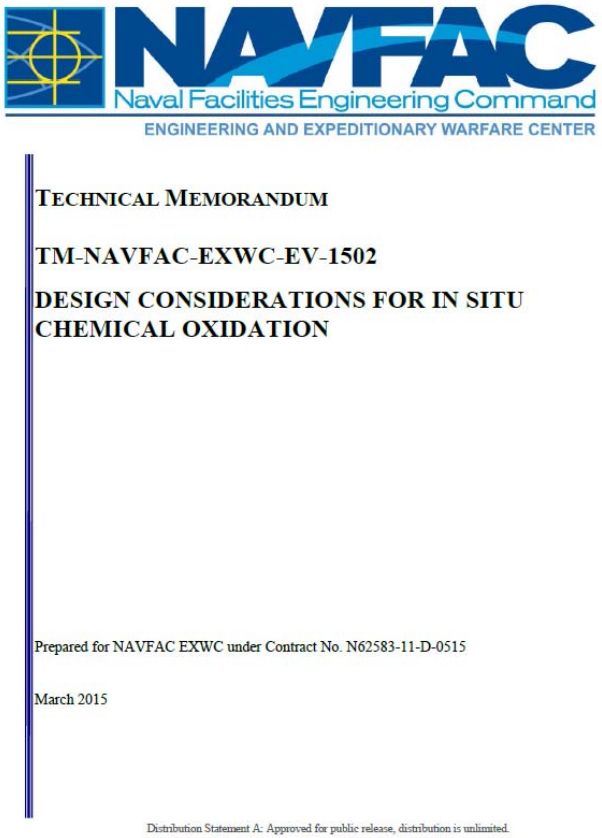
Naval Facilities Engineering Command
ENGINEERING AND EXPEDITIONARY WARFARE CENTER

NAVFAC RPM Tech Update: In Situ Chemical Oxidation Design Considerations

Presentation Overview

- Purpose
- Remedial Design Submittals
- Key CSM Elements
- Key Design Elements
- Drawings
- Specifications and Standards
- Schedule



Purpose

Develop improved and consistent design submittals within DON Environmental Restoration Program

- Provides a framework for ISCO design submittals
- Summarizes best practices for ISCO design
- Tips on appropriate QA/QC measures
- Information can be incorporated into a design format suitable to the scope of the project
  - Work Plan Approach
  - Design-Build Approach

Remedial Design Submittals

Work Plan Approach

- Draft review (15-30% design = conceptual design)
- Draft final review (50-60% design = preliminary design submittal)
- Final submittal (90-100% = final design)

