The Oklahoma Corporation Commission

December 2021

Pollution Abatement Department, Oil and Gas Conservation Division, Guardian Guidance for the Assessment and Cleanup of Complex Crude Oil, Condensate, and Other Hydrocarbon Release Sites, Including Historically Impacted Sites

Includes Appendix on Produced Water/Brine Assessment and Cleanup

Replaces Guardian Assessment and Cleanup Guidance Effective July 1, 2014

"I am the Guardian…And I will stand guard here,
over our great state, over our majestic land, over our values."
Senator Kelly Haney, sculptor of the **Guardian** statue that stands atop the new State Capital dome**.**

Oklahoma Centennial Commemorative Medallion
Design by Betty Price, Executive Director
Oklahoma Arts Council

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This document does not have the compliance requirements of a Commission rule. See:

- OAC 165:10-7 for the Division's Pollution Abatement rules and
- OAC 165:10-10 for the Division's Brownfield rules.

PURPOSE, SUMMARY TABLE, and SIMPLFIED FLOW CHART

Most oil and gas field hydrocarbon or brine spills in Oklahoma are to soil near the wellhead, flowlines, or tanks. These spills are reported to and cleaned up in consultation with a Field Inspector in one of the OCC's Oil and Gas Conservation Division's (O&G) Field Operations Department District Offices. Appendix III details how to obtain spill reporting requirements and other District information.

However, complex and/or unusually extensive[1] (see footnote) spills and historic pollution cases at oil and gas sites, pipelines, and tank farms in Oklahoma, especially those involving ground water or surface water, are managed in consultation with the O&G Division's Pollution Abatement (PA) Department. The step-by-step process an operator follows to assess, clean up if necessary, and close these sites is summarized below in Steps 1-7, and is explained in more detail in subsequent pages.

SUMMARY TABLE OF STEPS, AND ACTIONS TO BE TAKEN BY OPERATOR

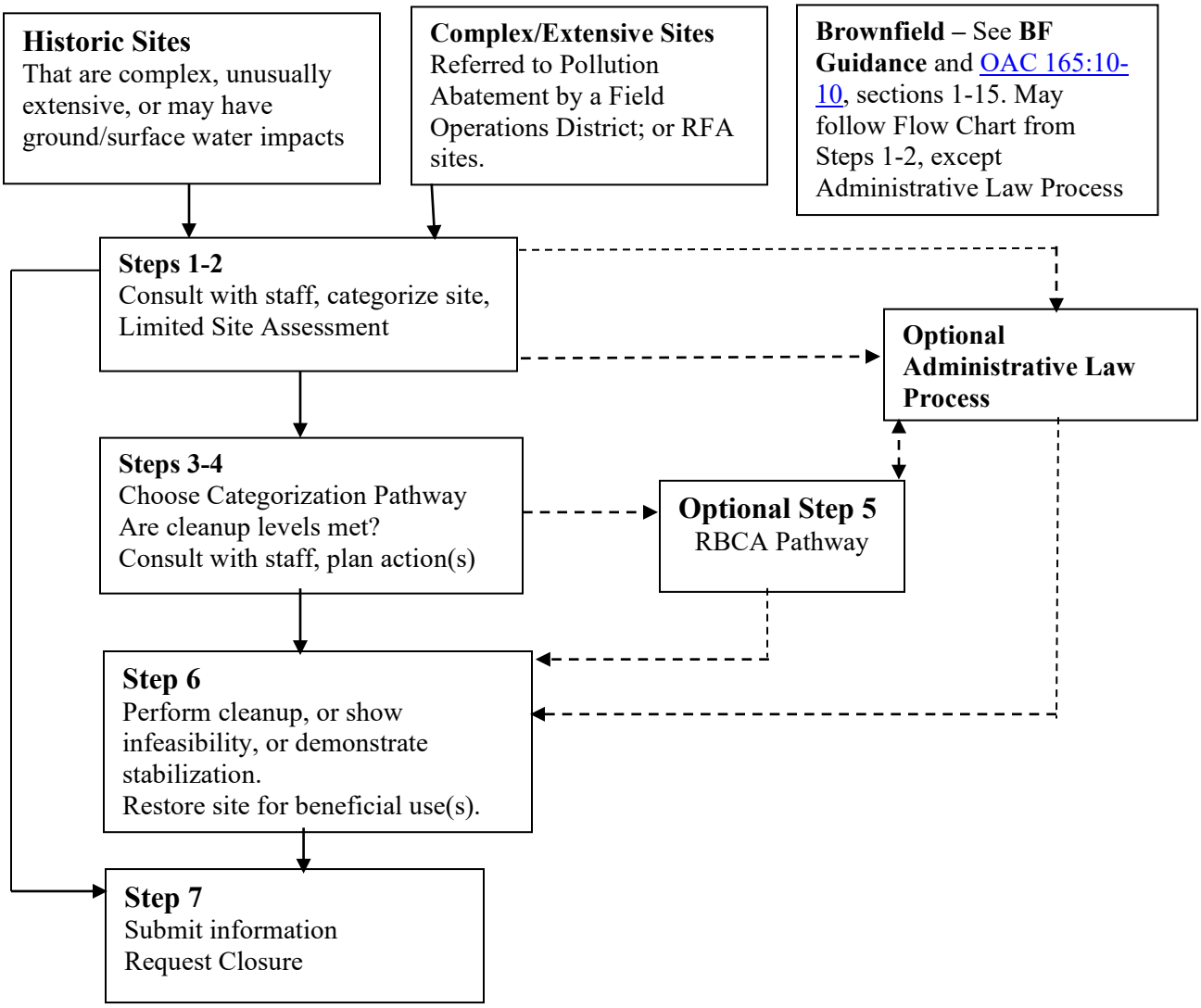
Step	Descriptive Title	Actions (May choose to follow RBCA or Admin. Law Hearing pathway from Step 1 onward)
1	Consult with Pollution Abatement Department and Categorize Site.	Categorize site and discuss future actions. Then choose pathway - Category (Steps 1-4, 6); or RBCA (Step 5); or Administrative Law Hearing.
2	Limited Site Assessment	Collect soil/water/other site data (page 6)
3	Are category cleanup levels met?	If yes, confirm with PA, then determine if beneficial use restoration is achieved (Step 6C). If yes, request closure (Step 7). If no, then proceed to Step 4 or Step 5.
4	Consult with PA staff to plan and perform a cleanup and/or show stabilization or use RBCA.	Discuss with PA and choose actions to be done. • Step 6A and 6B • Step 5 (RBCA Pathway) or Hearing
5	Optional RBCA (risk based corrective action)	Prepare conceptual site model (see page 9). Consider chemicals of concern (especially benzene and TPH), possible pathways/transport mechanisms to receptors, site beneficial use(s), and state standards. Then develop RBSLs or SSTLs for site cleanup criteria. If criteria met, request closure (Step 7). If not, go to Step 6.
6	**A&B.** Perform cleanup and/or provide stabilization data. **C.** Restore site beneficial use(s) (example: site revegetation)	For A&B remove/remediate soil/water to meet Category or RBCA cleanup levels or Demonstrate stabilization For C restore site beneficial use(s). If done, Operator can request closure (Step 7). If it cannot be done, then the Operator can consider the route of a Hearing.
7	Operator submits data to PA staff and requests case closure	Submit final report (see Submittal Checklist, Appendix I) and request closure.

1 Complex and/or unusually extensive sites are those that
a) involve several different polluting substances; and/or
b) involve impacts to surface water or ground water or bedrock, not just soil; and/or
c) affect a relatively large area (e.g. from a large tank or pipeline break, or the fluid flowed a long way downhill).

SIMPLIFIED FLOW CHART

(for complete detailed Decision Tree flow chart, go to Appendix I)

(For Brownfields flow chart – see Brownfield guidance and rules)



STANDARD CATEGORIZATION AND CLEANUP PATHWAY (STEPS 1-4)

This guidance is intended to cover sites that are overseen by the Oklahoma Corporation Commission Oil and Gas Conservation Division's Pollution Abatement (PA) Department. The two main types of sites/cases overseen by PA include:

Complex and/or Unusually Extensive Sites
Recent spill sites where the assessment and/or remediation are likely to be complex and/or unusually extensive, and sites that have known or likely impacts to ground water or surface water, are often assigned (referred) by a Field Operations District Office to the PA Department. In addition, some complex request-for-assistance (RFA) sites (which are those sites that are handled by a Field Inspector with the requested assistance of a PA Hydrologist) may also be subject to all or part of this guidance as appropriate.

Historically Impacted Sites
A historically impacted site is not the result of a recent spill. It can be 1) an old spill site that was not adequately cleaned up, or 2) one that has site impacts resulting from practices that once were legal, but which have resulted in a pollution problem(s), or 3) one that has pollution from an unknown source. Although not subject to the 24-hour spill/release reporting rule, these sites still should be reported when found, and must be cleaned up and/or restored to beneficial use. Sites that have only soil impacts are reported to the District Office, which will assign an incident number. Complex and/or unusually extensive sites/cases, and those likely to have impacts to ground water or surface water, may be reported directly to the PA Department (see Appendix III), which will assign the incident number.

