

Remedial Safety in In-Situ Chemical Oxidation, Crucial to Success

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Sources:

Pac, Tim, Cohen, Elizabeth, Crimi, Michelle, Dombrowski, Paul, Duffy, Baxter, Lee, Michael, Klemmer, Mark, Pittenger, D. Scott and Robinson, Lance, "Remedial Safety in In-Situ Chemical Oxidation, Crucial for Success," Remediation, 32 (3): 195 – 209 (2022).

Pac, Tim, Lee, Michael, Byrd, Jennifer, Cohen, Elizabeth, Crimi, Michelle, Dombrowski, Paul, Duffy, Baxter, and Schnell, Deborah, "Remedial Safety in In-Situ Chemical Oxidation, Crucial for Success," 12th International Conference on Remediation of Chlorinated and Recalcitrant Compounds (2022).

30 September 2024



*Those who cannot remember the past
are condemned to repeat it.
– George Santanyana*

Presentation Outline

Step changes in the evolution of “Safety” and Safety First

Personal advocacy for chemical safety

- Awareness of basics
- Advanced knowledge

“**Incidents**” of injection (Top 4)

Top 3 “**skills**” with mitigation strategies

What can You do?



Did We Need Safety?



COMMON SENSE
Just because you can, doesn't mean you should.

Evolution of Safety First in Remediation I

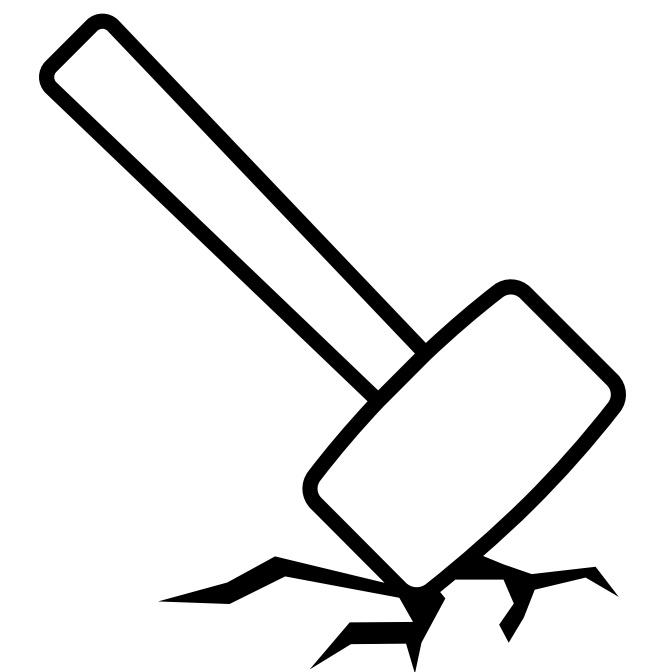
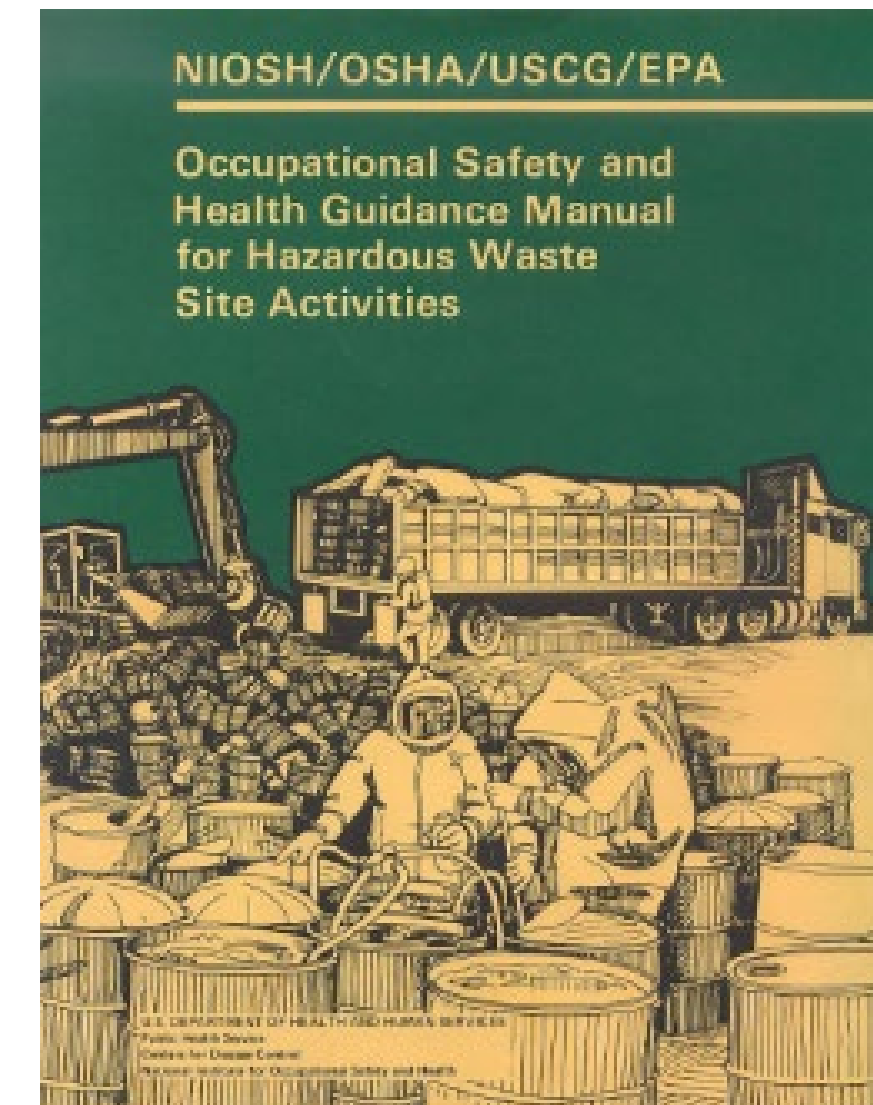
1985 –

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities required “... a site health and safety program... must provide:

- Comprehensive protection against all potential hazards and
- Specific protection against individual known hazards,
- It should be continuously adapted to new information and changing site conditions.”