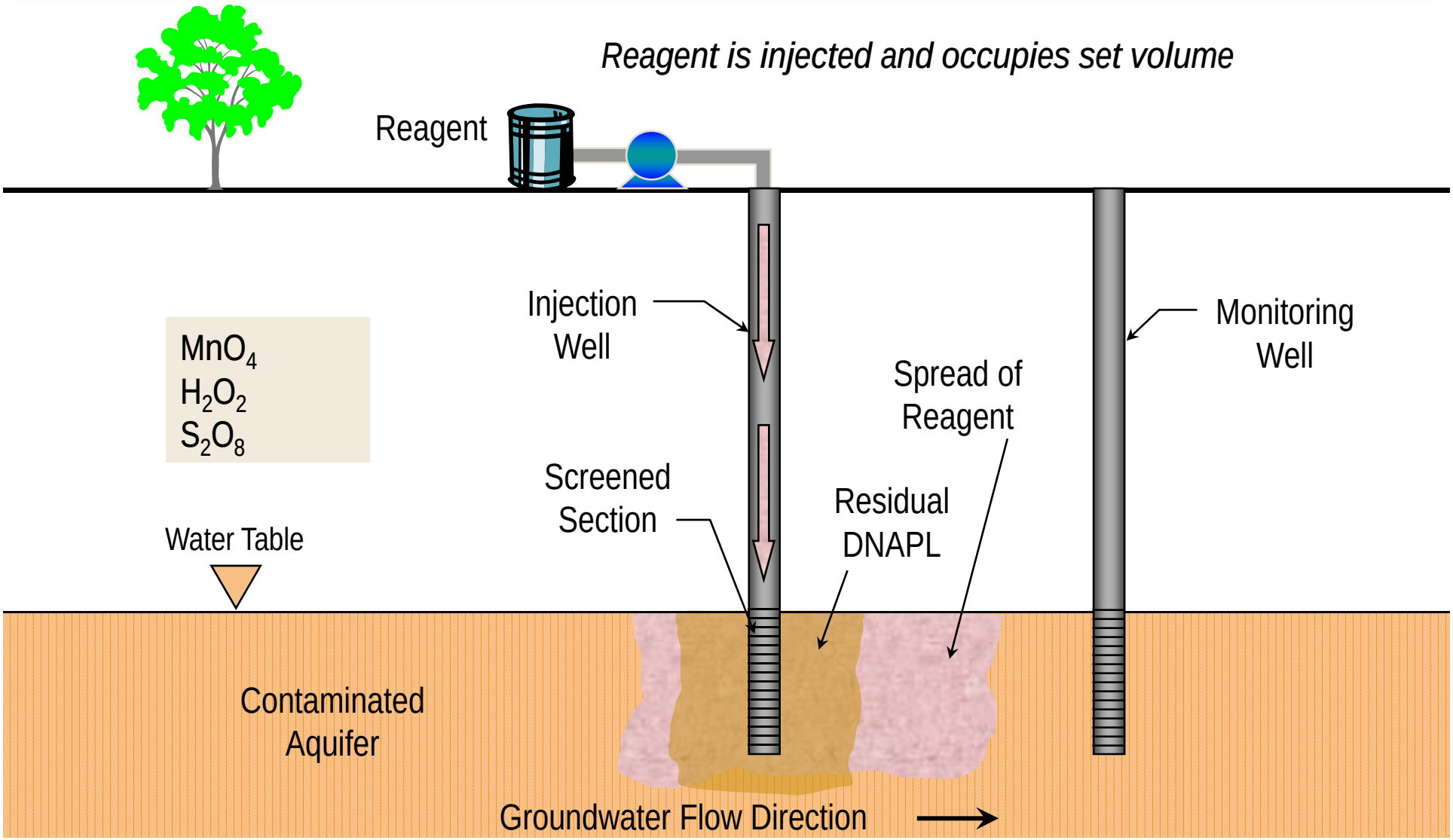
Design-Build Approach

- Contains Performance-Based Language
- Drawings and Specifications

Remedial Design Submittals (cont.)

Basis of Design	• Conceptual site model, rationale for design, calculations, descriptions
Drawings	• Detailed drawings describing system construction and operation
Specifications	• Detailed performance based specifications on construction, operation and maintenance
QA/QC plans	• Project-specific contractor quality control (CQC) plan
Schedule and Milestones	• Remedial designs performed in several phases

ISCO Conceptual Process



Key CSM Elements

Nature and extent of contamination

- Mass of COCs, age and origin of COCs, heterogeneity of COC, COC physical and chemical properties

Human and ecological health risks

- Risks presented by COCs and oxidants

Fate and transport of the COCs

- Location of injection, concentration of oxidants, flowrates, delivery mechanism

Key CSM Elements (cont.)

Site-specific infrastructure and characteristics

- Urban vs. rural environment, presence of buildings and utilities, proximity to nearby receptors, current and future land use

Hydrogeology

- Understand lithology, hydrogeology, groundwater velocity, mineralogy

Hydrogeochemistry

- DO, ORP, buffering capacity, pH, soil organic matter to estimate foc and distribution coefficients (Kd)

