 -- Health Hazard: Hazardous - use breathing apparatus  
Yellow 0 -- Reactivity: Normally stable

#### General Description

PCBs are colorless oily liquids. Much denser than water and insoluble in water. May burn under exposure to intense heat or flames for prolonged environment and potential for long term chronic environmental and health risks. Immediate steps should be taken to limit spread to the environment and nearby waterways.

#### Hazards

[What is this information?](#)

##### Reactivity Alerts

none

##### Air & Water Reactions

Insoluble in water.

##### Fire Hazard

Special Hazards of Combustion Products: Irritating gases are generated in fires. (USCG, 1999)

##### Health Hazard

Acne from skin contact. (USCG, 1999)

##### Reactivity Profile

POLYCHLORINATED BIPHENYLS are incompatible with the following: Strong oxidizers (NIOSH, 1997).

##### Belongs to the Following Reactive Group(s)

- [Halogenated Organic Compounds](#)



## NIOSH POCKET GUIDE TO CHEMICAL HAZARDS

DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health

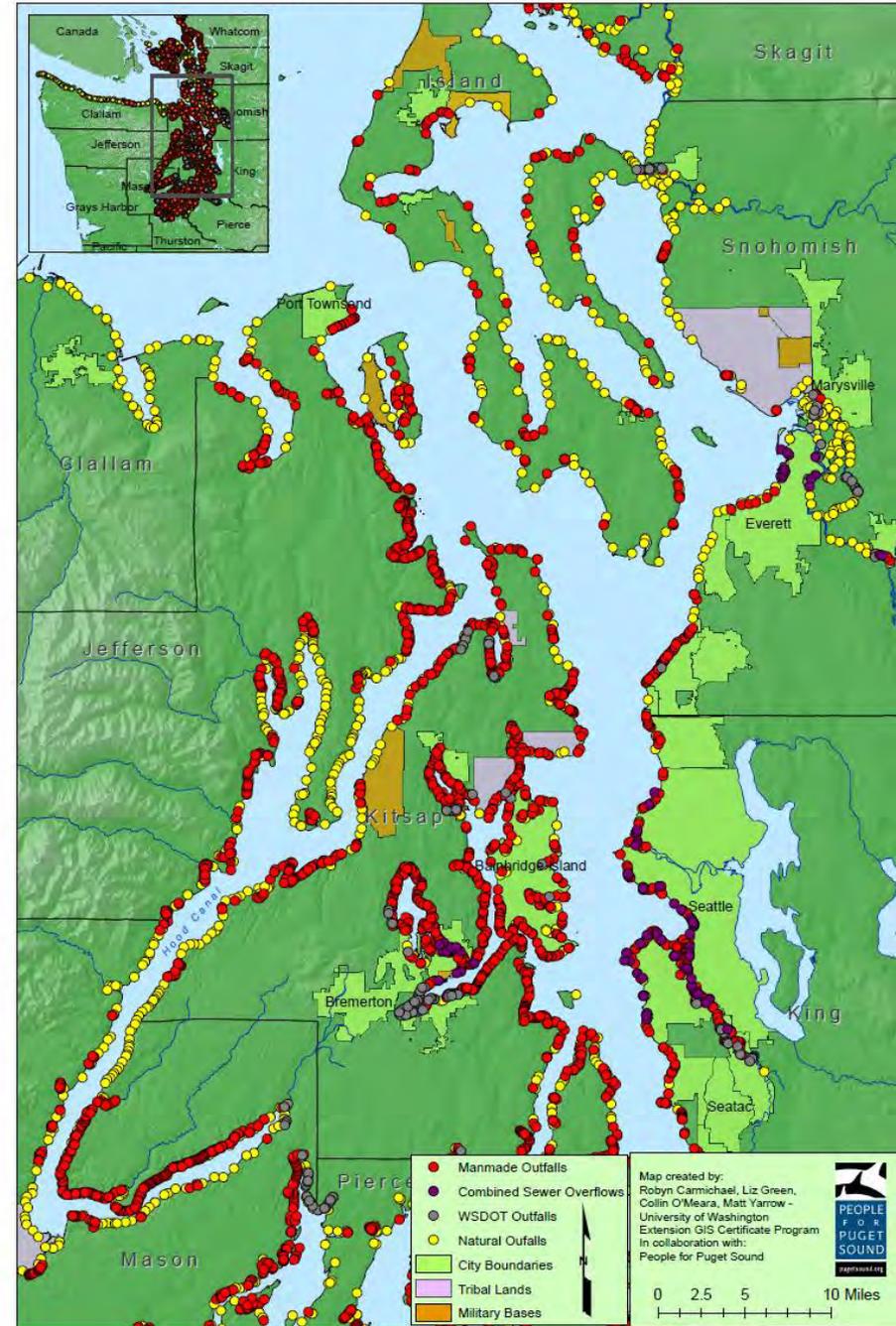
# Stormwater is Contaminated

- Pet waste
- Oil
- Metals
- PAHs



• Over 100,000 metric tons of toxic chemicals per year in Puget Sound  
(Seattle Times, 2009)