PA staff prefers a voluntary, consultative process to formal hearings, and will provide guidance. There may be regulatory or other requirements to be met before a site/case is finished (see closure, in glossary). However, if there is disagreement over what should be done at a site, an Administrative Law Hearing may be requested by Pollution Abatement or an operator or a complainant (OAC 165:10-7-4(e)). In addition, the RBCA pathway may be chosen anytime from Step 1 onward.

STEP 1 – Consult with PA Staff about the Site, and Complete the Initial Site Categorization using the Petroleum Risk Factor Index Table in Appendix I:

Complete, sign, and submit the Index Table in Appendix I to PA with a brief explanation of how the risk factors (e.g., volume lost, distance to water well, etc.) were determined. Operators may wish to consult with PA staff prior to completing the table(s), especially if there is more than one (different type of) impacted area at a site necessitating the submission of more than one Table. The table(s) should be reviewed and, if necessary, revised and resubmitted whenever new site information is obtained. Basic site and release/impacted area information may also be requested in this step by PA staff for sites lacking full documentation by the Field Inspector (Form 1085, usually). See the optional *Initial Site Evaluation Report*, Appendix VI, for the types of information that may be requested.

Choose either the PA category cleanup/stabilization or the RBCA pathway (see flow chart).

STEP 2 – Limited Site Assessment to Collect Needed Site Data:

The purpose of a limited site assessment is to document whether or not there is impact at/from the site that could cause a significant risk to human health or the environment requiring a cleanup. For guidance on what information (maps, reports, sampling data, etc.) needs to be submitted, refer to the submittal checklist for Step 7 in Appendix I. The optional forms in Appendix VI may be used instead of the submittal checklist. See Appendix II for Site Assessment Guidance.

A list of environmental consultants and laboratories is provided in the PA Department Environmental Directory.

If there could be additional site impacts in the release area from other sources (e.g. heavy metals from tank bottoms and sludges, old refining activities, former gas plants, mud pits; excess soil or water salinity from brine spills or old brine pits; glycol from a natural gas dehydrator), operators can refer to Appendices VII and VIII, consult with PA staff, request one of the Commission's other guidance documents, and/or look up one of the many guidance documents available from the American Petroleum Institute (API; https://www.api.org/oil-and-natural-gas/environment)

For Brownfield-specific assessment requirements see Brownfield Program guidance and rules at OAC 165:10-10.

STEP 3 – Have the Appropriate Category Levels Been Met? See the Category Cleanup Table in Appendix I and, if the impacted site is in a Sensitive Area, the bulleted guidance below:

Make any necessary revisions to the Index Table score and appropriate Category determination following the Site Assessment (for example, if impacts exceeding Category I cleanup criteria to water are found, or if ground water was found at a different depth than predicted, the points assigned to risk factors #1 and/or #2 may change, changing the Category of the site). Then compare the sample concentrations from the assessment to background and to the appropriate Category cleanup levels in the Category Cleanup Table (Appendix I), or the Sensitive Area criteria below.

If cleanup criteria are met, confirm with PA, then go to Step 6. If cleanup criteria are not met, go to Step 4, or follow Step 5 the RBCA pathway.

- **"Sensitive Areas"** with high soil contact uses (includes residential):
    1. Sensitive Areas are the yards and gardens of homes (see glossary, Appendix V,) plus the grounds of schools, day care centers, sports fields, playgrounds, and similar areas, if frequently accessed by vulnerable groups with high soil contact uses.
    2. Because of the potential for residents and children to have increased exposure levels via a direct soil contact pathway in these areas, the following soil cleanup criteria should be applied in or within 330 feet of Sensitive Areas.

- "**Sensitive Area" soil cleanup criteria** (based on the lowest of the human health risk, plant tolerance, and/or mobility limit numbers**)**
    1. Benzene – 3 mg/kg in shallow groundwater/Category I areas; 5 mg/kg otherwise.

2. TPH - 3000 mg/kg for condensate; 2600 mg/kg for crude oil.
3. Lower levels may be necessary if these levels create offensive odors or other nuisance problems.
4. These criteria apply only to the shallow soil(s) that people are likely to touch. For deeper subsurface soils, see the Category Cleanup Table or perform a RBCA analysis.

STEP 4 - Consult with Pollution Abatement Staff and Decide:

Discuss what additional cleanup and/or restoration work needs to be done. Then:

- Plan to clean up to Category levels, or
- Demonstrate plume stabilization, with MNA as the "cleanup" option (see glossary, Appendix V, and Step 6), or
- Choose the RBCA pathway (see Step 5).

If all the work necessary to close a site cannot be done within one-year, interim data, reports, and/or other information (see the submittal checklist, Appendix I) will probably be requested. When there are groundwater impacts above Category cleanup levels this usually includes quarterly groundwater monitoring for plume movement and concentration changes.

OPTIONAL RBCA PATHWAY (STEP 5)

STEP 5 - RBCA:

A risk-based corrective action (RBCA) approach is an option for determining cleanup levels at any time in the Step 1 through Step 4 process for any or all pollutants (state explicitly which, and why). If the RBCA approach is used, it should follow established methodologies, such as most current ASTM RBCA (E1739), which considers a full range of petroleum constituents including both BTEX and TPH as necessary. The PA Department strongly recommends the use of the American Petroleum Institute's RBCA spreadsheet, which has been customized for the risk assessment of crude oil and condensates (https://oklahoma.gov/content/dam/ok/en/occ/documents/og/tph-ss-6-25.xls) The Petroleum Storage Tank Division's ORBCA method, which does not consider impacts from TPH, will no longer be accepted.

In general, the traditional RBCA approach is a tiered method in which the level of effort is tailored to the needs of a particular site in question. The general process steps outlined below should be followed when using the traditional RBCA approach. **For Sensitive Areas as defined in Step 3, assume a residential land use for RBCA purposes.** Consider:

- Chemicals of concern (COCs), especially benzene and TPH (and fractions, as necessary). Refer to Step 2 for basic site assessment guidelines on identifying COCs for crude oil and condensate, and Appendix VII for other material(s).
- Possible migration pathways to receptors (see Figure 1 on page 10 and the glossary in Appendix VI).
- Possible receptor exposure points (see glossary). Include direct contact with soil or water; surface water or ground water ingestion; and dust/air inhalation in a confined space, as in

buildings and trenches, but not in open air.
- State water quality standards, to be met at the receptor exposure point (see the WQSIP).
- Site/area conditions including land use, topography, soil (type(s), fraction organic carbon).
- Plume stabilization, similar to Step 6, can be considered as part of a RBCA.
- Beneficial use(s) of the site (or immediate future use if transferring control of the site); and
- Other factors as necessary.

If there is more than one impacted area(s) within a large site, different RBCA evaluations may be appropriate for each one.

The default tables assume that the plume length will not exceed 300 feet, which is the case for most groundwater plumes (Characteristics of Dissolved Petroleum Hydrocarbon Plumes, Results from Four Studies, API Bulletin No. 8, December 1998). However, if the plume exceeds or is likely to exceed 300 feet, other criteria may be applied on a case-by-case basis.

The amount of cleanup and/or monitoring required depends upon the results of the RBCA.
- Compare the appropriate RBSL or SSTL levels to site COC levels. Are criteria met?
- If additional work is needed to meet the RBCA-calculated RBSLs or SSTLs, submit a plan to do the cleanup work necessary and go to Step 6.
- If the site can be closed without additional work, go to Step 7.

Tier 1 Analysis
- Develop the Conceptual Site Model (see Figure 1, and CSM in the glossary, Appendix V):
    1. Conduct a site assessment to gather all necessary information.
    2. Prepare a Conceptual Site Model (CSM) to describe the site situation. The CSM may be graphical and/or narrative. An example of a graphical CSM is shown in Figure 1.
        a. The CSM describes all pathways through which receptors might be exposed to chemicals of concern at the site. Examples of exposure pathways include direct contact and groundwater ingestion. Other pathways may be relevant and must be included if appropriate.
        b. Use realistic land uses (e.g., commercial, industrial, residential, agricultural).
        c. Evaluate transport mechanisms. If necessary, collect information to verify NAPL (see glossary, App. V) immobility, dissolved plume stability and/or the presence or absence of preferential flow pathways (e.g., utility conduits, abandoned well bores, fractured clay, etc.).

- Characterize Risk:
    1. Compare site COC levels to risk-based screening levels (RBSLs) in the Tier 1 Lookup Table. If the CSM includes any exposure pathways or receptors not included in the Table propose and provide justification for additional RBSLs.
    2. For the soil leaching to groundwater pathway, the default Tier 1 Lookup Table assumes that the nearest water well is in the impacted area. The OK RBCA Spreadsheet may be used for calculating an alternative Tier 1 RBSL for this pathway, by setting an alternative distance to a downgradient receptor well**.** This would be a Modified Tier 1. **No other parameters may be changed in Tier 1.**

- Decide Risk Management Approach:
    1. If levels of COCs at the site are below Tier 1 RBSLs, submit a request for closure to the PA Department, including sufficient documentation of the site assessment, CSM and Tier 1 analysis described above.
    2. If levels of COCs are above Tier 1 RBSLs, either clean up the site to Tier 1 levels, or do a Tier 2 analysis.