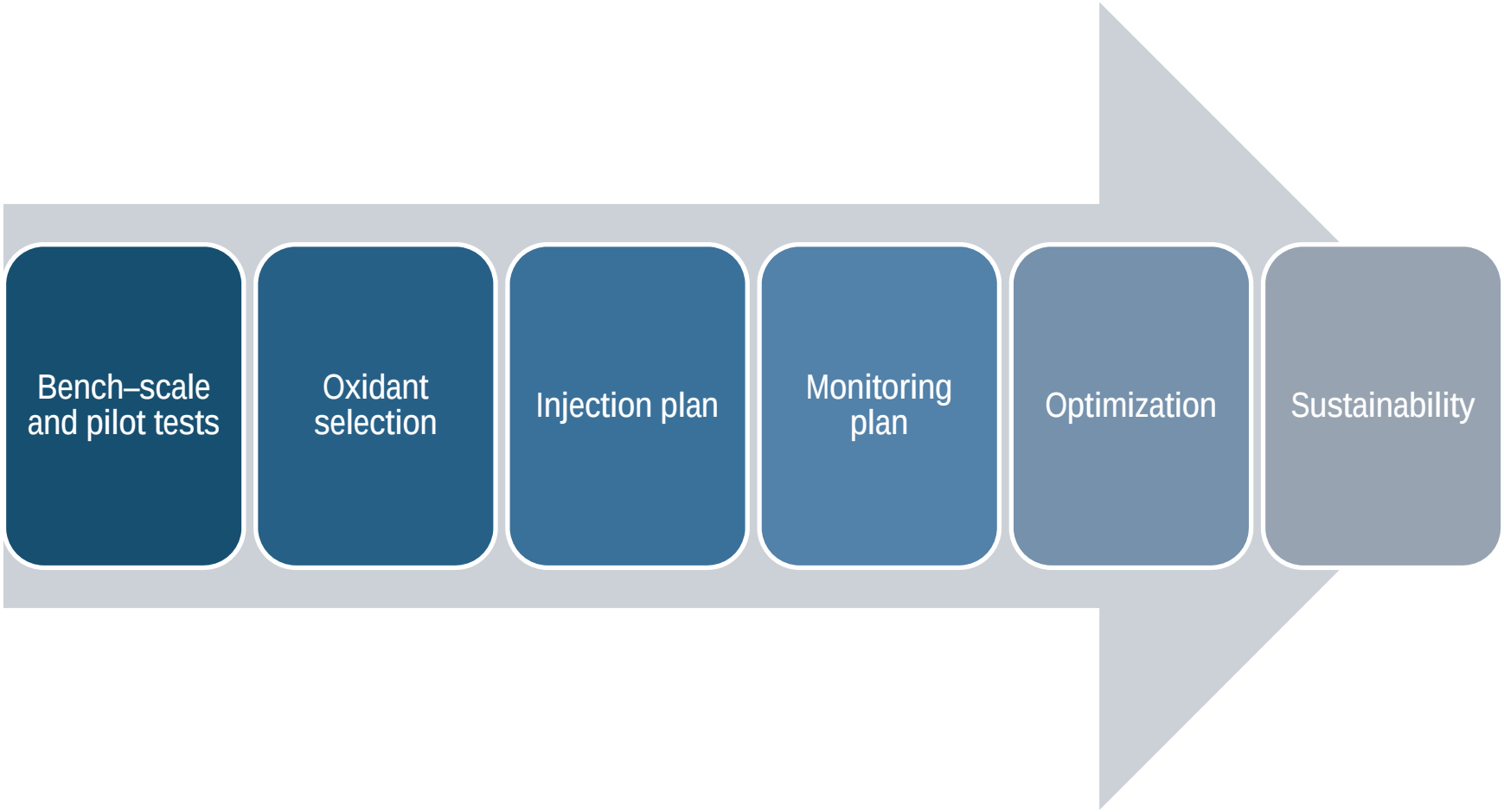
Key Concerns for Regulators and Stakeholders

Common stakeholder concerns include:

- Time required to complete field implementation
- Time required to meet remedial action objectives
- Redistributing contaminant into uncontaminated zones
- Potential for vapor intrusion during implementation
- Potential for re-injecting contaminated groundwater
- Creating byproducts or changes to geochemistry

Address concerns early in the design process and incorporate countermeasures into plans

Key Design Elements



Key Design Elements (cont.)

Bench-scale and Pilot Tests

- Selection of the optimal oxidant, oxidant concentrations, activator selection, determine natural oxidant demand, ROI (pilot-scale)

Oxidant Selection

- Site-specific design considerations for oxidants based on bench scale results ; several guidance documents available

Injection Plan

- Includes design parameters, injection and delivery approach, treatment milestones, contingencies, health and safety issues, regulatory issues

Key Design Elements (cont.)

Monitoring Plan

- Process monitoring; performance monitoring; measurement metrics, applicable milestones, contingency triggers

Optimization

- Incorporate optimization during site characterization, ISCO design and evaluation; construction; operation; and monitoring

Sustainability

- Incorporate best management practices (BMPs) for ISCO during construction and implementation

Oxidant Selection

Hydrogen Peroxide

- Exothermic/gases
- VI from heat/vapor
- Surfacing
- Short-lived, but stabilized with phosphate/citrate
- Iron, acid, chelating agents to activate or stabilize
- Materials must be compatible with heat
- Naturally-occurring carbonate or bicarbonate affects rates

