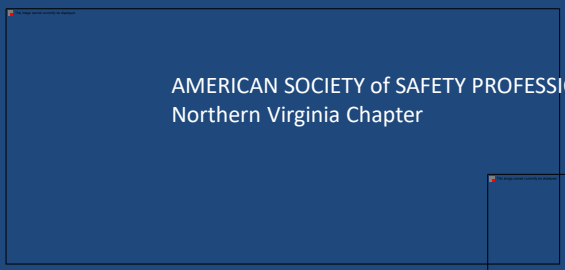
Intro to RCRA

Environmental Regulation Overview



AMERICAN SOCIETY of SAFETY PROFESSIONALS
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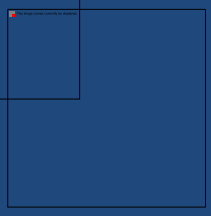


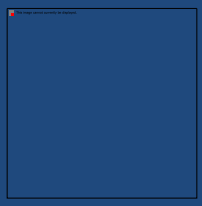
Wichita State University
Department of Environmental,
Health & Safety

Defining Hazardous Waste

- In order for a material to be considered a hazardous waste, it must first meet the definition of a solid waste. (40 CRF 261.2)
- A solid waste is any material that is discarded.
  - Abandoned
  - Inherently waste-like
- May be a solid, liquid, gas, or any combination of these physical states.
- Exclusions to the solid waste definition:
  - Domestic sewage sent to sanitary sewer
  - Spent Sulfuric Acid
  - Other industrial exclusions

Defining Hazardous Waste

- Exhibits characteristic hazards:
  - Ignitibility
  - Corrosivity
  - Reactivity
  - Toxicity



Defining Hazardous Waste

- Specifically listed in regulations :
  - F-List (Non-specific sources)
  - K-List (Specific sources)
  - P-List (Acutely Toxic Commercial Chemical Products)
  - U-List (Commercial Chemical Products)

Generator Classifications

- Very Small Quantity Generator
- Small Quantity Generator
- Large Quantity Generator
- * Conditionally exempt small quantity *

Very Small Quantity Generators (VSQGs)

- Very Small Quantity Generators (VSQGs) generate 100 kilograms or less per month of hazardous waste or one kilogram or less per month of acutely hazardous waste.
- Requirements for VSQGs include:
- VSQGs must identify all the hazardous waste generated.
- VSQGs may not accumulate more than 1,000 kilograms of hazardous waste at anytime.
- VSQGs must ensure that hazardous waste is delivered to a person or facility who is authorized to manage it.

Small Quantity Generators (SQGs)

Small Quantity Generators (SQGs) generate more than 100 kilograms, but less than 1,000 kilograms of hazardous waste per month.

•SQGs may accumulate hazardous waste on-site for 180 days without a permit (or 270 days if shipping a distance greater than 200 miles).
•The quantity of hazardous on-site waste must never exceed 6,000 kilograms.
•SQGs must comply with the hazardous waste manifest requirements at 40 CFR part 262, subpart B and the pre-transport requirements at 40 CFR sections 262.30 through 262.33.
•SQGs must manage hazardous waste in tanks or containers subject to the requirements found at 40 CFR sections 262.16(b)(2) and (3).
•SQGs must comply with the preparedness and prevention requirements at 40 CFR sections 262.16(b)(8) and (9), and the land disposal restriction requirements at 40 CFR part 268.
•There must always be at least one employee available to respond to an emergency. This employee is the emergency coordinator responsible for coordinating all emergency response measures. SQGs are not required to have detailed, written contingency plans.

Large Quantity Generator

- Large Quantity Generator (LQG) Standards:
  - Large Quantity Generators
  - generate 1,000 kilograms per month or more of hazardous waste or more than one kilogram per month of acutely hazardous waste
    - Accumulation of hazardous waste up to 90 days.
      - Hazardous waste must be shipped off site within this time period.
      - 90-day limit does not apply to satellite accumulation.
    - If hazardous waste is stored longer than 90 days, only one extension may be granted by KDHE .
    - Must submit annual waste report and monitoring fee to KDHE
    - Conduct weekly inspections of hazardous waste storage areas.
      - Satellite accumulation areas not part of inspection requirement.
    - Must conduct waste determinations for every waste stream generated.
      - Documented for at least 3 years after last shipment of waste stream.
      - Additional supporting documentation required
        - Safety Data Sheets (SDS's)
        - Process Flow Diagrams
        - Analytical Results (TCLP)
    - The only waste stream not required to have a waste determination is office trash

