API Order No. G00004

Guidelines for Commercial Exploration and Production Waste Management Facilities

Exploration and Production Waste Management Facility Guidelines Workgroup

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Foreword

This document is the result of a cooperative effort among representatives of the oil and gas industry, commercial waste management facilities, and state governments to develop guidelines for managing exploration and production (E&P) waste. These guidelines reflect our industry's continuing commitment to environmental protection and to assuring that the wastes from oil and gas exploration and production are properly managed. These guidelines were developed by the an Exploration and Production Waste Management Facility Guidelines Workgroup, coordinated by the American Petroleum Institute (API), which represents a broad cross-section of parties interested in E&P waste management issues. The workgroup includes representatives from the following entities:

- American Petroleum Institute
- ARCO
- Chevron
- Exxon
- Marathon
- Mobil
- Newpark Resources
- Shell
- State of Colorado
- State of Louisiana
- State of Oklahoma
- State of Texas
- Texaco
- U.S. Liquids

These guidelines are intended to identify design, construction, and operational options that may be used, depending on site-specific conditions, at facilities to protect human health and the environment. Their purpose is to provide flexible guidance to waste management facility owners and operators while remaining protective of human health and the environment. Although these guidelines are intended to be useful to a varied audience, three audiences will find the information contained herein particularly useful: (1) E&P waste facility owners and operators; (2) customers of the waste management facility (*i.e.*, E&P companies); and (3) state regulatory personnel.

Please note that the terminology for various waste management techniques (e.g., land treatment) may vary from state to state. This document includes a glossary (Appendix D) that describes what is meant by the terms as they are used in this document.

Users of this document should also refer to API RP 2219, *Safe Operation of Vacuum Trucks in Petroleum Service* for additional guidance on safe handling of hazardous material and safety in vacuum truck operations. API RP 2219 includes emphasis on hazard communication with its associated training (including BS&W), and specific comments regarding open discharge and alternatives when unloading vacuum trucks. For additional guidance, users may also refer to OSHA Safety and Health Information Bulletin SHIB 03-24-2008 *Potential Flammability Hazard Associated with Bulk Transportation of Oilfield Exploration and Production (E&P) Waste Liquids.*

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Introduction

Production of oil and natural gas results in substantial volumes of waste products. Produced water and drilling muds and cuttings represent the majority of these wastes. In addition, a wide range of other wastes are produced in much smaller volumes. E&P wastes typically contain volatile organic compounds (VOCs) and other waste components that, if managed properly, have little potential to impact human health and the environment. Although most E&P wastes are managed on-site, approximately one percent of these wastes are managed by commercial and centralized waste management facilities located off-site. These facilities use a variety of treatment and disposal methods and are located in a variety of environmental settings throughout the United States. Although all oil and natural gas producing states regulate on-site E&P waste management, regulations specific to off-site E&P facilities are less universal. States lacking regulations specific to commercial facilities apply a combination of on-site requirements and site-specific determinations. In addition, all facilities, regardless of state regulation, are subject to numerous federal environmental regulations.

This document provides guidelines for the design and operation of commercial E&P waste management facilities. These guidelines may also be applicable to large centralized facilities operated by E&P companies. One objective of the guidelines is to allow facility operators to identify areas where their facility could have impacts on nearby populations or the surrounding environment and to provide options for preventing or reducing those impacts. These guidelines are not meant to supercede any applicable local, state, or federal requirements; they are intended to work with existing regulations and allow facilities to enhance protection of human health and the environment as warranted.

Specifically, this document provides facility operators with the following information:

- Key facility considerations (Chapter 1);
- Siting, design, and operating considerations for building a new facility or operating an existing one (Chapter 2);
- Options for assessing and reducing the potential impacts or nuisance that a facility's operations may pose to the surrounding environment and community (Chapters 3 and 4); and
- Other basic information, such as summaries of existing state regulations, regulatory contacts, and a glossary (Appendices).

Users are cautioned that the information in this document is not all-inclusive and may not cover all types of waste management situations. Because of the diversity of geographic, geologic, hydrologic, and climactic conditions in which E&P waste management facilities operate, these guidelines are designed to offer options or alternatives rather than prescribe recommended practices. What is appropriate for one location may not be appropriate in another. In developing these guidelines, it has been impossible to consider every factor that could affect whether the facility may have an impact on the surrounding environment; this effort has focused on the major considerations. Facility operators should consider the applicability of the options provided to the conditions at their site, also considering any relevant factors not covered by this document. Facility operators, working with state regulators where appropriate, are best positioned to determine the appropriate design, operation, and environmental protection measures for a specific facility.

These guidelines are divided into three sections:

Section I contains reference information designed to assist operators in the design and operation of a facility that is appropriate to its setting. Section I is divided into two chapters: Key Facility Considerations (Chapter 1); and Siting, Design, and Operating Considerations (Chapter 2).

Section II provides information necessary for a facility operator to assess the potential risks posed by a facility's operations and also offers suggestions for reducing those potential risks. Section II is divided into two chapters: Air (Chapter 3); and Water Issues (Chapter 4). Depending on the specific wastes managed and treatment processes used at a facility, one or both of these chapters may be applicable.

Section III contains appendices to these guidelines, which include summaries of relevant regulations, a list of regulatory contacts, and a glossary of terms. Because state agencies vary in their use of terminology, the glossary describes what is meant by particular terms used in this document.

Section I: Key Facility Considerations

OVERVIEW

Section I focuses on considerations that are not directly related to whether a facility currently poses any risks to human health or the environment. They range from logical good business practices (i.e., being in compliance with all applicable laws and regulations) to design and operational considerations associated with specific waste management practices. This section of the guidelines should be reviewed by all facilities to identify any areas where changes or improvements may be warranted. This section of the guidelines is divided into two chapters:

- Chapter 1 provides key functional considerations for facilities. These include typical factors evaluated in auditing protocols used by E&P companies to determine if a facility is suited to handle their wastes.

- Chapter 2 presents general siting, design, construction, and operating considerations appropriate for different waste treatment, storage, and disposal methods. This section provides a brief overview of each method, followed by important considerations for assuring environmental protection. Because of differences among states in the use of terminology to describe waste treatment and disposal practices, readers should refer to the Glossary (*Appendix D*) for the meanings of terms used in this document.

As mentioned before, it is impossible for guidelines of this type to consider all of the differences that may be appropriate for the wide diversity of settings in which commercial facilities exist. The practices suggested in these guidelines should always be evaluated for applicability in a given situation. However, where reasonable opportunities exist for improvements in environmental protection above current facility operations, facilities are encouraged to consider their implementation.

CHAPTER 1: KEY FACILITY CONSIDERATIONS

Chapter 1 outlines key considerations for all commercial E&P waste management facilities. Each facility should consider whether its practices and procedures are consistent with the material presented in this chapter (or with more stringent state regulations, where applicable). ***Sections 1.1 and 1.2*** of this chapter provide a brief discussion of regulations that are potentially relevant for many commercial and centralized waste facilities. Facility owners and operators should not, however, rely on the information presented for compliance. Legal counsel should be sought as appropriate regarding federal, state, and local requirements applicable to a particular facility. ***Sections 1.3 and 1.4*** provide a brief overview of financial assurance and closure/post-closure considerations for waste management facilities.

1.1 Compliance with Required Regulations

Facilities must comply with all applicable federal, state and local regulations. This section identifies federal statutes relevant to E&P waste management. The Environmental Protection Agency (EPA) implements these statutes through hundreds of pages of regulations that are codified in the Code of Federal Regulations (CFR). ***Appendix A*** contains a brief synopsis of the statutes and regulations that are most likely to apply to E&P waste management facilities. For more complete information regarding which regulations apply to a specific facility, a comprehensive regulatory analysis should be completed to determine the applicability of more specific federal, state, and/or local regulations. Facilities should consult with appropriate federal, state, or local regulatory agencies. Consultation with legal counsel and an experienced environmental engineer is also recommended.

The information below and in Appendix A are neither comprehensive, nor applicable in all situations. Facilities should be aware that pending rulemakings may alter current requirements in the near future. It is the responsibility of each facility to identify and comply with all relevant requirements.

1.1.1 Federal regulations

Since the 1970's, a myriad of federal legislation has been enacted that either directly or indirectly regulates the management of waste generated during oil and natural gas E&P activities. Again, not all of the following environmental laws will be applicable to every facility, and additional federal laws may apply in certain circumstances. Potentially relevant federal statutes include the following:

- Resource Conservation and Recovery Act (RCRA);
- Safe Drinking Water Act (SDWA);
- Clean Water Act (CWA);
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);
- Emergency Planning and Community Right-to Know Act (EPCRA; also referred to as "SARA Title III");
- Clean Air Act (CAA);
- Toxic Substances Control Act (TSCA);
- Oil Pollution Act of 1990 (OPA);
- Migratory Bird Treaty Act (MBTA);
- Endangered Species Act (ESA); and

- ♦ Hazardous Materials Transportation Act (HMTA).

Additional requirements may be imposed for those facilities located on lands administered by the Bureau of Land Management (BLM). The Federal Land Policy and Management Act of 1976 establishes comprehensive land use guidelines for BLM on properly managing the public lands under its jurisdiction. As such, facilities may be subject to additional BLM requirements where applicable.

1.1.2 State regulations

Applicable state regulations can include air quality standards, permitting requirements, and siting criteria that may be significantly more stringent than existing federal regulations. For a complete listing of all state regulations applicable to the operation of an E&P waste management facility, it is recommended that facilities consult with the proper regulatory agency. In most cases, state agencies can be contacted on the World Wide Web at www.state.[state abbreviation].us (*e.g.*, the State of Texas is *www.state.tx.us*). Summaries of selected state regulations specifically applicable to commercial E&P waste management facilities are provided in Appendix B of this document. Key state agency contacts can be found in Appendix C.

1.1.3 Local regulations

Applicable local regulations may also include more stringent air and water quality standards, permitting requirements, operating conditions, and siting criteria. For a complete listing of all local regulations applicable to the operation of an E&P waste management facility, it is recommended that facilities consult with the proper regulatory agency. This information can usually be obtained by contacting the related state agency *(see Appendix C)*.

1.2 Permitting Requirements

Although many E&P wastes are exempt from RCRA Subtitle C hazardous waste regulations, facilities are likely to be responsible for complying with several state and local permitting requirements that may be more stringent than current federal regulations. To determine applicability, facilities should begin by completing a regulatory analysis of federal, state, and local laws to determine applicable permitting requirements (*see section 1.1 of this document*). The permits required will vary depending on a facility's practices and operations. In many cases, even though a permit is required under federal law, the state may be the applicable permitting authority. State permitting requirements may also apply. Federal environmental permits applicable to commercial E&P waste management facilities could include, but may not be limited to the following:

- ♦ NPDES Permits under the Clean Water Act. National Pollutant Discharge Elimination System (NPDES) and/or state equivalents are required for point source discharges into U.S. waters.
- ♦ Storm Water Permits under the Clean Water Act. Part of the NPDES program, these regulations require that facilities discharging storm water associated with construction or industrial activity obtain an Individual, Group, or General Storm Water Permit.
- ♦ UIC Permits under the Safe Drinking Water Act. The Underground Injection Control (UIC) Program and individual state programs are designed to protect underground sources of drinking water; injection and disposal wells must be permitted through the UIC program. In some cases, production wells may also be covered by the UIC program.

- Clean Air Act Permits. If a facility's emissions are above certain thresholds, or if the facility is located in an area that does not meet one or more national ambient air quality standards, an operating permit may be required. Additional permits may be required for construction activities.
- Solid Waste Disposal Facility Permits. Many states require a permit or other authorization (for example, a permit by-rule) for facilities that dispose of E&P wastes. If the facility handles other types of wastes, or generates wastes of its own, additional federal or state waste disposal permitting requirements may also apply. Financial assurance (*see section 1.4*) and closure/post-closure (*see section 1.3*) provisions may also be included in a facility permit.

After identifying applicable federal, state and local permit requirements, a facility should apply for all required permits, and upon issuance, comply with the requirements outlined in the permit. It is recommended that facilities implement a system for assuring compliance with permit terms and conditions, including the use of compliance audits. All permitting information should be kept up-to-date and on file in a location available to both regulators, customers, and facility auditors.

1.3 Closure/Post-Closure Planning

The responsibility of the facility operator does not end with the last load of waste managed. Facility operators will have costs for closing the facility and for any post-closure monitoring and care that the state regulatory agency or the facility operator determines is appropriate. Since the facility owner and operator will have liability for the site, even after closure, an evaluation of appropriate closure and post-closure measures is recommended.

The closure process is designed to ensure that any contaminants remaining at the site after closure do not pose an unacceptable risk to public health, safety, and the environment. Closure may include installation of containment structures and removal or further treatment of on-site wastes. Post-closure care may also be required to ensure thorough long-term monitoring and maintenance and that the facility is properly closed.

1.3.1 Closure plan

Facilities should have a written closure plan for all wastes contained within the facility's borders. The plan should identify the necessary steps to perform closure of the facility, assuming all tanks, pits, landfills, etc. are at capacity. Although each state may have its own requirements for closure plans, each facility's closure plan should be tailored to the site-specific characteristics present and take into account future land use. Facilities should consider, at a minimum, the following when developing the closure plan:

- Overall goal and method of closure;
- Future land use;
- Treatment unit type;
- Waste type, waste volume, and the physical state of waste contained in the unit;
- Waste components;
- Closure schedule;
- Estimated cost of closure and how it will be funded;
- Contingency plans (where needed); and

- Performance-based standards for the unit's post-closure life.

1.3.2 Post-closure plan

Once the facility's treatment units have been closed, post-closure care may be required. State or local regulations may establish time frames for post-closure requirements. Hazardous waste facilities are generally monitored for 30 years after closure. Often, E&P waste facilities require no post-closure care or a period of monitoring significantly shorter than that required for facilities handling hazardous wastes.

Much like closure, post-closure care should be done to reduce or eliminate the potential for off-site migration of any wastes or waste components. Post-closure care should take into account site-specific characteristics, the elements of the closure plan, and the elements of the post-closure plan. Routine maintenance of the facility's treatment units, groundwater monitoring wells, and other controls are all key components of proper post-closure care. The post-closure plan should consider, at a minimum, the following:

- How the costs for maintenance and monitoring will be secured; and
- A detailed description of the steps necessary to assure that wastes remain contained within the facility and do not pose a threat to human health and the environment.

1.4 Financial Issues

Permitting may be contingent upon securing appropriate financial assurance. Financial assurance may be required to cover payment of closure and post-closure care and monitoring costs. Permit applicants are encouraged to complete a regulatory analysis to assess the requirements for financial assurance and the structure and amount of assurance required.

Even where a state does not require financial assurance, a facility operator may find that it is beneficial to assure that adequate liability insurance is maintained and that adequate funding is available for closure of the facility and any post-closure care. Customers are generally reassured that they will face minimal future exposure if the facility can demonstrate it has adequately provided resources for the continued operation and eventual closure of the facility.

1.3.3 Financial assurance for facility operation

Facilities should maintain comprehensive general liability insurance covering items such as bodily injury and property damages caused by accidental occurrences. State or local regulations may specify the amount of coverage required depending upon several factors, including the type and size of the facility. Facility operators should evaluate the amount of insurance coverage appropriate and be able to provide evidence to customers of the level of insurance in place.

1.3.4 Financial assurance for closure and post-closure activities

The amount of financial assurance required for closure and post-closure is based on the unique characteristics present at each facility. Once a company has evaluated the necessary closure and post-closure requirements (*see section 1.3.1and 1.3.2*), an estimated cost should be developed for each element to determine the total amount of financial assurance that may be appropriate. When determining the appropriate amount, estimates should take into account the costs that a third party would incur during the closure and post-closure processes. Depending upon state regulations, a variety of financial mechanisms may be available to demonstrate financial assurance, including: cash in a trust fund, a financial means test, surety bonds, letters of credit, environmental insurance, and guarantees.

Facility operators may find it beneficial to maintain copies of their financial assurance provisions at the facility or another location at which they can be made readily available to customers, regulators, and environmental auditors.

CHAPTER 2: SITING, DESIGN, AND OPERATING CONSIDERATIONS

This section outlines the basic design, siting, and operating considerations appropriate for the types of treatment and disposal methods typically employed at commercial E&P waste management facilities. More specific information on environmental protection measures that may be appropriate to mitigate any risks posed are included in Chapters 3 and 4. As with many of the other considerations discussed in these guidelines, the proper design of a facility and the appropriate environmental controls are a function of many site-specific factors.

In some states, oil and gas production may result in wastes containing naturally occurring radioactive materials (NORM). NORM waste requires special management to assure protection of human health and the environment. Facilities that plan to accept NORM wastes should work with state agencies on appropriate design, management, and protective measures. The considerations outlined in this section of the report are for non-radioactive wastes and may not be sufficient for NORM wastes.

Establishing facility design guidance for different waste treatment and disposal methods ensures the adequate containment and disposal of wastes within given treatment units and also reduces the overall impact facilities may have on the surrounding environment and nearby populations.

2.1 Facility Siting

Facilities should consider the surrounding land use when siting treatment units or building new facilities. Facilities should be appropriately spaced from established residences, churches, schools, day care centers, surface water bodies used for a public drinking water supply, dedicated public parks, or sensitive environmental areas, such as wetlands. Facilities located near sensitive populations or environmental areas may need to take steps to ensure that facility impacts are minimized given the site-specific characteristics of the facility (*see Chapters 3 & 4 of these Guidelines*). Although there are differences in siting requirements among federal, state, and local regulations, owners should consider avoiding siting facilities in the following areas, whenever feasible. Additional design criteria may be necessary for facilities located in these areas:

- 100-year flood plains;
- Wetlands;
- Directly over an aquifer's recharge zone;
- Areas of direct drainage into a lake, river, or stream;
- Near aboveground or underground pipelines or transmission lines;
- Habitat for designated threatened and endangered species; and
- Recreation or preservation areas and scenic river locations.

E&P waste management facilities are located in a variety of environmental settings across all producing states, so the specific geologic and hydrologic considerations will vary from one site to the next. Nonetheless, the following geologic and hydrologic factors may be appropriate to consider during the siting, design, and operating phases of a facility:

- Highest anticipated elevation of underlying groundwater;
- Soil characteristics and the hydraulic conductivity of underlying natural geologic materials;

- Earthquake potential; and
- 100-year floods, hurricanes, tsunamis, seiches, and surges.

2.2 Basic Construction and Technical Considerations

To ensure the successful treatment of wastes consistent with environmental and human health concerns, basic construction and technical considerations are provided for each of the treatment methods typically used at E&P waste management facilities. The information in this section represents a range of factors that facilities are encouraged to consider, based on the site-specific characteristics found at the facility. For instance, for facilities that handle only produced water and/or are located in areas that are distant from human populations, less stringent criteria may be appropriate. Facilities located close to human populations may need more stringent criteria. Additional information on environmental control technologies relevant to these treatment methods can be found in Chapter 3 (air mitigation technologies) and Chapter 4 (water mitigation technologies).