Permanganate

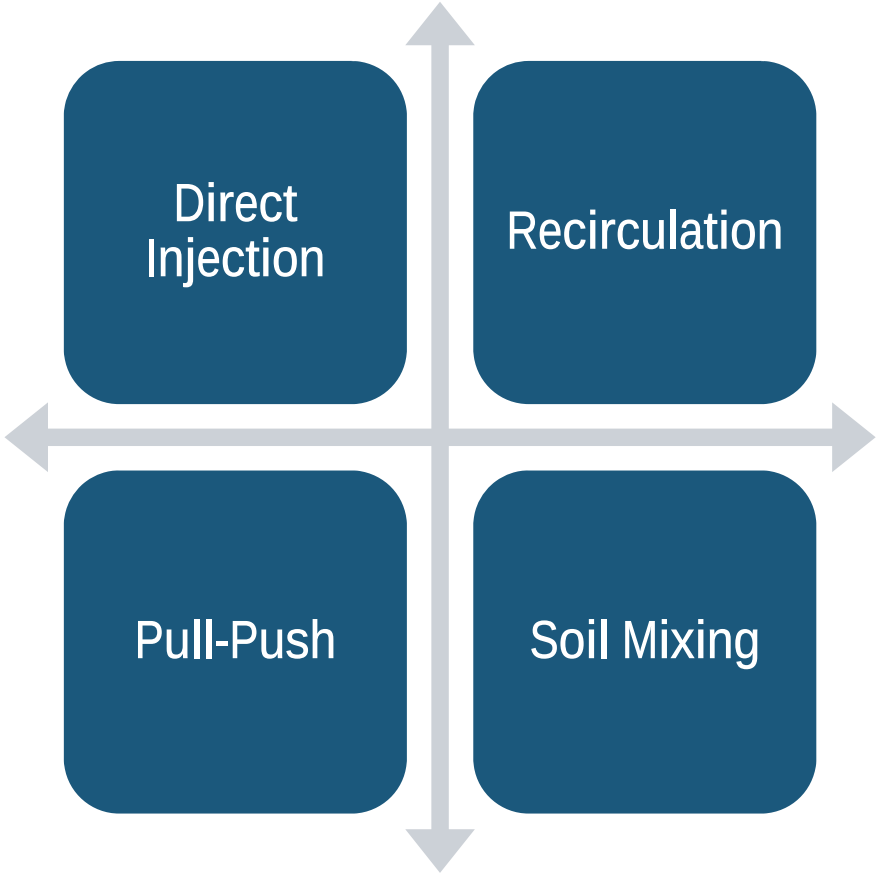
- Long lasting in aquifer
- Potential for long-term persistence if site is overdosed
- Can be used in barriers
- Purple color observed in surface water/wells if not controlled
- Manganese dioxide, insoluble precipitate
- Lower oxidation potential vs. persulfate and peroxide, so not applicable to some COCs

Persulfate

- Long lasting in aquifer if dosed greater than the demand
- Can be used in reactive barriers
- Compatibility with injection equipment
- Additional reagents to activate (strong bases, iron catalyst, chelating agent, hydrogen or calcium peroxide)

Injection Plan

- Document outlines key contents for injection plan and strategies for selecting the delivery method



Monitoring Plan

Process and performance monitoring involves observing and measuring parameters that provide information about the state of the remedial action during implementation

Process Monitoring Example Elements

- Groundwater levels, pressures, flow rates and volumes
- Oxidant activator and concentrations
- Visual observations, soil gas and well vapors
- Groundwater temperature
- Groundwater quality (DO, ORP, pH, conductivity)
- Total organic carbon
- Metal concentrations

40+ GSR BMP Examples for ISCO

Materials Management & Waste Reduction

- Consider amount of oxidant needed for adequate treatment
- Consider carbon footprint of oxidants during selection
- Footprints of the most commonly used oxidants include:
  - Hydrogen peroxide: 1.2 tons CO_2 per ton
  - Sodium persulfate: 1.25 tons CO_2 per ton
  - Potassium permanganate: 4 tons CO_2 per ton
- Consider reusing existing wells for injections and monitoring to the extent practical