Tier 2 Analysis

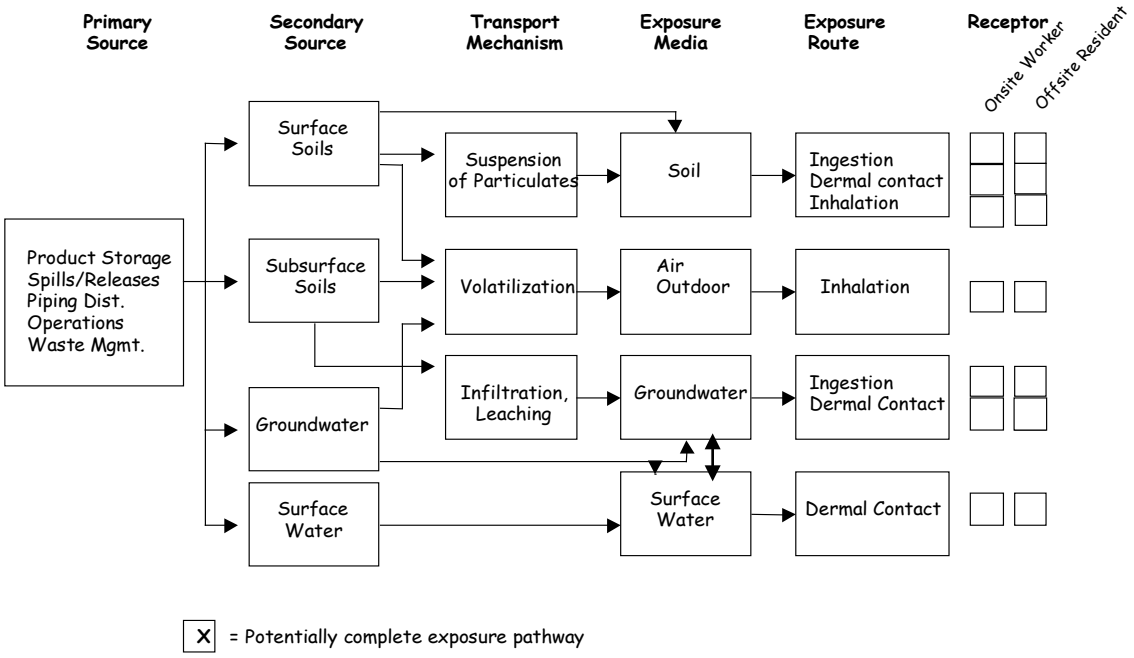
- Refine CSM: Collect additional site-specific information, if necessary, to refine the CSM developed in Tier 1 analysis.
- Characterize Risk: Calculate Tier II Site-Specific Target Levels (SSTLs). The OK RBCA Spreadsheet may be used to calculate TPH, benzene, and BTEX Tier 2 SSTLs.
- Compare site COC levels to Tier 2 SSTLs.
- Decide Risk Management Approach:
    1. If COC levels at the site are below Tier 2 SSTLs, submit a request for closure to the PA Department, including sufficient documentation of the site assessment, CSM and Tier 2 analysis (including site-specific input parameters) described above.
    2. If levels of COCs are above Tier 2 SSTLs, either cleanup site to Tier 2 levels, or do a Tier 3 analysis.

Tier 3 Analysis

Tier 3 assessments, though rarely conducted, may be appropriate for very complex sites. Tier 3 assessments usually involve a sophisticated level of data analysis and use of alternative fate and transport models. Contact the PA Department prior to initiating a Tier 3 analysis.

- Refine CSM: Collect additional site-specific information to refine the CSM, if necessary.
- Characterize Risk: Conduct site-specific fate and transport analysis and risk assessment. Develop Tier 3 SSTLs and submit SSTLs along with sufficient documentation of the site assessment, CSM and Tier 3 analysis to the PA Department for approval.
- Compare site COC levels to Tier 3 SSTLs.
- Decide Risk Management Approach:
    1. If COC levels at the site are below Tier 3 SSTLs, submit a request for closure to the PA Department, including sufficient documentation of the site assessment, CSM and Tier 3 analysis (including site-specific input parameters) described above.
    2. If site COC levels are above Tier 3 SSTLs, clean up the site to the Tier 3 SSTLs.
    3. If a cleanup is for some reason impractical or technically infeasible, consult with PA staff. An Administrative Law hearing is also an option (OAC 165:10-7-4(e)).

Figure 1. Example Graphical Conceptual Site Model



TIER 1 LOOKUP TABLE

	Groundwater (mg/L)	Soil (mg/kg) Sensitive Area		Soil (mg/kg) Non-Sensitive Area		Soil (mg/kg)	Soil (mg/kg)
Chemical of Concern		Residential Surface Soil	[1] Leaching to GW	Non-residential Surface Soil	[1] Leaching to GW	Oil Mobility Limit	[2]Plant Protection Limit
Benzene	0.005	44	3	190	3	NA	NA
Toluene	1	6700	RES	52000	RES	NA	NA
Ethylbenzene	0.7	5400	RES	60000	RES	NA	NA
Xylenes	10	21000	RES	100000	RES	NA	NA
Total Petroleum Hydrocarbons, condensate	5	4400	RES	46000	RES	3000	10000
Total Petroleum Hydrocarbons, crude oil	5	2600	RES	41000	RES	13000	10000

RES = Target hazard index could not be reached at any concentration of this chemical.
NA = Not Applicable
1 Leaching to GW assumes that the receptor well is located beneath the source. **To consider alternate well locations downgradient from the source (Tier 1a), use the Oklahoma Spreadsheet for Calculating Risk Based Screening Levels to calculate the Tier 1a RBSL.**
2 The Plant Protection Limit only applies in the root zone (see glossary, Appendix V).

Use the CSM for each site to determine which exposure pathways are complete. When using the Tier 1 Lookup Table to determine the appropriate risk-based screening level for a specific chemical or substance at a site, use the strictest (lowest) RBSL for all complete exposure pathways or the mobility limit, whichever is lower. For example, when considering a condensate spill in a non-residential area, 46,000 mg/l is the risk-based number, but 10,000 mg/l is the general plant protection limit and 3,000 mg/kg is the soil mobility limit. 3,000 mg/kg is the number that must be used. Benzene must also be analyzed at a condensate spill site. The appropriate RBSL to meet for benzene is 190 mg/kg, if leaching to groundwater is not a complete exposure pathway at the site. However, if leaching to groundwater is a pathway of concern at the site, then the appropriate RBSL is 3 mg/kg.

PERFORM A CLEANUP OR DEMOSTRATE STABILIZATION TO ENSURE THAT SITE BENEFICIAL USES ARE MET (STEP 6)

STEP 6 – Cleanup or Stabilization and Beneficial use(s):

A. **Clean up** – remove or remediate - the soil and/or water until the Category Cleanup Table levels (see Appendix I), or the calculated RBCA RBSLs/SSTLs, are met, to ensure that standards are met at the point of compliance (see glossary Appendix V). Additional site assessment work to document that the requisite cleanup levels have been met may be necessary. Soil/water disposal may require permits. If there is more than one release or impacted area(s) within a large site, different levels of cleanup and/or restoration may be appropriate for each.

If a full cleanup is **impractical/technically infeasible**[2], consult PA staff or request an Administrative Law hearing.

B. **Demonstrate stabilization** (see glossary), with further remediation by **natural attenuation**.

1. Fully document the extent of the impacted area(s), as in Step 2.
2. Long term monitoring can show that a groundwater plume is stable or shrinking with natural attenuation. See EPA's OSWER Directive 9200.4-17P, and the Monitored Natural Attenuation references in the Data Sources (Appendix III).
3. Stabilization alone is not appropriate if there are pollutant levels that could pose a health risk, or which prevent beneficial use of the site. To ensure public safety, stabilization is often combined with site institutional controls, such as a fence or deed restriction, to help prevent access to, and thus contact with, impacted soil or water.
4. The Commission is more likely to accept the "demonstrate stabilization" option if one or more of the following is documented:
    a. Natural microbial activity and biodegradation can:
        i. sometimes be shown to be occurring at a site by sampling and analyzing for changes in water chemistry that are consistent with biodegradation as described in the Natural Attenuation references (Appendix III), or
        ii be more **definitively demonstrated** through the use of Bio sampling (see glossary) or other biologic testing.
    b. A lack of migration pathways (see definition and examples in the glossary, Appendix V), making movement toward possible receptors very unlikely.
    c. The absence of human or other receptors in the area, based on a receptor study, as well as no likely land/crop damage.

C. Once approved site cleanup and/or stabilization efforts have been completed, the site must be restored to beneficial use(s). To get plants to grow, this may include reducing/removing toxic materials and/or making nutrients available (e.g., by applying fertilizer).

An operator may then request that a No Further remedial Action (NFA) letter be issued.

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2 Example - if an aquifer is impacted near a well and cannot feasibly be cleaned up to drinking water standards before the well is likely affected, providing a new water supply may be the best short-term solution.