Public Stormwater Outfalls to Puget Sound:  
Central Sound & Hood Canal



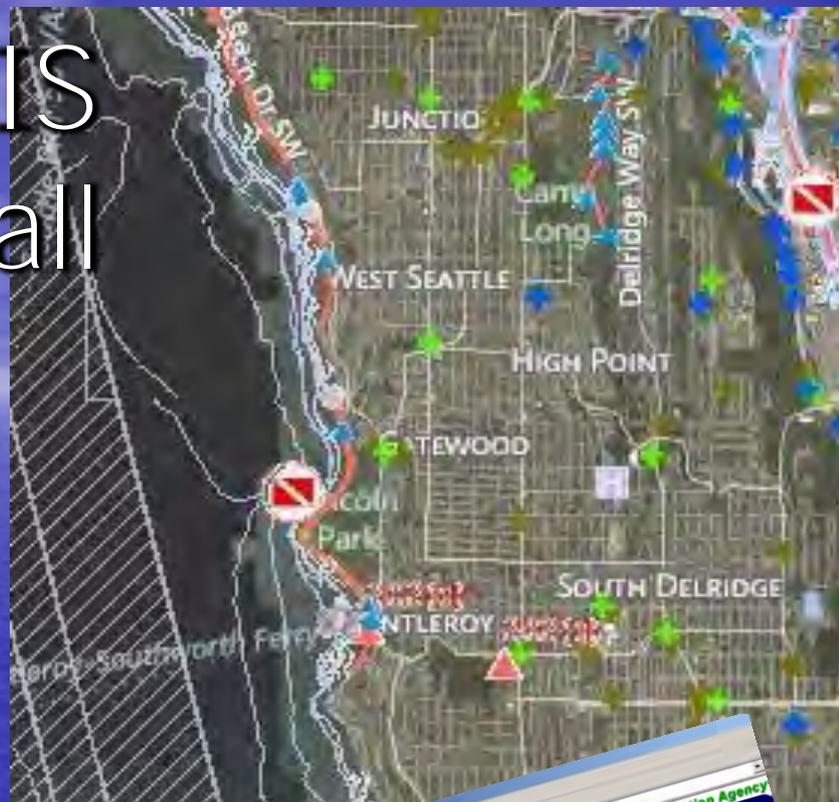
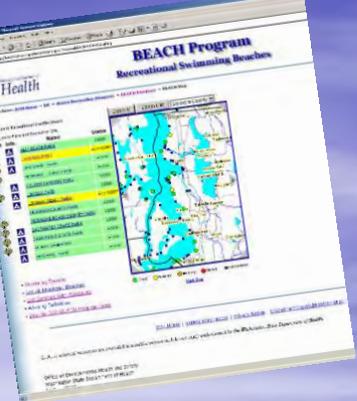


