

# Utah Division of Oil, Gas and Mining Guidance Document

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Prepared By:

**Ammon McDonald**  
Environmental Scientist



## Cleanup Level Selection Guidance Document (re: Utah Oil & Gas Conservation General Rules R649-3 Drilling and Operating Practices R649-9 Waste Management and Disposal)

This document is intended for use when evaluating appropriate cleanup levels for oil and gas exploration and production (E&P) related sites. Utah Administrative Code R649-3 and R649-9 should be used in conjunction with this guidance.

### FOR FURTHER INFORMATION CONTACT:

Division of Oil, Gas and Mining  
1594 West North Temple, Suite 1210  
P.O. Box 145801  
Salt Lake City, Utah 84114-5801  
Telephone: (801)538-5340

### *Our Mission*

*The Utah Oil and Gas Program within the Division of Oil, Gas and Mining:*

- Promote the exploration, development and conservation of oil and gas resources*
- Foster a fair economic return to the general public for those resources*
- Maintain sound, regulatory oversight to ensure environmentally acceptable activities*

## **Scope and Applicability**

This document is applicable for determining cleanup levels at a wide range of E&P sites in the State of Utah. This document depicts minimum cleanup levels for surface abandonment of E&P materials.

Sensitive sites may be required to meet more stringent cleanup standards. This document should be used to determine the required cleanup levels for sensitive sites and non-sensitive sites.

## **Salts**

Salts have been identified as a principal limiting constituent of concern relative to onshore exploration and production operations because they may induce phytotoxicity, deteriorate soil structure interrupting normal soil-plant-water relationships, and causing excessive erosion. Salts associated with Exploration and Production (E&P) wastes also pose a threat to surface and groundwater resources if not properly managed.



Salinity of E&P waste or treated waste products applied to soil surface should be limited by the following final disposition criteria:

- Electrical Conductivity:  $EC \leq 4$  mmho/cm; which approximates a TDS of 2,560 mg/L
- Exchangeable Sodium Percentage:  $ESP \leq 15\%$
- Sodium Adsorption Ratio:  $SAR \leq 12$

If natural background soil characteristics show poorer quality than depicted by these limits, or if higher levels can be demonstrated to be consistent with the intended land use, then these limits can be exceeded.## In sensitive areas, restrictive limits for salinity may be applied on a case-by-case basis, especially for large volumes of waste to be abandoned.

## **Hydrocarbons**

Hydrocarbons have been identified as a principal limiting constituent of concern relative to onshore exploration and production operations because they may reduce the usability of land due to environmental damage and human health risks. Hydrocarbons associated with E&P wastes also pose a threat to surface and groundwater resources if not properly managed.

Weathering of petroleum, which occurs over time, shifts constituents toward heavier fractions. Heavy end components are generally considered less toxic: ORO (Oil Range Organics). The weathering fate of crude oil is considered an uncertainty. Lighter fractions are more mobile and thus have lower limits to adequately protect surface-waters and shallow groundwater: GRO & DRO {Gasoline Range Organics (1,000 ppm) & Diesel Range Organics (2,000 ppm)}.

The use of conservative assumptions is a necessary part of a sound, generic, cleanup standard of any kind. Soil contamination can be a source of groundwater and surface-water contamination, reduce the usability of surface land, and weathered petroleum residuals can stay bound in soils for extended periods of time. The maximum level of the fractions of Total Recoverable Petroleum Hydrocarbons (TRPH < 10,000 ppm) concentration allowed above background levels will be determined as follows:

- $TRPH = GRO + DRO + ORO$ ; with the maximum ORO value determined by
- $ORO_{max} = 10,000\text{ppm} - (GRO_{ppm} + DRO_{ppm})$ 
  - 1% or 10,000 ppm TRPH<sub>max</sub>
- TRPH will be characterized using the following fractions:
  - $TRPH = GRO + DRO + ORO$
  - $GRO_{max} = 1,000\text{ ppm}$
  - $DRO_{max} = 2,000\text{ ppm}$

Crude oil typically contains about 15% by weight total aromatics; oily wastes may contain similar compositions. However, heavier compounds are less soluble than lighter ones and justify less consideration for mobility in the environment. Fresh crude oils generally contain less than 3% significantly soluble aromatics. Aromatics are of greater concern, which are in general less degradable than aliphatic hydrocarbons. Since, in sensitive areas, it is likely that some aromatics will make their way into ground or surface waters, more stringent cleanup levels will apply.

For sites with higher environmental sensitivity, 0.01 ppm to 9,999 ppm TPH is recommended; cleanup level will be dependent upon the BTEXN levels in waste.