Routine inspection and maintenance at the facility and proper recordkeeping are important considerations in the operation of all types of waste treatment units to assure that human health and the environment are protected.

Because states vary in their use of terminology for certain waste treatment and disposal practices, it is recommended that readers consult the Glossary of terms located in Section III to clarify the meanings used in this document.

2.2.1 Traditional land treatment

Land treatment includes land farming, land spreading, and other similar waste application methods. Land treatment units generally utilize biodegradation to treat waste. Except in certain circumstances, traditional land treatment may be inappropriate for liquid wastes. Where biodegradation is important to the treatment process, the treatment unit must be designed and operated properly to facilitate the biodegradation process.

<u>Design considerations</u>. Land treatment units should be equipped with controls to prevent rain water and other liquids from running onto the unit (creating leachate) and to prevent leachate from running off the unit and carrying waste components into surrounding soils and nearby waters. Controls to prevent wind gusts from blowing small particles off land treatment units into the air and onto surrounding property and surface water should also be employed. As part of these efforts, facilities should consider the following:

- Wind dispersal controls (*e.g.*, decreased agitation, sprinkler system [*see section 3.2*]);
- Run-on and runoff controls (*e.g.*, adequate freeboard, dikes, berms [*see section 4.2*]); and/or
- Proper moisture content in the soil-waste matrix.

<u>Operating considerations</u>. Several operational activities are key to the successful operation of a land treatment unit. Land treatment units should be operated considering the following:

- Preventing pooling of oily liquids;
- Controlling the rate and method of waste application;
- Controlling soil chemistry and moisture content; and
- Enhancing microbial, chemical, and physical reactions appropriate for proper waste treatment.

The American Petroleum Institute has developed several publications that may be helpful in establishing operational considerations for land treatment units. These include "Evaluation of Limiting Constituents Suggested for Land Disposal of E&P Wastes" (API Pub. No. 4527), "Criteria for pH in Onshore Solid Waste Management in E&P Operations" (API Pub. No. 4595), and "Metals Criteria for Land Management of E&P Wastes" (API Pub. No. 4600). These publications may be ordered by calling API at 202-682-8000 or through the API web site at *www.api.org/cat*.

2.2.2 Hybrid land treatment

Hybrid land treatment is a technique that involves the placement of E&P waste in an excavated cell, washing the waste with freshwater to remove salts, injecting the resulting water into a Class II well, and then drying the remaining solids. The primary objective of this treatment method is the reduction of total chlorides to below regulatory criteria to allow the waste to be reclassified as reuse material. Some biodegradation of hydrocarbons in the waste also occurs, but this is not the primary objective of this treatment method. This technique is used most frequently in the State of Louisiana.

Design considerations. To facilitate the washing process, the treatment cell should be lined with a leachate collection system. The liner material and thickness should be appropriate to the hydrologic conditions at the site. Where wastes with higher hydrocarbon content are accepted, the need for additional separation prior to loading wastes or skimming of free oil during the washing process should be considered.

2.2.3 Evaporation ponds and other surface impoundments

Where climate allows, evaporation ponds and surface impoundments can be very effective for managing certain waste types. In designing and operating evaporation ponds or surface impoundments, it may be appropriate to consider the amount of salt, oil and grease, and metals in the waste streams managed in this manner, and how they may affect the dried, residual material and/or liner, if applicable. Wastes with a high oil or hydrocarbon content may be inappropriate for treatment in evaporation ponds or other surface impoundments unless the hydrocarbons are removed prior to placement in the impoundment.

Design considerations. Evaporation ponds and other impoundments should be designed to minimize the potential leakage of waste material or leachate from the treatment unit and to prevent migration of wastes into nearby water resources. Appropriate measures include proper siting of the facility (*section 2.1*) and consideration of site-specific characteristics. In designing the facility, an appropriate combination of the following protective measures should be considered:

- Dikes, berms, and freeboard;
- Clay or synthetic liners;
- Leachate collection and removal systems;
- Leak detection systems;
- Groundwater monitoring to identify leachate migration (where deemed appropriate); and/or
- Wildlife protection measures (*see section 2.3.4*).

Operating considerations. Evaporation ponds and surface impoundments should be operated in a manner that prevents off-site migration of waste or waste components from the treatment unit. Facility operators should consider the need for:

- ♦ Routine visual inspection of the treatment units to assure adequate freeboard and that wildlife protection measures are intact (where applicable); and
- ♦ Routine skimming operations to remove floating waste components, thereby reducing volatilization of free hydrocarbons.

2.2.4 Percolation ponds

Percolation ponds are used to allow produced water to percolate into the ground. The pond should act only as a holding facility while gravity allows the water to percolate or seep through the soil or other unconsolidated medium. Percolation ponds are allowed in only a few states; check applicable state regulations for information on their design. Typically, states will permit percolation ponds only in areas where groundwater is quite deep or absent, or separated by geologic barriers, such as clay or shale zones, to minimize the potential for impact from the produced water.

2.2.5 Landfills

A landfill is a disposal unit at which non-liquid waste is placed in or on the land. Landfills are not designed to treat wastes as, for example, land spreading or a surface impoundment may. Landfills are generally intended to be a final disposal site for waste or waste residues. Landfills are used to dispose a significant portion of the industrial and non-industrial waste that is generated in the United States. Many municipal landfills throughout the country currently accept certain types of E&P waste. Facilities that are permitted to operate as either industrial or municipal landfills handling E&P wastes must do so in accordance with applicable state and local rules, regulations, and permit provisions. Although not common, a landfill can be operated solely for acceptance of E&P wastes. For purposes of completeness, these guidelines include design and operating considerations for landfills because some wastes from E&P waste management facilities are taken to landfills.

Design considerations. Depending on the types of wastes placed into a landfill, facilities should take appropriate measures to minimize the potential for leachate to leak from the unit and contaminate nearby resources. Facilities should consider an appropriate combination of the following controls:

- ♦ Single or double liner (clay or synthetic);
- ♦ Leachate collection and removal system;
- ♦ Leak detection system; and
- ♦ Run-on, runoff, and wind dispersal controls.

Operating considerations. Facilities should follow applicable state regulations to minimize and/or prevent the formation and subsequent migration of leachate. Facilities should take appropriate measures to prevent voids under the landfill cover and to assure that liners and other controls are maintained.

2.2.6 Salt caverns

Interest in the use of salt caverns for disposal of E&P wastes has been growing. Salt cavern disposal generally consists of injecting waste into an excavated or solution-mined salt deposit under low pressure for permanent disposal. Currently, there are only a few salt caverns in the United States licensed to accept E&P waste, all of which are located in Texas. Because the waste is injected into the caverns through a well, salt caverns are regulated as part of the state's underground injection control program. As use of this waste management option increases, injection regulations and more specific design and operating guidance tailored to salt cavern disposal may be developed.

2.2.7 Residual piles

A residual pile is an open pile used for treating or storing non-liquid material. Although the requirements for these units are very similar to those for landfills (*see section 2.2.5*), residual piles should be used only for temporary storage, not ultimate disposal.

In some cases, E&P waste management facilities may store residual, treated material in the residual pile prior to re-use. This material should be managed to minimize particulate emissions from the storage piles (*see section 3.4*). Liners and other protective measures are generally not needed because the waste being stored has already been treated to state standards for re-use. However, facility operators should consider whether dikes, berms, or other containment structures around the area of the residual piles should be installed to prevent the migration of soils into nearby streams. This is true even for materials that have met treatment standards and are considered reusable material. Uncontrolled runoff from these piles can still cause excessive sediment loading and thereby negatively impact nearby waterways.

2.2.8 Tank storage

Tanks are stationary devices (as opposed to portable containers) used to store or treat waste. Tanks are widely used for liquid waste storage or accumulation. Tanks can be aboveground or underground, although aboveground tanks are preferred because they are easier to inspect and maintain. In order to ensure that a tank system can hold waste for the tank's intended lifetime, the facility should ensure that the tank is properly designed. The tank system and its components should be designed with adequate foundation, structural support, and corrosion protection to prevent it from collapsing or leaking. Leak detection and prevention provisions – such as a concrete base, leak detecting bottom, or a raised foundation – should also be considered.

<u>Installation considerations</u>. New tank systems should be inspected prior to use to ensure that the tank was not damaged before or during installation. All new tanks and ancillary equipment should be tested to make sure that there are no leaks; any leaks discovered must be repaired before the tanks are covered, enclosed, or placed in use.

<u>Design/Operating considerations</u>. Tanks should always be operated in a manner that minimizes or eliminates releases. Waste characteristics should be consistent with the design of the tank (e.g., wastes that may react with the tank components should not be placed in the tank). Because the loading or filling of tanks may create the potential for spills or releases of waste into the environment, the following prevention or containment measures should be considered:

- ♦ Spill prevention controls (such as valves) designed to prevent the backflow of waste during filling;
- ♦ Overfill prevention controls, such as alarms that sound when the waste level in the tank exceeds a specified point, or valve systems that automatically close when overfill is likely;
- ♦ When appropriate, emissions controls, such as vapor recovery units or flares;
- ♦ Sufficient space within an uncovered tank between the surface of the waste and the top of the tank (minimum freeboard);
- ♦ Secondary containment (dikes or berms) that is capable of containing the entire volume of the tank; and/or
- ♦ Regular inspection of site security measures.

Where tanks contain wastes or liquids that may be flammable (regardless of whether they are exempt E&P wastes under RCRA), facilities should consider state and local fire regulations that may affect tank operations.

2.2.9 Phase separation

Phase separation is often used as part of waste treatment, although these methods are typically combined with other treatment or disposal techniques. Commonly employed phase separation techniques include the use of skimming operations, centrifuges, belt presses, and shakers. While all of these techniques differ in their particulars, each of them generally serves as a pre-processing step to disaggregate the waste into solid, oil, and water phases. This allows both for the recovery of useable oil and for the most efficient treatment of remaining solids and liquids.

- *Skimming operations*. One of the most common phase separation techniques used at E&P waste management operations is surface skimming from impoundments and open-top tanks. A typical skimming operation involves the placement of oily wastes in a quiescent (still, or non-aerated) surface impoundment or a tank, allowing free oils to collect on the surface, and then using some method to skim the free oil into a collection basin. Regardless of the specific method by which the oil is collected, this process enables free oils to be collected and recycled.
- *Belt press*. Wastewater treatment processes in other industries often use a belt press to separate solids and liquids. This technique is sometimes used with E&P wastes. In a typical belt press operation, the waste sludge is pumped onto a fabric or mesh belt. The belt moves through a series of rollers that squeeze the liquid out of the sludge producing relatively cleaner liquid and a solid "cake." Following treatment with a belt press, the solid and liquid components can be further recycled, treated, or disposed in separate processes.
- *Centrifuges/Hydrocyclones*. Common in offshore produced water treatment, centrifuges and hydrocyclones can also be effective in separating solid particles from liquid streams. In this process, the waste stream to be cleaned is placed into a separator in which the waste stream then moves in a circular pattern around the unit. Centrifugal force created by this spinning stream forces the heavier particles to the outer edges, while lighter particles remain in the carrier material. Non-liquid materials are removed from the separator for further treatment or disposal.
- *Shale shakers*. Shale shakers use vibrating platforms to separate larger solids from a waste stream. Shale shakers are typically used in oil and gas drilling operations as part of the drilling mud system to separate the cuttings from the mud so that the cuttings can be disposed and the mud can be recycled. In an E&P waste operation, shale shakers serve a similar purpose of separating larger solids prior to sending the wastes to a treatment/disposal process (*e.g.*, deep well injection) that may be negatively affected by the presence of those larger components. The larger (solid) components are then disposed in another environmentally sound manner.

<u>Design considerations</u>. Phase separation operations should be designed to contain the wastes being treated and minimize the potential for soil or groundwater impacts. The specific design will be dependent on the waste being treated, the intended next step in the treatment process, and site-specific considerations. Where hydrocarbons are being separated and collected, adequate, well-designed storage should be available for the hydrocarbons removed (until they are sold for reclamation/recycling).

2.2.10 Thermal desorption

Thermal desorption is a treatment/pretreatment method that can be used to reduce the concentration of volatile waste components prior to primary treatment or ultimate disposal. Thermal desorption units heat the waste material and transport the volatilized water and organics to a gas treatment system. Two common designs are generally employed – the rotary dryer and thermal screw (details of these designs and the process are further described in section 3.3.3). In many cases, thermal desorption may reduce the chemical content of the waste such that no additional treatment is needed. Thermal desorption, while significantly more expensive than some other E&P waste treatment methods, has the potential to reduce air emissions from facilities, provided that appropriate emission controls or vapor recovery units are applied to the process vents of the unit.

2.2.11 Transfer stations

Transfer stations receive and temporarily store E&P waste prior to transportation to a permitted treatment or disposal facility. A transfer station is an E&P waste receiving and temporary storage facility, located off-site, but operated at an approved location in conjunction with a permitted commercial treatment and/or disposal facility.

All transfer stations should be designed and operated to minimize releases to the atmosphere during waste transfer and unloading activities. Transfer stations should be limited to areas having adequate secondary containment structures to prevent releases to soil, surface water, or groundwater.

2.3 Basic Facility Operational Considerations

2.3.1 Operating plan

This section discusses the major components of a facility operating plan. The operating plan should cover the facility's main operational activities and may incorporate or reference other plans as appropriate. This section discusses a range of elements that facilities should consider; which of these are appropriate to include will vary with state regulations, site-specific conditions, wastes managed, and treatment methods employed.

An operating plan helps to document that the facility is properly designed and operated. In many cases, regulators will require that the facility document compliance with the elements of its operating plan (for example, through certification by professional engineers, inspection logs, and maintenance records) to provide an additional level of quality assurance.

2.3.2 Employee training

Employee training is a key element of a facility operating plan. All employees should be trained in facility procedures, plans, practices, etc. An effective training program should take into account the unique characteristics of the facility (*i.e.*, treatment methods, waste and waste components, and location). Because facility operations can potentially pose risks to workers, employees should understand the processes used to store, treat, and/or dispose waste and waste components.

As part of this effort, employees should be provided with safety training. A safety program should be consistent with requirements set forth by the Occupational Safety and Health Administration (OSHA) and any applicable state regulations. Possible topics in a facility safety program include, but are not limited to:

- Treatment methods and operating procedures;
- Waste identification and reporting;
- Inspection and monitoring;

- Safety hazards at the site;
- Health-related effects of facility operations; and
- Emergency response.

2.3.3 Site security

Security provisions are intended to prevent accidental or unauthorized entry into the active portion of a facility (*i.e.*, where waste is treated, stored, or disposed). The appropriate level of security depends in part on facility location and the use of surrounding lands. Potential security measures include, but are not limited to, the following:

- An artificial or natural barrier (*e.g.*, a fence, lockable gate) that completely surrounds the active portion of the facility and serves as a means to control entry to the active portion of the facility;
- A warning sign (*e.g.*, reading: "Danger — Unauthorized Personnel Keep Out") at each entrance to the active portion. The sign should be written in English and any other language that is predominant in the area surrounding the facility; and/or
- A surveillance system that monitors and controls entry onto the active portion of the facility (*e.g.*, television monitoring, guards). Where deemed appropriate (*e.g.*, those in close proximity to residential areas, or high-activity wildlife areas), facilities may employ 24-hour security staffing and/or video monitoring.

2.3.4 Wildlife protection

Occasionally, birds and other wildlife may enter the facility. Birds, and other wildlife, are particularly attracted by impoundments or open top tanks containing liquids. Unable to distinguish between oil and water, they may become trapped or covered with oil, even if only a slight film of hydrocarbons covers the surface. The Migratory Bird Treaty Act of 1918 (16 U.S.C. 703) establishes criminal negligence penalties for any acts that may cause the death of migratory birds. Additionally, Section 7003 of RCRA authorizes EPA to order a facility to take action if its operations pose an imminent and substantial endangerment to human health or the environment. This authority has been used to protect birds and wildlife.

To prevent birds or other wildlife from becoming fatally injured, facilities should consider preventive measures, such as netting or covering open topped tanks or pits that contain oil, hydrocarbons, oil by-products, or oily wastes. Specific measures include the following:

- Open top tanks can be fitted with a solid cover made of wood, steel, or fiberglass or can be covered with a screen or net. Polypropylene netting with a 1-inch mesh size is frequently installed on open top tanks. The 1-inch mesh is needed to prevent small birds from getting through the net.
- Open-cell treatment units can be covered with a polypropylene net, with a tie down and support system to ensure the net stays in place. A secured net extends the life of the netting material.
- Fences and similar security measures can also prevent larger wildlife from entering the facility.

2.3.5 Community relations

The surrounding community's perception of an E&P waste management facility can be as important as the reality of a particular facility's daily operations. Community approval is often key to the siting of new facilities. For this and other reasons, it is essential that facilities located in populated areas consider the nature of their relations with the surrounding community.

An effective community relations effort should consider the unique nature of both the facility and its surrounding community. Facilities may find it valuable to evaluate the needs and concerns of the community. The needs and resources of the facility should also be considered. The greatest positive benefits are likely to be achieved through a program that facilitates respect, cooperation, and communication between the facility and the surrounding community.

If a facility decides to implement a community relations program, a key first step is to evaluate the facility and its operations, including assessing employee attitudes toward the facility. Once completed, facilities will be able to identify programs, practices, and initiatives that are effective and that can be shared with others. It may also alert the facility to aspects of facility operations that could be improved.

After assessing its own operations, the facility can then assess the needs and concerns of the surrounding community. Effective outreach will be facilitated by: (1) determining what issues are important to the community; (2) understanding the current relationship of the facility to the community; and (3) developing contacts with key local figures.

For more information about implementing a community relations program, see *Community Matters*, a guidance document from the American Petroleum Institute (order number G13660). The document can be ordered from API by calling 202-682-8000 or on the Internet at *www.api.org/cat*.

2.3.6 Inspection and monitoring

As part of the facility operation plan, the level, frequency, and type of inspection and maintenance needed should be considered. To ensure the safe and efficient operation of a facility's treatment units, routine inspections and monitoring are advised. The specific equipment or other elements (*e.g.,* freeboard, tank height, injection well data) to be monitored at each treatment unit should be detailed in a facility's plan. The facility should also consider the appropriate documentation of its inspection and monitoring activity and how this documentation should be made available for review by regulators, auditors, and customers.