Satellite Accumulation

- Hazardous waste generators may accumulate up to 55 gallons of hazardous waste or up to 1 quart of acutely hazardous waste in one area if:
  - The container is located at or near the point of waste generation
  - Under the control of the operator
  - Labeled with the words "Hazardous Waste"
  - Kept closed except when adding or removing waste
    - Funnels latched
    - Lids and bungs tightened

Satellite Accumulation

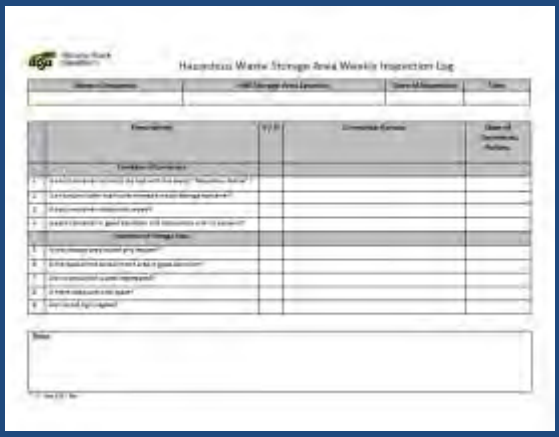
- Only one satellite container per waste stream is allowed in the same location
  - Once a satellite container becomes full, it must be marked with the date if became full and moved to the hazardous waste storage area within 72 hours.
  - Satellite containers can not be consolidated into another satellite container
- Hazardous waste accumulation in containers greater than 55 gallons must be managed as "Storage Containers."
  - Must be marked with an accumulation start date on the day waste is first placed in the container
  - Must be shipped off site within 90 days
  - Must be inspected weekly

Inspections

- Large Quantity Generators must conduct and document weekly inspections of hazardous waste storage areas.
  - Container labeling
  - Accumulation start dates
  - Container closure and condition
  - Evidence of leaks or spills
  - Accumulation area locked and secured
  - Containment area base in good condition
  - Incompatible wastes segregated
  - Adequate aisle space
  - Legible hazard signs

Inspections

- Weekly inspections records must also include:
  - Name and signature of the inspector
  - Date and time of the inspection
  - Observations of any deficiencies
  - Date, time, and nature of any remedial actions



Characteristic Hazardous Waste

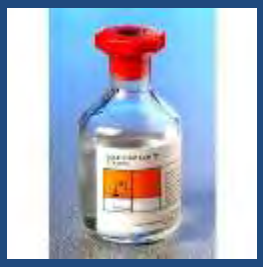
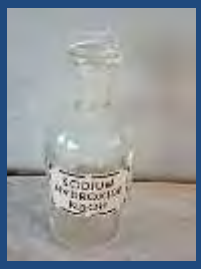
Characteristic Hazard	EPA Waste Codes
Ignitable	D001
Corrosive	D002
Reactive	D003
Toxic	D004 – D043

Ignitiblity Characteristic

- EPA Waste Code D001
  - Liquids with Flashpoint of < 140° F
  - Solids that may cause a fire through friction, absorption or moisture
  - Solids that may spontaneously combust at normal temperature and pressure
  - Ignitable compressed gases
  - Oxidizers (chlorate, inorganic peroxides, permanganate)

Corrosivity Characteristic

- EPA Waste Code D002
  - Aqueous material with a pH ≤ 2 or ≥ 12.5
  - A liquid that corrodes steel at a rate > ¼ inch per year


Reactivity Characteristic

- EPA Waste Code D003
  - Normally unstable and readily undergoes violent change without detonating
  - Reacts violently with water
  - Forms potentially explosive mixtures with water
  - When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment
  - Cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a dangerous quantity
  - It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement
  - Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure

Determining Toxicity

- EPA Waste Codes D004 – D043
  - Toxicity can be determined by process knowledge using a Safety Data Sheet (SDS) or by a Toxicity Characteristic Leachate Procedure (TCLP)
  - TCLP
    - Standardized test method used for determining levels of hazardous constituents in a sample material
    - Sample material is exposed to an acidic solution that simulates landfill leachate
    - Solution is analyzed for toxic constituents
    - Analysis is used to determine if the toxic constituent levels are above the regulatory limit in Table 1 of 40 CFR §261.24

Determining Toxicity

- EPA Waste Codes D004 – D043

Chemical	EPA Code
Arsenic	D004
Barium	D005
Benzene	D018
Cadmium	D006
Carbon Tetrachloride	D019
Chlordane	D020
Chlorobenzene	D021
Chloroform	D022
Chromium	D007
o-Cresol	D023
m-Cresol	D024
p-Cresol	D025
Cresol	D026
2,4-D	D016
1,4-Dichlorobenzene	D027