- Benzene  $\leq 0.9\text{ ppm}$
- Toluene  $\leq 25\text{ ppm}$
- Ethylbenzene  $\leq 23\text{ ppm}$
- Xylene  $\leq 142\text{ ppm}$
- Naphthalene  $\leq 51\text{ ppm}$

## **Metals**

Heavy metals are constituents of concern relative to onshore exploration and production operations because they are toxic to flora and fauna when they become concentrated in the environment. Metals associated with E&P wastes pose a threat to degrade surface and groundwater resources when not properly managed.

If significant levels of toxic metals are believed to exist, or there is concern due to the type or source(s) of wastes, testing will be required and mobility evaluated utilizing the Toxicity Characteristic Leaching Procedure (TCLP). If TCLP testing is required, the following limits for heavy metals will be used:

- Arsenic  $\leq 5$  ppm
- Barium  $\leq 100$  ppm
- Cadmium  $\leq 1$  ppm
- Chromium  $\leq 5$  ppm
- Lead  $\leq 5$  ppm
- Mercury  $\leq 0.2$  ppm
- Selenium  $\leq 1$  ppm
- Silver  $\leq 5$  ppm

### **Guidance for Determining Cleanup Levels**

This section should be used as guidance for oil and gas operators and Division Staff in evaluating the appropriate cleanup levels for oil and gas exploration and production (E&P) related sites. This guidance also applies to treated oily E&P waste material which is to be applied to soil or buried.

The approach utilizes a ranking system to evaluate the environmental sensitivity of a site. The subsequent score derived from the ranking process is used to determine appropriate cleanup level.

### **Levels of Environmental Cleanup and Recommended Cleanup Levels for Soils and Oily Wastes**

<u>Sensitivity Level</u>	<u>Total Petroleum Hydrocarbon (TPH in mg/kg or ppm)</u>
Level I	0.01 ppm to 9,999 ppm
Level II	10,000 ppm

For sites with a Sensitivity Level I, the cleanup level will be calculated using the formula below. Values of 9,999 ppm and 0.01 ppm TPH are the upper and lower limits of cleanup required.

- $0.009 \div \text{fraction benzene in soil} = \text{cleanup level in ppm}$ 
  - where: 0.009 = attenuation factor
- Example:  $0.009 \div 0.0001 = 90\text{ppm TPH}$ 
  - For a 0.01% benzene level in waste or soil to be abandoned
  - The percentage of TPH which is benzene is an indication of the aqueous solubility of the waste

### **Summation of Ranking Criteria to Determine Sensitivity & Cleanup Levels**

The summation of all of the above ranking scores will yield one value which shall be used to determine the appropriate soil cleanup levels on a case-by-case basis. The sensitivity levels are as follows:

- Level I Sensitivity Cleanup: For scores totaling  $\geq 50$
- Level II Sensitivity Cleanup: For scores totaling  $< 50$

**Sensitivity Evaluation Ranking Criteria and Ranking Scores for Cleanup Levels**

<b>Site-Specific Factors</b>	<b>Ranking Score</b>
Distance to Groundwater (feet)	
>100	0
100 to 75	5
75 to 50	10
50 to 25	20
25 to 10	30
<10, or recharge area	50
Native Soil Type	
Low permeability	0
Mod. permeability	10
High permeability	20
Annual Precipitation (inches)	
<10	0
10 to 20	5
>20	10
Distance to Nearest Municipal Water Well (feet)	
>5280	0
1320 to 5280	10
500 to 1320	20
<500	30
Distance to Other Water Well (feet)	
>1320	0
300 to 1320	10
<300	20
Distance to Surf. Water (feet)	
>1500	0
1000 to 1500	5
500 to 1000	15
300 to 500	30
<300	50
Affected Populations	
<100	0
100 to 300	5
>300	10
Presence of Utility Conduits	
Not Present	0
Unknown	5
Present	10

## **Ranking Criteria for Sensitivity Levels**

### **1) Depth to Groundwater**

Depth to groundwater is evaluated in feet below lowermost contamination depth. This evaluation must consider the highest seasonal average. In some cases, depth to groundwater and subsurface contamination are both relatively deep. In addition, recharge areas are considered to be as environmentally sensitive as the lowest distance from contamination to groundwater. Sites located in recharge areas may therefore be considered zero feet from contamination to groundwater.