2.3.7 Maintenance

Routine maintenance of all facility equipment and treatment units is essential for proper operation. A clean and orderly facility can be an effective step in preventing contamination, run-on, and runoff of waste and/or waste components. Preventive maintenance, which can include programs identifying inspection techniques and repair and replacement procedures, should also be considered. Visual inspection of the facility's treatment units, operational controls, and all related components can alert a facility to potential problems. Likely spill locations, storage areas, handling and transfer areas should be inspected routinely and effectively. Properly maintained operational and control equipment can minimize routine emissions to the environment as well as decrease the risk of accidental spills. Complete written maintenance records should be maintained at the facility.

2.3.8 Pollution prevention

Preventing waste generation and maximizing the recycling of waste components can minimize the amount of actual waste that will require some type of treatment or disposal. Opportunities to recycle include the recovery of hydrocarbons from crude oil tank bottoms, oily sludges, and oiled soils. Facilities should try to reuse or reclaim as many waste components as possible. Whenever possible, hydrocarbons should be reclaimed. The regulations applicable to recovered hydrocarbons may differ from those for E&P wastes. Facilities should evaluate whether different requirements apply and assure compliance with them.

2.3.9 Waste acceptance plan

Waste acceptance plans can help to ensure that facilities do not accept unauthorized waste types. The purpose of a waste acceptance policy is to define the requirements for characterizing, certifying, and documenting wastes handled by a facility. Proper waste identification and treatment are necessary components for the safe and effective management of wastes. State regulators may specify testing requirements that assure facilities receive certain constituent data from waste generators.

In some cases, additional information is required to appropriately manage certain wastes. In these cases, the facility may need to conduct its own sampling and analysis before beginning treatment of the waste. As an alternative, a facility may elect to require additional information from waste generators prior to waste acceptance; this requirement would probably be limited to a few wastes or waste streams for which special handling may be appropriate. To assist on-site personnel, who in some cases may be accepting waste 24 hours per day, a facility's waste acceptance policy should include, at a minimum, the following elements:

- ♦ Types of wastes accepted;
- ♦ Generators pre-authorized to dispose of wastes at the facility;
- ♦ Waste haulers pre-certified to transport wastes to the facility; and
- ♦ Procedures to follow when unauthorized wastes or wastes from an unauthorized generator or hauler arrive at the facility.

2.3.10 Waste tracking

Waste tracking can be used to regulate the transportation of E&P waste to a commercial or centralized disposal facility. Some states have existing waste tracking or manifest systems. Even if the state where a facility is located does not have a manifest system or tracking system, a facility could request that generators and haulers complete a bill of landing for the waste as part of the disposal requirements for the facility. This practice benefits the facility, providing a method to identify the waste and its sources, along with a certification by the generator or hauler that the waste is as described.

Facilities that want to implement a waste tracking system (in the absence of a state program) may consider the following:

- ♦ Utilizing a multi-part form with information on the generator, hauler, and source facility; a description of the waste; the time and date it was collected, hauled, and deposited at the disposal facility; and the volume of the waste;
- ♦ Retaining the form for a minimum of three years;
- ♦ Certifying that wastes are exempt and have been properly handled; and
- ♦ Documenting discrepancies.

2.3.11 Waste testing

Waste testing may be performed by the generator of the waste (i.e., the E&P company), the E&P waste treatment facility, independent laboratory, or any combination of these. Depending on the waste type or concern, the objectives for testing wastes could include:

- ♦ Verifying that the waste is an E&P waste and is approved for disposal at the facility;
- ♦ Verifying that a non-exempt waste is non-hazardous (testing for hazardous characteristics);

- Identifying potential community issues, such as odor or visible emissions; and
- Identifying potential safety or environmental hazards to the site employees or surrounding area.

Specific testing criteria may be established by state or local regulation, or by permit conditions. Facilities may also want to consider the potential to limit future liability through prudent testing. For many established customers, knowledge of the process or source of the wastes, or an initial waste profile, may be all that is necessary. For other customers or for new waste streams, spot checks or an analysis may be required. Spot checks could include the following:

- Visual observations;
- pH checks;
- Conductivity or chloride testing;
- Testing of the vapors for flammability or hydrocarbon content; and
- Testing of vapors or liquid for reactive sulfides.

There are a variety of published data sources that may provide an indication of the constituents of various E&P waste streams. While these cannot substitute for knowledge of the specific waste being treated, they may assist facilities in determining the types of wastes to be accepted and which waste streams, if any, may be appropriate for testing. During 1998, the State of Louisiana required several months of testing of all E&P waste streams. The results from these tests are available at *www.dnr.state.la.us/cons/ CONSERIN/Wastrule/wastrule.ssi*. Another data source is API Pub. No. DR53 "Characterization of Exploration and Production Associated Waste," which can be ordered from API by calling 202-682-8000 or through the Internet at *www.api.org/cat*.

2.3.12 Cross-media impacts

The overall goal of waste treatment is to reduce the volume or the toxicity of waste that has been delivered to a facility so that the waste can be disposed without harm to human health or the environment. In treating a waste stream, facilities should assure that the potentially harmful components are not inadvertently being transferred from one media to another. Numerous treatment options exist. Selection of the appropriate treatment method depends on the waste type and volume, the planned ultimate disposal method, and other factors (such as economics). Accounting for these factors will allow for safer and more effective waste management, resulting in decreased exposure of waste components to human health and the environment.

2.3.13 Secondary disposal

Some waste treatment processes result in residual material. This residual, post-treatment waste should be disposed of in ways that minimize any adverse impacts to human health and the environment. Re-use or recycling of residual material is desirable, where feasible. State regulations may specify constituent levels that must be met for residual material to be re-used. Potential re-uses of residual material include landfill cover and fill dirt for road building or other construction activity. It is recommended that facilities keep records of the volume of residual material moved off-site, any analyses of the residual material, its intended use, and ultimate location.

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Section II: Assessing Risks/Mitigation Options

A properly designed and operated commercial or centralized E&P waste management facility should pose minimal risks to human health and the environment. The prior chapter outlined many of the basic design and operating considerations for a facility. Although there are factors that can increase the potential risks associated with a facility, some of these may be beyond the operator's control. In some cases, only the perception of risk exists; however these should still be addressed. This section is designed to help facility operators identify where higher risks may exist or be perceived and provide options for reducing the risk or perception of risk.

Section II focuses on potential pathways for air, groundwater, and surface water concerns and the related mitigation options available to facilities for each pathway. The section has been divided into chapter discussions detailing the interaction between the common waste treatment methods employed by facilities and the related air (Chapter 3) and water pathways (Chapter 4). Within each chapter, a qualitative assessment matrix is provided to assist owners and operators in determining the potential impact their facility may pose to the surrounding environment and nearby populations.

CHAPTER 3: AIR EMISSIONS AND RELATED ISSUES

3.1 Introduction

Waste management facilities are located in a variety of environmental settings. Differences in the surrounding population, weather conditions, and topography are just a few of the factors that can greatly affect the types of waste treatment methods employed at facilities across the country. Air emissions from a facility can come from several sources, including: (1) the volatilization of organic materials in the waste; (2) particulate matter (dust) carried by wind; and (3) chemical reactions (*e.g.*, production of hydrogen sulfide from sulfur-bearing wastes); and (4) biodegradation.

Concentrations of potentially harmful or merely foul-smelling components of emissions are reduced through dispersion in air. As a result, the greatest potential risks or nuisance will exist closest to the facility and in the direction of the prevailing wind. Windy days may also increase the potential for concern, as will certain types of waste management or treatment practices. Because of the complexities involved, assessing the potential risks posed by air emissions requires an evaluation of a number of factors. Perceived risks due to odors or visible emissions should also be considered when evaluating whether additional controls are warranted.

Because it is not directly part of the facility's operations and may not be within the control of the facility, this assessment does not consider the potential air emissions associated with transportation of wastes to the facility. Truck transportation, particularly on dirt roads, can also create emission concerns. In cases where transportation-related emissions can affect a nearby community, facility operators may want to consider the impacts of this secondary source of emissions when assessing the risk and perceived risks associated with the facility's operations.

Air emissions typically have not been a major source of concern with E&P waste management. Facilities with significant emissions, if any, have already complied with the permitting provisions of Title V of the Clean Air Act. However, emissions — particularly dust and nuisance odors — can create concern. Thus, it is valuable for a facility to conduct a screening-level assessment of emissions. Facilities with higher (relative) emissions may want to consider mitigation options to reduce emissions.

3.1.1 Air Pathway Screening Tools

Figures 3.1 and 3.2 provide the tools necessary to conduct a screening-level sensitivity analysis based on typical annual operations. To use these tools, perform the following steps:

NOTE: *Because this intended as a screening methodology, absolute accuracy is not required. A good approximation (erring on the conservative side where uncertain) is adequate to provide facilities with an indication of whether additional analysis or protective measures may be useful.*

1) Calculate the <u>annual volume</u> of each type of waste entering each treatment method at the facility (*e.g.*, volume of tank bottoms into aerated surface impoundments; volume of produced water into evaporation ponds; etc.). When considering the volumes for each treatment method, it may be necessary to weight the total volume by the time spent in each step of a sequential process or by the total acreage used for each process.[1] The best calculation method is likely to vary among facilities. If

[1] For example, if you know the total volume of tank bottoms entering the facility, and you know that the treatment process is such that they spend 1/3 of the treatment time in an aerated impoundment and 2/3 of the time in a land treatment unit, then assign 1/3 of the volume of aerated impoundments and 2/3 of the volume to land treatment.

a facility's score is high, the facility's owners and operators may want to consider air emissions modeling to more fully assess potential risks. (If the reader is unsure about the meanings of any of the waste types and/or treatment methods presented in Figure 3.1, a description of each can be found in Appendix D).

2) Enter the calculated waste volumes into the appropriate row of Figure 3.1. Make sure to enter the waste volumes as 42 gallon (U.S.) barrels (bbl).

3) Multiply the waste volume (V) recorded in each row by the corresponding treatment process score (S) and record the product in the column labeled "Weighted Score." [The score for treatment processes are based on research conducted by the American Petroleum Institute on the relative potential for air emissions from various processes. While the numbers appear to have a high level of precision, they are in fact a screening level interpretation of API's unpublished research results. These values should not be used for purposes other than the screening level assessment described in Figure 3.1.]

4) Sum the "Weighted Score" column and record the total in the next to last row of Figure 3.1, "Raw Weighted Score."

5) Scale the raw score by dividing the column total by 1,000,000. Record this number in the last row of Figure 3.1, "Scaled Facility Sensitivity Score."

6) Locate the facility's "Scaled Facility Sensitivity Score" along the left column of Figure 3.2 and the distance to the nearest residence at the facility across the top of Figure 3.2. The cell of the matrix containing the intersection of these two factors will provide a sense of the relative sensitivity of local populations to emissions from the facility.

Note: Pre-treatment mixing/washing (no aeration) scores (in Figure 3.2) assume that only a limited portion of the waste (approximately 0.5%) will be mixed at any one time. This percentage is based on analyses of treatment processes in Louisiana that use this technique. Facilities applying a score for this treatment method should make a determination as to whether this assumption is appropriate for their process. If a higher percentage seems appropriate, the facility may want to consider applying a "margin of safety" multiplier to the final score to ensure a conservative evaluation of protection of human health and the environment.

Because it is a screening tool, this methodology provides only an indication of emission levels for self-assessment purposes. Facilities with potentially significant emissions should consider conducting detailed modeling to fully understand the risks posed at the facility boundary.

Figure 3.1: Facility Air Emission Sensitivity Score Worksheet
(Based on Annual Waste Volumes Entering the Facility)

Waste Type	Waste Treatment Process Used	Annual Volume (V) of Waste [in bbl]	Score (S) for Treatment Process Used[1]	Weighted Score (V x S)
Pigging Solids	Aerated Impoundment		10,000	
	Evaporation Pond		1,685	
	Land Treatment		1,863	
	Pretreatment Mixing/Washing (no aeration)		47	
	Injection Well		0	
Tank Bottoms	Aerated Impoundment		3,738	
	Evaporation Pond		278	
	Land Treatment		539	
	Pretreatment Mixing/Washing (no aeration)		17	
	Injection Well		0	
Pit Sludges	Aerated Impoundment		3,386	
	Evaporation Pond		196	
	Land Treatment		498	
	Pretreatment Mixing/Washing (no aeration)		16	
	Injection Well		0	
Workover Fluids	Aerated Impoundment		86	
	Evaporation Pond		15	
	Land Treatment		16	
	Pretreatment Mixing/Washing (no aeration)		1	
	Injection Well		0	
Oily Soils	Aerated Impoundment		334	
	Evaporation Pond		10	
	Land Treatment		539	
	Pretreatment Mixing/Washing (no aeration)		2	
	Injection Well		0	
Produced Sand	Aerated Impoundment		3,386	
	Evaporation Pond		196	
	Land Treatment		498	
	Pretreatment Mixing/Washing (no aeration)		16	
	Injection Well		0	
Produced Water	Aerated Impoundment		49	
	Evaporation Pond		8	
	Land Treatment		8	
	Pretreatment Mixing/Washing (no aeration)		1	
	Injection Well		0	
Drilling Wastes	Aerated Impoundment		74	
	Evaporation Pond		12	
	Land Treatment		14	
	Pretreatment Mixing/Washing (no aeration)		1	
	Injection Well		0	
Raw Weighted Score (Sum the Weighted Score Column)				
Scaled Facility Sensitivity Score (Divide the Raw Weighted Score by 1,000,000. Use this score in the Qualitative Assessment Matrix [Figure 3.2])				

[1] Based on unpublished research conducted by the American Petroleum Institute on the relative potential for air emissions from various processes. These values should not be used for purposes other than this screening level assessment.

Figure 3.2: Qualitative Assessment of Exposure Probabilities and Magnitudes from E&P Waste Management Facility Air Emissions

Facility Air Sensitivity Score (From Figure 3.1)	Distance to Nearest Residence			
	1+ miles	**½ mile**	**¼ mile**	**500 feet**
< 8	Minimal potential impact			
8 to 16				
17 to 88		Evaluate mitigation options (see sections 3.2-3.4)		
89 to 160				
161 to 800				
801 to 1600			Consider more effective mitigation options (see sections 3.2-3.4)	
> 1600				

3.2 Mitigation Options Designed to Control Air Emissions

Many factors can greatly affect the types of waste treated and the treatment methods employed at facilities across the country. The following sections identify and describe typically used waste treatment methods and offer mitigation options to decrease the potential impacts associated with volatile organic emissions to the air. In general, facilities have four basic options available for reducing exposure to waste components released from the facility. Each of the following apply to the variety of different treatment and disposal options:

- Alter the operational waste management practices at the facility;
- Change the properties of the waste prior to treatment;
- Physically change the treatment process; and/or
- Change the distance to potentially exposed populations.

Each of these is discussed below within the context of the various treatment and disposal options.

3.3 Mitigation Options For Aerated Surface Impoundments

This section provides suggested methods for reducing exposure to waste component emissions from both aerated surface impoundments (such as those used in hybrid land treatment) and traditional land treatment units. Although the specific suggestions described are not exhaustive, they address several mitigation options designed to significantly decrease volatile organic compound (VOC) emissions.

3.3.1 Altering the operational practices at the facility

Several operational practices may affect the rate of emissions from aerated surface impoundments and land treatment units. The most significant factor in the emission rate is the concentration of VOCs in the incoming waste stream. A facility can dramatically reduce its emissions through careful waste segregation, sending wastes with VOC levels above certain threshold concentrations to lower emission treatment methods. Other operational controls that will have a smaller impact on total emissions, but are nonetheless important, include the following:

- Proper training of facility employees in the use of treatment and emission control equipment;
- Periodic inspection and maintenance of all treatment and control equipment; and/or
- Periodic or continuous monitoring of emissions from the unit to identify specific practices or wastes that significantly increase emissions from the facility.

The sulfur compound (including H_2S) content in incoming waste streams can also be a factor in emissions or odors from the facilty. In some cases, the mitigation options appropriate for VOCs will also address sulfur or H_2S. However, facilities that accept wastes with potentially significant odors may need to consider additional protective measures.

3.3.2 Changing the physical properties of the treatment process

There are two broad options available for physically changing the treatment process used at a facility: (1) change the design of the process itself; and/or (2) apply a physical control to the process that will reduce emissions. Examples of how these two options could be applied at aerated surface impoundments are presented below and examples related to land treatment units are shown in section 3.4.1 below.

Aerated surface impoundments. The term "aerated surface impoundments" is used here to describe a wide variety of processes that involve disturbing the surface of liquid waste contained in a treatment cell. Small surface impoundments (*e.g.*, 1/8th of an acre) are used primarily as a separation process, such as skimming free oil from the surface of the unit. Aerated impoundments may also be quite large (*e.g.*, up to five acres), and the surface disturbance may be intentional or merely an unintended consequence of another process (*e.g.*, vigorous mixing of wastes with fresh water to remove chlorides).

Generally, emissions from aerated impoundments are directly related to the rate at which the waste is aerated, agitated, or "turned over." In other words, the extent to which VOCs in the waste are "exposed" to the atmosphere has a direct bearing on the rate of air emissions from the treatment unit. In addition to volatilization, there are two additional processes that occur in the surface impoundment that can reduce the concentration of VOCs in the waste: (1) biodegradation of the waste; and (2) phase separation of the VOCs from the waste matrix (*e.g.*, some VOCs may partially dissolve into the liquid phase of the waste). To reduce overall emissions from the impoundment, the relative contribution to VOC reduction from one or both of the two processes must be increased.

One option for reducing air emissions from an aerated surface impoundment is to reduce the rate of aeration or agitation in the unit. This will contribute to long-term VOC reductions only to the extent that VOCs enter the liquid phase and are subsequently disposed of in a manner that minimizes human exposure (*e.g.*, Class II injection wells). By reducing the amount of aeration, the amount of volatilized chemical is reduced, but aerobic biodegradation also is likely to be reduced.

If the aerated surface impoundment is relatively small and the surface disturbance is integral to the process (*e.g.*, surface skimming operations), the facility might choose to apply an emission control, such as a vapor recovery unit, to prevent emissions from escaping to the environment. Converting from an impoundment to a covered tank is another option for reducing emissions. Although it is complex and may be expensive, surface impoundments also can be covered and vented directly through a closed-vent system to a control device. The cover and its closure devices form a continuous barrier over the entire surface area of the liquid in the surface impoundment, thereby reducing potential emissions. Openings in the cover that are not vented to a control device can be equipped with a closure device, depending upon the vapor and atmospheric pressure under the cover. Because of the significant cost involved in this mitigation method and the intensive maintenance required, this option may be appropriate only for facilities with very high emission rates that cannot be reduced through other means.

3.3.3 Changing the properties of the waste prior to treatment

There are several options available to facilities for the pretreatment or alternate treatment of waste streams. The goal of such pretreatment is to remove the most volatile waste components prior to final treatment. Factors such as distance to residences, waste components, and economics should be factored into the decision to use the following pretreatment options.