Chemical	EPA Code
1,2-Dichloroethane	D028
1,1-Dichloroethylene	D029
2,4-Dinitrotoluene	D030
Endrin	D012
Heptachlor	D031
Hexachlorobenzene	D032
Hexachlorobutadiene	D033
Hexachloroethane	D034
Lead	D008
Lindane	D013
Mercury	D009
Methoxychlor	D014
Methyl Ethyl Ketone	D035
Nitrobenzene	D036
Pentrachlorophenol	D037

Chemical	EPA Code
Pyridine	D038
Selenium	D010
Silver	D011
Tetrachloroethylene	D039
Toxaphene	D015
Trichloroethylene	D040
2,4,5-Trichlorophenol	D041
2,4,6-Trichlorophenol	D042
2,4,5-TP (Silvex)	D017
Vinyl Chloride	D043

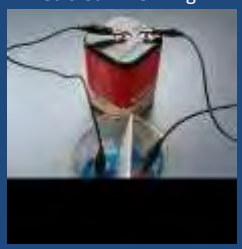
- These waste codes apply when the waste fails a Toxicity Characteristic Leaching Procedure (TCLP) test.

Listed Hazardous Waste

F-Listed Waste	K-Listed Waste	P & U-Listed Waste
• Non-specific sources	• Specific Sources	• Discarded Commercial Chemicals

F-Listed Waste

- Wastes from non-specific sources
  - Spent Non-Halogenated Solvent (F003, F005)
  - Spent Halogenated Solvent (F001, F002)
  - Degreasing Operations
  - Electroplating
  - Petroleum Refining



K-Listed Waste

- Wastes from specific sources
  - Wood preservation process wastes
  - Inorganic pigment production wastes
  - Organic Chemical distillation still bottoms
  - Pesticide production wastes
  - Explosives manufacturing wastes
  - Veterinary pharmaceuticals production residues and sludges
  - Ink formulation washes and sludges

P-Listed Waste

- Discarded Commercial Chemical Products
  - Acutely Toxic Chemicals
  - Very hazardous to health and environment
  - Must be in unused form for P-code to apply
  - Container residues and spill residues are considered P-listed wastes
  - Examples:
    - Sodium Azide – P105
    - Acrolein – P003
    - Sodium Cyanide – P106
    - Nicotine, & Salts – P075
      - Used nicotine patches/gum are not considered P-listed wastes since they have been used for their intended purpose.

U-Listed Waste

- Discarded Commercial Chemical Products
  - Toxic Chemicals
  - Slightly less hazardous than P-listed wastes
  - Must be in unused form for U-code to apply
  - Container residues and spill residues are considered U-listed wastes
  - Examples:
    - Acetone – U002
    - Acetonitrile – U003
    - Hydrofluoric Acid – U134
    - Methanol – U154
    - Mercury – U151

Empty Containers

- Containers are considered empty when:
  - All contents are removed by normal procedure and
    - < 1 inch or < 3% remains in a non-bulk container
    - <0.3% remains in a bulk container
      - Bulk container is considered > 119 gallons
  - Normal Procedure refers to the standard process of removing contents from container
    - Siphon pump
    - Hand-pouring
  - The general rule for an empty container on campus is "drip dry"
- These standards do not apply to compressed gas cylinders or acutely toxic chemicals (P & U List)
  - Cylinders must be at or near atmospheric pressure
  - Acutely toxic chemical containers must be triple-rinsed with an appropriate solvent before they can be considered empty

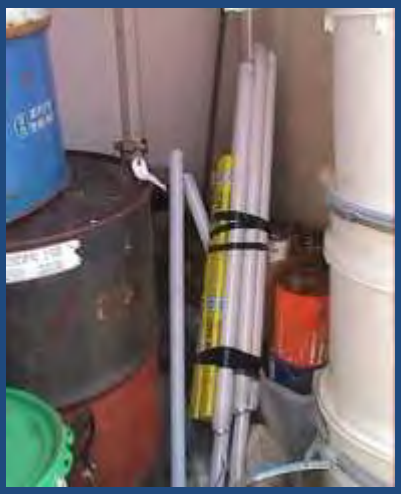
QUESTIONS

Other Wastes

- Universal Waste
- Polychlorinated Biphenyl (PCB)
- Used Oil
- Medical Waste
- Lead-Acid Batteries

Universal Waste

- Universal Waste includes:
  - Used Batteries
  - Pesticides
  - Mercury-containing equipment
  - Waste Lamps
    - Fluorescent
    - HID
    - Neon
    - Mercury Vapor
    - High Pressure Sodium
    - Metal Halide
    - LED