# Many online resources exist, but you have to fit the puzzle together

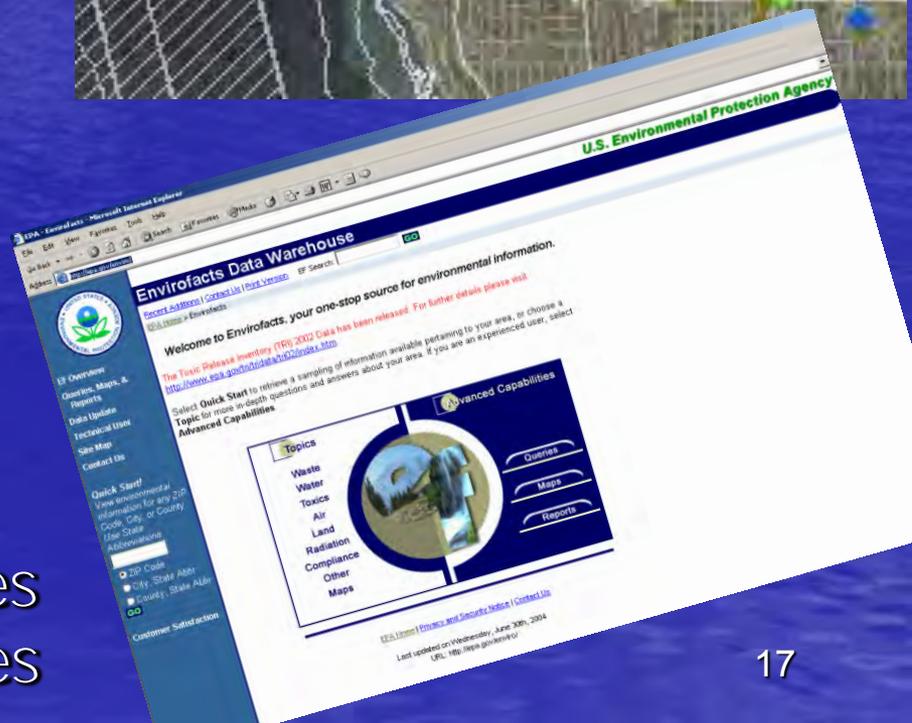
<http://www.epa.gov/region10/dive/>

- [National Weather Service - Seattle Weather / Small Craft Advisory Status](#)
  - [VHF channels; R10 dive plans require monitoring of 13, 14, and 16](#)
- ### Sediment and Water Quality Data
- National
- [National Map of Toxic Algae](#)
  - [Fish advisories near your dive site](#)
  - [How's my waterway?](#)
  - [National Coastal Condition Report IV - April 2012 \(PDF\)](#) (368 pp, 25MB)
  - [RCRA Corrective Action site locations](#)
  - [Superfund cleanup site locations](#)
  - [Discharge Monitoring Report Pollutant Loading Tool](#)
  - [Water Quality Status at Washington Beaches](#)
  - [Water Quality Status at Oregon Beaches](#)
  - [National Beach Water Quality Data](#)
  - [Sediment data - NOAA Office of Response and Restoration](#)
  - [Water Quality Data - NOAA's Mussel Watch](#)
  - [Checking for nearby pollution sources: Envirofacts](#)
- Regional
- [Outfall Locations in Puget Sound](#)
  - [State of Washington Environmental Information Management \(EIM\)](#)
  - [Washington State Fish Advisories](#)
  - [Washington State Shellfish Closures](#)
  - [Puget Sound Fecal Coliform Atlas](#)
  - [Northwest Association for Networked Ocean Observing System](#)
  - [Public Stormwater Outfalls to Puget Sound: King County CSO status](#)
- ### Polluted Water Diving
- [Integrated Risk Information System](#)
  - [Harmful algae blooms \(HAB\), CDC](#)
  - [Toxic Release Inventory](#)
  - [National Response Center](#)
  - [NOAA Office of Response and Restoration; Incident News](#)
  - [OSHA Hazardous waste operations and emergency response \(HAZWOPER\)](#)
  - [Diseases with vaccines, CDC](#)
  - [CAMEO chemical data](#)
  - [NIOSH chemical data](#)
  - [NOAA Polluted Water Diving Resources](#)
  - [Viking chemical resistance testing](#)
  - [Comparison of dryglove materials for polluted water diving](#)

# EPA uses a GIS tool to put it all together



- Outfall locations (industrial, stormwater, sewer)
- Types of industrial discharges (envirofacts)
- Effects of exposure, chemical properties (CAMEO/NIOSH data)
- Typical bacterial counts (BEACH program)
- NOAA's mussel watch
- Superfund data for many harbor sites
- 303d list of impaired water bodies
- Online searches for fish advisories



- ▼  **Time & Current Stations**
- ▼  **Outfalls (CSO)**
  - Combined Sewer Overflow Point
- ▼  **Outfalls (NPDES Facilities)**
- ▼  **Fish Advisories**
  - Fish Consumption Advisories Point
  - Fish Consumption Advisories Line
  - Fish Consumption Advisories Area
- ▼  **Impaired Waters (303d)**
  - ▶  Impaired Listed Waters 303(d): EPA
- ▼  **Beach Closures**
  - Beaches Point
  - Beaches Line
- ▼  **Other EPA Regulated Sites**
  - NPL - Superfund
  - FIFRA - Pesticides
  - FRP - Oil Storage
  - RMP - Large Quantity Chemicals
  - TRI - Chemical Discharges
  - AFS - Air Discharges
  - UST - Underground Tanks
  - NPDES - Water Dischargers
  - RCRA - Chemical Transfer, Storage, Disposal
  - EPCRA - Small Quantity Chemicals
  - TSCA - PCB Handling