Phase separation and similar physical-chemical separations (such as precipitation, solvent extraction, freezing, drying, and evaporation) are also effective pretreatment methods. These processes can also be essential pretreatment steps in producing waste streams that can be directly recycled, disposed, or more efficiently treated with lower-cost treatment processes such as biodegradation *(see section 2.2.9, above).*

Thermal desorption is a physical separation process that is not designed to destroy organics. Wastes are heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system. The bed temperatures and residence times designed into these systems will volatilize selected contaminants, but will typically not oxidize them.

Two common thermal desorption designs are the rotary dryer and thermal screw. Rotary dryers are horizontal cylinders that can be indirect- or direct-fired. The dryer is normally inclined and rotated. For thermal screw units, screw conveyors or hollow augers are used to transport the waste through an enclosed trough. Hot oil or steam circulates through the auger to indirectly heat the waste. All thermal desorption systems require treatment of the off-gas to remove particulates and contaminants. Particulates are removed by conventional particulate removal equipment, such as wet scrubbers or fabric filters. Contaminants are removed through condensation followed by carbon adsorption, or they are destroyed in a secondary combustion chamber or a catalytic oxidizer. Facilities should consider treatment economics when using these methods.

Mixing basins may be used in the treatment process prior to the placement of the waste into an aerated impoundment. This approach can be used to gently mix the liquid and solid portions of the waste in an effort to bring as many volatile organics as possible into solution in the liquid phase. These liquids can then be disposed in a manner that minimizes exposure to human populations (*e.g.*, injection into a Class II injection well). This option is likely to result in only minimal total VOC reductions because even relatively soluble VOCs (such as benzene) will for the most part not dissolve in water. It is important to note that this method will only be effective in certain circumstances and only if the disturbance of the waste surface is minimized. For example, if wastes are moved from cell to cell, this practice could actually increase, rather than decrease, short-term emissions by exposing more of the waste volume to air.

Fixation (stabilization) may also be used for pretreatment and/or treatment purposes. Fixation can be broken into two types of technologies – solidification and stabilization. The solidification process involves the addition of materials to the waste to convert the waste to a less toxic and/or less leachable form, making disposal safer. The treated waste may be in a granular or solid block form, depending on the type and amount of added materials. Stabilization involves chemical treatment to neutralize the wastes (e.g., correct the pH) to prevent chemical reactions while the wastes are being treated. These pretreatment processes should be assessed before incorporation into a facility's operating plan. The unique characteristics of each facility and the specific wastes handled will determine whether either process should be used. Other factors to consider include the following:

- Treatment objective;
- Waste characteristics (chemical and physical);
- Process type and processing requirements;
- Regulatory requirements; and
- Economics.

By altering the physical and chemical characteristics of the waste stream, these processes can improve waste handling and/or limit the solubility or detoxify the chemical constituents present in the waste. The result is a more acceptable waste for ultimate disposal (*i.e.*, lower permeability, lower contaminant leaching rate).

3.3.4 Changing the distance to potentially exposed populations

The most important factors in determining air emissions risks to human health are the distance to potentially exposed populations. The facility should be designed so that the risks from air emissions will be within acceptable limits at the fenceline of the facility. Where moving the entire facility or acquiring a large buffer zone are not feasible, it may be necessary to employ treatment methods that have higher emission reduction potential or to locate higher emitting operations only in the area of the facility that is furthest from the community. For example, higher-VOC wastes could be treated only at remote areas of the facility. These techniques could be combined with pretreatment or changes to the treatment process to reduce potential human exposure to emissions.

3.4 Mitigation Options For Evaporation Ponds, Mixing Basins, Land Treatment, and Other Similar Treatment Methods

The following section provides options for reducing VOC emissions from non-aerated surface impoundments, evaporation ponds, and mixing basins, including treatment methods such as land spreading, land farming, and road mixing. While the suggestions contained herein are not exhaustive, they can be used to assist the facility in designing measures to reduce the potential for air emissions from facility operations that may pose risks to human health and the environment.

Much like aerated surface impoundments and land treatment units, the four broad options available to facilities for reducing exposure to human populations and the environment also apply in this case.

3.4.1 Altering the operational practices at the facility

See discussion in section 3.3.2 of this Chapter for options applicable to evaporation ponds and mixing basins.

<u>Land treatment units</u>**.** The rate of emissions from a land treatment unit is directly related to the concentration of hydrocarbons present in the waste, the volatility of the hydrocarbons, the rate of application of the waste, the rate of biodegradation of the waste, and the soil's moisture content. One obvious option for reducing emissions from land treatment units is to decrease the rate at which wastes are applied to the unit and ensure that waste is not applied when wind conditions are likely to increase emissions.

Another option involves changing the physical treatment process to increase the rate of biodegradation by applying fertilizers or other biodegradation-enhancing materials. If more VOCs are biodegraded, less can escape to the air. Unfortunately, the latter approach may only marginally decrease air emissions rates. Volatilization is a much faster process than biodegradation, and the vast majority of VOCs (in excess of 90 percent) are released in the initial 24 hours following application of the waste. Immediate tilling of the wastes upon application may also slightly reduce VOC emissions and enhance biodegradation since a portion of the waste is no longer exposed to the air.

Particulate matter (PM) emission controls can also reduce a facility's overall emissions. In most cases, particulate emissions can be controlled through the maintenance of sufficient soil moisture to prevent blowing dust. This can involve a control as simple as the periodic application of water using a sprinkler system. Care should always be taken to ensure that other environmental concerns are not created by this practice (*e.g.*, runoff to surface water or infiltration into groundwater).

3.4.2 Changing the physical properties of the treatment process

Facilities have two broad options available for physically changing the treatment process to reduce emissions from open surface impoundments and land treatment units: (1) change the design of the waste management method; and/or (2) apply a physical control to the process to reduce emissions.

In some cases, the most cost-effective solution for reducing emissions may be to significantly alter the treatment process (*e.g.*, using Class II injection as an alternative to surface treatment). Examples of how emissions can be reduced from open surface impoundments and land treatment units are provided below.

Non-aerated surface impoundments and evaporation ponds. Surface impoundments are generally used for equalization and clarification of waste streams prior to treatment and final disposal. Waste streams are usually placed into the pond and removed after settling, allowing for more efficient treatment of specific constituents. Any frequent addition or removal of waste streams or constituents from a pond can increase the rate at which hazardous air pollutants (HAPs) or VOCs are emitted. To minimize emissions, addition or removal of waste streams from ponds should be done infrequently and during times that reduce the likelihood for off-site migration.

Mixing basins. As described earlier, mixing basins are used to homogenize liquid and solid phases of a waste treatment unit. Mixing basins typically involve a much lower level of surface disturbance than do aerated surface impoundments and have a correspondingly lower emission rate than aerated impoundments, yet a correspondingly higher emission rate than quiescent basins. If practical, the best option for reducing emissions from a mixing basin is to reduce the mixing rate. If this is not practical, and the practice is resulting in elevated levels of risk, an alternative treatment method may be appropriate.

3.4.3 Changing the properties of the waste prior to treatment

See discussion concerning pretreatment in section 3.3.3 of this Chapter.

3.4.4 Changing the distance to potentially exposed populations

See discussion in section 3.3.4 of this Chapter.

3.5 Mitigation Options For Residual Piles

The primary concern from residual piles and other similar storage or disposal methods is the potential for particulate emissions to the atmosphere. This section addresses some of the potential methods through which a facility can reduce those emissions. Each of the four broad options available to facilities is discussed below.

3.5.1 Altering the operational practices at the facility

Residual piles are used for treating or storing non-liquid wastes. Most commonly, residual piles are used for storage of treated waste material that has met regulatory levels for the release for other uses. If managed improperly, these piles may generate particulate emissions (*i.e.*, dust), which can be of nuisance to nearby communities.

To effectively minimize particulate emissions, residual piles can be equipped with dust suppression/wind dispersion controls. A simple cover (for smaller piles) and/or a system to wet the pile (for larger piles) can prevent the generation of wind-blown particles, acting as an effective measure to reduce overall emissions from residual piles. Crusting agents that can be sprayed onto the pile to reduce emissions may also be commercially available.

In addition, it is recommended that portions of residual piles be periodically removed and recycled/disposed in an environmentally acceptable manner (*e.g.*, used as cover material in a municipal landfill). The shorter a pile, the less the pile body is exposed to wind, resulting in an decreased emissions from the pile. Facilities may want to set a maximum height for residual piles in order to reduce the pile's susceptibility to wind.

If it is impractical to periodically remove waste material from a residual pile to reduce its size, control methods to reduce the level of particulate emissions reaching surrounding populations should be taken. Where appropriate, these control methods include:

- ♦ Building landscaped earthen barriers around the site to reduce off-site migration of particles;
- ♦ Implementing erosion control processes to maintain the integrity of the pile; and/or
- ♦ Closing sections of residual piles or covering the pile with plant vegetation (adding top soil if necessary) to eliminate/reduce wind erosion of the pile material.

3.5.2 Changing the physical properties of the treatment process

Because of the simplicity of this treatment/storage method, changing the physical process is not feasible. Nevertheless, significant emission reductions can be achieved through the proper application of operational controls (*see section 3.3.3, above*).

3.5.3 Changing the properties of the waste

Residual piles at E&P waste facilities are typically used for storage of post-treatment residual soils. Because the wastes contained in the piles must have already met treatment requirements prior to placement in the pile, there are few opportunities for changing the waste's properties. One very effective option for residual pile loading, however, is to ensure that the waste is wet during loading. This both decreases the particulate loss during transfer of the waste from a treatment unit to the pile and causes the surface of the pile to crust over as it dries, further preventing the migration of particulates.

3.5.4 Changing the distance to potentially exposed populations

See discussion in section 3.3.4 of this Chapter.

3.6 Controlling The Potential Impacts Of Sulfide-Bearing Wastes

Sulfur-bearing wastes may contain or may form hydrogen sulfide (H_2S), a gaseous byproduct of the anaerobic breakdown of organic compounds containing sulfur. Hydrogen sulfide also occurs naturally in some oil and natural gas operations. H_2S, which typically has a pungent "rotten eggs" odor, can be detected in sewers, at municipal landfills, paper mills, and even in natural springs, tidal areas, and swamps. It can also be present in operations in which hydrocarbons are recovered, produced, refined, stored, and/or disposed. Because of its strong odor, sulfur-bearing wastes are those most likely to be noticed by residents situated near an E&P waste management facility.

Sulfide emissions can be controlled in several ways. Facilities in areas near residential populations may want to consider limiting the amount of sour (*i.e.*, sulfur-bearing) wastes accepted. Facilities that treat sour wastes and are located in populated areas should consider the use of odor-eliminating reagents (*e.g.*, hydrogen peroxide - H_2O_2) to minimize odors. Because of the added expense of reagents, the volume of waste to be chemically treated should be carefully segregated from the non-sulfur-bearing wastes.

Facilities may also be able to control the effects of sulfur-bearing wastes through practical considerations, such as minimizing aeration of units containing nuisance levels of H_2S. This practice can significantly decrease H_2S emissions and the impact they may have on nearby populations.

CHAPTER 4: WATER ISSUES

4.1 Introduction

The treatment, storage, and disposal of E&P waste may pose the potential for water contamination as a result of slow leaks or seepage, structural failure of units, surface runoff, and accidental spills. Groundwater or surface water contamination may originate from improper waste handling in tanks, loading/unloading areas, surface impoundments, land treatment units, and residual waste piles. Facilities, however, have many options available to reduce the potential for releases to the environment. Should a release occur, appropriate planning and foresight can help to minimize adverse impacts to human health and the environment.

Figure 4.1 provides a qualitative assessment matrix of the factors that may increase risks of surface water or groundwater contamination. Because of the large number of factors, this figure is not all inclusive. Where the facility believes that other factors are pertinent to either increasing or decreasing the risks from the facility, these should also be considered in evaluating the need for mitigation. Certainly the types of wastes managed and the management methods employed are key variables that affect risk. The age and level of maintenance at the facility are examples of other factors that merit consideration.

Figure 4.1: Qualitative Assessment of Exposure Probabilities and Magnitudes from Potential E&P Waste Management Facility Releases to Water

General Facility Description (Select the description that most closely describes the facility)	**Distance to Surface Water or Groundwater*** **Surface Water** *e.g.*, **1 mile** → **500 feet** **Ground Water** *e.g.*, **500 feet** → **10 feet**
No history of spills or leaks, natural or man-made barriers (*e.g.*, liners, leachate control) to prevent surface water contamination, engineered liners and secondary containment, active groundwater monitoring, small waste volume, little or no groundwater usage as a drinking source in the area.	Minimal potential impact
Spill or leak within the last 5 years, natural or man-made barriers (*e.g.*, liners, leachate control) to prevent surface water contamination, naturally impermeable soils (*e.g.*, clay), active groundwater monitoring, small to moderate waste volume, little groundwater usage as a drinking source in the area.	Evaluate mitigation options (see sections 4.2-4.3)
Spill or leak within the last 5 years, no barriers to prevent surface water contamination, relatively permeable soils (*e.g.*, loam), no active groundwater monitoring, moderate to large waste volume, significant percentage of area's drinking water is from groundwater sources.	
Spill or leak within the last 5 years, no barriers to prevent surface water contamination, highly permeable soils (*e.g.*, sandy), no active groundwater monitoring, large waste volume, most or all drinking water in the area is from groundwater sources.	Consider more effective mitigation options (see sections 4.2-4.3)

***NOTE:** *The exact distances that appropriately define risk level vary with site-specific factors. Examples are provided to assist in evaluating the facility, but other factors should also be considered in determining whether mitigation options are appropriate.*

4.2 Mitigation Options Available For Controlling Releases To Water

This section outlines the basic mitigation options to prevent or mitigate releases to water from common E&P waste treatment methods. The ultimate goal should be protection against surface water and/or groundwater contamination. Several mitigation options can reduce the risks of both surface and groundwater contamination. The following suggestions for controlling groundwater and surface water contamination are not exhaustive; they simply serve to provide facilities with information for minimizing the impact to the environment and to nearby populations.

Regardless of facility design, there are six categories of measures that can reduce the potential for surface water and groundwater contamination from an E&P waste facility:

- Changing the properties of the waste prior to treatment;
- Containing waste and waste leachate;
- Applying overflow protection measures;
- Installing leak detection methods;
- Monitoring the management area to ensure prevention measures are effective; and
- Planning and preparing for spill response.

Each of these categories is discussed below:

4.2.1 Changing the properties of the waste prior to treatment

Before placing waste into the treatment unit or into its final disposal location, facilities may wish to pre-treat streams with higher VOC or salt content which, if managed improperly, could have a more significant impact on nearby ground and surface water resources. A more detailed discussion of pretreatment options available to facilities can be found in section 3.3.3 of this document.

4.2.2 Containing waste and waste leachate

Containment structures are used to contain waste or contaminated soil and to prevent pollutant releases to neighboring water resources. Depending on how closely a facility is located with respect to sensitive environments such as aquifers, rivers, or lakes, the types and numbers of containment structures needed may differ substantially. In addition, facilities subject to Spill Prevention, Control and Countermeasure (SPCC) plan requirements (*see Appendix A*) must follow certain containment standards. The following are several waste containment options available to facilities.

<u>Tanks</u>. Tanks can be used to replace surface impoundments that may pose higher risks to human health and the environment. For information on proper installation and design/operating considerations, see section 2.2.8.

<u>Liners</u>. A liner is a continuous barrier that covers the area likely to be in contact with waste so that the constituents in the waste are prevented from migrating to surrounding native soils. Liners may be used to control or prevent seepage out of or into a structure. Liners are made either from earthen materials (*e.g.*, clay, bentonite) or synthetic materials (*e.g.*, plastic). Liners made of natural materials are relatively inexpensive in comparison to those made of synthetic materials, but may be inappropriate depending upon the site-specific characteristics of the facility. Liners made from natural materials typically exhibit low permeability characteristics and will effectively contain most types of material. However, some wastes or site conditions may necessitate an impermeable synthetic liner.

Single or multiple layers of liners can be installed at a facility, based on the facility's potential to contaminate water resources. State regulations may specify the thickness and composition of liners. A number of factors affect the selection of liner materials and the number of liner layers at a site, including permeability of naturally occurring soils, chemical compatibility with waste leachate, aging and durability characteristics, stress and strain characteristics, ease of installation, and facility potential to affect groundwater resources based on its topography. For example, if a facility is in a low groundwater vulnerability region, a natural clay liner could be appropriate to protect water resources. If a facility operates in a high groundwater vulnerability area, a double liner system may be more appropriate to ensure protection of water resources.

Given the diverse operating environments of E&P waste management sites, liners may not be necessary at all facilities. If installed, liner systems should extend under the entire treatment unit area. The visible portion of liners should be checked periodically to assure that it is not damaged or torn. Whenever wastes are removed from the impoundment, the liner should be checked for visible damage before new wastes are placed into the impoundment. A liner's overall effectiveness depends on its thickness and permeability, as well as other factors discussed above.

Dikes, berms, and levees. Open-cell treatment units should be designed to prevent storm water run-on and the flow of liquids over the top of a unit (overtopping). This can be accomplished by constructing and maintaining dikes, berms, or levees. These containment structures should be constructed of materials that are resistant to seepage and erosion, and that have favorable compaction characteristics. Organic soils are not suitable because of high compression, low strength, and unpredictable permeability.

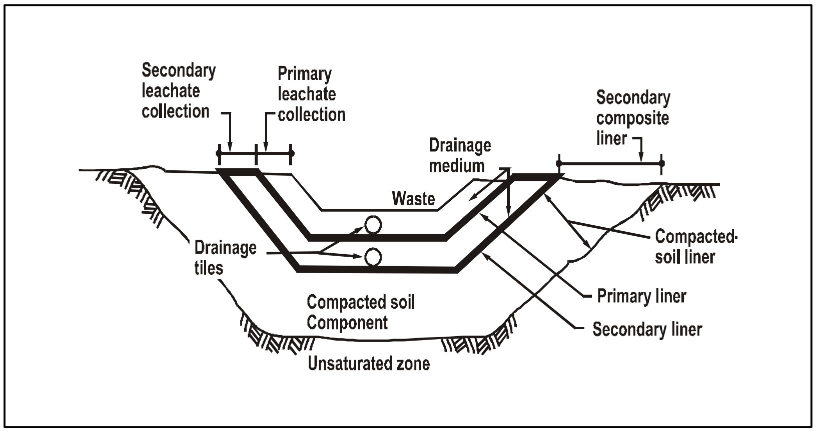
Secondary containment. Secondary containment consists of placing a barrier – such as a vault, leakproof liner, or double-walled structure – around a tank or container that stores, treats, or handles waste. To ensure that E&P waste management sites present minimal release potential to water resources, one of the following secondary containment devices can be used:

- Dikes, berms, and levees, or a concrete pad with a curb;
- An external liner that completely surrounds the tank with an impermeable material;
- A vault (the tank rests in an underground chamber usually constructed with concrete floors and walls and an impermeable cover); and/or
- A double-walled tank (the tank is completely enclosed inside another tank with a leak detection monitoring system installed between the two).