Universal Waste Requirements

- Universal Waste containers must be:
  - Closed except when adding or removing waste
  - Marked with an accumulation start date on the day waste is first placed in the container
  - Shipped off site within 1 year
  - Labeled with the words "Universal Waste_____"

Used Oil Definition

- Definition of Used Oil (40 CFR 279.10)
  - Any oil that has been refined from crude oil, or any synthetic oil, that has been used and as a result of such use is contaminated by physical or chemical impurities.
  - Used Oil includes, but is not limited to
    - Materials that contain free-flowing used oil
    - Wastewaters that contain more than "de minimis" amounts of used oil
    - Water-soluble cutting oils and coolants
    - Heat transfer oils

Used Oil Requirements

- Used oil generators must comply with the following storage requirements:
  - All containers, aboveground tanks, and fill pipes for underground tanks must be labeled with the words “Used Oil”
  - All storage units must be in good condition
    - Not leaking or corroded
  - Used oil spills must be cleaned up immediately in order to prevent the release from impacting the environment
    - Granular absorbent, spill pads, rags
    - Any used oil spill debris may be placed in the regular trash for landfill disposal
  - Free-flowing used oil must be shipped off-site for recycling

Used Oil Filters

- Non-tern used oil filters that are properly hot drained for 12 hours or are processed to remove all free-flowing used oil are exempt from the hazardous waste regulations.
  - May be disposed of at a permitted landfill (recycling preferred)
  - Still require proper labeling
    - “Used Oil Filters”

Lead-Acid Batteries

- Lead-acid batteries are regulated as hazardous wastes only if they are NOT recycled.
  - May also be managed as Universal Waste
  - Must be labeled “Universal Waste Batteries” with an accumulation start date

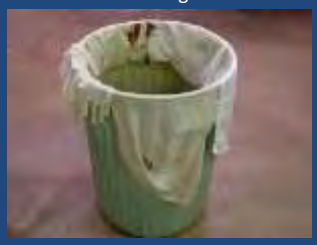
Leaking batteries are considered hazardous waste until the leaking sulfuric acid is cleaned up

Mud-Trap Waste

- The mud-trap located north of the Landscape Building is used for the collection of dirt, leaves, grass clippings and grime from the power-washing of landscape equipment.
  - Nothing else should be poured or allowed to drain into the pit
  - Wipe off any of the following substances prior to washing equipment
    - Oil
    - Fuel
    - Pesticides
    - Any other chemical
- Mud-trap waste samples are routinely sent for analytical testing to verify it is non-hazardous.

Solvent-Contaminated Rags

- Solvent-Contaminated Rags may be considered hazardous waste depending on the chemical being used.
  - These rags are managed as hazardous waste within Facilities Services and must be disposed of in an appropriate hazardous waste container
    - Paint Shop
    - Carpentry Shop
    - Automotive Shop
  - Do not throw into regular trash or allow to air dry



Review

- All hazardous waste containers must:
  - Remain closed except when adding or removing waste (funnels latched/lids closed)
  - Be labeled with the words “Hazardous Waste”
- All universal waste containers must:
  - Remain closed except when adding or removing waste
  - Be labeled with the words “Universal Waste_____“
  - Be marked with an accumulation start date
- All used oil containers must:
  - Be labeled with the words “Used Oil”
- No wastes shall be poured down the drain or into the mud trap
- No waste shall be allowed to air-dry prior to disposal

Questions?

Thank you

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Spill Prevention, Control, and Countermeasure Plan (SPCC) Overview

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Souderton, PA 18964

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Agenda

- SPCC Rule
  - Summary
  - History
- SPCC Rule Applicability
  - ASTs
  - USTs
  - Types of Oil
- What do Covered Facilities Have to Do?
- Tier I Qualified Facilities
- Reporting Requirements
  - National Response Center
  - SPCC Reporting Requirements

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SPCC Rule

- SPCC Rule Summary

- Found in 40 CFR Part 112
- Oil Pollution Prevention Regulation
  prevention of, preparedness for, and
  response to oil discharges at specific non-transportation-related facilities
- Develop and implement SPCC Plans

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SPCC Rule

- SPCC Rule History

- 1973 published under CWA
- 1990 Oil Pollution Act Amended CWA to include Facility Response Plans (FRP)
- Amendments:
- Milk Exemption – April 18, 2011
- 2009 Amendments

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2009 Amendments

- Address numerous issues raised by the regulated community
- Increase clarity
- Tailor and streamline certain industry sector requirements
- Facilitate compliance by facility owners or operators
- Effective January 14, 2010

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SPCC Rule Applicability

- Is the facility considered non-transportation related?
- Is the facility engaged in drilling, producing, gathering, storing, processing, refining, transferring, distributing, using, or consuming oil?
- Could the facility be expected to discharge harmful quantities of oil into navigable waters?