Responsibility of the employer, elicited response

- HAZWOPER 1910.120 (40 hour, annual, supervisor) in 1990
- Specialized worker training programs (construction, demolition, sampling)
- Selection and use of Personal Protective Equipment (PPE)
- Creation of Site-specific Health and Safety Plans (HSPs/HASPs)



Evolution of Safety-First In Remediation II

2000

Recognition of “*what does safety mean to me?*”

- Safety awards, recognition – group and individual
- Targeted technical training
 - Classes, On-the-Job (OTJ), previous relevant experience
 - Observation / Supervision / Mentoring
 - Demonstration of competence/ Peer review
 - Examination / Certification / Licensure



Evolution of Safety-First In Remediation III



2010

Individual empowerment and engagement - *"I am responsible for the safety of myself and my team"*

- **My knowledge** – awareness, recognition and knowledge
- **My actions** – observation, inspection and correction
- **My support for safety** – budget, equipment, team bias for action

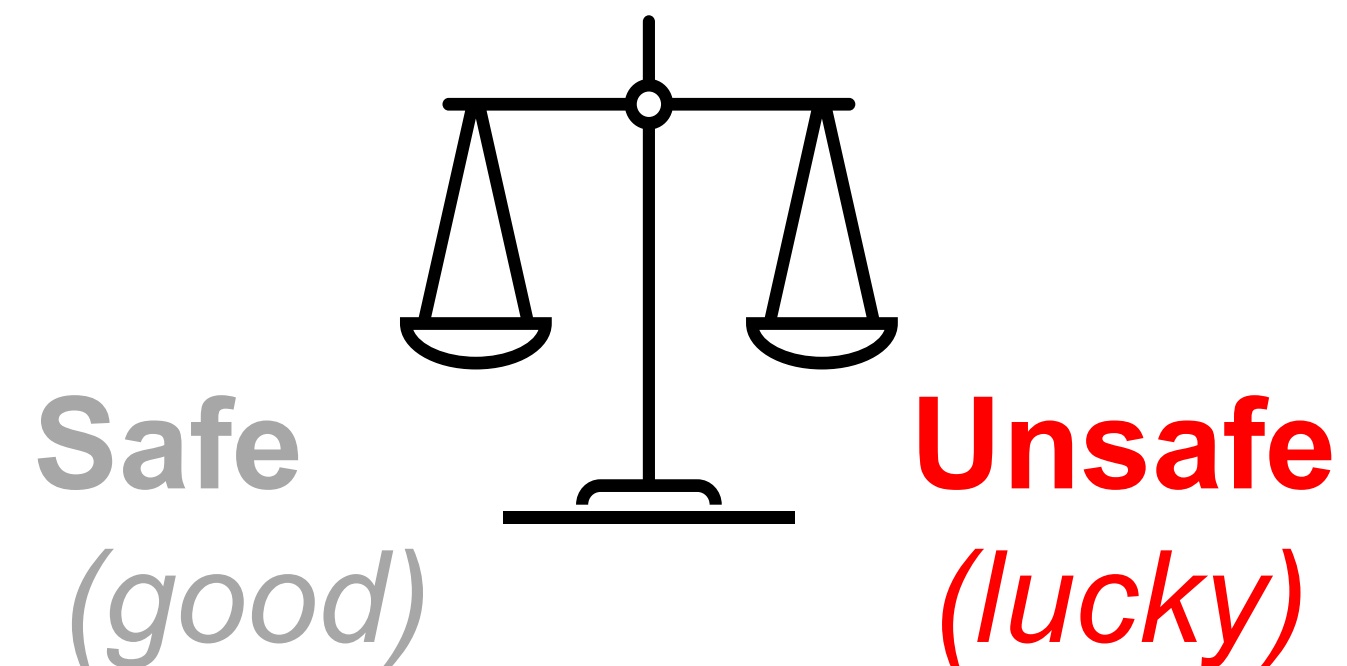
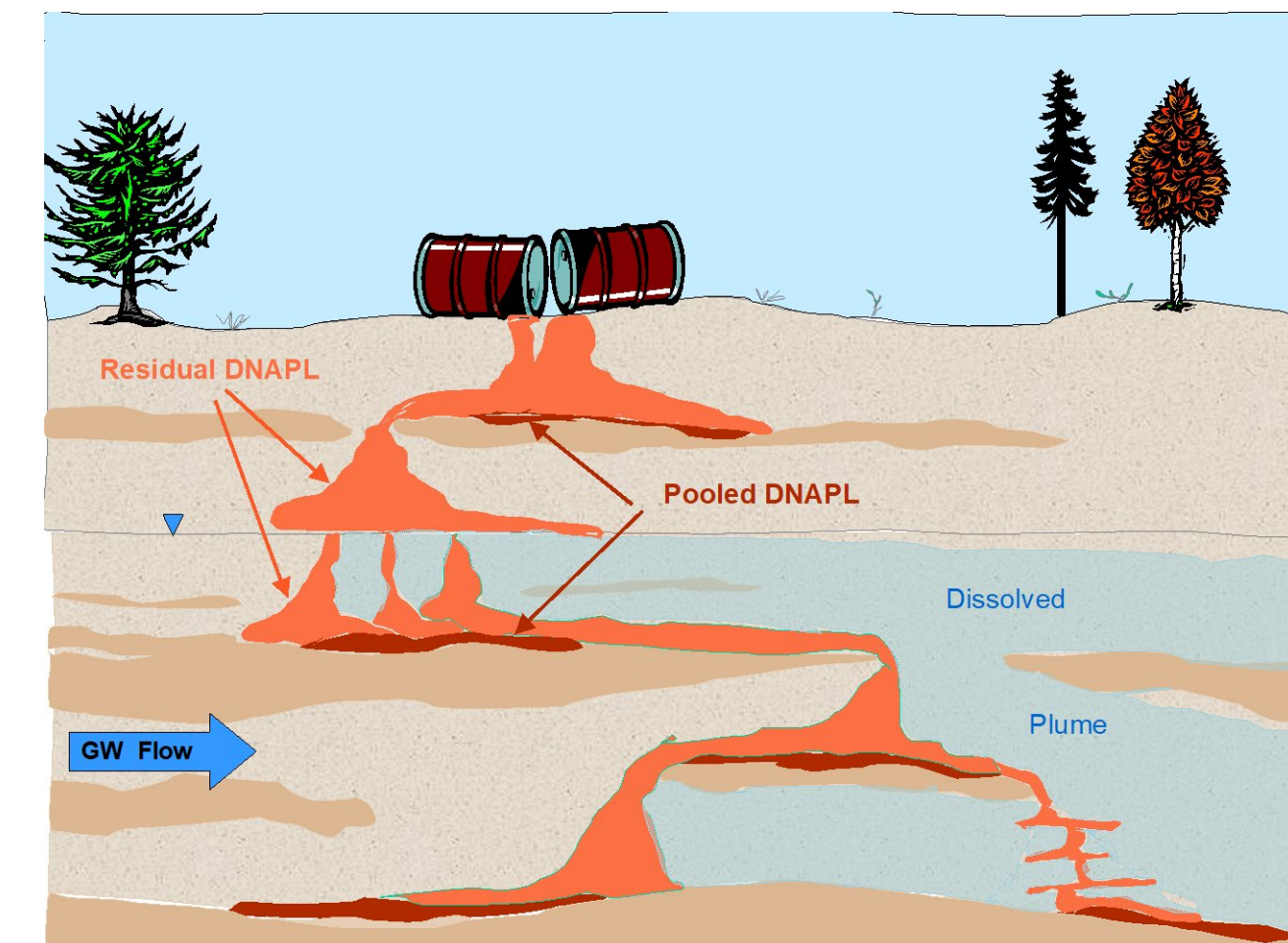
Present?