However, final site closure is dependent upon completing all regulatory (e.g., monitoring) or consent order (following a hearing) requirements, or other agreed upon actions (see closure, hearing, and monitoring in the glossary, Appendix VI). Interim reports and/or photographs may be requested.

When the site is ready for closure, go to Step 7.

DATA SUBMISSION AND CLOSURE REQUEST

STEP 7 – Submit Information and Request Closure. Submit necessary maps and information to the PA Department (the optional forms in Appendix VI may be used):

- A copy of the completed/revised Index Table.
- A copy of the basic site and assessment information (see checklist Appendix I).
- Monitoring information if any
- The data supporting closure due to:
    1. meeting category cleanup levels, or
    2. meeting the stabilization option, or
    3. meeting RBCA guidelines, without or following a cleanup.
- A request for closure stating why no further remedial action is needed at the site.
- Documentation that the site has been restored to applicable beneficial use(s).
- Documentation that all regulatory (e.g., monitoring, proper abandonment of borings and monitoring wells), consent order, and/or other agreed upon requirements are met.
- Any other necessary information.

APPENDIX I

PA's PETROLEUM RISK FACTOR INDEX TABLE (STEP 1)

CATEGORY CLEANUP TABLE (STEP 3)

SUBMITTAL CHECKLISTS (STEPS 1 AND 7)

DECISION TREE (Complete Flow Chart)

PETROLEUM RISK FACTOR INDEX TABLE

The Table(s) needs to be reviewed, and may have to be revised, when new data is obtained.

Site Name: _____ Incident Number: _____

Legal Location: _____ County: _____

Instructions: Complete this Index Table in Step 1 even if a risk assessment is to be done. Select the risk level that is most reasonable for each risk factor at your site. IF THE RISK FACTOR IS UNKNOWN, USE THE HIGH-RISK NUMBER. Enter the corresponding points in the box to the right. Add the points and enter the amount in the bottom right box beside "Total". If you need assistance, contact PA staff.

Risk Factors (See data sources, App. II, and the glossary, App. VI)	**Low Risk**	**Moderate**	**High Risk**	**Score**
1. Estimate quantity of oil, condensate, or oil/water mix not recovered by initial response action	< 5 barrels to soil (not recovered) **2 points**	5-50 barrels to soil (not recovered) **6 points**	> 50 barrels to soil or ANY amount lost to GROUND OR SURFACE WATER **10 points**	
2. Distance from ground surface to groundwater table. Consider hydrologically sensitive areas (HSAs; See Appendix II)	>35 ft. and not in HSA **2 points**	15-35 ft. and not in HSA, or ≥ 25 ft. in HSA **6 points**	<15 ft.; or <25 ft. in HSA; or contaminated. soil IN CONTACT WITH surface/ground WATER **10 points**	
3. Distance to nearest potable water well from edge of visibly impacted soil; wellhead protection area (WHPA)	> 1320 ft., not in WHPA **2 points**	330 to 1320 ft., not in WHPA **6 points**	< 330 ft. not in WHPA, or in WHPA **10 points**	
4. Background groundwater quality	TDS > 5,000 mg/l **0 points**	TDS 1,000-5,000 mg/l **4 points**	TDS < 1,000 mg/l **8 points**	
5. Predominant soil/rock type in impacted area(s), or "confining layer", between release zone and groundwater,	Tight[7] soil, or "unfractured clay or shale layer >1 ft. thick" **0 points**	Silt, clay/silt/sand mixtures[3] **4 points**	Sand, gravel, fractured clays[7]; shallow porous/fractured bedrock **8 points**	
6. Average annual precipitation, inches	< 28 **0 points**	28-40 **4 points**	> 40 **8 points**	
39-54 points: Category I; 22-38 points: Category II; 6-21 points: Category III			TOTAL	

In the lines below, summarize how and why the risk levels were chosen for each risk factor. Refer by number:

_____

_____

_____

_____

_____

_____

Name and title of person filling out the table: _____

Signature and date: _____

3 FYI - The permeability for tight soils is usually $\leq 10^{-6}$ cm/sec; for silts and mixtures (Unified Soil Classifications ML, OL, SM, GM, or MH) permeability is in the 10^{-3} to 10^{-6} cm/sec range; and for sand/gravel/fractured clays it is $\geq 10^{-3}$ cm/sec.

CATEGORY CLEANUP TABLE[1]

	Category III	Category II	Category I
Index Table Score	6-21 points	22-38 points	39-54 points
Chemical of Concern	**Maximum levels for NonSensitive Area/NonResidential Soils[2][3][6]**		
Benzene[4]	31 mg/kg if ≤ 330 ft. to drinking water (DW) supply 310 mg/kg if > 330 ft. to DW supply	23 mg/kg if ≤ 330 ft. to DW supply 230 mg/kg if > 330 ft. to DW supply	3 mg/kg
TPH from Condensate	10,000 mg/kg ≤ 2 ft. deep, 20,000 mg/kg > 2 ft. deep (Total TPH)	5,000 mg/kg ≤ 3 ft. deep, 10,000 mg/kg > 3 ft. deep	3,000 mg/kg
TPH from crude oil		10,000 mg/kg	5,000 mg/kg
Chemical of Concern	**Maximum levels, for Groundwater[5]** The Category I criteria for water apply to all Categories when <u>in an aquifer within 330 ft. of a drinking water well.</u>		
Benzene or BTEX	0.5 mg/l benzene	0.05 mg/l benzene	MCLs B/T/E/X mg/l 0.005/1/0.7/10
Maximum TPH	De minimis measurable free product	25 mg/l	5 mg/l[7]

1. Alternate levels are acceptable under special circumstances, with Commission concurrence. For example, less stringent cleanup limits for soils at historic pollution sites that have stabilized and are naturally attenuating, <u>if beneficial uses are met.</u> However, more stringent limits may be requested if the defined category cleanup levels create nuisance or other problems.
2. For **Sensitive Areas** (homes, schools, etc.) with high soil contact uses, see Step 3.
3. If impacted soil is in contact with ground water or surface water (excepting unused perched non-aquifer zones), lower soil concentrations of TPH or benzene are appropriate.
4. No levels are set for toluene, ethylbenzene, or xylenes in soils since risk-based criteria for these compounds are above what would be present from all oils and condensates analyzed at the benzene and TPH levels listed.
5. Surface waters must meet OWRB standards. See the Oil & Gas Division's Water Quality Standards Implementation Plan (WQSIP) guidance (see glossary Appendix V).
6. 1000 mg/kg TPH is the usual limit for soil to be taken off-site to a landfill or used within the lease for berms etc.
7. For taste and odor, not health based, reasons, the Commission may request a cleanup down to the EPA's drinking water SNARL (see glossary, Appendix VI) limit of 0.1 mg/l for petroleum/TPH from a fresh source affecting a well or other DW supply

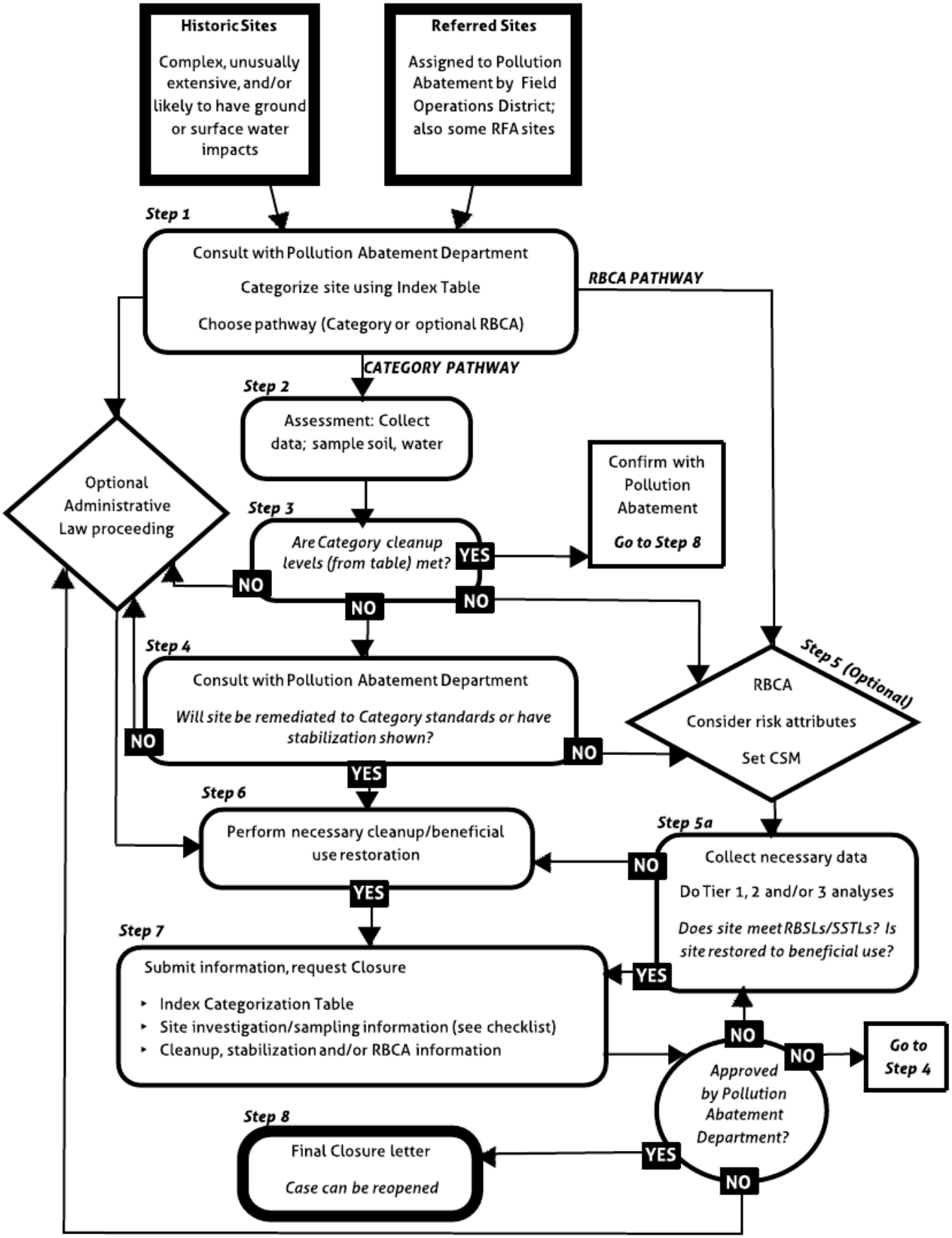
GUARDIAN -OPERATOR'S SUBMITTAL CHECKLIST (FOR STEPS 1 AND 7[4])