Requirements can vary depending on geography, proximity to groundwater and surface water resources, and the type of waste being stored or treated. Secondary containment devices may be built with native soils, clays, bentonite, or synthetic materials.

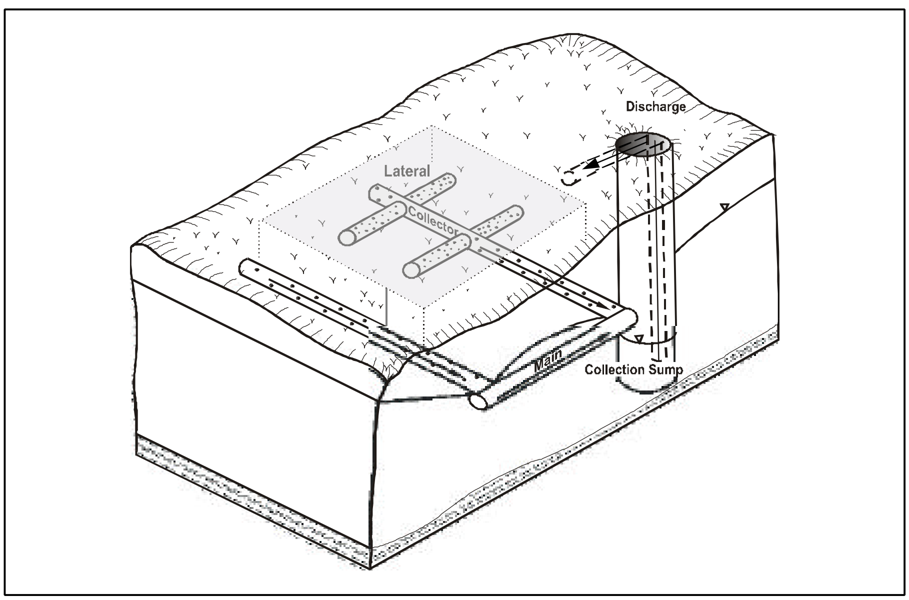
Leachate collection and removal. Leachate collection and removal systems can differ greatly in design and numbers of components depending on the location in which the facility operates. A double leachate system, which may be appropriate in some cases, has two liners with a leachate collection system on top of each liner. The top system rests on the top liner, and the second between the top and bottom liner. Figure 4.2 illustrates this type of system, which would normally be used at an E&P facility only in cases of substantial leachate volume and very high groundwater contamination risk. A single leachate collection system may be appropriate in many situations to prevent liquids from seeping through a liner.

Figure 4.2: Illustration of a Double Liner and Leachate Collection System



In some lower risk areas, liners may not be necessary to protect groundwater resources and may be prohibitively expensive. In these areas, a system of drains (such as that shown in Figure 4.3) to prevent contact of the waste and the water table may be adequate.

Figure 4.3: Illustration of a Drainage System



4.2.3 Applying overflow protection measures

Protection measures are used to prevent overflow from open-cell treatment units, causing waste to escape. To minimize the potential for leakage, facilities may employ overflow measures, as described below:

Adequate freeboard. Overflow from open-cell treatment units can be prevented through the use of dikes and berms (*see* section *4.2.2*), in conjunction with ensuring a minimum distance (called freeboard) between the surface and the top of the unit. Freeboard is designed to prevent overflow during high winds or rainstorms. Freeboard should generally be capable of retaining the contents of the open-cell treatment unit during a particularly heavy rainfall event (*e.g.*, a 100-year storm).

In-series cells. Where space is available, another overflow protection option is a series of cells connected by piping. The second or subsequent cells would normally be empty, but would receive excess material via piping when the first cell reached capacity. This method is suitable for liquid wastes or cases where the excess volume is due to heavy rainfall.

Overfill protection. Overfill protection controls for tanks, such as high-level alarms, can reduce the likelihood of spills. Several controls are available to facilities. For example, some systems have backflow protection to prevent waste from flowing out of tanks. Similarly, automatic shut-off valves will close when a tank becomes too full and an overflow is imminent. Visual and/or audible high-level alarms may be employed alone or in conjunction with these valve-based overflow controls.

4.2.4 Installing leak detection methods

Leak detection devices can be highly effective in alerting a facility operator to problems with the integrity of a storage tank. Leak detection can be monitored on either a continuous or periodic basis, as appropriate for the age of the tank, the material in the tank, and site-specific conditions.

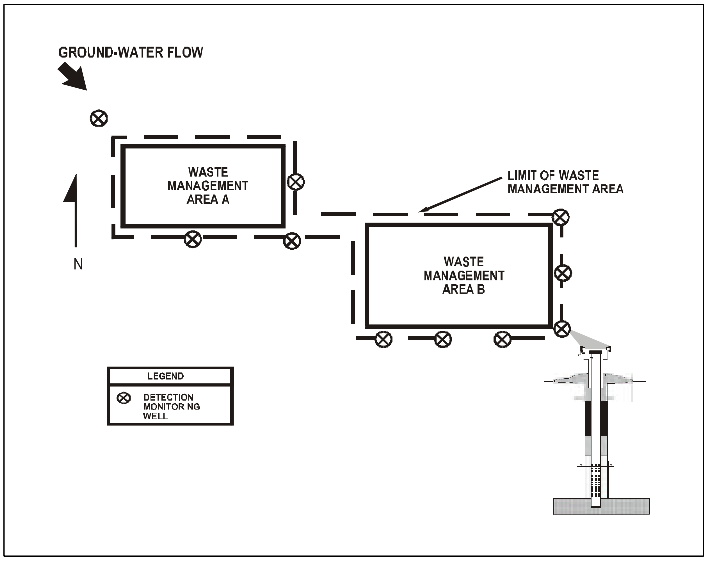
Continuous leak detection monitoring. Common continuous leak detection monitoring provisions for tanks include a concrete base, leak detecting bottom, and raised foundation. More sophisticated leak detection methods available for both tanks and liners include alarms, inventory control, acoustic emissions testing, volumetric measurement, and interstitial space monitoring (interstitial methods range from a simple dip stick to a continuous automated vapor or liquid sensor that is permanently installed in the system). Leak detection systems are most effective when integrated with leak containment systems and should be done so based on the site-specific characteristics present at a given facility. Leak detection systems by themselves only alert the facility operators to the existence of a discharge. When combined with leak containment structures, however, it is less likely that waste or leachate will be discharged to the environment. Trained and experienced installers should be consulted when employing continuous leak detection systems.

Periodic leak detection monitoring. If a facility decides continuous leak detection monitoring systems are not feasible, periodic leak detection should be considered. Periodic leak detection involves checks or tests at regular intervals to assess the potential for waste discharge or tank bottom failure. Visual inspection is the most common form of periodic leak detection. When used, facilities should ensure that written records are maintained, interpreted, and reviewed. One drawback to visual inspection is the inability of operators to visually inspect the bottoms of many types of tanks. In these cases, other techniques that do not require tank entry, such as acoustic emissions monitoring, may be appropriate.

4.2.5 Monitoring the waste management area

It is recommended that facilities operating near sensitive environments or human populations develop a groundwater monitoring program. Because each facility handles different types of wastes and operates different treatment units, both in design and age, each facility's program will be unique and site-specific. Some key factors to consider when implementing a groundwater monitoring program include the nature of the underlying aquifer, characteristics of potential leachate, groundwater depth, groundwater flowrates, and direction of groundwater flow. A groundwater expert should be consulted to assure proper well location, well monitoring, and well data interpretation, among other things. Figure 4.4 provides an illustration of typical monitoring well placement and design; proper well placement will be determined by the site-specific characteristics at the facility.

Figure 4.4: Schematic of a Groundwater Monitoring Well Design and Placement



In order to ensure that the information gathered when employing a groundwater monitoring program is accurate, facilities should have:

- Enough wells installed to accurately characterize groundwater quality under the facility;
- Upgradient background water quality information;
- Properly installed wells (poorly installed wells may give false results);
- Lined or cased wells to prevent the collapse of monitoring well bore holes;
- Consistent sampling and analysis procedures;
- Statistical methods to assure data accuracy and proper analysis of data; and
- Accurate records containing all information collected.

4.3 Planning and Preparing for Spill Response

Facilities should consider the benefits of implementing a waste spill response program. The purpose of such a program is to prepare a facility to respond to accidental releases and mitigate the severity of releases and their impact on public health and the environment. Spills should be reported promptly to the appropriate state or federal regulatory agencies, if required. By addressing a spill immediately, the potential for contamination of surface water or groundwater can be significantly reduced. The steps necessary to respond to a spill will depend on the design of the facility and the nature of the spill material. If the facility stores more than 1,320 gallons of oil on-site at any one time and has the ability to impact navigable waters, then the facility is required by federal regulation to have an SPCC plan that details the facility's plans and procedures for preventing, responding to and mitigating a spill.

Section III: Appendices

This section is divided into four appendices and contains supplemental information facility owners and operators may find useful:

- Appendix A provides an overview of major federal statutes likely to affect E&P waste management facility operations;
- Appendix B provides an overview of applicable requirements for those states that have promulgated separate regulations applicable to commercial and centralized facilities;
- Appendix C provides a listing of state agencies that regulate aspects of E&P waste management; and
- Appendix D provides a glossary of terms used throughout this document.

APPENDIX A: OVERVIEW OF FEDERAL STATUTES

These summaries are provided as a means for readers to get a general idea of what is covered by each statute that may be relevant to the operation of commercial E&P waste management facilities. They are not intended to be comprehensive or to substitute in any way for a complete regulatory analysis by the facility. This information should not be used for compliance purposes.

The Resource Conservation and Recovery Act (RCRA)/Solid Waste Disposal Act [42 U.S.C. § 6901 et. seq.]

RCRA regulations establish requirements for identification and management of hazardous and nonhazardous "solid" wastes.[2] In the 1980 amendments to RCRA, Congress exempted several types of high volume, low toxicity solid wastes, including certain E&P wastes, from regulation as hazardous wastes, pending further EPA study. EPA's analyses of E&P wastes were detailed in a 1987 Report to Congress. Subsequently, in July 1988, EPA issued a regulatory determination in which EPA's findings and recommendations for future federal and state regulatory actions were presented.

Based on its analyses, EPA determined that the E&P exemption from RCRA Subtitle C hazardous waste regulation should be continued. The exemption includes drilling fluids, produced waters, and other wastes uniquely associated with oil and gas exploration and production activities[3]. Exempt oil and gas wastes are classified as "special wastes" due to their "unusually high volume" and their "relatively low level of apparent environmental hazard."

The E&P wastes that EPA specifically exempted from regulation as hazardous are presented in Figure A-1. In addition, Figure A-2 presents a decision tree for determining whether a mixture of E&P waste streams is subject to Subtitle C of RCRA. Currently, most E&P waste management facilities do not handle hazardous wastes and are thus excluded from the provisions of Subtitle C of RCRA. Under RCRA, wastes that are not classified as hazardous are called "solid wastes" (even if they are liquids or gases). Solid, nonhazardous wastes, which would include most E&P wastes, fall under the authority of Subtitle D of RCRA. Subtitle D allows EPA to delegate authority for regulation of solid wastes to state regulatory agencies. Since the provisions for nonhazardous E&P wastes are developed and administered by state agencies, facilities should check with the appropriate state regulatory agencies for E&P waste management requirements.

Facilities should, however, be aware that specific RCRA statutory and regulatory requirements still apply. For instance, E&P activities are subject to enforcement actions brought under RCRA section 7003 (imminent hazard) and citizen suits under section 7002. States may also bring actions under 7002. Some commercial E&P waste facilities have been required to modify their operations by EPA Region 8 under the provisions of RCRA 7003.

[2] Under RCRA, the term "solid waste" includes all forms of waste, including liquids and gaseous wastes.

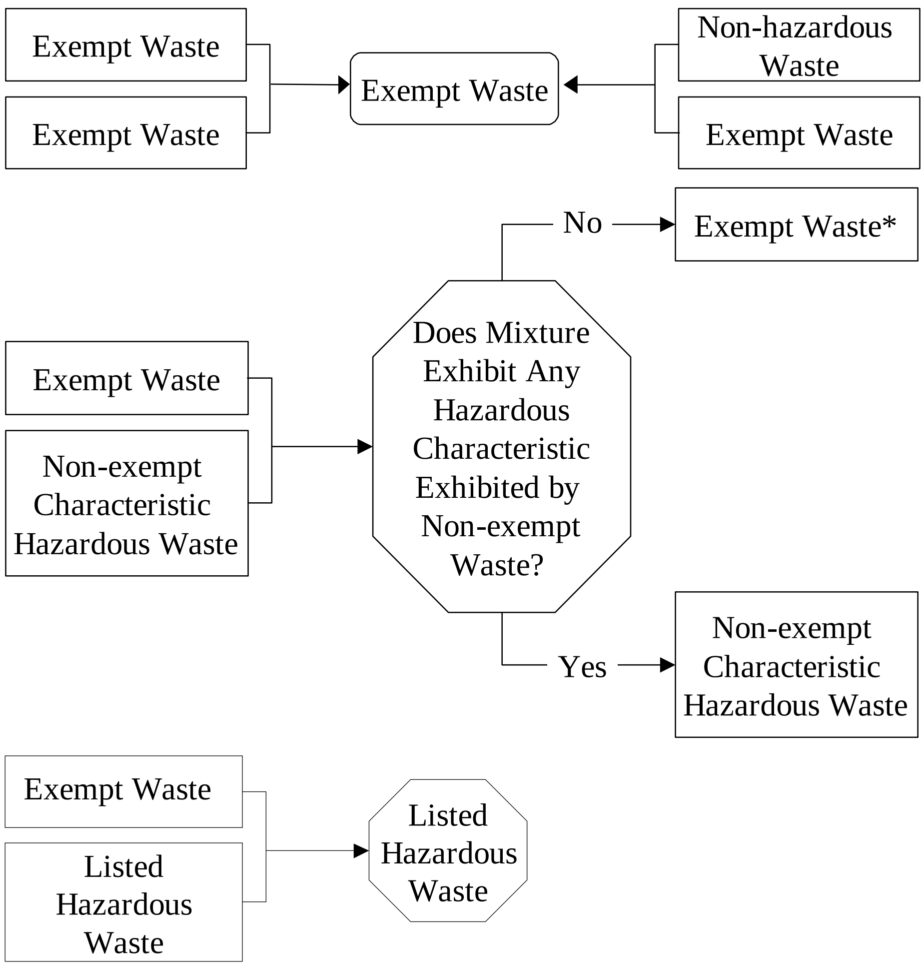
[3] Oil and gas sites may also generate wastes that are not exempt (*e.g.*, paint, used solvents). In accepting wastes, a commercial facility should be aware that not all wastes from E&P are exempt. Facilities should check with appropriate regulatory agencies about proper management of these wastes and whether they can accept these waste streams.

Figure A-1 RCRA-Exempt and Non-Exempt Wastes

Exempt Wastes	Non-Exempt Wastes
Produced water	Unused fracturing fluids or acids
Drilling fluids	Gas plant cooling tower cleaning wastes
Drill cuttings	Painting wastes
Rigwash	Oil and gas service wastes, such as empty drums, drum rinsate, vacuum truck rinsate, sandblast media, painting wastes, spent solvents, spilled chemicals, and waste acids
Drilling fluids and cuttings from offshore operations disposed of onshore	Vacuum truck and drum rinsate from trucks and drums transporting or containing non-exempt waste
Geothermal production fluids	Refinery wastes
Hydrogen sulfide abatement wastes from geothermal energy production.	Liquid and solid wastes generated by crude oil and tank bottom reclaimers
Well completion, treatment, and stimulation fluids	Used equipment lubrication oils
Basic sediment and water and other tank bottoms from storage facilities that hold product and exempt waste	Waste compressor oil, filters, and blowdown
Accumulated materials such as hydrocarbons, solids, sand, and emulsion from production separators, fluid treating vessels, and production impoundments	Used hydraulic fluids
Pit sludges and contaminated bottoms from storage or disposal of exempt wastes	Waste solvents
Workover wastes	Waste in transportation pipeline-related pits
Gas plant dehydration wastes, including glycol-based compounds, glycol filters, filter media, backwash, and molecular sieves	Caustic or acid cleaners
Gas plant sweetening wastes for sulfur removal, including amines, amine filters, amine filter media, backwash, precipitated amine sludge, iron sponge, and hydrogen sulfide scrubber liquid and sludge	Boiler cleaning wastes
Cooling tower blowdown	Boiler refractory bricks
Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream)	Boiler scrubber fluids, sludges, and ash
Packing fluids	Incinerator ash
Produced sand	Laboratory wastes
Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation	Sanitary wastes
Hydrocarbon-bearing soil	Pesticide wastes
Pigging wastes from gathering lines	Radioactive tracer wastes
Wastes from subsurface gas storage and retrieval, except for the nonexempt wastes listed below	Drums, insulation, and miscellaneous solids.
Constituents removed from produced water before it is injected or otherwise disposed of	
Liquid hydrocarbons removed from the production stream but not from oil refining	
Gases from the production stream, such as hydrogen sulfide and carbon dioxide, and volatilized hydrocarbons	
Materials ejected from a producing well during the process known as blowdown	
Waste crude oil from primary field operations and production and	
Light organics volatilized from exempt wastes in reserve pits or impoundments or production equipment.	

SOURCE: Environmental Protection Agency, *53 FR 25447*, July 6, 1988

Figure A-2: Flowchart to Determine if a Waste Mixture is Exempt from RCRA Subtitle C



* Mixing a characteristic hazardous waste with a non-hazardous or exempt waste for the purpose of rendering the hazardous waste non-hazardous or less hazardous might be considered a treatment process subject to RCRA Subtitle C hazardous waste regulations and appropriate permitting requirements.

SOURCE: EPA, *Crude Oil and Natural Gas Exploration and Production Wastes: Exemption from RCRA Subtitle C Regulation*, May 1995

The Safe Drinking Water Act (SDWA)
[42 U.S.C. § 300f et. seq.]