Mutual goal - everyone goes home, like they arrived!



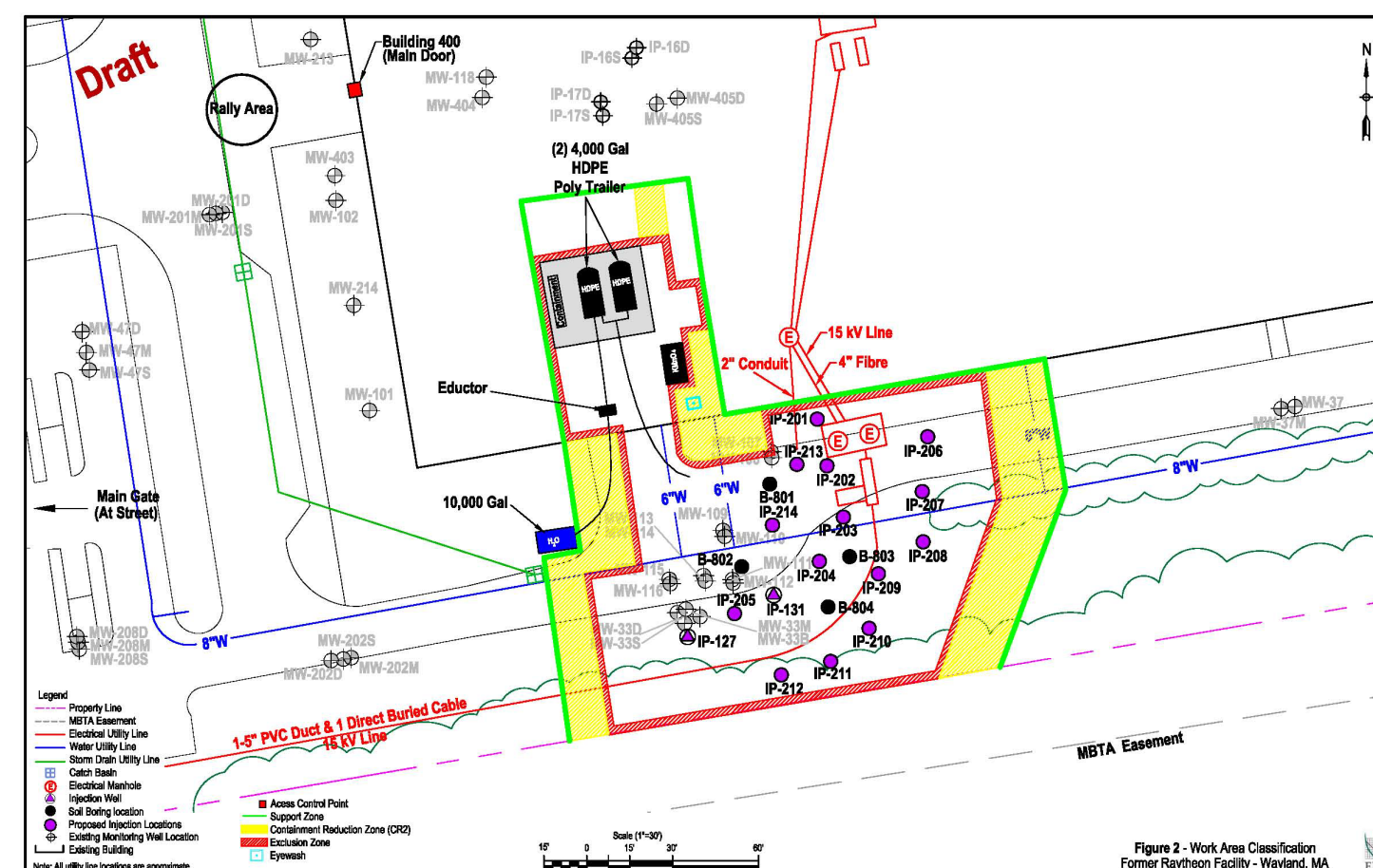
Safety-First Key Topics

- **Knowledge** - training to provide understanding, increasing capabilities with ownership of activities, situational awareness, hazard recognition, anticipation of hazards and empowerment with stop work authority
- **Action** - active observation, chronic unease, continuous inspection, personal responsibility for correction and toughness and resilience in execution
- **Creating bias for safety** - budget, equipment, personal ownership, control, leadership, proactive change, and total team focus



Knowledge

- Promote and reinforce safety first culture
 - empowerment – shared authority and responsibility
 - engagement – contributions by all
 - inclusion – all observations and opinions matter
- Daily briefs - what has, is, and will be happening
- Set expectations – project and personal
- Use stop work practices – take a “pause” as needed to communicate and/or correct



Action

- Proper **labelling** – every container, no “*unknowns*”
- **SDS** – accessible reference materials (PPE, fire fighting, first aid, exposure, hazards and concentrations)
- **Storage** – proper securement, separation of incompatibles, ventilation, spill prevention
- **HSPs/HASPs** – useful, relevant and complete
 - project objectives
 - Site-specific
 - timely and updated
 - project activities in appropriate detail



Bias for Safety

- Understand, accede and support
- Maintain consistency
- Assure knowledge (of proper practices) and training (gaps)
- Communicate monitoring (parameters, frequency, method, who/how/when?)
- Actively verify chemical management procedures
- Continuously implement risk management practices (observe and correct)