Place a check mark beside each item submitted (or completed, even if no written submittal is needed)

Step	Submitted/Completed	Report Reference
1	___ Petroleum Risk Factor Index Table, with explanations and signature. ___ Notify PA staff as to path chosen (Category, RBCA, Hearing).	
7	**BASIC SITE AND ASSESSMENT INFORMATION FOR MOST SITES**	
	___ Index Table, if modified after initial submission or not previously submitted.	
	___ Information from initial spill & cleanup (information not already on Field Ops 1085 form).	
	___ Site map with facilities, utilities, pipelines, impacted area, etc. shown.	
	___ Area maps and photos available – mark the site location on one map that shows section #s. __ topographic ___ soil ___ hydrogeological ___ wellhead protection area __ aerial photo ___other: _____	
	___ Written narrative covering site/area activities and observations (description of land use; wells/surface waters; soils; stains, odors, or other, impacts to soil/water/plants/animals.)	
	___ Map showing sampling locations. Include screening information, observations, rationale.	
	___ Table (preferred) or listing of soil and water analytical results, and copies of lab analyses.	
	___ Boring/excavation logs. Cross-sections if made.	
	___ Other relevant information.	
	IF SALINE WATER IS/WAS PRODUCED/HANDLED AT THE SITE AND IMPACTS ARE APPARENT	
	___Have likely produced water/brine impacts been evaluated? See Appendix VIII	
	IF MONITORING WELLS ARE INSTALLED	
	___ Well installation information.	
	___ Table (preferred) or listing of water sample analytical results, and copies of lab analyses.	
	___ Groundwater elevation measurements, and a map showing flow direction(s).	
	___ Free product information and measurements, and a plan to deal with it.	
	___ TDS or TSS for waters sampled.	
	___ Contoured groundwater plume map(s); depth/time/concentration graphs as necessary.	
	FOR CATEGORY PATHWAY SITES	
	___ Compare Category cleanup levels to site impact levels. Are numerical criteria met? **or**	
	___ Data to show plume is stable (sample all around to background/Category level). Options: ___ Bioenhancement activities or evidence of remediating bacteria/byproducts ___ Institutional controls, if any_____Absence of receptors or pathways.	
	FOR RBCA PATHWAY SITES	
	___ Data documenting the RBCA processes, how RBSLs or SSTLs were calculated.	
	___ RBSLs and/or SSTLs comparison to site COC levels.	
	IF A CLEANUP AND/OR RESTORATION FOR BENEFICIAL USE WAS DONE	
	___ Cleanup information, if any, with **post-completion sampling results** to show the site now meets appropriate Category or RBCA calculated levels.	
	___ Post-action monitoring, if needed to document cleanup conditions and/or restoration.	
	INFORMATION AND DOCUMENTATION NEEDED TO ACHIEVE CLOSURE	
	___ A request for closure stating why no further action is needed at the site.	
	___ Documentation that the site has been restored to beneficial use(s).	
	___ Documentation that all regulatory (e.g. monitoring, proper abandonment of borings and monitoring wells), consent order, and/or other agreed upon requirements are met.	

4 Data and reports will be requested prior to Step 7 if all of the work required to close a site cannot be done within one year.

DECISION TREE (Complete Flow Path)



APPENDIX II

SITE ASSESSMENT GUIDANCE

Typically, the following basic site and assessment information is necessary:

- Requested background data and maps (contact PA staff for assistance, guidance).
    1. Specify the site legal location (qtr-qtr-qtr, Sec-Twp-Rng), and street address (if any).
    2. Show the location on an aerial photo or a topographic, county road, or other appropriate map that is labeled with the site's section, township, and range.
    3. Include the Latitude/Longitude from GPS readings or other sources when available.
    4. Include a Topographic map, and area geological and hydrological data (including water table depth and water quality) if available, to help in determining possible migration pathways (see glossary Appendix V). Soil information can be obtained from the USDA-NRCS soil survey maps and descriptions.
    5. Provide site historical data relevant to the pollutants found onsite, including materials used, transported, and/or produced in specific locations onsite (insofar as it is known) and analytical records on materials released, if available.

- Site information - Provide a short, written narrative and a site map for the following:
    1. A visual site inspection at and near the spill/impacted area (e.g., impairments seen, including damage to crops or pasture; surface soil type; hydrocarbon stains, odors, and seeps; buildings, equipment, and power lines; evidence of underground utilities or pipelines). Draw structure and observation locations on a site map.
    2. Include any relevant information from the initial spill cleanup, and/or other pertinent information, that is <u>not</u> included on a Field Inspector's 1085 form (PA will have a copy of the 1085 if the case originated as a new release/spill).
    3. Observable area information (e.g., agricultural or other land use; all wells and water bodies within 1320 feet; known and flagged oil and gas lines).
    4. Obtainable records, such as data on rural water lines, Oklahoma Water Resources Board (OWRB) water well records, and wellhead protection area (WHPA) maps.

- Sampling data - delineate the horizontal and vertical extent and concentration(s) of pollutants in the impacted area(s) by taking samples in, around, and under the affected soil and/or groundwater plume(s). Compare the pollutant concentrations to background or the appropriate Category level, whichever is higher.
    1. All sampling shall be:
        a. Performed or witnessed by Commission personnel (prior notification to the Commission of sampling events is strongly encouraged), or
        b. Performed by or under the oversight of a qualified geoscientist (see glossary), or
        c. Performed by other qualified person(s) with appropriate and documented soil and/or water sampling training and/or experience; attach a statement on their training/experience to reports submitted.
    2. The Commission may request a copy of acceptable sampling procedures followed or to be followed during the sampling event.
    3. A field kit, field GC, soil gas analyses, or other on-site testing/screening methodology may be used to identify the impacted versus unimpacted areas, and to pinpoint the areas with the highest concentrations. However, field analysis alone is not sufficient to demonstrate whether or not Category or RBSL (risk-based screening levels) or SSTL (site specific target levels – see glossary Appendix V) cleanup levels are met; confirming laboratory analytical samples are necessary (see 5a below).

4. The Commission recommends that one or more soil and water background sample(s) (unimpacted by the release – upgradient for water samples) be taken. The Commission does not require a cleanup more stringent than background levels.
5. Sampling includes borings (or other excavations) in the site area(s) most likely to be impacted based on-site screening data, visual and olfactory criteria, normal movement of liquid contaminants downhill/downgradient, and/or other information. There may be more than one release and/or impacted area per site. Sample in, around, and beneath any obvious surface contamination or pipeline break down into material that has insignificant contamination levels (background or to below the appropriate site category standard, whichever is higher), or to groundwater.

    a. The soil or bedrock sample in each boring or grab sampling area which seems the most contaminated, based on PID/FID data, staining, and/or other information, should be analyzed at a laboratory for:

        - Benzene (DEQ's GRO method or other approved EPA method);
        - TPH as per Texas method 1005 extended to C_{35} for most crudes, and condensates; and
        - Other appropriate constituents[5] (for example, analyze for glycol if there are indications of a spill near a glycol dehydrator unit).

    b. If an excavation below 3 feet is necessary to remove pollutants in the soil, samples from the sides and floor of an excavation, after impacted soil is removed, are necessary to determine concentrations in affected soil remaining on site. Take one sample on each side and from the floor in small (less than 10'X10'X6' deep) excavations. For much larger and/or deeper excavations:

        - Take multiple samples from each of the sides and from the base, 1 in each distinct area when there are clear lithologic or staining/odor/PID/FID changes within/across the excavation and, if field screening is utilized, analyze the sample(s) from each side and floor that appear to be the most contaminated as in 5a, or
        - When there are no clear lithologic or staining/odor/PID/FID changes within/across the excavation, take and analyze composited samples from each side and the bottom, being depth zone consistent.
        - For disposal or treatment of large volumes of excavated soil, analyze at least one composite sample per 50 – 100 cubic yards.[6]

    c. A detailed descriptive log for each boring or excavation from the surface to total depth (TD), including changes in soil (using sand-silt-clay percentages) and/or rock types and apparent degree of contamination. We recommend the use of a standard classification system such as the Unified Soil Classification System or

5 TPH method 1005 is normally sufficient for fresh crude and condensate. However, an analysis for PAHs and other chemicals may be needed for heavy and/or old crude oil spills when the 1005 test shows C28+ to be proportionately high. You can use either EPA method 8260 or 8270.