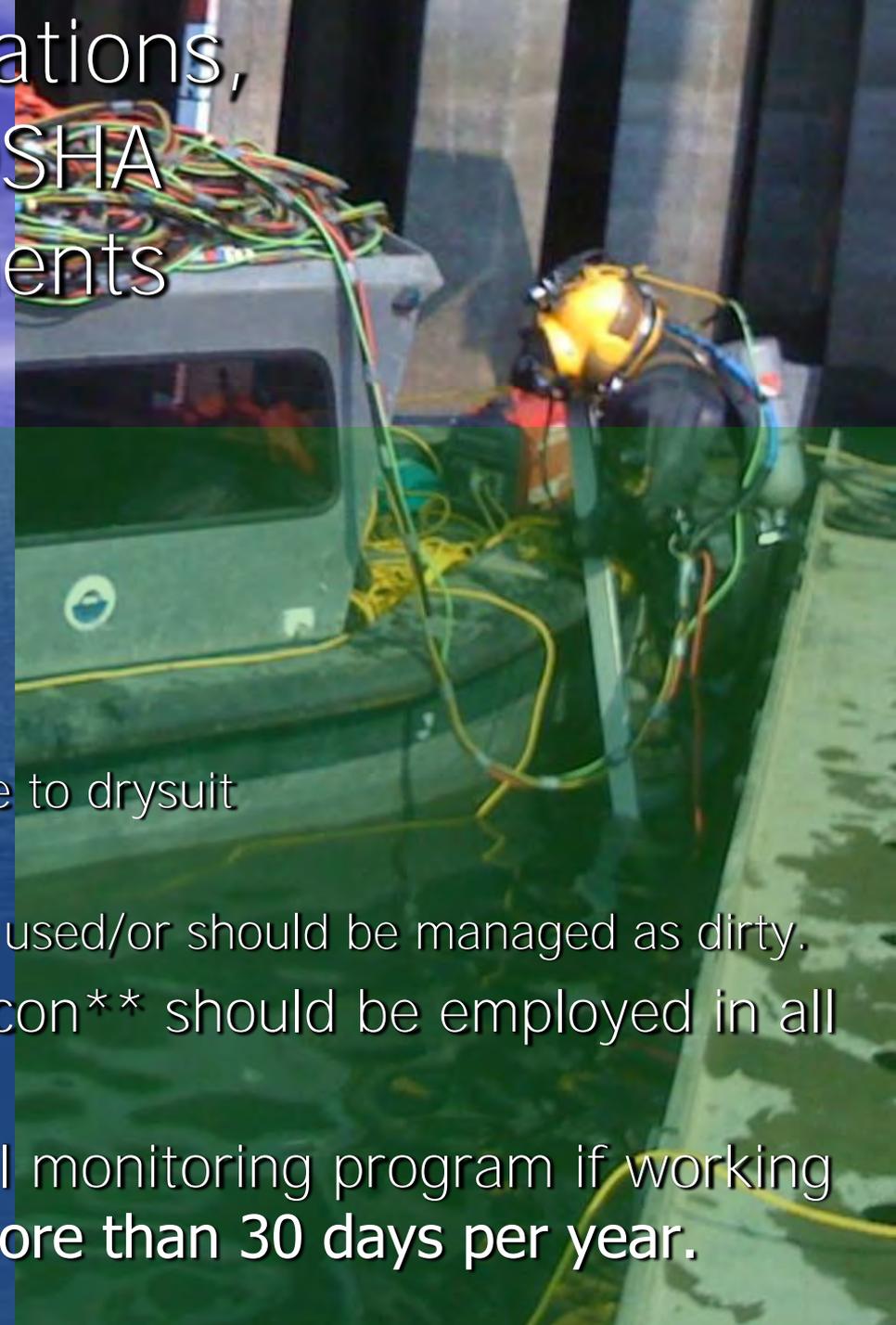
Turning on and off layers can quickly show you what sites can be bad actors in your geographic area

# Contaminant Levels

- Sediment levels change slowly-testing can be useful
- Water column levels of contamination can change in minutes
  - testing is moot as conditions change rapidly
  - few contaminants can be tested for in real time or cost effectively
- How much bottom interaction is dictated by the dive operation?

# Like land based operations, dives must meet OSHA 1910.120 requirements concerning

- Training
- Immunizations
- PPE
  - Keep the diver dry.
  - Hardhats or full face masks; mate to drysuit
  - No neck dams.
  - Neoprene material should not be used/or should be managed as dirty.
- A *minimum* of potable water decon\*\* should be employed in all harbor areas.
- All workers must be in a medical monitoring program if working on a “hazardous waste site(s)” more than 30 days per year.



# How to tackle the Task Hazard Analysis (THA/AHA)

- Sediment interaction?
- Level of contamination (water column, sediment, both?) ?
- Managing exposure (divers and tenders)
- Manage points of exposure (selection of PPE/failure points)
- Feedback loop

# Glove or suit leak

ACTIVITY	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS
	Exposure due to damaged dive gear/gloves	<ul style="list-style-type: none"> <li>- Divers will immediately report any known or suspected leaks or damage to their gloves or dive gear.</li> <li>- Supervisors will alert the tenders that the diver will be surfacing and will inform of the suspected damage.</li> <li>- Divers can elect to abort the dive after exposure if they are uncomfortable with the following exposure procedures and do not have open cuts, sores, scrapes or mucus membranes that have been exposed to the contaminant.               <ul style="list-style-type: none"> <li>- <b><u>If the outer glove is damaged:</u></b> Tenders will remove the damaged glove and inspect the integrity of the inner glove. If the inner glove is intact, the diver's hand will be decontaminated with decontamination solution, dried and a new outer glove will be sealed to the cuff ring.</li> <li>- <b><u>If both gloves are damaged:</u></b> The diver will have both gloves removed, his/her skin will be washed with antibacterial soap, and their cuff will be inspected for further leaks. If no further leaks are found, the diver will receive a new inner and outer glove.</li> <li>- <b><u>If there is a leak in the dry suit:</u></b> The dive will be aborted and the suit will be repaired and leak tested before being used again. The diver will remove all contaminated undergarments and will wash all exposed skin with antibacterial soap and potable water.</li> <li>- <b><u>If there is a leak in the dive hat or neck seal:</u></b> The dive will be aborted and the hat/neck seal will be repaired and tested before being used again. The diver will remove all contaminated undergarments and will wash all exposed skin with antibacterial soap and potable water.</li> <li>- <b><u>If the diver is exposed to contaminants from cuts, sores, scrapes or exposure to mucus membranes, the dive will be aborted and they will be examined by a medical professional.</u></b></li> </ul> </li> </ul>