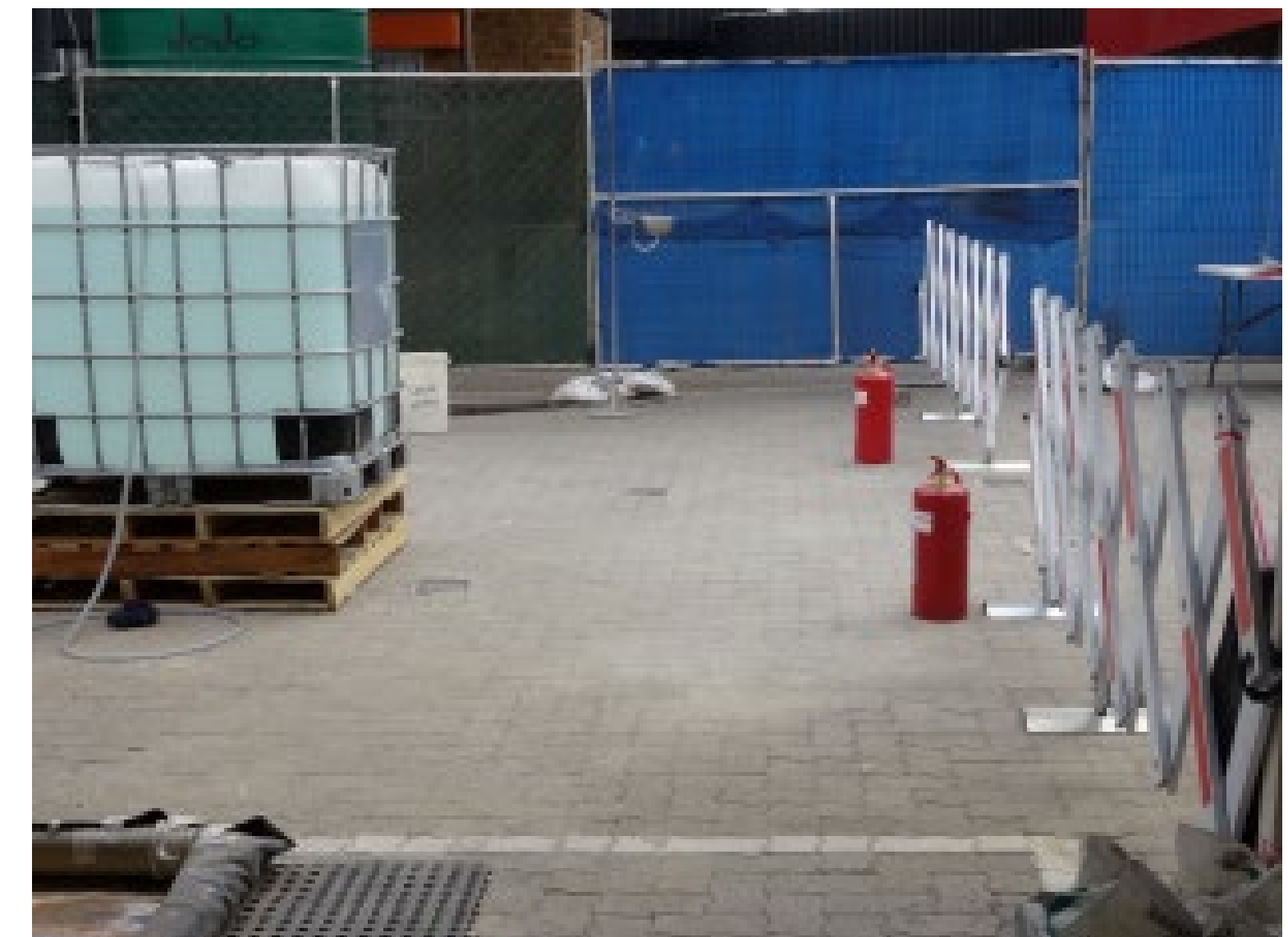
***What?
When?
Where?
Why?
How?***



Specialized Chemical Knowledge (e.g., persulfate)



- Class 1 oxidizer (*may* ↑ **burning rate of combustibles**)
- High solubility (42% w/w)
- **Corrosive** ($pH < 2$ SIU)
- Inhalation (*dust during transfer*)
- Splash hazard (*eye wash, wash down & shower*)
- **Pressure and over pressurization** (*unintended reaction*)
- **Incompatibles** (*proper storage, day tankage*)



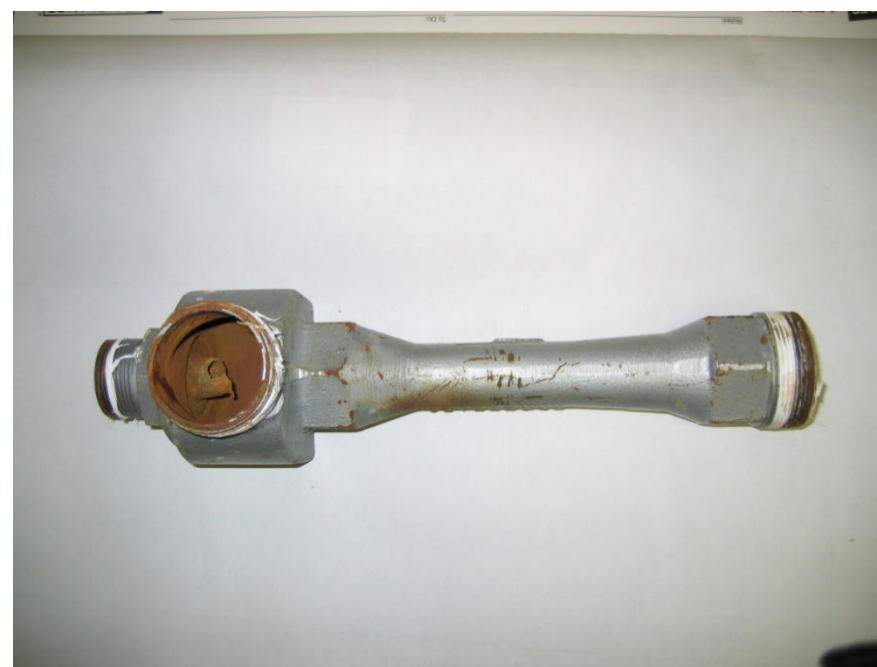
Corrosion is Real

Virginia (2008)

Geoprobe
Rods



Eductor



Texas (2010)

Mixing
tank



Steel
manifold



New Jersey (2022)

Geoprobe
Rods



Fittings



Risk Management

INCIDENTS (Top 4)

1. Storm Sewers
2. Other Utilities and Structures
3. Errors and Omissions
4. Contingency Planning



MITIGATIONS

- Planning
- Executing
- Correcting

Top Risks #1 – Storm Sewers

Injected materials entering, following and/or discharging via sewer or backfill due to

- **Construction-** storm sewers are, by definition, unsealed (leaky)
- **Placement** - permeable backfill/ filled / disturbed area provides enhanced migration
- **Changed condition** – raises in local water table
- **Over pressurization** – resulting in inadvertent soil lift and fracture



North Smithfield RI Sodium Permanganate Release North Smithfield, RI - EPA Region I