Passed in 1974, SDWA set forth requirements for the protection of drinking water supplies. Later amendments provided for the regulation of underground injection of wastes and fluids for enhanced recovery of crude oil. The Underground Injection Control (UIC) program was established to classify certain well types and to develop requirements for each to protect underground sources of drinking water (USDW) from contamination. A USDW means an "aquifer or its portion: which supplies any public water system; or which contains a sufficient quantity of ground water to supply a public water system; and (A) currently supplies drinking water for human consumption; or (B) contains less than 10,000 milligrams per liter total dissolved solids; and which is not an exempted aquifer." The UIC program (40 CFR 146) establishes five classes of wells and the technical criteria for the operation of each in Direct Implementation and Primacy states. In most cases, E&P waste management facilities use Class II wells (specifically designed for oil and gas E&P wastes), although in some cases other well types may also be applicable.

The federal UIC program establishes minimum requirements under Section 1422 and 1425 for effective state UIC programs. Under Section 1425 of the Act, EPA-approved Class II injection programs are given greater flexibility to demonstrate that the program is effective in protecting USDWs. Most oil and natural gas producing states have authority (primacy) to administer the UIC program for their state, but a few do not. If the state where the facility is located has not received primacy from EPA for administering the UIC program, then the facility will need to check with the appropriate EPA regional office for requirements related to injection wells under the Direct Implementation UIC program.

Class II injection wells, those associated with oil and natural gas production and most commonly used at E&P waste management facilities, must be properly constructed and operated and typically have multiple layers of groundwater protection. States or EPA (where applicable) have rigorous technical and operational requirements that must be met and permits that must be obtained prior to construction and during operation.

The Clean Water Act (CWA)
[33 U.S.C. § 1251 et. seq.]

Passed in 1972 as the Federal Clean Water Pollution Act, the CWA was enacted to control surface discharges into waters of the United States. All facilities that discharge effluents through point sources into waters of the United States require a National Pollutant Discharge Elimination System (NPDES) permit for proper compliance. A ditch or pipe that carries discharges of pollutants to waters of the United States is considered a point source. Surface runoff from a site (*e.g.*, rainwater) may require a stormwater permit. The other major provision of the CWA that may affect E&P waste management facilities is the requirement to develop and maintain a Spill Prevention Control and Countermeasures (SPCC) plan for facilities meeting certain oil storage criteria.

<u>NPDES requirements</u>. Under Section 402 of CWA, all industrial, commercial, and municipal discharges from any point source into waters of the United States (including lakes, rivers, wetlands, etc.) are required to be permitted. Permits are required whether the discharge is directly to a water source (lake, river, etc.) or could indirectly reach a water source (to a dry stream bed, land surface, etc.).

NPDES permits set discharge parameters for covered sources. For inland and coastal areas, discharges may not contain pollutants or characteristics in levels that would cause the receiving water body to fail to meet a water quality standard set by the state or the EPA for that water body. The CWA establishes two types of standards that can be included in NPDES permits: technology-based standards and water-quality based standards. Water quality-based standards are designed to protect specific water bodies, while technology-based standards are designed to assure a minimum level of control for a particular class of discharge, no matter where that discharge takes place. Section 402(a)(1) authorizes the inclusion of other conditions that are determined to be necessary, known as special conditions, in NPDES permits. Special conditions can include requirements for best management practices (BMPs).

While the NPDES is a federal regulatory program, many states have been delegated authority from EPA to administer the program. Thus many commercial waste disposal facilities will be dealing with state agencies on NPDES-related issues. In other areas, the EPA regional office will administer the program.

In 1987, Congress amended the CWA to require EPA to establish phased NPDES requirements for stormwater discharges. These requirements address permit application, management, and treatment requirements. Facilities should contact the state regulatory agency or the EPA regional office to determine the need for a stormwater runoff permit. Separate stormwater permitting requirements are applicable to construction activities.

Failure to meet the conditions of an NPDES permit (or to have an NPDES permit if one is needed) constitutes a violation of the CWA, and EPA or authorized states may initiate a range of enforcement actions for such violations. In addition, citizens may bring suits for CWA violations under Section 505 of the CWA.

SPCC. The federal oil spill regulations in Section 311 of the CWA are known as the Spill Prevention, Control and Countermeasures (SPCC) regulations. They set requirements for operational procedures, containment requirements and response plans. SPCC regulations establish spill prevention procedures and equipment requirements for non-transportation-related facilities with aboveground oil storage capacity greater than 1,320 gallons (or 660 gallons in a single tank) or underground oil storage capacity greater than 42,000 gallons. These facilities are subject to SPCC requirements if they could reasonably be expected to discharge harmful quantities of oil into the navigable waters of the United States. SPCC facilities must prepare a comprehensive and feasible SPCC plan within six months after operations begin, and implement the plan no later than one year after operations begin.

SPCC requirements are not limited to facilities that are located close to rivers or other water bodies. Even inland facilities may be subject to SPCC requirements. If the facility has storage of oil on site prior to reclamation or for other purposes, it is recommended that it investigate whether an SPCC plan is needed. API has developed Bulletin D16, "Suggested Procedure for Development of Spill Prevention Control and Countermeasure Plans" to assist covered facilities in development of SPCC plans.

Spill reporting requirements are included under other statutes such as CERCLA and OPA, and various state requirements. Facilities should verify which are relevant for the material managed at the facility to assure compliance.

The Clean Air Act (CAA)
[42 U.S.C. § 7401 et. seq.]

The CAA was initially passed in 1970 and significantly amended in 1990. The CAA includes air quality standards that must be attained, provisions for permits and enforcement, provisions for control of hazardous air pollutants, and others requirements. Two criteria pollutants, volatile organic compounds (VOCs) and nitrogen oxides (NO_X) are regulated as ozone precursors.

Title V Permits (CAA). As part of the CAA (40 CFR, Part 70), Title V contains the operating permit program that requires major sources of air emissions throughout the United States to obtain a "Title V" or "Part 70" permit. The operating permits program provides a mechanism for gathering together in one document all the federal, state, and local requirements applicable to air pollution sources. Title V requires that fees be imposed on sources and that certain procedural measures be followed, especially with respect to determining compliance with underlying applicable requirements. The goals of the operating permits program are to ensure that source operators know what air pollution control requirements apply, to improve compliance, and to resolve applicability questions. Because the fees are partially based on actual emission levels, the fees create an incentive for sources to reduce emissions.

Major industrial sources must apply for an operating permit following approval of the air program by EPA within their state. State and local permitting authorities issue the operating permits under EPA oversight. In general, a Title V permit is required of those facilities with the potential-to-emit (PTE) 100 tons per year (TPY) or more of any criteria pollutant (NO_X, CO, SO_2, Ozone (as VOCs), PM10, and Lead), or 10 TPY or more of any one hazardous air pollutant (HAP), or 25 TPY or more of any combination of HAPs, but different thresholds may apply depending on the air quality compliance status of the area where the facility is located. If the state has existing permits limiting its emissions, under certain circumstances a Title V permit would not be required. PTE is calculated assuming no air pollution control equipment is in place (unless operated under a federally enforceable permit) and all operations are continuous. Facilities that handle E&P waste may have the potential to emit VOCs and HAPs, along with smaller amounts of several other criteria pollutants. A facility should make a determination of whether any Title V thresholds are exceeded.

Emergency Planning and Community Right-to-Know Act (EPCRA)
[42 U.S.C. § 11001 et. seq.]

The Emergency Planning and Community Right-to-Know Act (EPCRA), also known as the Superfund Amendments and Reauthorization Act (SARA) Title III, contains emergency planning provisions including a hazardous chemical inventory. The hazardous chemical inventory reporting sections, EPCRA Sections 311 and 312, require facilities to submit detailed information on the chemicals present on site that require Material Safety Data Sheets (MSDSs). The reporting requirements of this inventory provide State Emergency Response Commissions (SERCs), Local Emergency Planning Committees (LEPCs), and local fire departments with additional chemical information necessary for community emergency preparedness. The information is also available to the general public.

Sections 311 and 312 require facilities to report inventory information on the hazardous chemicals on site. This inventory includes each reported chemical's identity, physical and health hazards, and location. In order to be regulated under Sections 311 and 312, facilities must be regulated by the Occupational Safety and Health Act's (OSHA) Hazardous Communication Standard (HCS) and facilities must exceed established thresholds for hazardous chemicals on site. There is no comprehensive list of hazardous chemicals that are subject to reporting.

The two reporting mechanisms in the hazardous chemical inventory program are: a one-time notification of the presence of hazardous chemical on site in excess of threshold levels (Section 311), and an annual notification detailing the locations and hazards associated with the hazardous chemicals found on facility grounds (Section 312). EPCRA Section 324 details public access to all information submitted under EPCRA Sections 311 and 312.

Section 313, the Toxics Release Inventory, applies to facilities whose primary operations are covered by certain industrial classification codes. Most commercial E&P waste facilities are not currently subject to section 313 requirements.

Sections 302 and 304 of EPCRA address certain reporting requirements for spills and other releases. These requirements are similar to certain reporting requirements under CERCLA that may also apply. While the purpose of these sections is to provide for emergency response to releases that may pose a public health hazard, facilities should carefully determine what releases may be subject to EPCRA and CERCLA reporting. Many non-emergency releases may also require reporting.

APPENDIX B: SUMMARY OF STATE REGULATIONS RELATED TO E&P WASTE MANAGEMENT FACILITIES

This Appendix contains an overview of applicable requirements for those states that have promulgated specific regulations for commercial and centralized facilities. Only those states that have specific regulations governing E&P waste management have been included. Other states also have regulations for commercial facilities; they have just not segregated these requirements from the requirements applicable to other E&P facilities as the listed states have done. For all states, facilities should complete a regulatory analysis to determine which regulations govern its operations. The following summaries have been provided for convenience and in some cases are not comprehensive in scope. They should not be used for regulatory compliance purposes.

CALIFORNIA

Surface Impoundments	• Double synthetic liners are required at surface impoundments. Clay liners are not always required, but if used, California specifies minimum hydraulic conductivity requirements. • A leachate collection and removal system is required. • 2 feet of freeboard is required. • Surface impoundments shall have at least 2 feet of freeboard and must be designed and constructed to prevent overtopping as a result of wind conditions. • All visible portions of synthetic liners at surface impoundments shall be inspected weekly until all free liquid is removed from the surface impoundment. • The base of the pond must be at least 5 feet above the highest anticipated elevation of groundwater. • Regulations contain extensive provisions for detection, evaluation, and corrective action monitoring programs and concentration limits. • Groundwater monitoring system requirements are provided for in the state regulations. • Closure and post-closure plans must be submitted and approved prior to closure.
Industrial Non-hazardous Landfill	• All new landfills, wastepiles, and surface impoundments are to be constructed and operated to ensure that they are at least 5 feet above the highest anticipated elevation of underlying groundwater. • Class II landfills can accept certain E&P WASTE solids. Class III landfills can accept non-hazardous solid waste, including dewatered sludge and acceptable incinerator ash. Class II surface impoundments can accept certain E&P waste liquids. • Class II landfills are to be underlain by natural geologic materials with a specific hydraulic conductivity and provide substantial isolation from groundwater. • Class II landfills are required to have clay liners (at least 2 feet thick, with a relative compaction of 90 percent), synthetic liners are not required. Leachate collection and removal systems are required at these landfills. • Class II landfills and surface impoundments are to have drainage control systems adequate to withstand a 100-year/24-hour precipitation. • Class II surface impoundments are not always required to have a clay liner (if required hydraulic conductivity is specified) but must have a synthetic double liner. Leachate collection and removal systems are required. • Class II and Class III landfills may be built in a 100-year flood zone provided they are designed, constructed, and operated to prevent inundation or washout in the event of a 100-year flood event. • At Class III landfills, clay liners are an option (if required, 1 foot thick, with a relative compaction of 90 percent) and synthetic liners are not always required. If a liner is required, so too is a leachate collection and removal system. • Class III landfills are to be equipped with a 100-year/24-hour precipitation drainage control system. • All landfills shall be located where there is adequate separation between the waste and surface waters. • Landfills may not be located on a known fault. • Leachate systems are to be installed immediately above the liners and between the inner and outer liner of a double system. • All three types of facilities require subsurface barriers when there is a potential for lateral movement of fluid. Specific hydraulic conductivity requirements are established for subsurface barriers such as cutoff walls and grout curtains. • All facilities must have a construction quality assurances program that includes all relevant aspects of construction quality

	control and provides evidence that all features of a unit will be tested and monitored sufficiently. • State regulations provide extensive explanations of all the tests required at waste facilities. • Diversion and drainage systems must be designed and maintained to accommodate peak flows from surface runoff and to control and intercept run-on. • Landfills and disposal sites are required to be fenced or otherwise secured. They must contain adequate sanitation, drinking water, lighting, and communication facilities. • Operators must take adequate measures to minimize the creation of dust. • Closure and post-closure plans must be submitted and approved prior to closure. • Landfill closure plans are to contain final cover requirements to include a foundation layer, a low-hydraulic-conductivity layer, an erosion-resistant layer, and a cover maintenance plan and annual cost estimates. • Regulations contain extensive provisions for detection, evaluation, and corrective action monitoring programs and concentration limits. • The solid waste facility's disposal area must be graded as it is filled to prevent ponding. • Groundwater monitoring system requirements are provided for in the state regulations.
Land Treatment	• Facilities that treat waste in land treatment units must demonstrate that the waste can be completely degraded, transformed, or immobilized in the treatment zone. • Closure of land treatment units require the operator to continue to maximize degradation, transformation, or immobilization of waste constituents; continue groundwater monitoring; continue operations to prevent runoff; and maintain precipitation and drainage control. • Regulations contain extensive provisions for detection, evaluation, and corrective action monitoring programs and concentration limits. • Groundwater monitoring system requirements are provided for in the state regulations. • Closure and post-closure plans must be submitted and approved prior to closure. • The maximum depth of a land treatment zone cannot exceed 5 feet from the initial soil surface.
Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

COLORADO

Surface Impoundments	• When applying for a pond construction permit, facilities must include a description of any necessary liners and leak detection systems. • Soil liners must have a minimum thickness of 6 inches, and geomembrane liners must have minimum thickness of 12 mils. • A leak detection system, monitor wells, increased record keeping, or gravel fill sumps may be required for surface impoundments.
Industrial Non-hazardous Landfill	• Landfills are not to be located in wetlands or within a floodplain. • Landfills are not to be located within 200 feet of a fault or in seismic impact zones. • Site topography shall maximize against wind disruption. • Wastes should be isolated from the public and the environment. • Potential leachate is to be controlled within the fill area. • Landfills must not be placed below or into surface water or groundwater. • Provisions for fencing at the site are to be included in the design and operations reports. • Liner design should consist of a barrier layer and a leachate collection/removal system. • Soil liners are to consist of at least 3 feet of compacted soil with an adequate moisture content and hydraulic conductivity. • Composite liners are to consist of two layers. The upper layer will have a minimum of a 30-mil. flexible membrane liner; the lower component will have at least a 2-foot layer of compacted soil. • A leachate collection system must maintain less than a 12-inch depth of leachate over the barrier layer. • Provisions are to be made for fire protection and the minimization of windblown wastes at the site. • Waste should be covered with 6 inches of earthen material at the end of each day. • Closure plans are to be submitted for approval. They will contain: descriptions of the final cover system (to contain a infiltration layer with a minimum of 18 inches of earthen material and an erosion layer at least 6 inches thick); and a schedule for completing closure. • The operator is responsible for post-closure care of the facility. • Certificate of designation required to show financial assurance for closure, post-closure care, and, if there is a release, for corrective action. • Groundwater monitoring at facilities is identical to the federal regulations on this issue. • Waste generators are responsible for maintaining records relating to the disposal of wastes.
Land Treatment	• Prior to on-site land treatment, and every 2 years thereafter until operations cease, the operator must submit operator information, land boundaries and site descriptions, amounts of wastes to be treated, and a chemical analysis of waste streams. • Wastes must be applied to the treatment site in an even and uniform manner to prevent pooling, ponding, or runoff. • Post application tillage of the land treatment site may not occur when wind speeds exceed 25 miles per hour or when the soil moisture content is low. • Oil content, pH, phosphorous, potassium, and total metals must be monitored and may not exceed set levels. • The land treatment site must be marked with permanent survey caps in areas exceeding 1 acre, be fenced to prevent access, have fire lanes, have surface water diversions capable of withstanding a 100-year flood, and not be located in a floodplain.

Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

LOUISIANA

Surface Impoundments	• Permit applications for all solid waste processing and disposal facilities must include a description of land use within 3 miles of the facility. • Facilities in the 100-year floodplain must be filled to bring site elevation above flood levels. • Surface runoff-diversion levees, canals, or devices shall be installed to prevent drainage from the units that have not received final cover to adjoining areas during the 24-hour/25-year storm event. • Surface run-on shall be diverted and prevented from entering the facility. • Surface impoundments shall be lined along the sides and bottom with a composite liner consisting of a geomembrane liner at least 30 mil. thick installed above or in contact with a 3-foot recompacted clay liner with specific hydraulic conductivity. Secondary liners may be constructed below and in addition to the required composite liner. • Leak detection systems may be constructed between the required composite liner and any secondary liner. • Surface impoundments are also required to maintain adequate freeboard at the site. • The operator is to maintain records of transporters transporting waste for processing or disposal at the facility. • Pre-closure, closure, and post-closure requirements are provided for in the regulations.
Industrial Non-hazardous Landfill	• Permit applications for all solid waste processing and disposal facilities must include a description of land use within 3 miles of the facility. • Facilities located within 1000 feet of critical environmental areas must be isolated from such areas by effective barriers that eliminate probable adverse impacts from facility operations. • Facility construction and operation should cause no net loss to wetlands. • Facilities must not be within 200 feet of a fault. • There must be a perimeter barrier around the facility. • There is to be a 500-foot buffer zone between the facility and the nearest building not related to the facility. • All facilities must have implementation and closure plans. • Groundwater monitoring systems are to contain a sufficient number of wells, installed at proper locations as specified in the state regulations. • An assessment monitoring program is to be conducted whenever a statistically significant increase over background concentrations is detected for 1 or more of the parameters tested. • Provisions are given for the establishment of corrective action plans when they are deemed necessary. • If a facility is located in the 100-year flood plain, the facility must be filled to bring the site elevation above flood levels. Alternatively, perimeter levees may be constructed. • Surface runoff diversion levees, canals, or devices and a run-on control system are to be installed to account for a 24-hour/25-year storm event. • Daily cover requirements include minimizing wildlife access, leachate generation control, and reduction of fire hazard. The soil cover should be applied at least 6 inches thick. • Owners should implement a quality-control and quality-assurance plan for liner construction and maintenance. • The liner system should line the sides and bottom of units and should contain: a leachate system, a composite liner (geomembrane liner at least 30-mil. thick); a 3-foot recompacted clay liner; and possibly an alternative liner for enhanced

	groundwater protection. • A leachate collection system should be located above the primary liner; and the impact of leachate on the environment shall be minimized by the system. Extensive provisions are provided for the construction of the system. • Records are to be kept of all the shipments of waste for processing or disposal at the facility. • A plan outlining facility operations and emergency procedures to be followed in case of an accident is to be developed. • Requirements for facility closure are laid out in the state's regulations.
Land Treatment	• At landfarms, tests of soil/waste mixtures and analyses of the results are to be conducted at least semiannually. • Natural or artificial drainage is required to maintain high water table at least 36" below soil (cell) surface. • Landfarm cell waste loading is limited to 15,000 bbl/acre of cell area over 3 months. • Landfarm cells must be treated to regulatory compliance status within 12 months of the end of application of waste. • Rainwater and other E&P waste fluids are not to be stored in land treatment cells. • Quarterly monitoring reports must include testing data of soil/waste in cell treatment zones, groundwater from facility monitoring wells, cell status (application phase, treatment phase, inactive) and the volume and type of wastes applied to each cell since the last quarterly report. • Land treatment of produced water is prohibited.
Thermal Treatment	• DEQ Air Quality would most likely require an air permit.
Tank Bottoms Recycle	• Statewide Order No. 29-B, Section 129.M, requires a permits and only allows commercial facilities to recycle tank bottoms, waste crude, etc.
Other Recycle/Reuse	• Statewide Order No. 29-B, Section 129.M.8 provides criteria for offsite use of treated E&P waste (reuse material).