# Exposure to divers and tenders

HAZARDS	HAZARDS	RECOMMENDED CONTROLS
DIVER DECONTAMINATION	Worker exposure to hazardous substances	<ul style="list-style-type: none"> <li>- Decon procedures will be further defined in the Dive Plan and will be conducted in accordance with EPA and OSHA regulations.</li> <li>- All workers will don level gear appropriate for the type of contaminate and degree of severity.</li> <li>- PFD's will be worn with level gear when decon is being conducted aboard the dive vessel.</li> <li>- All members of the crew will be diligent in making sure they and their coworkers are dressed properly with all PPE in place and seals taped.</li> <li>- Any PPE issues will be taken care of prior to entering the warm or hot zones.</li> <li>- Contaminated PPE will be contained in lined waste bins labeled "CONTAMINATED WASTE" and will be double bagged and taped shut for disposal in clear drum liners.</li> <li>- Eating, drinking and use of tobacco products are not permitted in the hot and warm zones. Workers will wash hands prior to eating, drinking and using tobacco products.</li> </ul>
	Slips trips and falls	<ul style="list-style-type: none"> <li>- Level gear and hazmat diving gear can be cumbersome. Tenders and decon personnel will ensure that walkways stay clear (particularly from the divers entry/exit point to the decon area).</li> <li>- Decon personnel will take care to prevent chemicals or puddles of water to gather on the walking surfaces.</li> <li>- Divers will be escorted from the dive ladder to containment as he/she will still be wearing their gear and will have a limited field of vision.</li> <li>- Divers will typically have contaminants covering their suits, on the soles of their dry suit boots, on their hands and covering their faceplates upon exiting the water, ensure the diver's egress is as simple and efficient as possible.</li> </ul>
	Ineffective or incomplete decon	<ul style="list-style-type: none"> <li>- Personnel and equipment (including dive umbilicals and all tools and hoses) will not leave the warm zone until they are free of contaminants.</li> <li>- All contaminated trash is to remain in the warm zone, clearly labeled and is to be bagged and taped for disposal.</li> </ul>
DECONTAMINATION SOLUTIONS	<p style="text-align: center;"><b>Decon solution has been selected for the contaminant and with reference to the USN Guidance for Contaminated Water Diving, Table 5-1 - Environmental Response Team – Decontamination Solution Effectiveness/Safety to ensure effectiveness and safety for personnel and equipment.</b></p>	
	Ineffective or incomplete decon	<ul style="list-style-type: none"> <li>- Simple Green will be mixed in solution of 50% simple Green and 50% potable water. If needed, Simple Green may be used in concentrated form depending on the degree of contamination.</li> <li>- Simple Green solution will be allowed to sit on contaminated surfaces for at least 5 minutes.</li> <li>- Potable water will be used to rinse the solution and contaminants from the diver, gear and equipment.</li> <li>- Personnel and equipment will not leave the warm zone until they are free of contaminants.</li> <li>- All contaminated trash is to remain in the warm zone, clearly labeled and is to be bagged and taped for disposal.</li> </ul>
	Injury/irritation from decon solution	<ul style="list-style-type: none"> <li>- Personnel are to wear eye protection and face shields when applying the decon solution from a spray bottle or pump sprayer.</li> <li>- Paying attention to overspray is critical to prevent exposing unaware or inadequately protected workers.</li> </ul>

# Reducing exposure - Decon

- EPA study has shown a potable water rinse to be as effective at removing bacteria as an antimicrobial wash process.
- Decon compatible gear is important



Possible exposure to biological agents if PPE fails?