Site Contact:
Michael S. Barry
OSC
barry.michael@epa.gov

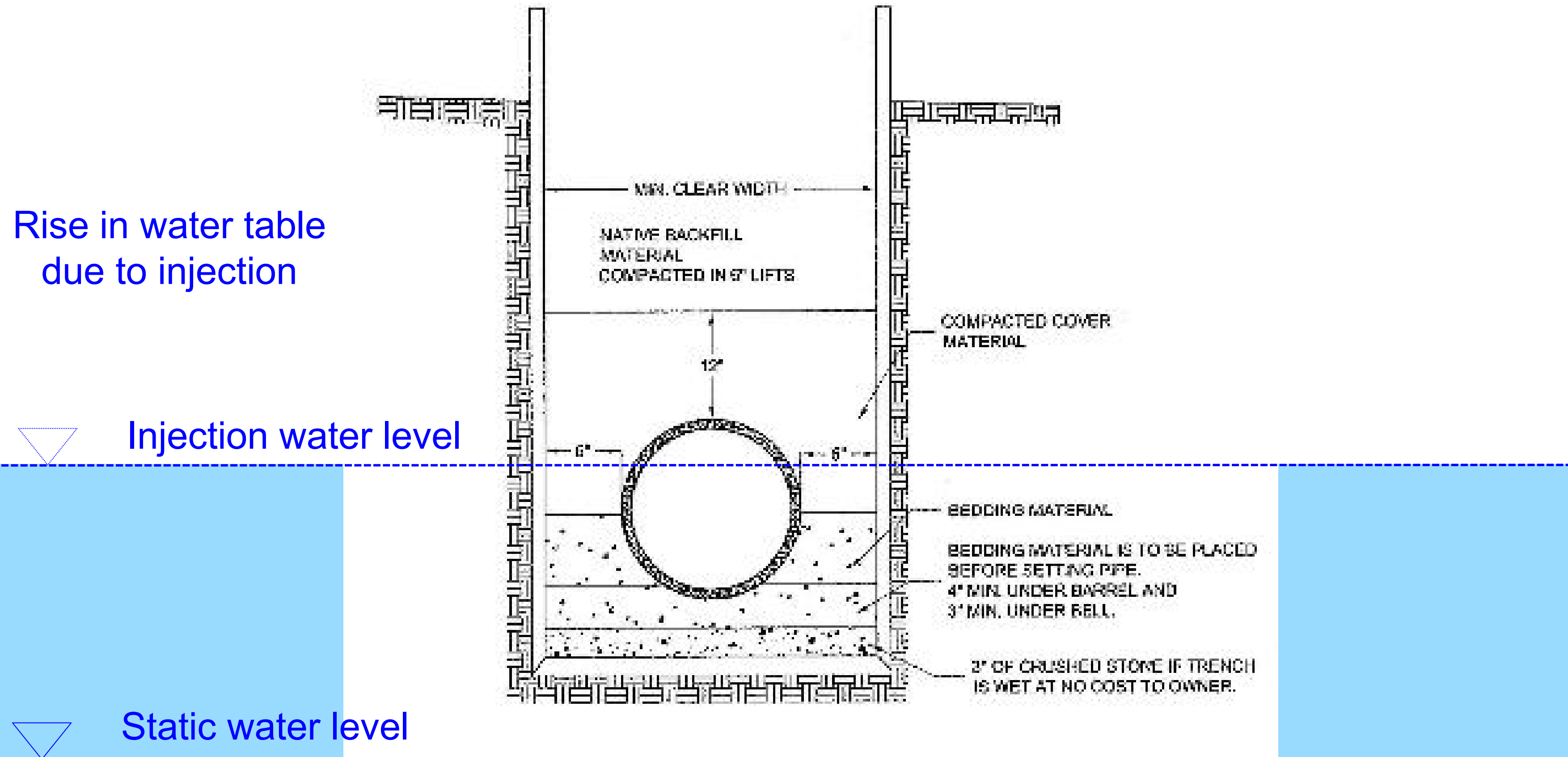
www.epaosc.org/northsmithfieldripermanganate

[Area Weather Forecast](#)

At 2315 hours on 15 March 2004, OSC Jakabhazy was dispatched to a suspected release of sodium permanganate in Smithfield, RI to the Branch River. RIDEM arrived on scene at approx 1800 hours to a reported release into the Branch River that had been reportedly ongoing for several hours. The source was traced catch basin on the Phillips Components Facility on Industrial Road, off the Pound Road exit of Rt 146. Coord



Top Risks #1 – Storm Sewers – Why?



5 TRENCH DETAIL
NOT TO SCALE

Top Risks #2 – Other Utilities and Structures



- Injected material following **other known or unknown** lines, structures (basements, foundations), previously disturbed areas (excavations) and (former) USTs
- Structures with **ambiguous location** or construction – no “as-built” or facility knowledge
- **Undetected** during subsurface clearance and inspection
- **Improperly abandoned** historical activities (e.g., borings or disturbed areas)



Top Risks #3 – Errors and Omissions (design and execution)

- **Material compatibility** - enhanced corrosion, decomposition
- **Improper/incomplete** - procedures, operations, supervision, instrumentation
- **Equipment failure** - mechanical, seals, pressure rating, verification prior to use, inspection
- **Insufficient training/engagement** – breakout, spill response, inattention, inexperience, neutralization
- **Management of change** - personnel, equipment, weather, unknown contaminants



Top Risks #3 – Errors and Omissions (design and execution)



Material	Oxidants				Biologic Amendments		NAPL			
	Sodium Persulfate 15%	Perman-ganate 5%	Hydrogen Peroxide 50%	Ozone	Lactic Acid	Soybean Oil	Benzene	Gasoline (GRO)	Diesel (DRO)	TCE
Ferrous Metals										
304 SS	Green	Green	Yellow	Yellow	Green	Green	Yellow	Yellow	Green	Yellow
616 SS	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Yellow
Black Iron	Red	Green	Yellow	Red	Red	Green	Yellow	Yellow	Yellow	Yellow
Galvanized Iron	Red	Red	Yellow	Red	Red	Green	Yellow	Yellow	Yellow	Yellow
Carbon Steel	Red	Green	Yellow	Red	Red	Green	Yellow	Yellow	Yellow	Yellow
Non ferrous Metals and Alloys										
Aluminum	Red	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow	Green
Brass	Red	Green	Red	Yellow	Yellow	Green	Yellow	Yellow	Green	Yellow
Copper	Red	Green	Red	Green	Yellow	Green	Yellow	Yellow	Green	Yellow
Fibers										
Cotton	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green
FRP	Green	Green	Green	Green	Green	Green	Yellow	Green	Green	Green
Plastic and Elastomers										
Nitrile	Red	Red	Red	Red	Red	Green	Red	Green	Green	Red
EDPM	Green	Green	Red	Green	Green	Yellow	Red	Red	Red	Red
Neoprene	Green	Red	Red	Yellow	Green	Green	Red	Green	Green	Red
Natural Rubber	Red	Red	Yellow	Red	Green	Red	Red	Green	Green	Red
Polyethylene (LD & HD)	Green	Green	Yellow	Yellow	Green	Green	Green	Green	Green	Green
PVC	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Red
Teflon	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Viton	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green

Sources

- Carus Chemical Company, "RemOx™ S ISCO Reagent Material Compatibility," (2007)
- Cole Parmer Instrument Company, Chemical Compatibility, online (2022).
- Industrial Special Metals, Chemical Compatibility Cart, online (2022).
- McCaulou, Douglas R., Jewett, David G. and Huling, Scott G., "Compatibility of NAPLs and Other Organic Compounds With Materials Used in Well Construction, Sampling, and Remediation," GWMR, fall: 125 - 131 (1996).
- Ozone Solutions, Ozone Compatible Materials, online (2021).
- Peroxychem, "Corrosion and Material Compatibility with Klozur Persulfate Technical Bulletin," (2015).
- United Initiators, NPS Safety Data Sheet (2018).