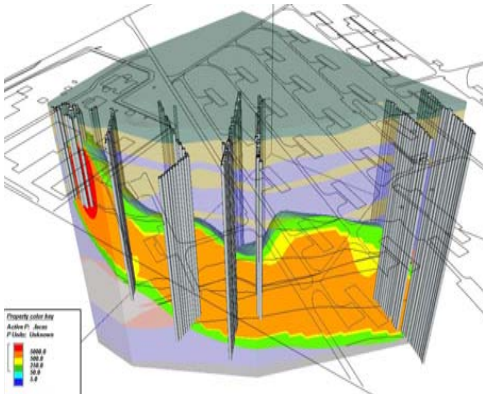
Example ISCO System Layout

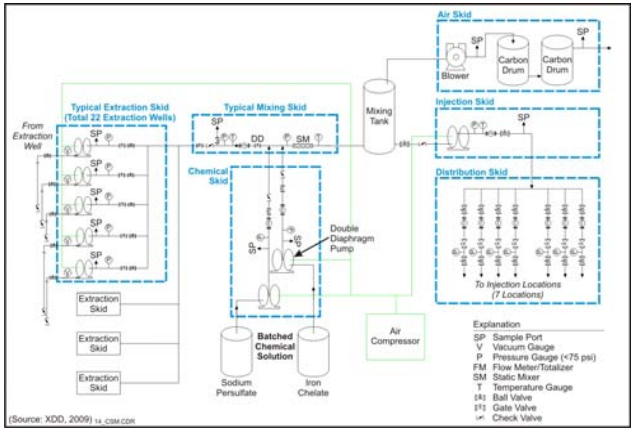
Courtesy of Battelle

Drawings

Design submittals should include the following drawings

- Site layout drawing
- Target treatment area schematic
- Injection location drawings
- Well and/or injection point design
- Process and instrumentation diagram for above ground equipment
- Monitoring location map





Courtesy of Battelle

Specifications and Standards

UFC system is prescribed by MIL-STD-3007 (Department of Defense, 2006a)

- FEAD adheres to the UFC system, RPMs should confirm the applicable format if the project involves FEAD oversight
- The most important message is to ensure that the technical content requirements are met regardless of the selected format

Unified Facilities Guide Specifications (UFGS)

- Used to organize specifications and other project information
- Document identifies UFGS that may be applicable to ISCO projects

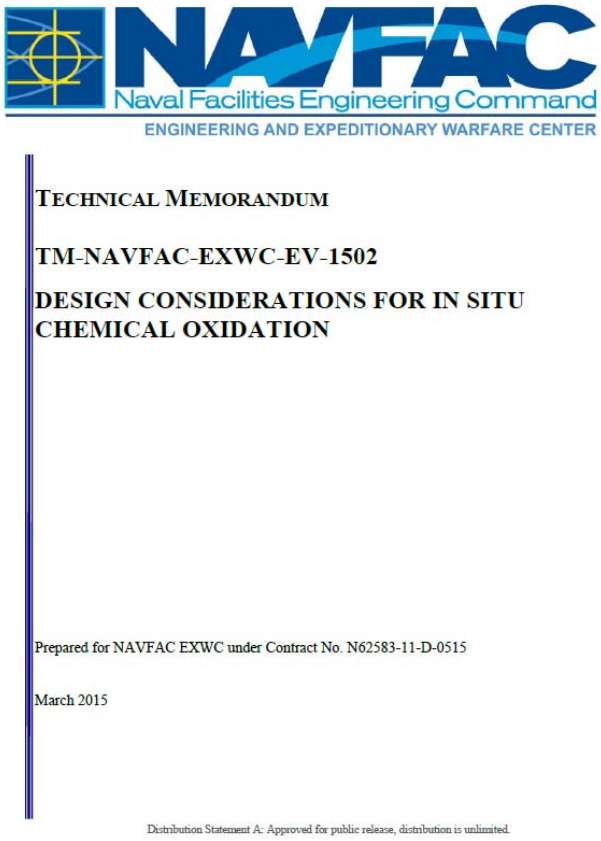
Schedule

- Schedule should be included as part of the design

Example Milestones
Submittal and acceptance of 30%, 60%, 90% and 100% design
Completion of Site Preparatory Activities
Completion of First (Second and Third) Injection Event
Completion of First (Second and Third) Groundwater Monitoring Event
Submittal and Acceptance of Remedial Action Completion Report

Conclusions

- Visit the ERB Web site to download the ISCO Design Considerations document
- Share with your team
- Goal is to support optimized ISCO design and implementation
- Implement GSR BMPs for ISCO when it makes sense for your ER site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TECHNICAL MEMORANDUM

TM-NAVFAC-EXWC-EV-1502

DESIGN CONSIDERATIONS FOR IN SITU CHEMICAL OXIDATION

Prepared for NAVFAC EXWC under Contract No. N62583-11-D-0515

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