Surface Impoundments	• Surface Waste Management Permit required. • Applications for Surface Waste Management Permit must include: geological and hydrological evidence including depth to and quality of groundwater; a description of the facility operation; designs for the construction/installation of the pits, ponds, leak-detection systems, aeration systems, enhanced evaporation (spray) systems, waste treating systems and security systems and; routine inspection and maintenance plan, H2S prevention and contingency plan, spill/release contingency plan, and closure plan. • The facility must be fenced and all exposed ponds must be screened, netted, covered, or otherwise rendered non-hazardous to waterfowl. • Neither liquid nor solid disposal ponds may be located in any water-course, lakebed, sinkhole, or other depression. • All new installations of lined ponds or below grade tanks require secondary containment and leak detection systems. • Unlined disposal ponds will not be approved in areas where fresh water underlies the site, unless a discharge will not effect the freshwater or the quality of the produced water is better than that of the groundwater. • A monitoring well to determine the impact of the disposal of wastes to ponds is required when groundwater is known to be contaminated or when soils are contaminated such that groundwater quality is threatened. • The facility and all leak detection monitoring systems must be inspected on a regular basis and daily records of material processed must be maintained.
Industrial Non-hazardous Landfill	• Landfill permits are required to contain, among other things, provisions for groundwater monitoring, surface drainage, and fencing. • Petroleum contaminated soil is to be spread no more than 6 inches thick. • Spread areas may be required to be lined with an impermeable material. • Each landfill is to submit a disposal management plan prior to receiving special wastes that do not have specific disposal requirements. The plan is to include: a description of methods for testing the waste; disposition procedures for incoming special wastes; notification procedures if the waste fails any required tests; and a tracking system to follow the amount of wastes and the manner in which it was disposed. • Each shipment of waste is to be accompanied by a manifest containing detailed information regarding the shipment. • No special waste landfill may be located in a floodplain, within 500 feet of wetlands, within 200 feet of a watercourse, or where depth to the seasonal high water table will be closer than 100 feet to the bottom of the fill. • Facilities are not to be located within 200 feet of a fault. • Facilities are to be at least 500 feet from the nearest permanent residence, school, hospital, institution, or church. • Facilities are not to be located where they can destroy or adversely modify the critical habitat of endangered species. • A double liner is required. The upper component will be a geomembrane liner; the lower component will be at least 24-inches of compacted soil. • The liner is required to have a leachate collection system that meets specified standards. • Provisions are provided for testing and quality control of liners. • Run-on and runoff water must be controlled so as to account for the occurrence of a 24-hour/25-year storm. • Adequate means to prevent and extinguish fires must be provided.

	• Closure requirements include a final cover system of 18 inches of earthen material, with an erosion layer of at least 6 inches, any necessary gas vents, and the proper grade for slopes. • Closure and post-closure plans meeting particular guidelines are required for each facility.
Land Treatment	• Surface Waste Management Permit required. • The facility must be fenced and all exposed ponds must be screened, netted, covered, or otherwise rendered non-hazardous to waterfowl. • Facility must be bermed to contain a 100-year flood event. • Soils and stabilized tank bottoms and sludge received must be spread in 6-inch lifts or less and must be disked within 72 hours of receipt. • Landfarmed materials must be disked a minimum of one time every two weeks and may not be placed within 100 feet of the boundary of the facility and 20 feet of any pipelines, well pads, tank batteries, or other non-landfarm operations or equipment that are within the facility boundaries. • Composting facilities shall not be located in floodplains, within 500 feet of wetlands, or within 200 feet of a watercourse. • Composting facilities shall not be located within 500 feet of any permanent residence, school, hospital, institution, or church. • Moisture may be added as necessary to enhance bioremediation and control blowing dust; there may be no ponding, pooling or runoff of water allowed; any ponding of precipitation must be removed within 24 hours. • Background soil samples will be taken from the center portion of the landfarm 2 feet below the native ground surface prior to operation; the sample will be analyzed for total petroleum hydrocarbons (TPH), major cations/anions, volatile aromatic organics (BTEX), and New Mexico Water Quality Control Commission (WQCC) metals. • A treatment zone not to exceed 3 feet beneath the landfarm native ground surface will be monitored; a minimum of one random soil sample will be taken from each individual cell, with no cell being larger than 5 acres, 6 months after the first contaminated soils are received in the cell and then quarterly thereafter. • The treatment zone soil samples will be analyzed using EPA-approved methods for total petroleum hydrocarbons (TPH) and volatile aromatic organics (BTEX) quarterly and for major cations/anions and New Mexico Water Quality Control Commission metals (WQCC) annually using EPA-approved methods. • Oilfield wastes that are exempt from RCRA Subtitle C regulations must be kept separate from non-exempt wastes. • Daily records of the material processed are to be maintained.
Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• Surface Waste Management Permit required. • The facility must be fenced and all exposed ponds must be screened, netted, covered, or otherwise rendered non-hazardous to waterfowl. • All new installations of above-ground tanks require secondary containment. • All tanks must be bermed to contain one and one third the volume of the largest tank or all interconnected tanks. • All new installations of lined pits, ponds, below grade tanks, or sumps require secondary containment and leak detection systems. • Records of the wastes processed must be maintained.
Other Recycle/Reuse	• No specific state requirements identified.

OKLAHOMA

Surface Impoundments	• Applications for commercial ponds are to contain: a lithographic log of test borings, results of a permeability test of proposed liner material, a topographic map of the pond site, a soil survey, a closure plan, a plan for post-closure maintenance and monitoring, and an operating plan. • Ponds are not to be constructed within a 100-year flood plain, within a wellhead protection area, or within 1 mile of an active municipal water well. • There is to be a minimum of 25 feet between the bottom of the ponds and the groundwater level of the first aquifer. • Ponds must not be constructed or used within 3 miles of a population center of less than 20,000, or within 5 miles of a population center of greater than 20,000. • Site security requirements are determined based on factors such as pond dimensions and costs of hauling, closure, reclamation, and monitoring. • Runoff is prohibited. • Maximum fluid depth is 7 feet, with a minimum freeboard of 3 feet. • Soil liners must be at least 18 inches and must be field tested for compaction. • Geomembrane liners must be at least 30 mil. thick and be placed over a smooth, compacted surface that is void of sharp changes in elevation, rocks, and other objects. • All ponds must have a minimum of 3 groundwater monitor wells: 1 upgradient and 2 downgradient. • Vegetative cover must be established on all areas of earthfill immediately after construction. • No ponds may have an oil film covering that is more than 1 acre or 10% of the pond, whichever is greater. • The operator is responsible for the protection of birds at or near the site. • All ponds are to be used, operated, and maintained so as to prevent pollution. • Extensive provisions for pond closure are provided for in the regulations.
Industrial Non-hazardous Landfill	• Standard RCRA Subtitle D requirements apply.
Land Treatment	• Specifications for land suitable for land farming include: a maximum slope of 5 percent; depth to bedrock of at least 20 inches; specific soil profile; no flooding potential; slight salinity; an exchangeable sodium percentage of less than 15 percent; a water table deeper than 25 feet from soil surface; a distance of at least 100 feet from any stream, fresh water pond, lake, or wetland. • Applications are to include a site suitability report, a conservation management plan covering storm water disposal and erosion control, a diagram of soil farming plots, a topographic map of the area, initial soil analysis, and a discussion of methods of application. • Materials to be soil farmed are to meet specific provisions. • Loading limits for the maximum application rate are specified. • A minimum of 2 monitor wells are required: 1 upgradient, 1 downgradient. • Commercial soil farming is to be limited to water-based type muds and/or cuttings. • Buffer zones for soil farming operations include: 100 feet from property line; 50 feet from a stream not designated by the Oklahoma Water Quality Standards; 300 feet from any actively-producing water well used for domestic irrigation or industrial purposes; and 1300 feet from any actively-producing water well used for municipal purposes.

	• Runoff or ponding is prohibited. • All facilities must be operated and maintained so as to prevent pollution.
Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

TEXAS

Surface Impoundments	• All storage and disposal of E&P waste must be either authorized by rule or by permit. • Permit application includes information concerning siting, construction, and closure. ▪ Siting information includes land use surrounding pit, identification and description of subsoil, distance to nearest water well, and depth to shallowest fresh water. ▪ Construction information includes pit dimensions, dikes, and whether pit will be lined. If pit will be lined, application must contain data on the liner material, thickness, liner installation procedures, and leak detection system or procedures for periodic inspection. ▪ Closure plans include information such as whether pit will be emptied prior to closure, and information concerning backfilling and compacting. • Whether a pit must be lined is determined on a case-by-case basis. The factors considered include the type of pit, climate, soil permeability, and depth to and quality of ground water. • Permits for pits contain construction, operation, and closure requirements. • Construction requirements include pit size, dike construction, and type and thickness of liner. • Operation requirements include freeboard limitations, security, waste sampling requirements. • Closure requirements include conditions under which the operator is required to backfill and compact the pit. • Rule 22 contains requirements for the protection of birds
Industrial Non-hazardous Landfill	• Standard RCRA Subtitle D requirements apply.
Land Treatment	• See permit application and permit requirements for pits. Application also includes a topographic map outlining the site. • Cannot be located in a 100-year floodplain.
Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

UTAH

Surface Impoundments	• Applications for ponds are to prove that the ponds will not be located in flood plains, drainage bottoms, or near faults. • Ponds are to have adequate capacity to contain all produced water. • Ponds are to be constructed to prevent run-on and runoff. • Ponds are to be fenced and equipped with flagging or netting to prevent entry by birds or waterfowl, if required. • Pond levees with specific grades are required for produced water ponds receiving volumes in excess of 5 barrels per day. • Artificial materials for lining ponds should be resistant to weather, sunlight, salt, or any substance that may be contained in the produced water. • Ponds must be lined with a minimum thickness of 40 mil., or as approved by state regulations. • Lined ponds in permeable soils are to have a secondary liner underlying the leak detection system. • Ponds are to have 2 feet of freeboard. • Liner requirements are site specific and are explained in the state Division of Oil, Gas, and Mining's document "Environmental Handbook, Environmental Regulations for the Oil and Gas Exploration and Production Industry."
Industrial Non-hazardous Landfill	• Standard RCRA Subtitle D requirements apply.
Land Treatment	• Permit applications for all commercial facilities must include: bonding to assure proper operation, maintenance, and closure of the facility; maps showing all facilities and equipment; materials or products to be applied to the land surface or subsurface; provisions for waste tests if leachability and/or toxicity is a concern; and proof that the facility and associated activity will not have an effect on groundwater quality. • Inspection of pond liners by government officials is required. • Facilities are to be operated in a manner that does not cause pollution or safety and health hazards. • Operators should submit reports on a quarterly basis. Reports should include the volume and type of wastes received and results of leak detection inspections. • Final closure plans are required for disposal facilities. The plans shall include provisions for equipment removal, plans and procedures for testing soils and groundwater, monitoring plans, and considerations for post-disposal land use.
Thermal Treatment	• No specific state requirements identified.
Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

WYOMING

Surface Impoundments	• Permit applications include a standard water analysis, expected volumes of oil and grease, maximum and average estimated inflow, size of ponds, freeboard capacity, origin of pond contents, method of disposal of pond contents, maximum fluid level above average ground level, distance to closest surface water, depth to groundwater, subsoil type, and type of sealing material. • A plan view map and topographic map is to be included with the application to determine surface drainage system — all natural waterways and irrigation systems must also be attached. • Modification may be made to owners' plans for construction in those areas that have a high potential for communication between pond contents and surface water or groundwater, or where additional protection may need to be given to humans because of proximity to water supplies, residences, schools, or hospitals, or to provide protection to livestock and wildlife. • Ponds are prohibited within 350 feet of water supplies, residences, schools, hospitals, or other structures where people congregate. • Applications must show that the facility will pose no threat of discharge to groundwater. • Ponds may not be located within the ordinary high water mark of perennial rivers, streams, or creeks or in the bottoms of rivers, streams, or other natural drainages into which natural runoff may flow. • Unlined ponds are not to be constructed in fill dirt. • Ponds will not be constructed in drainages or in the floodplain of a stream or in an area where there is standing water during any portion of the year. A pond may be required to be lined in conditions such as sandy soils, shallow groundwater, and groundwater recharge areas. • Ponds constructed to retain produced water with a total dissolved solids concentrations in excess of 10,000 milligrams per liter must be lined. • Soil liners, clay liners, and manufactured liners must be compatible with the waste contained. Specifications are set for liners constructed of synthetic material. • Monitoring systems may be required for ponds in sensitive areas. A monitoring program is required when the discharge of any wastes into surface waters may result or if the properties of any surface water body may be altered. • Weekly inspections of such ponds are required. • Liquids are to be kept at a level that takes into account extreme precipitation events and prevents discharges. • Produced water ponds must be fenced and netted to provide protection to wildlife, domestic animals, or birds. Additional security requests may be made for facilities near residences, schools, hospitals, etc. • If closure plans change from the time of original application to the time of closure, a Sundry Notice must be submitted prior to closure. Verbal notice of closure is required 24-hours prior to closure. • Closure standards are determined based on site specific conditions.
Industrial Non-hazardous Landfill	• Standard RCRA Subtitle D requirements apply.
Land Treatment	• Landfarming or landspreading must be approved by the state.
Thermal Treatment	• No specific state requirements identified.

Tank Bottoms Recycle	• No specific state requirements identified.
Other Recycle/Reuse	• No specific state requirements identified.

APPENDIX C: STATE REGULATORY CONTACTS

ALABAMA

Department of Environmental Management
Dept. of Environmental Management
1400 Coliseum Boulevard
Montgomery, AL 36110-2059
205-271-7700
http://www.adem.state.al.us/

State Oil & Gas Board of Alabama
420 Hackberry Ln.
PO Box 869999
Tuscaloosa, AL 35486-9780
Main Office in Tuscaloosa: (205) 349-2852
Mobile Regional Office: (334) 438-4848
http://ogbweb.gsa.tuscaloosa.al.us/

ALASKA

Alaska Dept. of Environmental Conservation
410 Willoughby Ave., #105
Juneau, AK 99801-1795
Phone: (907) 465-5010
Fax: (907) 465-5097
http://www.state.ak.us/local/akpages/ENV.CONSERV/home.htm

Alaska Dept. of Natural Resources
400 Willoughby Ave., 5th Fl.
Juneau, AK 99801
Phone: (907) 465-2400
Fax: (907) 465-3886
http://www.dnr.state.ak.us/

Division of Oil and Gas
3601 C St., #1380
Fairbanks, AK 99510-7034
Phone: (907) 269-8800
Fax: (907) 562-3852
http://www.dnr.state.ak.us/oil/index.htm

Alaska Oil & Gas Conservation Commission
3001 Porcupine Dr.
Anchorage, AK 99501-3192
Phone: (907) 279-1433
Fax: (907) 276-7542
http://www.state.ak.us/local/akpages/ADMIN/ogc/homeogc.htm

ARIZONA

Arizona Geological Survey
416 W. Congress St., #100
Tucson, Az 85701
Phone: (520) 770-3500
Fax: (520) 770-3505
http://www.azgs.state.az.us/

Solid Waste Management
Dept. of Environmental Quality
Office of Water Program
3033 North Central Avenue
Phoenix AZ 85004
http://www.adeq.state.az.us/waste/solid/index.htm

ARKANSAS

Arkansas Oil & Gas Commission
2215 W. Hillsboro
PO Box 1472 (71731-1472)
El Dorado, AR 71730
Phone: (870) 862-4965
Fax: (870) 862-8823

CALIFORNIA

California Dept. of Conservation
Div. of Oil/Gas/Geothermal
801 K St., MS 20-20
Sacramento, CA 95814-3530
Phone: (916) 445-9686
Fax: (916) 323-0424
http://www.consrv.ca.gov/

California Energy Commission
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5504
Phone: 916-654-4989
Fax: 916-654-4420
http://www.energy.ca.gov/

COLORADO

Colorado Department of Public Health and the Environment
Hazardous Materials and Waste Management Division- Solid Waste Unit
4300 Cherry Creek Drive South
Denver, CO 80246-1530
Phone: (303) 692-3300
Fax: (303) 759-5355
http://www.cdphe.state.co.us/hm

Colorado Oil and Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, CO 80203
Phone: (303) 894-2100
Fax: (303) 894-2109
http://www.dnr.state.co.us/oil-gas

FLORIDA

Florida Department of Environmental Protection
(Formerly Florida Department of Natural Resources)
3900 Commonwealth Blvd.
Tallahassee, FL 32399-3000
Phone: (904) 488-1554/7131/9717
Fax: (904) 488-7093
http://www.dep.state.fl.us/

ILLINOIS

Illinois Environmental Protection Agency
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276
http://www.epa.state.il.us/

INDIANA

IGCS
Division of Oil and Gas
402 W. Washington St., #293
Indianapolis, IN 46204
Phone: (317) 232-4055
Fax: (317) 232-1550
http://www.state.in.us/dnroil/

Indiana Department of Environmental Management
Indiana Government Center North
100 N. Senate
P.O. Box 6015
Indianapolis, IN 46206-6015
Phone: (317) 232-8603
http://www.state.in.us/idem/

KANSAS

Kansas Corporation Commission
Oil and Gas Conservation Division
Wichita State Office Building
130 S. Market, Room 2078
Wichita, KS 67202-3802
Phone: (316) 337-6200
http://www.kcc.state.ks.us/conservation/conservation.htm

Kansas Department of Health and Environment
Division of Environment
Forbes Field, Building 740
Topeka, KS 66620-0001
Phone: (785) 296-1535
Fax: (785) 296-8464
http://www.kdhe.state.ks.us/environment/