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SPCC Rule Applicability

- Is the total aggregate oil capacity of ASTs > 1,320 gal? (no < 55 gal, permanently closed, mobile or WWTP storage)
- Is the total aggregate oil capacity of buried storage tanks > 42,000 gal? (no solid waste underground tanks – 40CFR 280/281, <55 gal, permanently closed, or WWTP storage)

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Types of Oil Covered by SPCC

- Oil of any type and in any form is covered, including but not limited to: petroleum; fuel oil; sludge; oil refuse; oil mixed with wastes other than dredged spoil; fats, oils, or greases of animal, fish, or marine mammal origin; vegetable oils, including oil from seeds, nuts, fruits, or kernels; and other oils and greases, including synthetic oils and mineral oils.

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Milk Exemption

- April 18, 2011 Final Rule published exempting milk and milk product containers, associated piping and appurtenances
- Capacity of milk and milk product containers, associated piping and appurtenances should not be included in a facility's total oil storage capacity
- Originally oils included animal fats and vegetable oils under SPCC

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Milk Exemption

- Milk products includes cheeses, yogurts, and ice cream
- Spills of milk and milk products must be reported to the National Response Center (NRC) at 1-800-424-8802 or 1-202-426-2675. NRC is the federal government's centralized reporting center, which is staffed 24 hrs. per day by the US Coast Guard

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What do Covered Facilities have to do?

- Prevent oil spills
  - Use suitable containers for the oil stored
  - Provide overfill prevention for oil storage containers
  - Provide sized secondary containment for bulk storage containers, i.e. dike or impoundment
  - Containment needs to hold the full capacity of the container plus possible rainfall. Double-walled tank may also suffice.

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What do Covered Facilities have to do?

- Prevent oil spills
  - Provide general secondary containment to catch the most likely oil spill where oil is transferred between containers and for mobile refuelers and tanker trucks.
  - Inspect and test pipes and containers periodically. Written records of inspections should be in SPCC Plan

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What do Covered Facilities have to do?

- Prepare and implement an SPCC Plan
  - Prepare in accordance with good engineering practices
  - Implement the SPCC Plan within six months after beginning operations
  - Operating procedures to prevent oil spills
  - Operating Control measures installed to prevent oil spills from entering navigable waters or shorelines
  - Countermeasures to contain, cleanup, and mitigate the effects of an oil spill that has impacted navigable waters or shorelines

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Important Elements of an SPCC Plan

- Facility Diagram and Description
- Oil discharge predictions
- Appropriate secondary containment or diversionary structures
- Facility Drainage
- Site Security
- Facility Inspections
- Requirements for bulk storage containers including inspections, overfill, and integrity testing requirements

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Important Elements of an SPCC Plan

- Transfer procedures and equipment including piping
- Requirements for qualified oil-filled operational equipment
- Loading/unloading rack requirements and procedures for tank cars and tank trucks
- Brittle fracture evaluations for aboveground field constructed containers
- Personnel training and oil discharge prevention briefings

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Important Elements of an SPCC Plan

- Recordkeeping requirements
- Five-year plan review
- Management Approval
- Plan certification (by a Professional Engineer (PE) or in certain cases by the facility owner/operator)

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Tier I Qualified Facilities

- Have the option of completing and implementing a stream-lined, self-certified SPCC Plan template (Appendix G to the rule)

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Tier I Eligibility Criteria

- 10,000 gal or less in aggregate oil AST capacity
- For the 3 years prior to Plan certification, or since becoming subject to the SPCC rule, if operating <3 years, the facility must not have had:
  - A single oil discharge to navigable waters or shorelines exceeding 1,000 US gal, or
  - Two oil discharges to navigable waters or shorelines each exceeding 42 US gal within a 12-month period; and
- Max individual oil AST capacity of 5,000 US gal.