6 Note – many rural landfills can only take soils up to 1000 mg/kg TPH.

Wentworth, and the Munsel color charts.

d. Cross-sections made from these logs showing changes across the site in soil/rock type, and contamination with depth and relative to the water table, will make the site evaluation easier.
e. Sampling for geotechnical parameters, for data needed for RBCA or remediation (e.g., fraction organic carbon (f_{oc}), permeability), can be collected now or in Steps 5 and 6.
f. Submit a table of sampling data with a map showing sampling locations.
g. Borings not converted to monitoring wells must be properly plugged back to surface using cement, bentonite, or other means as required by the OWRB.

6. Groundwater sampling (by qualified personnel):
   a. Unless c.i., c.ii., c.iii., or c.iv. below apply, install and sample at least three properly constructed monitoring wells[7,8] in a triangular pattern to determine both the groundwater flow direction and the extent of the plume. Sample in, around, and downgradient to any groundwater plume found down to background level, or to below the appropriate site category standard.
   b. Because there could be more than one release/impacted area per site, additional wells must be installed where needed to ensure that there are at least two wells for each separate area within a site likely to be contaminated (one in/adjacent, one downgradient).
   c. Wells do not have to be installed if:
      i. The groundwater table is not reached during boring/excavation, and there is at least five feet of tight clay or shale beneath the soil contamination (document the lithology and lack of permeability), or
      ii. The groundwater table is not reached during boring/excavation, and PID/FID or analytical data for hydrocarbons (PHCs) from at least two soil/rock samples taken at least five feet (vertically) apart beneath the contamination zone show unimpacted materials, or
      iii. The groundwater table is reached, the site is classified as a Category II or III site, pollutants have not impacted an aquifer or hydrologically sensitive area (HSA), and no contamination above (the higher of) natural background or the appropriate Category II or III levels is found in groundwater grab samples (see 6. d., below) in any of the borings, or
      iv. The groundwater table is reached, and the site is Category I or has impacted an aquifer zone or other HSA; however, no contamination above (the higher of) natural background or Category I levels is found in groundwater grab samples in any of the borings.
   d. Grab water samples may be taken for screening purposes from borings, geoprobe holes, and other probes or excavations if groundwater is reached, but be aware that contaminated soil may slough into uncased holes to cause cross-contamination.

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7 All wells must be installed according to OWRB's rules by a driller holding a current OWRB Drilling/Pump Contractor's License to drill and complete geotechnical borings and monitoring wells.

8 Monitoring wells can be completed in geoprobe holes if they are properly cased, screened, sand packed as necessary, sealed, and developed.

e. Water samples should be analyzed for Benzene or BTEX[9] (using DEQ's GRO method or other approved EPA method), TPH (see 5a above), and other appropriate constituents.
f. A background TDS (total dissolved solids) or TSS (total soluble salts) measurement, to determine the likely assigned or default groundwater beneficial use (OAC 785:45-7-3), is necessary.
g. If free product has been discovered, it must be considered in any cleanup or closure proposal. An operator may choose to remove free product immediately without waiting for concurrence with a remediation proposal.
h. If groundwater monitoring is done, reports submitted need to include:
    i. a comparison of the depth to groundwater/NAPL with the screened interval, to ensure that the most likely impacted zone is sampled.
    ii. contoured plume pollutant concentration map(s).
    iii. a groundwater flow direction map based on measured groundwater elevations in at least three wells which form a triangle and
    iv. if monitoring will likely exceed 1 year, submit graph(s) of groundwater elevation vs. contaminant concentrations in monitoring wells over time, annually or at requested intervals.
i. Before a site can be finally closed, all monitoring wells will have to be plugged and abandoned according to OWRB rules.

7. As per OWRB rules and the WQSIP (see glossary, Appendix V):
    a. If a surface water body (see Waters of the State/Waters of the US in the glossary) is potentially impacted, water and sediment samples, as necessary, should be taken and analyzed for BTEX (using DEQ's GRO method or other approved EPA method), TPH (see 5a above) and/or other appropriate constituents. Visual inspection (for oil sheen or rainbow) is also necessary.
    b. The TDS or TSS should also be measured and compared to OWRB surface water quality standards (OAC 785:45-5). Agricultural uses have numerical salinity standards (OWRB rules Appendix F); there is also the OWRB's narrative standard "Increased mineralization from other elements such as calcium, magnesium, sodium, and their associated anions shall be maintained at or below a level that will not restrict any beneficial use" (including fish and wildlife).

9 BTEX if in an aquifer within 330 feet of a well, or otherwise potentially endangering a water supply source.

APPENDIX III

DATA SOURCES AND RELATED ENVIRONMENTAL RESOURCES

DATA SOURCES AND RELATED ENVIRONMENTAL RESOURCES

District Information and Reporting Spills:
Spill reporting and immediate cleanup guidance is covered in the "Oil and Gas Frequently Asked Questions", available here:

- https://oklahoma.gov/occ/divisions/oil-gas/oil-and-gas-faq.html

To determine the appropriate district for reporting a spill or soil-only historically impacted site:

- Go to https://oklahoma.gov/occ/divisions/oil-gas/field-operations-department/districts.html

To obtain field inspector areas and cell numbers for reporting:

- Go to District 1, District 2, District 3, or District 4 to determine specific field inspector for your site.
- Contact the District Office to obtain a cell number for a field inspector. Go to https://oklahoma.gov/occ/divisions/oil-gas/field-operations-department/districts.html for District Office phone numbers.

To report historically impacted sites that are complex and/or unusually extensive, or that involve possible surface water or ground water impacts contact the appropriate PA Department District Environmental Coordinator (EC). Go to https://oklahoma.gov/occ/divisions/oil-gas/pollution-abatement-department.html for the EC's cell numbers.

For spills to navigable Waters of the US:
U.S. Coast Guard National Response Center (24 hour):

- 800-424-8802

For spills that affect surface water in the watershed of a water supply lake:
OK Department of Environmental Quality (24 hour):

- 800-522-0206

For spills affecting fish or wildlife:
Natural Resource Section of the Oklahoma Department of Wildlife Conservation:

- 405-521-4616 (office hours)
- 405-990-5048 (after hours)

For spills that are the result of motor vehicle accidents:
Oklahoma Highway Patrol

- 911

Aerial Photographs:

- The Oklahoma Corporation Commission now has an extensive collection of scanned aerial photographs gathered from various sources across the state, including everything from the Oklahoma Department of Libraries, Oklahoma Geological Survey, and Department of Environmental Quality, and various other sources.

Contact: Madeline Dillner, (405) 522-2750, madeline.dillner@occ.ok.gov

- USDA-Farm Service Agency can provide aerial photographs through the Aerial Photography Field Office at: http://www.fsa.usda.gov/FSA/apfoapp?area=apfohome&subject=landing&topic=landing

- USGS - online at: https://www.usgs.gov/centers/eros

- National Archives and Records Administration, Cartographic and Architectural Branch. http://www.archives.gov/research/order/maps.html#arc

- Aerial photographs can be purchased from various business enterprises in the state and online. However, in effort to make sure that the state shows no preference to an individual business these will not be listed in this document. You can find these through a personal web search.

American Petroleum Institute Environmental Guidance Documents:
https://www.api.org/

Average Annual Precipitation:
See Appendix IV

Environmental Consultants and Laboratories:
A list of environmental consultants and laboratories is available at https://oklahoma.gov/occ/divisions/oil-gas/pollution-abatement-department/environmental-directory.html

Hydrologic Atlases (for area groundwater depths and quality, and geologic information):
Download from the Oklahoma Geological Survey website:
http://www.ogs.ou.edu/pubsDLHAs.php

Latitude and Longitude Information:
- Make field readings on a GPS unit
- Use GPS coordinates from Google Earth or another online mapping source
- Use the maps on your cellular device

Natural Attenuation References:
Air Force Center for Environmental Excellence. 1998. Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation Of Fuel Contamination, Volumes I and II (A324248, A324247a, A324247b): Technology Transfer Division, San Antonio, Texas. https://frtr.gov/pdf/a324248.pdf

American Society for Testing and Materials, 1998. Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites. ASTM E-1943-98. pp. 875-916.

Buscheck, Timothy E.; O'Reilly, Kirk T.; Nelson, Sheldon N. 1993. Evaluation Of Intrinsic Bioremediation At Field Sites. Proceedings: Petroleum hydrocarbons and organic chemicals in ground water; prevention, detection, and restoration. Houston, TX; Nov. 10-12.