Immunizations



# Ensuring mitigation steps and equipment are understood before the dive -- training



# Heat stress management

	Temperature extremes	<ul style="list-style-type: none"><li>- Divers shall wear appropriate thermal protection for the water temperature.</li><li>- Divers will wear gloves appropriate for the task performed and the water temperature.</li><li>- Divers will be monitored by the diving supervisor upon entry and exit from water and through the duration of the dive via video and comms.</li><li>- Work shifts will be limited in extreme water temperatures in accordance with thermal stress management plans.</li></ul>
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# Management of vessel in zones

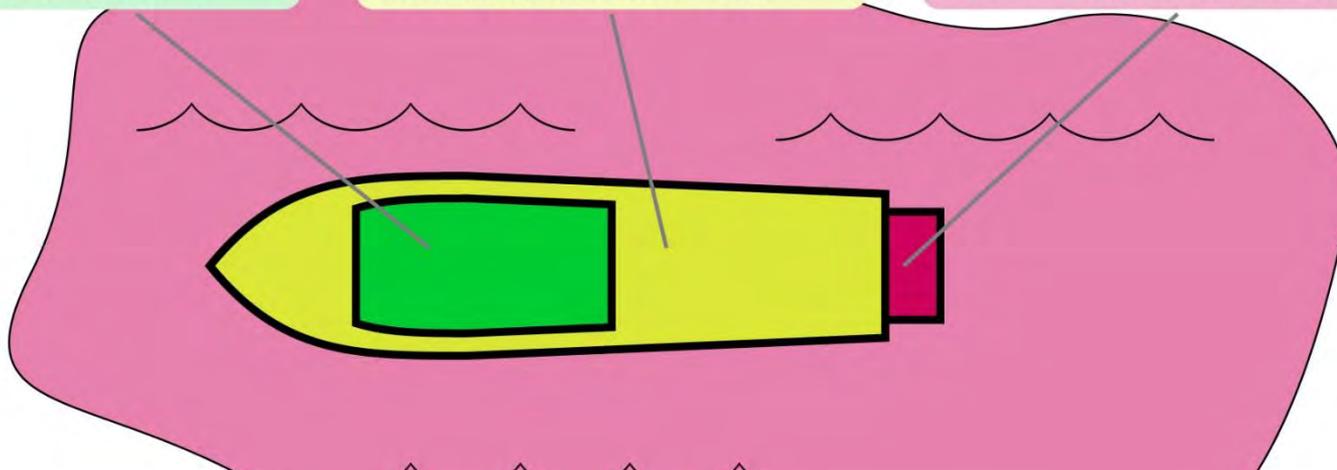
Breakdown of the zone management system resulting in contamination and/or exposure to personnel, equipment or environment

- The diver and/or standby diver (in an emergency) are the only members of the crew to enter the exclusion or "hot" zone.
- **The hot zone will be defined as the bow ramp of the landing craft style vessel and the surrounding waterway.**
- Tenders, line handlers and other support personnel directly handling the diver or his/her tools will be stationed in the contamination reduction or "warm" zone. These personnel will not be permitted to leave the warm zone without first completing the appropriate decontamination for their level and type of exposure.
- **The warm zone will be defined as the vessel deck amidships forward to the bow ramp.**
- Supervisors, medical personnel and other support staff not immediately handling the diver or his/her tools will be staged in the support or "cool" zone unless in the event of an emergency they are required to provide further assistance.
- **The cold zone will be defined as the cabin interior and the stern section of the vessel.**

**Support Zone, e.g. cabin area, forward area of vessel**

**Contamination reduction zone (CRZ, outside the cabin, but not including swim step)**

**Exclusion zone (swim step --aft part of the vessel--and water body)**



# Evaluating PPE breakthrough

## CONTAMINATED WATER DIVING

Unknown contaminants  
Hazardous contaminants

- Diving supervisors must be made aware of any sampling or air monitoring done and should be informed of what contaminants the crew can potentially be exposed to (in-water and on surface).
- In the event of unknowns, dive crews should be prepared with the maximum level of protection for divers and topside personnel.
- **When diving is conducted in chemical hazards, personnel must frequently and thoroughly inspect all dive gear that is exposed to contaminants for damage or signs of material and seal degradation.**

Did it all work?



# Exposure Monitoring

- OSHA dictates that 30 days or more of polluted water diving per year requires medical monitoring for chemical/biological exposure
- Exposure history adjusts blood test analyses



# Case Studies



Case  
Study #1:  
Sediment  
Sampling  
in a  
Harbor

What's  
wrong  
with this  
picture??