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Tier I Requirements

- Option to complete a self-certified SPCC Plan template instead of full PE certified SPCC Plan
- Template found in Appendix G to the SPCC Rule
- Template designed to be a simple SPCC Plan
- Limited to facilities that:
  - Don't use environmentally equivalent measures
  - Don't determine secondary containment to be impracticable
  - Don't need PE certification to comply with any rule requirements

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Summary Qualified Facilities Applicability

If the facility has…	And	And the facility has…	Then:
10,000 US gal or less aggregate oil AST storage capacity;	Within any 12-month period, three years prior to the Plan certification date, or since becoming subject to the SPCC rule if in operation less than three years, there has been: (1) No single oil discharge to navigable waters or shorelines exceeding 1,000 US gal; and (2) No two oil discharges to navigable waters or shorelines each exceeding 42 US gal in any 12-month period	No individual oil AST greater than 5,000 US gal; Any individual oil AST greater than 5,000 US gal;	Tier I: Complete and self-certify SPCC Plan template in lieu of full PE certified Plan Tier II: Prepare self-certified SPCC Plan in accordance with all applicable requirements of § 112.7 and subparts B and C of the rule, in lieu of a PE-certified SPCC Plan

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National Response Center (NRC)

- Report all oil discharges to waters of the US or shorelines to NRC at 1-800-424-8802
- Federal Gov centralized reporting center, staffed 24 hrs a day by US Coast Guard
- Any person in charge of a vessel or facility must notify NRC immediately after he/she has knowledge of the discharge
- NRC relays info to EPA or US Coast Guard depending on location
- An On-Scene Coordinator evaluates the situation and decides if federal response is necessary

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SPCC Reporting Requirements

- Report to EPA Regional Administrator when there is a discharge of:
- >1,000 US gal of oil in a single discharge to navigable waters or shorelines
- >42 US gal in each of two discharges to navigable waters or shorelines within a 12-month period

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SPCC Reporting Requirements

- When making this determination it is the amount of the discharge in gal that reaches navigable waters or shorelines (EPA considers the entire vol of the discharge to be oil for reporting purposes)
- An owner/operator must report the discharge(s) to the EPA Regional Administrator within 60 days

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For More Information

- Complete Oil Pollution Prevention Regulation (40 CFR Part 112)
  - http://www.gpoaccess.gov/cfr/
  - http://www.epa.gov/emergencies/lawsregs.htm
- EPA Emergency Management Website
  - www.epa.gov/emergencies
  - www.epa.gov/oilspill
- Superfund, TRI, EPCRA, RMP, and Oil Information Center
  - (800) 424-9346 or (703) 412-9810
  - TDD (800) 553-7672 or (703) 412-3323
  - http://www.epa.gov/superfund/resources/infocenter

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For More Information

- Government Printing Office Website at www.gpoaccess.gov/cfr to access current CFR
- SPCC Guidance for Regional Inspectors for more detailed guidance on specific SPCC provisions, at http://www.epa.gov/emergencies/content/spcc/spcc_guidance.htm

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Managing Contaminated Soil

Heather Tittjung, CHMM

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Agenda

- Management of Contaminated Soil
  - Ex Situ
    - Excavation
    - Blending/Landfarming
    - Soil Washing/ Soil Shredding
  - In Situ
    - Air Sparge/Soil Vapor Extraction
    - ISCO
    - Thermal Treatment

Ex Situ Managing of Contaminated Soil

- Ex-situ means Outside, off site, or away from the natural location

Excavation

- Digging up for disposal or treatment
- Commonly referred to as “dig and haul

- Pros
  - Contaminated soil is removed from the Site
  - Well understood process with a high degree of certainty of success
- Cons
  - Disruptive at active sites
  - Soil underneath buildings and in the area of underground utilities cannot be excavated
  - End point difficult to reach unless over excavate
  - Excavated soil must be treated and/or disposed of which can be expensive
  - Excavation does not address groundwater contamination

Small Excavations

Excavation for smaller spills may include a shovel and a drum. This drum of contaminated soil will be labeled, profiled at an appropriate landfill prior to disposal.

Following approval the drum will be transported to the approved landfill for disposal.
This is typically a cost effective method for this size of spill.

Large Excavations

Large Excavations and Weather Events

Containment

- Containment treatments are often performed to prevent or significantly reduce the migration of contaminants in soil or groundwater.
- Used whenever materials are to be buried or left in place.
- Performed when removal or the excavation of the contaminant presents a hazard, expected to incur unrealistic costs and other treatment technologies are not feasible

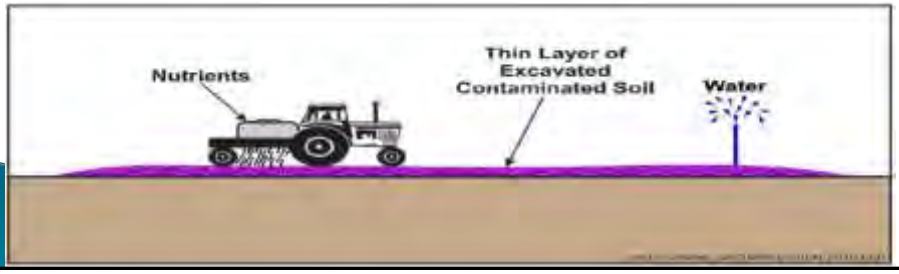
Example of a cover with several layers.