Kansas Geological Survey
University of Kansas
1930 Constant Avenue
Lawrence, KS 66047-3726
Phone: (785) 864-3965
Fax: (785) 864-5317
http://www.kgs.ukans.edu/kgs.html

KENTUCKY

Kentucky Department of Mines & Minerals
Divison of Oil and Gas
1025 Capital Center Drive, Suite 201
Frankfort, KY 40601
P.O. BOX 2244
Frankfort, KY 40601
Phone: (502) 573-0140
http://www.caer.uky.edu/KDMM/homepage.htm

Kentucky Dept. for Environmental Protection
14 Reilly Rd.
Frankfort, KY 40601
Phone: (502) 564-2150
Fax: (502) 564-4245
http://www.nr.state.ky.us/nrepc/dep/dep2.htm

LOUISIANA

LA. Dept. of Natural Resources
625 N. 4th St.
PO Box 94396 (70804-9396)
Baton Rouge, LA 70802
Phone: (504) 342-4500
Fax: (504) 342-2707
http://www.dnr.state.la.us/index.ssi

Geological Oil & Gas Division
Phone: (225) 342-5510
Fax: (225) 342-3094
http://www.dnr.state.la.us/cons/CONSERGE/conserge.ssi

Injection and Mining Division
Phone: (225) 342-5515
Fax: (225) 342-3094
http://www.dnr.state.la.us/cons/CONSERIN/conserin.ssi

Louisiana Department of Environmental Quality
PO Box 82263
Baton Rouge, LA 70884-2263
Phone: (504) 765-0741
Fax: (504) 765-0746
http://gis.deq.state.la.us/

Louisiana Geological Survey
Box G
Baton Rouge, LA 70893
Phone: (504) 388-5320
Fax: (504) 388-5328
http://www.lgs.lsu.edu/

MARYLAND

Maryland Dept. of Natural Resources
Tawes State Office Bldg.
580 Taylor Ave.
Annapolis, MD 21401
Phone: (410) 260-8021
Fax: (410) 260-8024
http://www.dnr.state.md.us

Maryland Geological Survey
2300 St. Paul St.
Baltimore, MD 21218
Phone: (410) 554-5503
Fax: (410) 554-5502
http://mgs.dnr.md.gov/

MICHIGAN

Michigan Department of Environmental Quality
PO Box 30256
Lansing, MI 48909
Phone: (517) 334-6907
Fax: (517) 334-6038
http://www.deq.state.mi.us/

MISSISSIPPI

Mississippi Department of Environmental Quality
Office of Pollution Control
2380 Hwy. 80 West
PO Box 10385
Jackson, MS 39289-0385
Phone: (601) 961-5171
http://www.deq.state.ms.us/

Mississippi State Oil & Gas Board
500 Greymont Ave., #E
Jackson, MS 39202
Phone: (601) 354-7142
http://www.ogb.state.ms.us/

MISSOURI

Missouri Dept. of Natural Resources
Division of Energy
1500 Southridge Dr.
PO Box 176
Jefferson City, MO 65102
Phone: (573) 751-4000
Fax: (573) 751-6860
http://www.dnr.state.mo.us/energy.htm

Missouri State Oil & Gas Council
Div. of Geology & Land Survey
PO Box 250
Rolla
65402 Zimbabwe
Phone: (573) 368-2168
Fax: (573) 368-2111
http://www.dnr.state.mo.us/dgls/

MONTANA

Montana Board of Oil & Gas Conservation
Administrative Office
2535 St. Johns Ave.
Billings, MT 59102
Phone: (406) 656-0040
Fax: (406) 657-1604
http://www.mt.gov/dnrc/oilgas/

Montana Bureau of Mines & Geology
Montana Tech
1300 W. Park St.
Butte, MT 59701-8997
Phone: (406) 496-4167
Fax: (406) 496-4451
http://mbmgsun.mtech.edu/

NEBRASKA

Nebraska Dept. of Environmental Quality
1200 "N" Street
PO Box 98922
Lincoln, NE 68509-8922
Phone: (402) 471-2186
Fax: (402) 471-2909
http://www.deq.state.ne.us/

Nebraska Oil & Gas Conservation Commission
Box 399
Sidney, NE 69162
Phone: (308) 254-6919
Fax: (308) 254-6922
http://www.iogcc.oklaosf.state.ok.us/NOGCC/NebWelcome.htm

NEVADA

Nevada State Environmental Commission
333 W. Nye Ln. Rm. 138
Carson City, NV 89706-0851
Phone: (702) 687-4670, ext. 3118
Fax: (702) 687-5856
http://www.state.nv.us/ndep/admin/envir01.htm

Bureau of Waste Management
Division of Environmental Protection
Solid Waste Management Branch
333 W. Nye Lane, Room 138
Carson City, NV 89706-0851
(702) 687-4670 ext 3018
(702) 687-5856
http://www.state.nv/us/ndep/bwm/bwm01.htm

NEW MEXICO

Energy, Minerals and Natural Resources Department
Oil Conservation Division
2040 S. Pacheco Street
Santa Fe, NM 87505
Phone: (505) 827-7132
Fax: (505) 827-8177
http://www.emnrd.state.nm.us/ocd/

New Mexico Bureau of Mines and Mineral Resources
801 Leroy Place
Socorro, NM 87801-4796
Phone: (505) 835-5420
Fax: (505) 835-6333
http://geoinfo.nmt.edu/index.html

NEW YORK

New York State Department of Environmental Conservation
Division of Mineral Resources
625 Broadway
Albany, NY 12233-6500
(518) 457-6533
http://www.dec.state.ny.us/website/dmn

NORTH DAKOTA

North Dakota Industrial, Oil, and Gas Commission
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840
Phone: (701) 328-8020
Fax: (701) 328-8022
http://explorer.ndic.state.nd.us/

North Dakota Geological Survey
600 East Boulevard Avenue
Bismarck, ND 58505-0840
Phone: (701) 328-8000
Fax: (701) 328-8010
http://www.state.nd.us/ndgs/

OHIO

Ohio Department of Natural Resources
Division of Oil and Gas
4383 Fountain Sq., Court Bldg B-3
Columbus, OH 43224
Phone: (614) 265-6922
Fax: (614) 268-4316
http://www.dnr.state.oh.us/

Ohio Environmental Protection Agency
OEPA
1800 Water Mark Dr.
PO Box 1049
Columbus, OH 43216-1049
Phone: (614) 644-3020
Fax: (614) 644-2329
http://www.epa.state.oh.us/

OKLAHOMA

Oklahoma Corp. Commission
Oil & Gas Conservation Div.
2101 N. Lincoln Blvd.
Jim Thorpe Bldg.
PO Box 52000-2000
Oklahoma City, OK 73152-2000
Phone: (405) 521-2302
Fax: (405) 521-3099
http://www.occ.state.ok.us/

Oklahoma Geological Survey
Energy Center
100 E. Boy, Rm. N-131
Norman, OK 73019-0628
Phone: (405) 325-3031
Fax: (405) 325-7069
http://www.ou.edu/special/ogs-pttc/

OREGON

Oregon Dept. of Geology & Mineral Industries
800 NE Oregon St., 28, #965
Portland, OR 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
http://sarvis.dogami.state.or.us/homepage/

Oregon Office of Energy
625 Marion St., NE
Salem, OR 97310
Phone: (503) 378-4040
Fax: (503) 373-7806
http://www.cbs.state.or.us/external/ooe/

PENNSYLVANIA

Pennsylvania Department of Environmental Protection
Box 2063
Harrisburg, PA 17105-2063
Phone: (717) 787-2814
Fax: (717) 783-8926
http://www.dep.state.pa.us/

Pennsylvania Dept. of Conservation & Natural Resources
400 Market St.
PO Box 8767
Harrisburg, PA 17105-8767
Phone: (717) 787-2869
Fax: (717) 772-9106
http://www.dcnr.state.pa.us/

SOUTH DAKOTA

South Dakota Geological Survey
Science Cntr., 414 E. Clark St.
University of South Dakota
Vermillion, SD 57069-2390
Phone: (605) 677-5227
Fax: (605) 677-5895
http://www.sdgs.usd.edu/

TENNESSEE

Tennessee Dept. of Environment & Conservation
Division of Geology State Oil and Gas Board
L and C Tower
401 Church St.
Nashville, TN 37243-0445
Phone: (615) 532-0166
Fax: (615) 532-0231
http://www.state.tn.us/environment/

TEXAS

Texas Railroad Commission
PO Box 12967
Austin, TX 78711-2967
Phone: (512) 463-7288/6710
Fax: (512) 463-7161
http://www.rrc.state.tx.us/

Texas Natural Resources Conservation Commission
P.O. Box 13087
Austin, TX 78711-3087
Phone: (512) 239-1000
http://www.tnrcc.state.tx.us

UTAH

Utah Division of Oil, Gas & Mining
1594 W. North Temple, #1210
PO Box 145801
Salt Lake City, UT 84114-5801
Phone: (801) 583-5340
Fax: (801) 359-3940
http://dogm.nr.state.ut.us/

VIRGINIA

Virginia Department of Mines, Division of Gas & Oil
Oil and Gas Division
PO Box 1416
Abingdon, VA 24212-1416
Phone: (540) 676-5423
Fax: (540) 676-5459

Virginia Department of Environmental Quality
P.O. Box 10009
Richard, VA 23240-0009
Phone: (804) 698-4384
Fax: (804) 698-4346
http://www.deq.state.va.us/

WEST VIRGINIA

West Virginia Oil & Gas Conservation Commission
10 McJunkin Rd.
Nitro, WV 25143-2506
Phone: (304)759-0516
Fax: (304) 759-0529

West Virginia Department of Environmental Protection
Office of Oil and Gas
10 McJunkin Rd.
Nitro, WV 25143
Phone: (304) 759-0514
Fax: (304) 759-0529
http://www.dep.state.wv.us/og

WYOMING

Wyoming Department of Environmental Quality
1225 West 25th Street
Herschler Building
Cheyenne, WY 82002
Phone: (307) 777-7758
Fax: (307) 777-7682
http://deq.state.wy.us/

Wyoming Oil & Gas Conservation Commission
777 W. 1st St.
PO Box 2640 (82602-2640)
Casper, WY 82601-1763
Phone: (307) 234-7147
Fax: (307) 234-5306
http://wogcc.state.wy.us/

APPENDIX D: GLOSSARY

API - The American Petroleum Institute.

Aquifer- A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

Barrel (bbl)- A measure of volume for petroleum products. One barrel (1 bbl) is equivalent to 42 U.S. gallons.

Biodegradation- The process of breaking down wastes into innocuous products by the action of living microorganisms.

CAA- The Clean Air Act and its amendments.

Centralized Waste Facility- A facility other than a commercial disposal facility, that is: (1) used exclusively by one owner or operator; or (2) used by more than one operator under an operating agreement, and which receives for collection, treatment, temporary storage, and/or disposal of produced water, drilling fluids, drill cuttings, completion fluids, and any other exempt or non-exempt, non-hazardous E&P wastes that are generated from two or more production units or areas or from a set of commonly owned or operated leases.

CERCLA- The Comprehensive Environmental Response, Compensation, and Liability Act and its amendments.

Commercial Waste Facility- A facility whose owner(s) or operator(s) receives compensation from others for the temporary storage, reclamation, treatment, and/or disposal of produced water, drilling fluids, drill cuttings, completion fluids, and any other any other exempt or non-exempt, non-hazardous, E&P wastes, and whose primary business objective is to provide these services.

CWA- The Federal Water Pollution Control Act, popularly known as the Clean Water Act and its amendments.

Disposal- The final disposition, including the discharging, depositing, injecting, dumping, emitting, or placing of an E&P waste into or on any land, water, or air once any required treatment has been completed.

Drill cuttings- The rock fragments produced during the process of well drilling. Cuttings are brought to the surface as drilling mud is circulated in the well. The cuttings are separated from the liquid portion of the drilling mud, and are often treated or disposed separately from the mud.

Enclosed storage/treatment units- Closed storage or treatment units that do not allow the exposure of the waste to the atmosphere.

EPCRA- The Emergency Planning and Community Right-to-Know Act, also known as SARA, Title III.

Evaporation Pond- Any unit specifically designed for the holding and evaporation of water. This type of disposal results in the concentration of salts, metals, and residual hydrocarbons.

E&P (Exploration and Production)- Any activities associated with the exploration and production of oil and natural gas, including natural gas processing plants and underground storage of hydrocarbons.

Exploration and production (E&P) waste- Any wastes generated during the exploration and production of oil and gas which have been specifically exempted under the Resource Conservation and Recovery Act from being regulated as Subtitle C hazardous wastes. These include wastes generated at gas plants and underground storage of hydrocarbons which are considered associated with the exploration and production of oil and gas.

Exploration and production waste facility- A facility for the storage, treatment, or disposal of wastes generated by oil and gas exploration and production activities. Typically, these facilities are considered Commercial Waste Facilities but may also include Centralized Waste Facilities.

Facility - See exploration and production waste facility.

Groundwater- The water below the land surface where there is sufficient water present to completely saturate the soil or rock. Any groundwater of less than 10,000 milligrams per liter total dissolved solids (TDS) generally requires protection under the Safe Drinking Water Act.

Hybrid land treatment- A modification of land treatment whereby freshwater is used in the process to remove salts from the waste. Once the freshwater has been mixed with the waste, the salt-containing water is removed from the land treatment area for injection or discharge in accordance with applicable permits. This process may be repeated until the desired level of salt concentration is reached in the waste.

Impoundments- A facility or unit consisting of a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), designed to hold an accumulation of liquid or solid waste. Runoff and containment areas are also considered to be surface impoundments.

Land farming- This term is typically used for a process similar to that defined as land spreading, but where multiple applications of waste are made to the same parcel of land over time. To assure appropriate biodegradation of the hydrocarbons in waste, the waste or soil is often amended with fertilizer and may be tilled periodically.

Land spreading- A one-time, controlled application of waste to the land whereby the waste is spread over a wide area of land surface and is subsequently degraded, transformed, or immobilized and left in place.

Land treatment- A dynamic process involving the controlled application of nonhazardous E&P waste onto or into the aerobic surface soil horizon, accompanied by continued monitoring and management to alter the physical, chemical, and biological state of the waste. Site, soil, climate, and biological activity interact as a system to degrade and immobilize waste constituents thereby rendering the area suitable for the support of vegetative growth and providing for beneficial future land use.

Landfill- A lined, excavated, or engineered disposal facility where the waste is placed in or on the land and then covered with soil or other suitable cover material. In general, these facilities will not accept liquid wastes for disposal.

Mixing basin- A surface impoundment used to homogenize the liquid and solid phases of waste prior to separating the liquids and solids for further treatment or disposal.

NORM (Naturally Occurring Radioactive Material)- Any nuclide which is radioactive in its natural physical state (*i.e.*, not man-made) but does not include source or special nuclear material.

Oil-based mud- A drilling fluid that is a water-oil emulsion with oil as the continuous phase. The oil content ranges from 50-98 percent oil. Oil-based muds are used to reduce drilling torque and to stabilize reactive shales that impede the drilling process.

OPA- The Oil Pollution Act of 1990.

Owner/operator- The owner and/or operator of a commercial waste facility is the person or company, either proprietor, contractor, or lessee, actually owning or operating the waste facility.

Percolation ponds- A type of unit used to dispose of liquids, usually produced water. Percolation ponds allow the liquids to drain or seep into the sides or through the bottom of the pond into the surrounding soils for disposal. These are only used in areas where the groundwater is very deep or nonexistent.

Produced water- The water extracted from the subsurface with oil and gas. It may include formation water, water that has been injected into the formation, and any chemicals added downhole or during the production/treatment process. Produced water is also called "brine" (and may contain high mineral or salt content) or "formation water." Some produced water is quite fresh and may be used for irrigation or livestock watering in some Western States (although sometimes treatment is required prior to use).

RCRA- The Resource Conservation and Recovery Act and its amendments.

Residual piles- Non-containerized, lined or unlined, accumulations of solid, nonflowing materials. Typically, these contain post-treatment materials available for re-use, re-cycling, or final disposal.

Road spreading or mixing- The practice of applying certain E&P wastes onto roadways or mixing with excavated native materials to form road paving materials.

SARA- The Superfund Amendments and Reauthorization Act and its amendments. SARA Titles I and II amended CERCLA, while Title III contains a separate statute, the Emergency Planning and Community Right-to-Know Act.

SDWA- The Safe Drinking Water Act and its amendments.

SPCC- Spill Prevention Control and Countermeasure plans. Regulated under the Clean Water Act.

Storage- The holding of waste for a temporary period prior to recycling, treatment, disposal, or storage elsewhere.

Surface impoundments- See Impoundments.

Synthetic-based mud- Synthetic based drilling mud can include vegetable esters, poly alpha olefins, synthetic paraffins, and other materials circulated down the drill pipe for lubrication purposes.

Tank bottoms- The liquids and residue, such as heavy hydrocarbons, solids, sands, and emulsions which collect in the bottom of treating vessels or remain in the bottom of storage tanks after a period of service.

TSCA- The Toxic Substances Control Act and its amendments.

Thermal desorption- Heating in an enclosed chamber under oxidizing or non-oxidizing atmospheres at sufficient temperature and residence time to vaporize organic materials from surfaces and surface pores such that the organic materials are removed from the heating chamber in a gaseous form.

Thermal treatment- The treatment of waste in a device which uses elevated temperatures as the primary means to change the chemical, physical, or biological character or composition of the waste. Incineration and thermal desorption are examples of thermal treatment.

Transfer station- An E&P waste receiving and storage facility, located offsite from the commercial waste facility, but operated in conjunction with a permitted commercial facility, which is used for the temporary storage of E&P waste prior to recycling, treatment, or disposal.

Treatment- The physical, chemical, or biological management of an E&P waste prior to disposal.

UIC- Underground injection control, a regulatory program contained in the SDWA.

USDW (Underground Source of Drinking Water)- An aquifer or its portion: (1) (i) which supplies any public water system; or (ii) which contains a sufficient quantity of ground water to supply a public water system; and (A) currently supplies drinking water for human consumption; or (B) contains fewer than 10,000 mg/l total dissolved solids; and (2) which is not an exempted aquifer.

VOC's (Volatile Organic Compound)- Organic chemicals that evaporate readily into the atmosphere, providing a path for transport through the environment

Water-based mud- A water-based mud is a type of drilling fluid used in the rotary drilling of wells to clean and condition the hole and to counterbalance formation pressure. Water based drilling fluid is the conventional drilling mud in which water is the continuous phase and the suspending medium for solids, whether or not oil is present. Drilling fluids are circulated down the drill pipe.

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Washington, DC 20005-4070
USA

202.682.8000