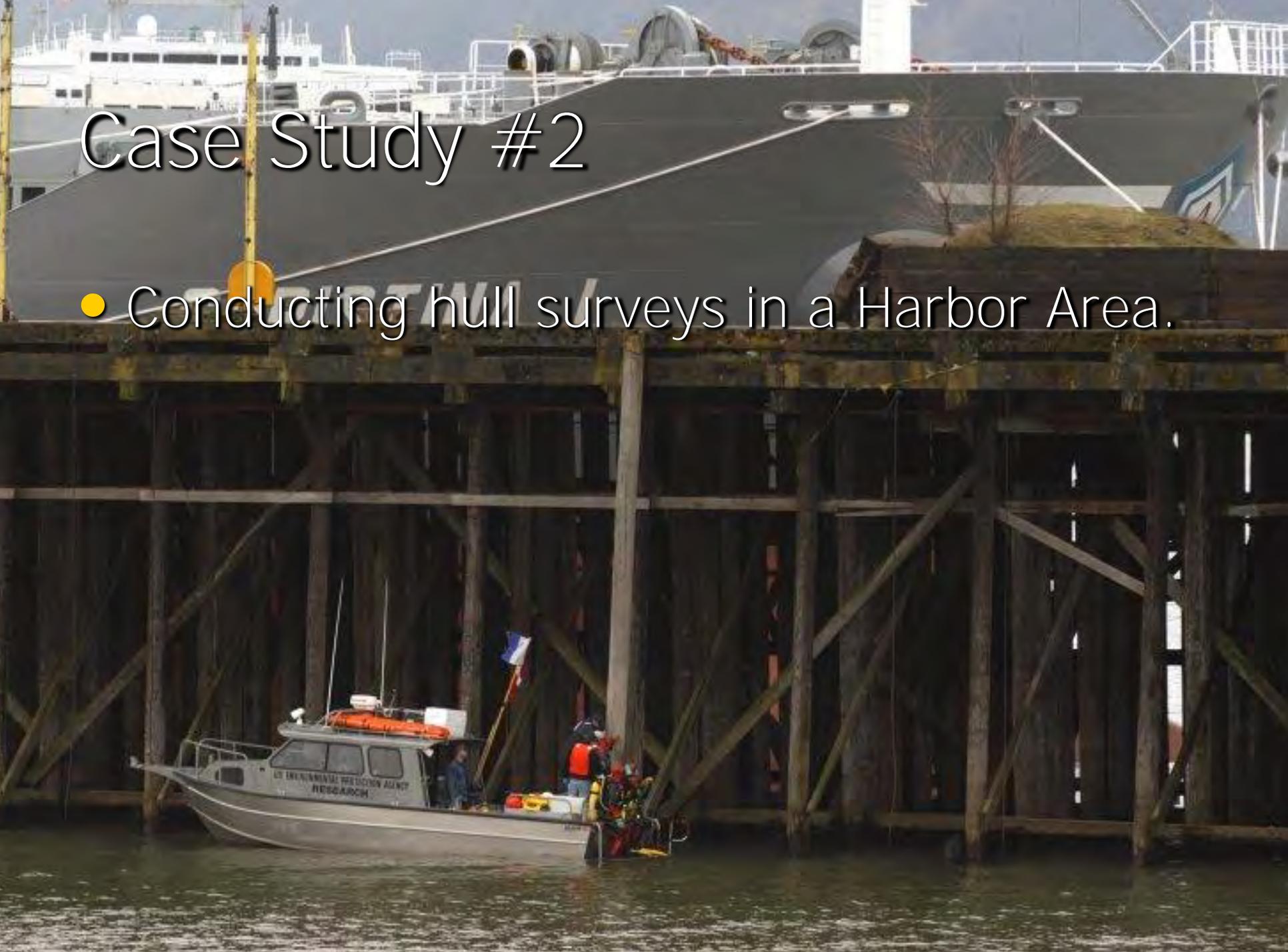
- Outcome: No negative outcomes.
- What is nearby: CSOs
- Diving at a Superfund Site (hazwoper)
- PPE inappropriate
- Lack of decon.
- No immunizations.
- No appropriate medical monitoring.

(Portland Harbor, 2008)



# Case Study #2

- Conducting hull surveys in a Harbor Area.



- Outcome: Entire dive crew becomes ill immediately after the dive.
  - Evacuated to mainland.
  - Two divers permanently disabled from necrotizing bacteria that took over one month to diagnose.
  - All divers wearing wetsuits / using mouthpiece regulators.
  - CSO nearby which had discharged over a million gallons of raw sewage to the dive site, published in local newspaper available pre-dive
- USCG, 2003 Seattle MSST (since disbanded)

# Case Study #3

- Scientific diver mapping survey of cenote underlying industrial facility

- Outcomes: Divers terminate dive after feeling a burning sensation. No lasting effects known.