Containment

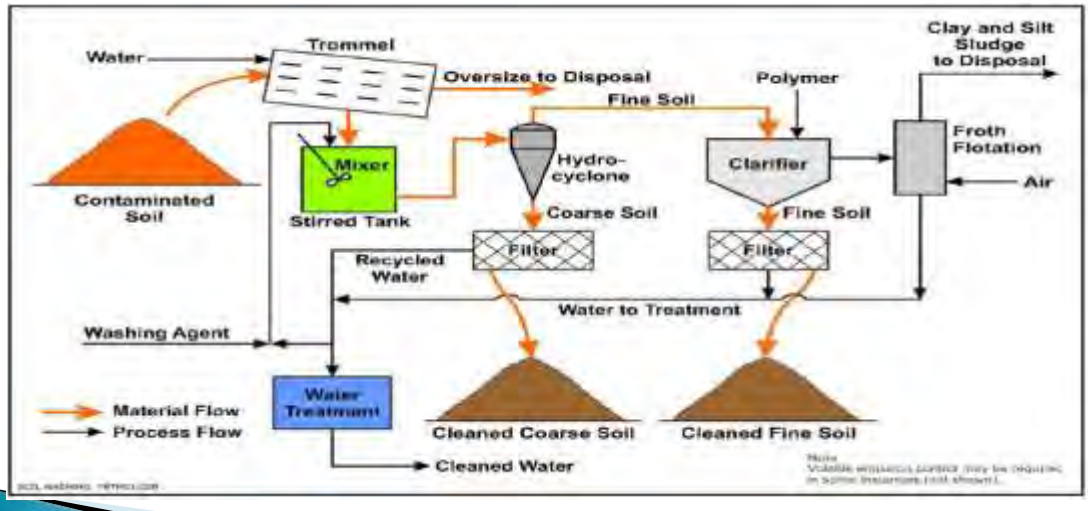
- Pros
  - Cost effectiveness
  - Temporary or long term solution
- Cons
  - May require extensive monitoring
  - Erosion and settlement
  - Invasive plants
  - Restricted land use

Ex Situ Land Farming

- Landfarming/Land Application
  - Uses agricultural practices to promote biodegradation of organic contaminants
- Typically requires an engineered design
- Large footprint
- Soil amendments can be added to accelerate process or increase microbial populations
- Routine maintenance