Key	
Green	Recommended
Yellow	Use with caution
Red	Not Recommended

Top Risks #4 – Contingency Planning

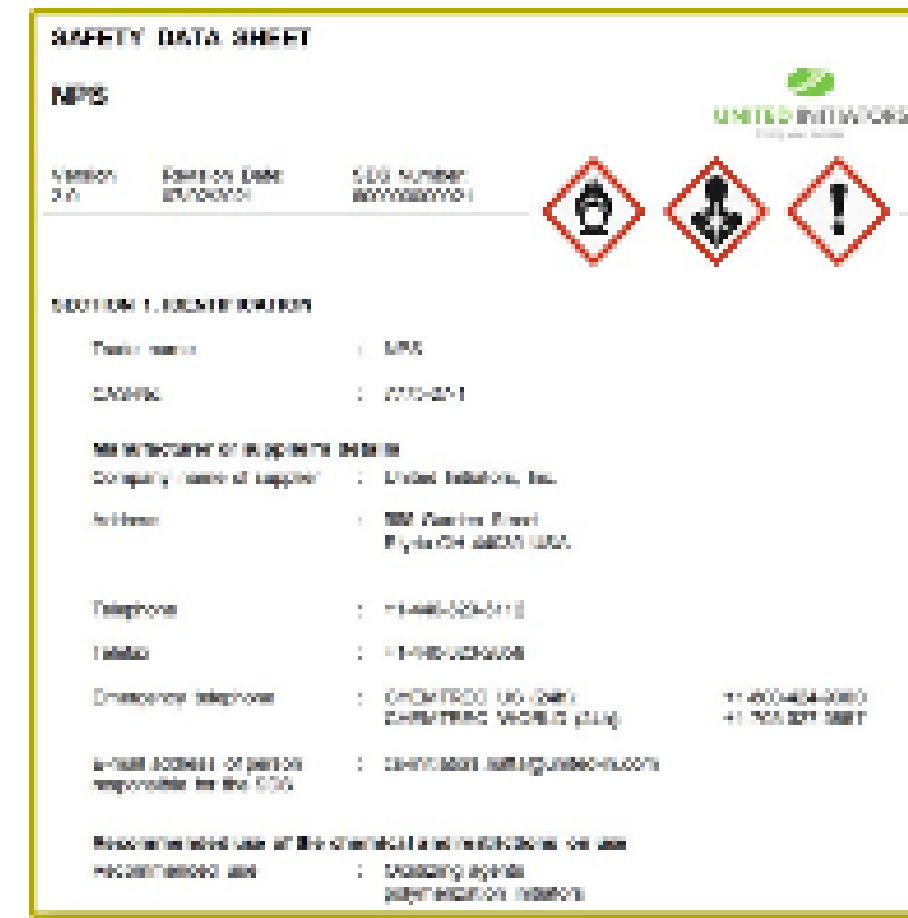


- Lack of Plans - spill response, release notification plan
- Communications – responsibilities, timeliness
- Hazard (HAZID) review – external review
- Spill response prioritization – focus on personnel safety
- Availability and quantity of supplies on site – PPE, spill control, contractors, neutralization

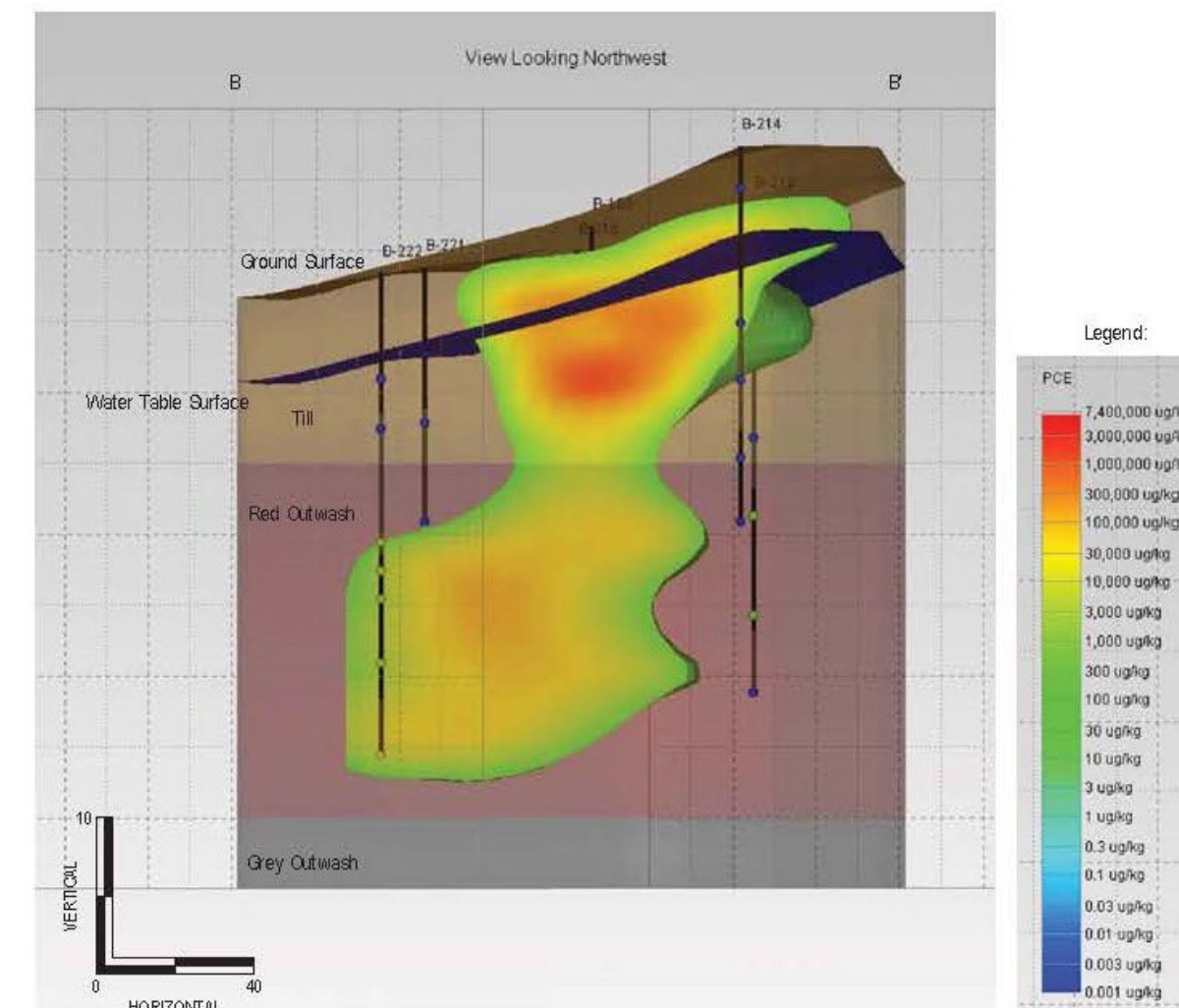


Top Skills – I. Planning

- Understanding and **acceding** the plans
- **Plan** completeness, relevance, timeliness, Site-specific, harmonized to the Site requirements
- **Aligned** with Conceptual Site Model (CSM)
- **Foresee reasonable occurrences**
- **Externally reviewed** by subject matter expert / experienced person