Buscheck, Timothy E.; Alcantar, Celia M. 1995. Regression Techniques And Analytical Solutions To Demonstrate Intrinsic Bioremediation. Bioremediation. 3 Vol. 1. Battelle Press, Columbus, OH, United States. pp. 109-116.

United States Environmental Protection Agency, Office of Solid Waste and Emergency Response (US EPA OSWER). April 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P. https://www.epa.gov/sites/default/files/2014-02/documents/d9200.4-17.pdf

Aquifer Maps; Water Quality; Boring and Monitoring Well/Driller Rules:
Go to your local Oklahoma Water Resources Board office, or
http://www.owrb.ok.gov/

Rainfall Data:
Free data for the general public is at:
http://www.mesonet.org/
Detailed data and maps, and historic data, is by account only. To set up an account, click above link and then click data tab.

RBCA Spreadsheet:
https://oklahoma.gov/occ/divisions/oil-gas/pollution-abatement-department/pollution-abatement-environmental-guidance.html

Soil Surveys:
Soil surveys are available at the regional offices of the USDA-NRCS (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/office/) or data can be viewed and downloaded by Area of Interest (AOI) online for free at the NRCS's data viewer:
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Topographic Maps:

- Purchase or Download from USGS on their website:
  https://www.usgs.gov/the-national-map-data-delivery/topographic-maps

- Topo Maps can be purchased from various business enterprises in the state and online. However, in effort to make sure that the state shows no preference to an individual business these will not be listed in this document. You can find these through a personal web search.

Unified Soil Classification System tables:
US Army Corps of Engineers:
https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3757/

WHPAs (Wellhead Protection Areas):
Obtainable from your local water system office or the area DEQ office, and viewable on DEQ's Flex data viewer: https://gis.deq.ok.gov/maps/

WQSIP (Water Quality Standards Implementation Plan):
On the Commission's web site at https://oklahoma.gov/occ/divisions/oil-gas/pollution-abatement-department/water-quality-standards-implementation-plan.html

APPENDIX IV

HYDROLOGICALLY SENSITIVE AREAS AND RAINFALL MAP OF OKLAHOMA

FROM HYDROLOGIC ATLASES (HAs)[10]
and
OKLAHOMA CLIMATOLOGICAL SURVEY

While this Appendix lists only major named hydrogeologically sensitive areas, which are shown at the ground surface on Hydrologic Atlases[10], other hydrologically sensitive areas as defined in the glossary or shown on OWRB maps (OWRB Technical Report 99-1, Statewide Groundwater Vulnerability Maps of Oklahoma) as vulnerable aquifer recharge zones should also be protected. See HSA in the glossary, Appendix V, for additional information.

10 HA maps are the Oklahoma Geological Survey Hydrologic Atlas Quadrangles

EASTERN OKLAHOMA

MAP HA-2 TULSA

Qal	Alluvium
Qt	Terrace Deposits
lPbv	Barnsall & Vamoosa Fm
lPt	Torpedo Fm
lPch	Chanute Fm
lPsn	Senora Fm & Chelsea Ss
lPbj	Bluejacket Ss
Mkr	Keokuk & Reeds Spring Fms
MDO	Chattanooga, Fernvale, Fite, Tyner, Burgen, & Cotter Fms

MAP HA-1 FORT SMITH

Qal	Alluvium
Qt	Terrace Deposits
lPsl	Seminole Fm
lPCV	Calvin Ss
lPsn	Senora Fm
lPt	Thurman Ss
lPbj	Bluejacket Ss
lPsv	Savanna Fm
lPmh	McAlester & Hartshorne Fms

MAP HA-9 McALESTER

Qal	Alluvium
Qt	Terrace Deposits
Ko	Ozan Fm
Kbr	Brownstone Marl
Kto	Tokio Fm
Kw	Woodbine Fm
Kgb	Grayson Marl & Bennington Ls
Kpm	Pawpaw Ss
Ka	Antlers Ss
Kh	Holly Creek Fm
lPt	Thurman Ss
lPbj	Bluejacket Ss
lPsa	Savanna Fm
lPha	Hartshorne Ss
lPjf	Jackfork Group
Sb	Blaylock Ss
Ow	Womble Fm
Ob	Blakely Ss
Ocm	Crystal Mountain Ss

CENTRAL OKLAHOMA

MAP HA-4 OKLAHOMA CITY

Qal	Alluvium
Qt	Terrace Deposits
Pm	Marlow Fm
Pd	Duncan Ss
Pch	Cedar Hills Ss
Pp	Purcell Ss
Pk	Kingham Slt
Pg	Garber Ss
Pw	Wellington Fm
lPv	Vanoss Group
lPa	Ada Group
1Pva	Vamoosa Fm
lPta	Tallant Fm
lPbd	Barnsdall Fm
lPch	Chanute Fm
1Ps	Seminole Fm
1Pw	Wewoka Fm
1Pca	Calvin Ss
1Pse	Senora Fm
1Pt	Thurman Ss

MAP HA-7 ENID

Qal	Alluvium
Qt	Terrace Deposits
Pch	Cedar Hills Ss
Pbi	Bison Fm
Psp	Salt Plains Fm
Pk	Kingman Silt

MAP HA-7 ENID

Pg	Garber Ss
Pw	Wellington Fm
lPa	Ada Group
1Pva	Vamoosa Group
lPt	Tallant Fm
lPbd	Barnsdall Fm
lPch	Chanute Fm

MAP HA-3 ARDMORE

Qal	Alluvium
Qt	Terrace Deposits
Kw	Woodbine Fm
	(Kwt Templeton)
	(Kwr Red Branch)
	(Kwd Dexter)
Ka	Antlers Sd
Pr	Rush Springs Fm
Pm	Marlow Fm
Pd	Duncan Ss
Pp	Purcell Ss
Pg	Garber Ss
Pw	Wellington Fm
lPa	Ada Fm
	(Collins Ranch Cgl)
lPva	Vamoosa Fm
lPca	Calvin Ss
lPse	Senora Fm
lPt	Thurman Ss
lPbj	Bluejacket Ss
lPsa	Savanna Fm
lPha	Hartshorne Ss
lPjf	Jackfork Ss

WESTERN OKLAHOMA

MAP HA-8 WOODWARD

Qal Alluvium
Qt Terrace Deposits
To Ogallala Fm
Kk&Kd Kiowa Fm and Dakota Group
Pdy Doxey Fm
Pcc Could Chief Fm
Fwh White Horse Group
(Pr Rush Springs Fm)
(Pm Marlow Fm)
Pch Cedar Hills Ss
Pbi Bison Fm
Psp Salt Plains Fm
Pk Kingman Fm

MAP HA-5 CLINTON

Qds Dune Sand
Qal Alluvium
Qt Terrace Deposits
To Ogallala Fm
Kk&Kd Kiowa Fm and Dakota Group
Pec Elk City Ss
Pdy Doxey Fm
Pcc Cloud Chief Fm
Pwh White Horse Group
(Pr Rush Springs Fm)
(Pm Marlow Fm)
Pch Cedar Hills Ss
Pd Duncan Ss
Pbi Bison Fm

MAP HA-6 LAWTON

Qal Alluvium
Qds Dune Sand
Qt Terrace Deposits
Pwh White Horse Group
Psa San Angelo Ss
Ppo Post Oak Cgl
Pg Garber Ss

MAP HA-450 BEAVER CO.

Qd Dune Sand
Qa Alluvium
To Ogallala Fm

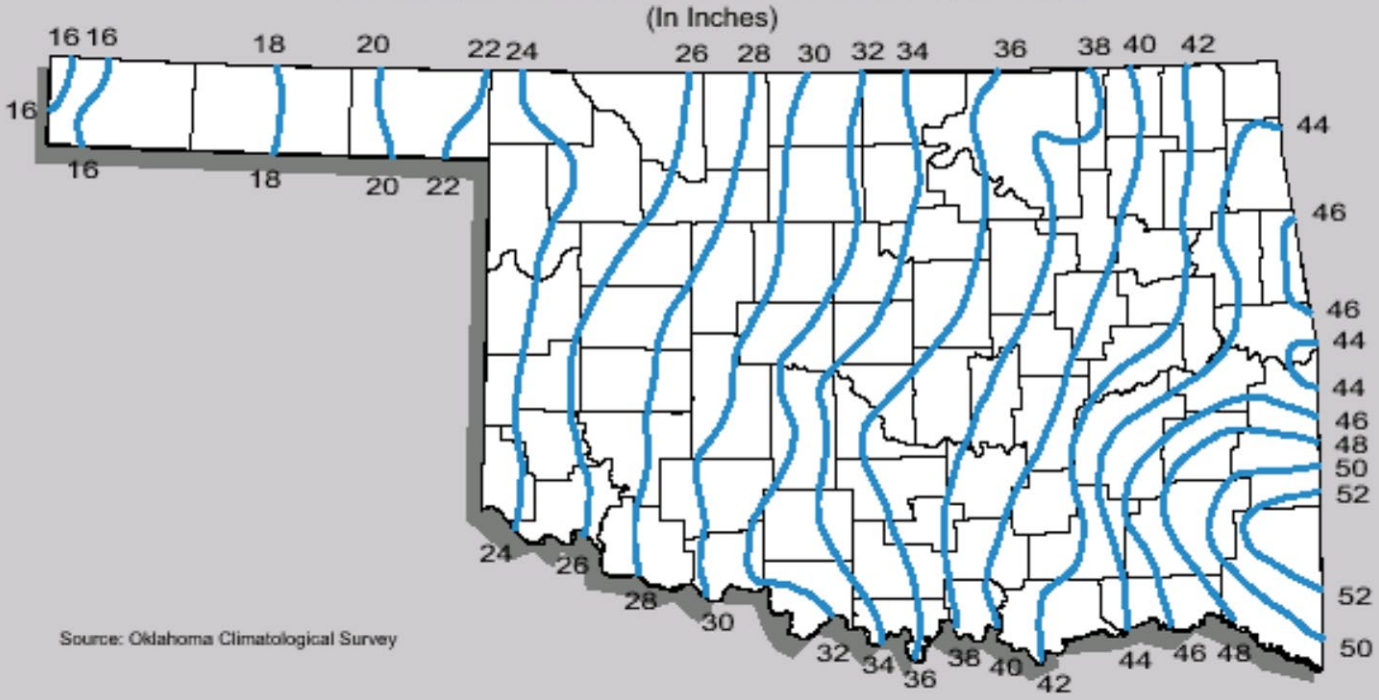
MAP HA-373 CIMARRON CO.