Ex Situ Soil Washing/Scrubbing



Soil Washing/Soil Scrubbing

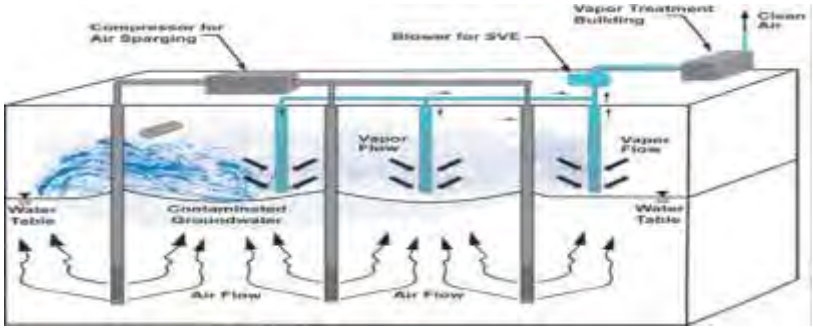
In Situ Management of Contaminated Soil

- In-Situ
  - Situated in original place

In Situ AS/SVE

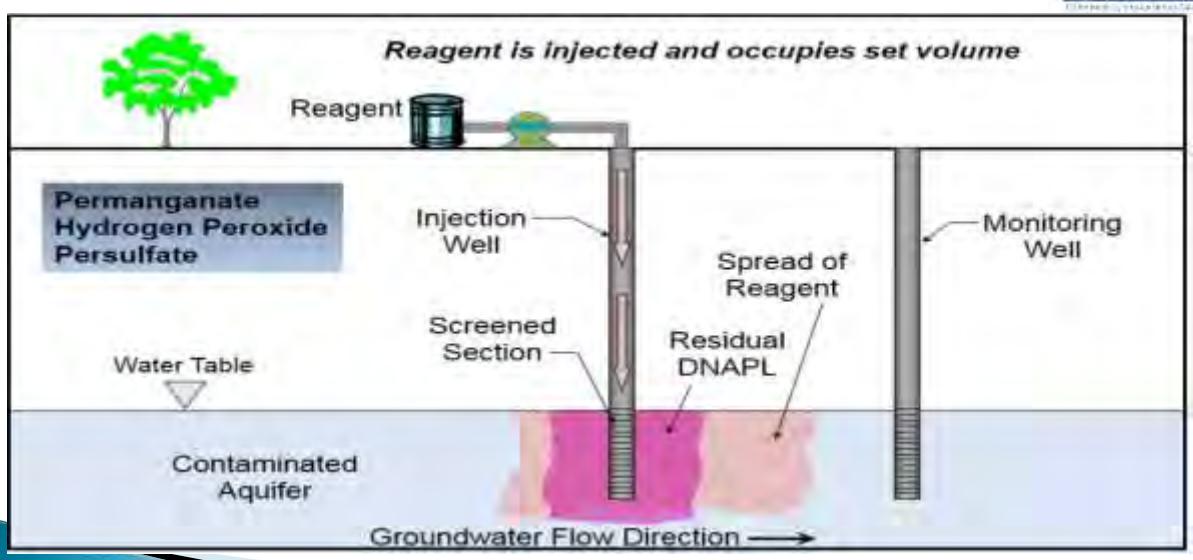
- Air Sparging (AS)
- Involves the injection of air or oxygen through a contaminated aquifer to remove volatile and semi-volatile organic contaminants by volatilization. The injected air helps to flush the contaminants into the unsaturated zone for treatment

- Soil Vapor Extraction (SVE)
- Applies a vacuum to unsaturated zone soil to induce the controlled flow of air and remove volatile and some semi-volatile organic contaminants from the soil.



In Situ Chemical Oxidation

- Oxidants are added to contaminated soil and groundwater a chemical reaction destroys the contaminates
- Used to treat contaminants like fuels, solvents and pesticides
- Typically injected underground in to treatment wells or borings
- For major oxidants are Permanganate, persulfate, hydrogen peroxide and ozone.
- ISCO is site specific and successful treatment is a function of an effective delivery system
- ISCO treatment may take longer when
  - The source area is large
  - Contaminates are trapped in fractures and clay
  - Groundwater flow is slow
- May require multiple applications which can be expensive



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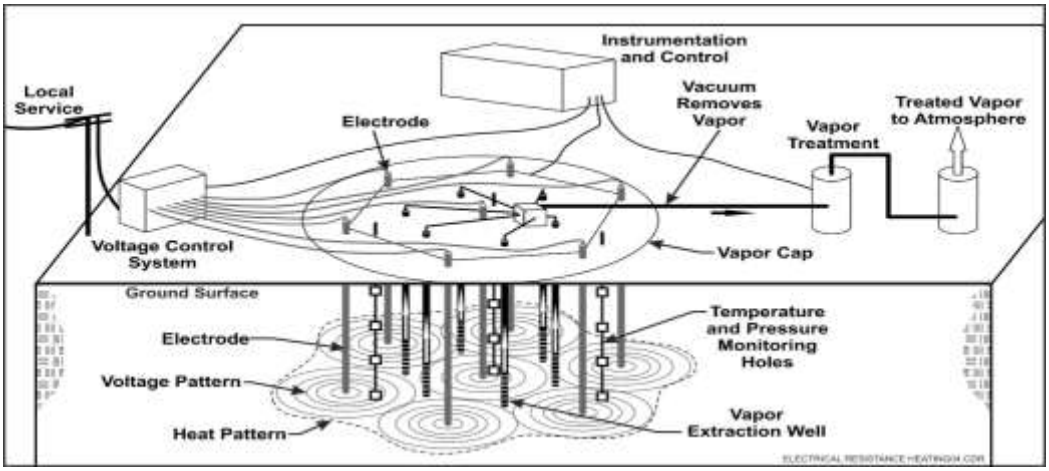
In Situ Thermal Treatment

- Uses heat to mobilize harmful chemicals from soil and groundwater
- Vapors treated above ground
- Types of In Situ Thermal methods
  - Electrical Resistant Heating
  - Steam Enhanced Extraction
  - Thermal Conduction Heating



Electrical Resistance Heating System Schematic

References and Resources

- Community Guide Series –Content maintained by EPA's Office of Superfund Remediation and Technology Innovation. 2021
  - https://clu-in.org/cguides/
- Technical/Regulatory Guidance for In Situ Chemical Oxidation of Contaminate Soil and Groundwater. Interstate Technology Regulatory Council (ITRC), Jan 2005
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