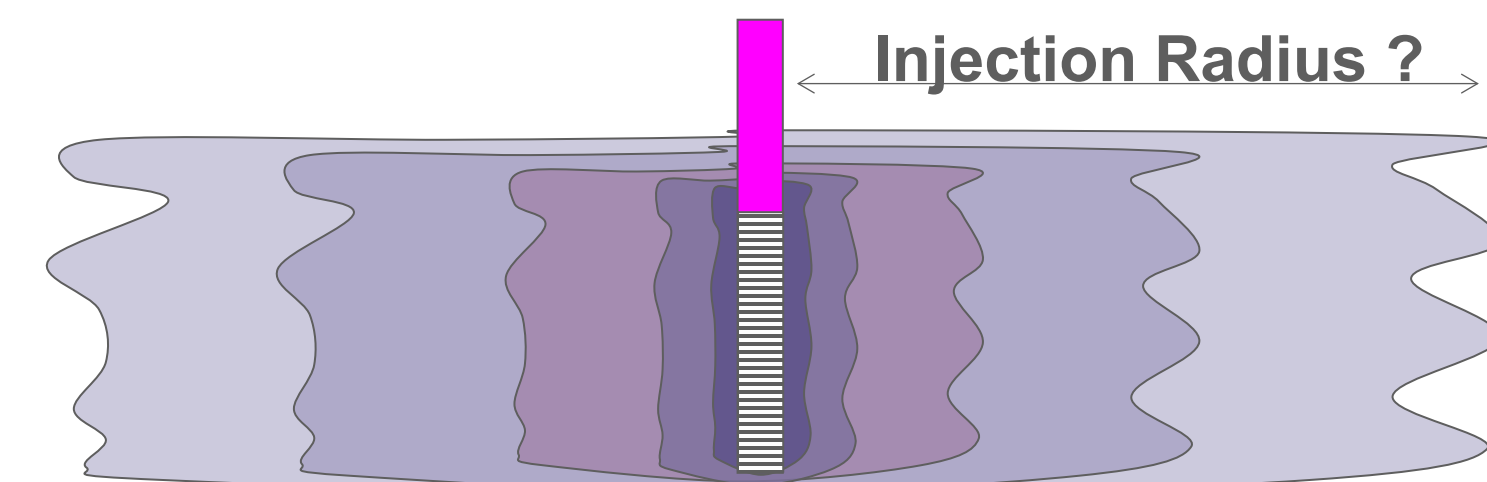


Section / Request Information	Initial Risk Status	Prepared PPH Comments/Notes/Explanation	Reviewed Comments/Notes/Explanation	PHS/OSHA HCS 2012 Compliance and PPH True Statement will justify design and/or construction to mitigate or minimize risk of project site incidents	Revised Risk Status
Does the SDS contain information regarding the hazards of the chemical? (e.g., GHS hazard pictograms, signal words, hazard statements, precautionary statements, etc.)	Yes				
Does the SDS contain information regarding the physical, chemical, and toxicological hazards of the chemical? (e.g., physical state, color, odor, boiling point, melting point, etc.)	Yes				
Does the SDS contain information regarding the reactivity of the chemical? (e.g., stability, reactivity with air, water, acids, bases, oxidizing agents, etc.)	Yes - describe	Verify and update all data on work for these three categories			
Does the SDS contain information regarding the environmental hazards of the chemical? (e.g., aquatic toxicity, bioaccumulation, etc.)	Yes - describe	PPH and HCS/Label of all chemicals must be updated			
Is the SDS up-to-date and reflects the current information? (e.g., SDS version number, revision date, etc.)	Yes	Greater than 25 feet from all buildings, roads, and other structures, except for the designated of support structure			
Does the SDS contain information regarding the safe handling and use of the chemical? (e.g., personal protective equipment, engineering controls, etc.)	Partially - describe	Full work for SDS and signage and monitoring			
Will the SDS be used by the workers? (e.g., SDS availability, training, etc.)	Yes				
Does the SDS contain information regarding the disposal and handling of the chemical? (e.g., waste management, etc.)	Yes				
Does the SDS contain information regarding the emergency response procedures for the chemical? (e.g., first aid, fire, spill, etc.)	Yes				
Does the SDS contain information regarding the transport and storage of the chemical? (e.g., labeling, packaging, etc.)	Yes - describe	Examine SDS program followed for inventory, activities - will be carried through for all program			
Does the SDS contain information regarding the stability and reactivity of the chemical? (e.g., stability, reactivity, etc.)	Yes - describe	Plan is generally accurate. Missing and providing the SDS, and SDS, ERM to ensure safety. MSDP			
Does the SDS contain information regarding the environmental fate and effects of the chemical? (e.g., environmental fate, etc.)	Yes - describe	Regulatory program will require the completion of a preliminary ERM investigation, which will be the basis for the ERM program specific to the site to be applied			
Does the SDS contain information regarding the physical and chemical properties of the chemical? (e.g., physical and chemical properties, etc.)	Yes	ERM to provide overall and to allow for field use			
Does the SDS contain information regarding the safety and health information of the chemical? (e.g., safety and health information, etc.)	Yes	Not applicable for these materials			



“Plans are nothing; planning is everything”

Dwight D Eisenhower



Top Skills – II. Executing



- Seeing and understanding
- Team engagement
- Premobilization meeting
- Control access to work area
- Use of state-of-the-art techniques and equipment
- Consistent reconciliation and progress tracking
- Site observations used to update conceptual model



“The fun for me in collaboration is, one, working with other people just makes you smarter, that’s proven.”

Lin-Manuel Miranda



Top Skills – III. Correcting

- Timely and relevant **communication**
- Procedure **modification** – recognize what is “working” and change what isn’t
- Recognize the law of “**unknown unknowns**” applies



“But I canna change the laws of physics, Captain!”

Scotty

What Can You Do?