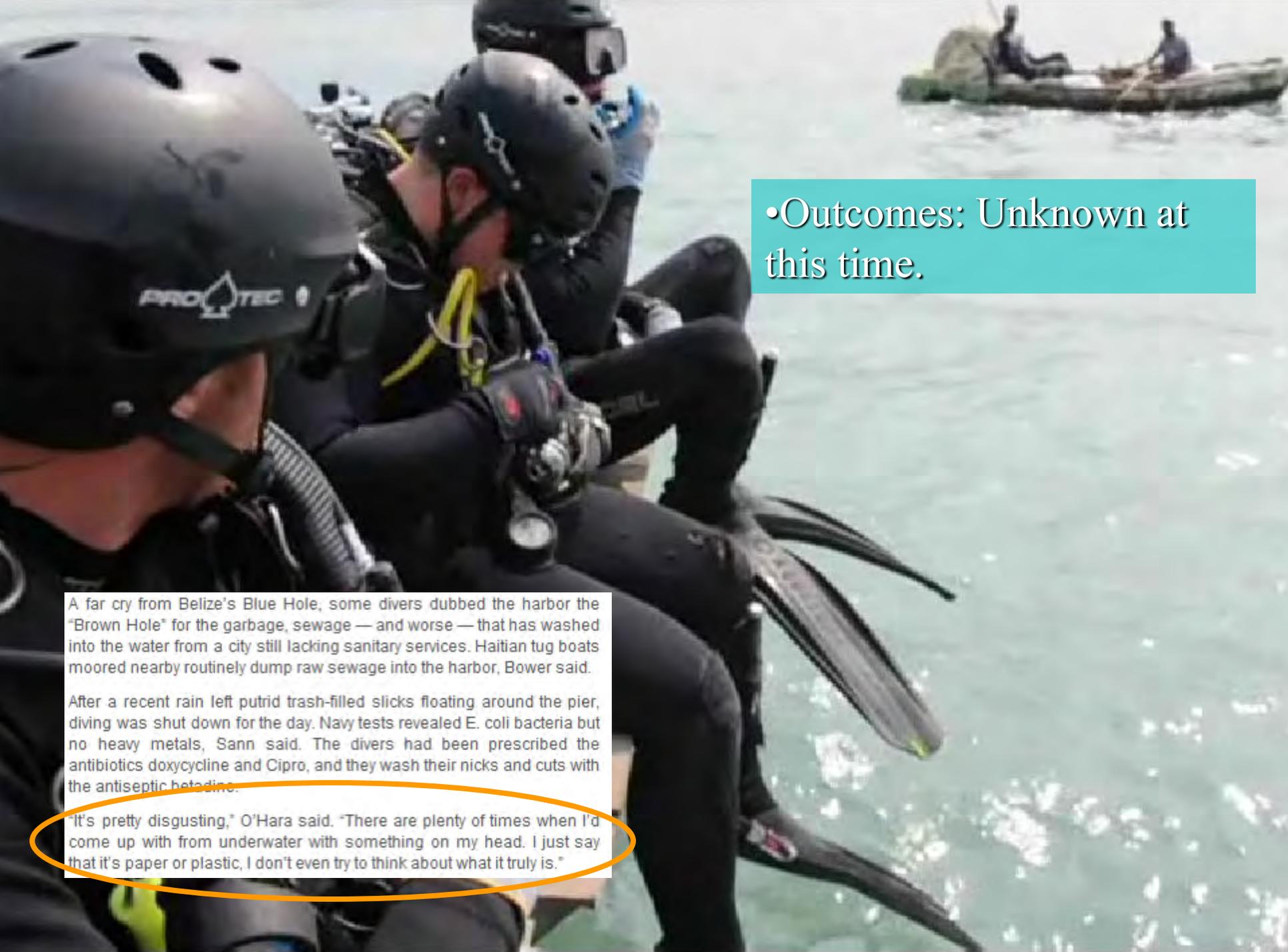
(AAUS, 2007)



# Case Study #4



- As part of a major relief effort, military divers begin rebuilding a port facility following an earthquake.
- Dive planning included warnings of sewage and at least hundreds of chemicals from spilled containers in the Bay.
- Military planners insisted on conducting the dives with wetsuits and mouthpiece regulators.
- Divers were given massive doses of cipro and doxycycline (Sheldrake, personal communication, 2010)



•Outcomes: Unknown at this time.

A far cry from Belize's Blue Hole, some divers dubbed the harbor the "Brown Hole" for the garbage, sewage — and worse — that has washed into the water from a city still lacking sanitary services. Haitian tug boats moored nearby routinely dump raw sewage into the harbor, Bower said.

After a recent rain left putrid trash-filled slicks floating around the pier, diving was shut down for the day. Navy tests revealed E. coli bacteria but no heavy metals, Sann said. The divers had been prescribed the antibiotics doxycycline and Cipro, and they wash their nicks and cuts with the antiseptic betadine.

"It's pretty disgusting," O'Hara said. "There are plenty of times when I'd come up with from underwater with something on my head. I just say that it's paper or plastic, I don't even try to think about what it truly is."

# Conclusions

- Polluted water is not easy to define.
- Training, immunizations, medical monitoring, and equipment for polluted water diving are not inexpensive.
- There are a variety of online dive planning tools available that will tell you the **likelihood** your site is polluted where PPE upgrades and other mitigation are necessary.
- If you're not sure if it's polluted **DON'T DIVE.**



# Questions/ Comments?

Sean Sheldrake, R10

(206) 553-1220

[sheldrake.sean@epa.gov](mailto:sheldrake.sean@epa.gov)

Alan Humphrey, ERT

[Humphrey.alan@epa.gov](mailto:Humphrey.alan@epa.gov)

For more information google: "EPA scientific diving"

[http://www.alertdiver.com/Assessing Water Quality Online Dive Planning Tools](http://www.alertdiver.com/Assessing_Water_Quality_Online_Dive_Planning_Tools)