### **2) Soil Type**

The predominant site lithology and native soil type will be determined by soils classified according to the Unified Soil Classification. Permeability of native soils shall be determined according to the following:

- a) Low permeability (clay, shale, fat clay, high plasticity clay, elastic silt low plasticity silt, lean clay, silty clay, sandy clay, silty or clayey fine sand, very fine gravelly clay, non-fractured igneous and metamorphic rocks, and consolidated, cemented sedimentary rocks; USC=Pt, OH, CH, MH,OL,CL,ML).
- b) Moderate permeability (clayey sand, poorly graded sand-clay mixtures, silty sand, poorly graded sand-silt mixtures, moderately fractured igneous and metamorphic rocks, moderately permeable limestone; USC=SC, SM).
- c) High permeability (fine sand, silty sand, sand, gravel, gravelly sand, clayey gravel, gravel-sand-clay-silt mixtures, silty, gravel, highly fractured igneous and metamorphic rocks, vesicular igneous rocks, cavernous or vuggy limestone; USC=SM, SP, SW, GC, GM, GP, GW).

### **3) Precipitation**

Average annual precipitation in a specific area must be identified to evaluate effects of recharge and potential for mobilization of contaminants. Values for average annual precipitation are specific for Utah and represent the annual average precipitation in the desert, mountain, and intermediate geographical regions in the state (Waddell, et.al., 1987). Precipitation information shall be obtained from the nearest national meteorological weather station. Onsite ground cover (e.g. concrete or asphalt) that might prevent infiltration of precipitation is not considered due to the potential for irregularities and fractures in the ground cover that could allow infiltration.

### **4) Distance to Nearest Municipal Water Well**

A municipal water well is assumed to be a well designed to supply groundwater for community consumption. The distances from subsurface contamination to a municipal water well, and corresponding scores shown below, are based on local and regional knowledge of properties of the deep confined aquifers that occupy many of the basins in Utah, and those which are tapped by production wells (Clark, et.al., 1990; Herbert, et.al., 1990, Hely, et.al., 1971). Using calculations for a well producing from a confined aquifer (Bouwer, 1978; Freeze and Cherry, 1979; Driscoll, 1986), the effective radii (r) of one-mile (5280 feet), one-quarter of a mile (1320 feet), and 500 feet induced by a high-capacity municipal well are calculated by applying a pumping rate (Q) of 1500 gallons per minute for 183 days (1/2 year) (t), from an aquifer with a hydraulic conductivity (K) of 100 feet per day (ft/day, clean sand), and an aquifer thickness (or perforated interval, b) of 500 feet, transmissivity (T) of 50,000 ft<sup>2</sup>/day (Clark, et.al., 1990; Herbert, et.al., 1990, Hely, et.al., 1971), and a storage

coefficient (S) of 0.001. The radii of influence is justified for a pumped or flowing well in a confined aquifer (Bouwer, 1978; Freeze and Cherry, 1979). The Environmental Protection Agency (1980) also suggests a critical minimum distance of 500 feet from a point source of contamination (a landfill, for example) and a down gradient drinking water well.

#### **5) Distance to Other Water Wells**

Other water wells will be defined as domestic, irrigation, and stock watering wells that generally have less capacity, and thus smaller radius of influence, than municipal wells. The critical distances of contamination from a low capacity well were also derived and are based on aquifer properties as described in hydrologic information publications for Utah (Hely, et.al., 1971, Waddell, et.al., 1987, Clark, et.al., and Herbert, et.al., 1990). Those properties include a hydraulic conductivity of 100 ft/day, aquifer thickness (or perforated interval) of 100 feet, transmissivity of 10,000 ft<sup>2</sup>/day, pumping rate (Q) of 200 gallons per minute, and a pumping period (t) of 8 hours, which would result in a critical radius of influence of 300 feet (Driscoll, 1986), and maximum radius of influence of one-quarter mile (1320 feet).

#### **6) Distance to Surface Water**

Surface water bodies include perennial rivers, streams, creeks, irrigation canals and ditches, lakes, and ponds. The critical distance of contamination to a surface water body is based on experimental modeling by Stokman (1987). The model evaluated the changes in benzene concentration in groundwater at varying distances from a release of unleaded gasoline. The model predicted that an initial benzene concentration of approximately three times the MCL was reduced to below the MCL at a distance of 300 feet from the source. Although this distance may not be applicable in all cases, 300 feet is considered to be an appropriate critical distance between a source of contamination and surface water. Approximately three times the most sensitive distance is 900 feet, which is rounded up to 1000 feet.

#### **7) Potentially Affected Populations**

The score for affected populations is based on the number of potential receptors within a three-mile radius of a release site, using census plot information. A three-mile radius is based on the ability of contaminants to travel three miles via utility conduits, or by other means. The potentially affected populations include residents, employees, recreational users, and others who regularly enter the area.

#### **8) Utility Conduits**

Utility conduits include water distribution lines, sewer lines, septic tanks, buried electrical lines, and any other pathway within 300 feet that may facilitate contaminant migration.

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