- **Engage** all individuals at the implementation site, to create a true team atmosphere. Project success depends on a united approach toward preservation of safety and minimizing risk to the team, the Site, and the environment
- **Empower** teams to find, respond to and correct problems during all phases of activity from planning, through execution and closure

“There is no ‘I’ in the word ‘team’”
Peter Drucker



What Can You Do?

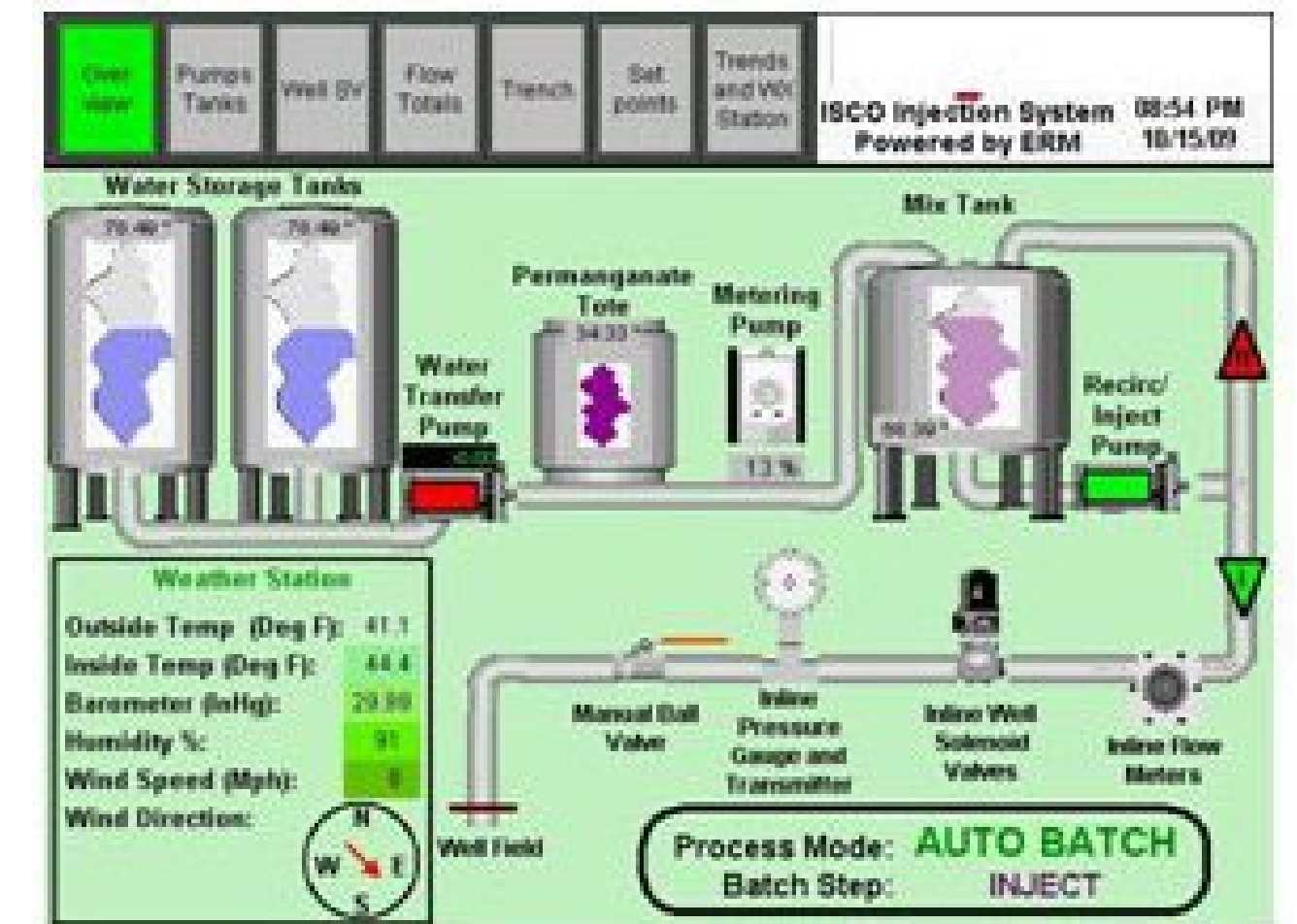
- **Vigilance** of everyone during all phases of the works, especially during implementation, to eliminate deficiencies and detect unwanted conditions
- **Share** information on incidents, near-misses, and continuous improvements within the industry to increase the state-of-the-art processes, provide safe procedures for all and facilitate the completion of safe and effective remedial programs into the future

If you are onsite, you are a part of the team!

If you are not onsite, you are still part of the team!

*“Only a fool learns from his own mistakes.
The wise man learns from the mistakes of others”*

Otto von Bismarck



QUESTIONS?



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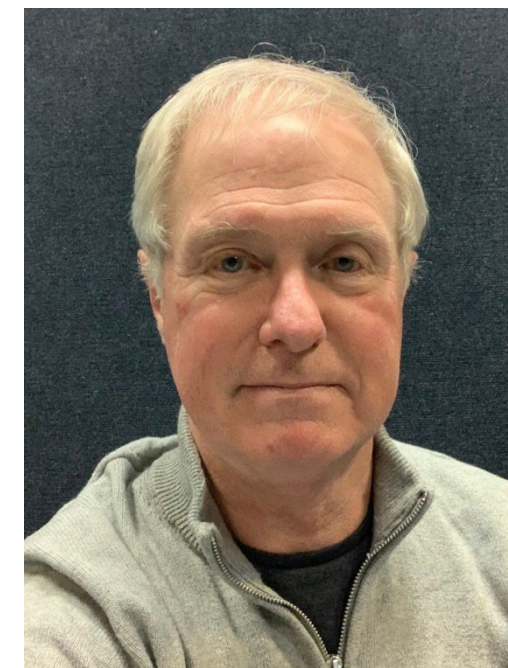
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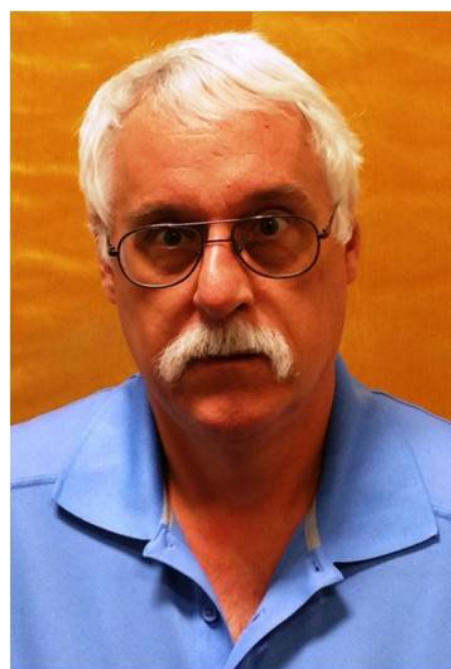


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