Qd Dune Sand
Qa Alluvium
To Ogallala Fm
KC Greenhorn Ls
(Colorado Group)
Kd Dakota Ss
Kp Cheyenne Ss
(Purgatuire Fm)
Jm Morrison Fm
Je Exeter (Entrada) Ss
Td Dockum Group

MAP HA-250 TEXAS CO.

Qd Dune Sand
Qa Alluvium
To Ogallala and Laverne Fms

Figure 7
AVERAGE ANNUAL PRECIPITATION 1961-1990
(In Inches)



APPENDIX V

GLOSSARY AND ACRONYMS

GLOSSARY AND ACRONYMS

While most technical terms used by the Commission are defined in the rules (OAC 165: 10-1-2), this guidance document uses some that are not. A list of these is below.

API American Petroleum Institute.

API Gravity The American Petroleum Institute method for identifying the specific gravity of crude oil or condensate.

Aquifer A geological formation or part of a formation or sedimentary zone or fracture system that is capable of yielding a significant amount of water to a well or a spring (commonly $\geq$ 1 gallon per minute sustained yield) that is sufficient for year-round daily domestic use, or for seasonal agricultural use.

Bio Sampling Bio-sampling methods (including trademarked Bio-Trap and Bio-Sep beads[11]) capture (usually using a growth medium) the active components of a subsurface microbial community, which can now be identified by various rapid DNA analyses. Some methods can also use samplers spiked with small amounts of ^{13}C enriched petroleum compounds to demonstrate uptake by active petroleum degraders. By actually capturing and identifying microbes including known petroleum degraders, and when possible showing petroleum uptake and/or degradation by microbes, biologic activity that will attenuate the petroleum pollutants can be demonstrated.

BTEX *Benzene, toluene, ethylbenzene, and xylenes,* which are often the main chemicals of concern at petroleum release sites. The EPA sets the maximum contaminant levels (MCLs) allowed in drinking water for these compounds.

Closure Occurs when all assessment, cleanup, and restoration activities at a site are complete, with documentation showing that all 1) regulatory requirements (e.g. monitoring if needed to demonstrate that cleanup or restoration activities have been effective (OAC 165:10-7-4(d)); the plugging of wells and borings (if any) to OWRB standards; copies of land application permits or waste disposal run tickets for soil and/or water removed from the site (OAC 165:10-7-24, 10-7-26, 10-7-27)), 2) hearing consent orders (OAC 165:10-7-4(e)), or 3) other agreed upon actions have been met/complied with. PA will issue a closure letter upon request when it concurs.

COC (Chemical of Concern) A chemical that has the potential to negatively impact human health and/or the environment at a site (a.k.a. pollutant).

11 Names included for information only; specific methods are NOT endorsed by the Commission

Complex and/or unusually extensive	Spills at most sites involve limited petroleum hydrocarbon or brine impacts to soil near the wellhead, flowlines, or tanks. Complex and/or unusually extensive sites are those that a) involve several different substances; and/or b) involve impacts to surface water or ground water or bedrock, not just soil; and/or c) affect a relatively large area (e.g., from a large volume tank or pipeline break, or the fluid flowed a long way downhill).
Consent Order	See *Hearing*
CSM	*Conceptual Site Model*. This describes the site in a graphical and/or narrative fashion, taking into consideration site conditions and the likely fate and transport of the COCs. A CSM identifies the potential ways that people may be exposed to COCs.
CWA	The federal *Clean Water Act* and amendments thereto. Section 303(d) requires states to identify waters of the US that do not and are not expected to meet applicable water quality standards and report them to EPA; this is sometimes referred to as the 303(d) List. States must also establish priority rankings for the listed waters, taking into account impact severity and designated beneficial uses of the waters.
DEQ	The Oklahoma *Department of Environmental Quality*
DRO	*Diesel Range Organics*, a measure of the Total Petroleum Hydrocarbons in the C11-C28± range. DEQ's extraction procedure is method 8000/8100M; see http://www.deq.state.ok.us/CSDnew/LabCert/DEQDROv4.1.pdf
DW supply	*Drinking water supply*
EPA	The United States *Environmental Protection Agency*
Exposure Assessment	A three-step process in which the exposure setting is characterized, complete exposure pathways are identified, and the magnitude of the potential exposure is estimated.
Exposure Pathway	The path via which a person or other receptor may be exposed to a chemical of concern; see migration pathway. Examples include inhalation of vapors, direct contact with contaminated soil, and swimming in or drinking polluted water. Dust/air inhalation is usually considered only in a confined space (building, trench) where it can concentrate instead of dispersing as it does in open outdoor air.
FID	*Flame Ionization Detector*. Gas is drawn into the instrument, which responds to any molecule with a carbon-hydrogen bond. A flame in the

	instrument ionizes the molecules. Negative ions are attracted to a collector electrode, producing a signal that is read as a concentration level.
f_{oc}	*fraction organic carbon* in soil – see organic carbon.
Free product	A measurable level of petroleum hydrocarbon on the ground surface or on surface water, or on ground water.
GC	*Gas Chromatograph,* equipment used for the separation of mixtures of compounds by partition between a mobile gas phase and a stationary liquid phase.
Geoscientist	A degreed geologist (defined 25 O.S. § 35), soil scientist (meeting OAC 165:10-7-19), or engineer (defined 59 O.S. Sup. 1999 Sections 475.1-475.22b) with appropriate soil science and/or geology and/or ground water hydrology education and training, plus appropriate experience, for soil and/or water sampling.
GRO	*Gasoline Range Organics*, a measure of the TPH in the C6-C11± range, measured according to EPA method 8015/8020M.
Ground water	Water found under the Earth's surface in soil or rock pores and fractures. Not all ground water is found in aquifers, and not all ground water receives the same protection or cleanup efforts.
HA	*Hydrologic Atlas*, a compendium of maps in specific geographic areas that delineate the groundwater depths, water quality, and geologic information about the area. Published by the Oklahoma Geological Survey.
Hearing, a.k.a. Administrative Law Hearing	A hearing held before a Commission Administrative Law Judge, as called for in OAC 165:10-7-4(e), when there is disagreement over what should be done at a site. Pollution Abatement or an operator or a complainant may request a hearing. This usually results in a consent order delineating the work that must be done at a site.
Historically Impacted Site	A site that is not the result of a recent spill. It can be 1) an old spill site that was not adequately cleaned up, or 2) one that has site impacts resulting from practices that once were legal but which have resulted in a pollution problem(s), or 3) one that has pollution from unknown sources. Although not subject to the 24-hour spill/release reporting rule, these sites still should be reported and must be cleaned up and/or restored to beneficial use.
Homes	Single and multifamily houses, condominiums, apartments, nursing homes, manufactured homes, etc. occupied more than 8 hours per day, 300 days per

year, by adults and/or children.

HSA — *Hydrologically Sensitive Area*, a.k.a. Hydrologically Vulnerable Area. An HSA is an area in which the ground water or surface water could easily be impacted by a spill. HSAs include 1) a principal bedrock aquifer, the recharge or potential recharge area of a principal bedrock aquifer, or an unconsolidated alluvium or terrace deposit, according to the Oklahoma Geological Survey "Maps Showing Principal Groundwater Resources and Recharge Areas in Oklahoma"; 2) small undefined or unnamed sensitive/vulnerable alluvium & terrace deposits near streams (potential migration pathways to streams); and/or 3) the vulnerable aquifer recharge zones defined by the OWRB in OWRB Technical Report 99-1, Statewide Groundwater Vulnerability Maps of Oklahoma.

Liner — Compacted soil/clay or an artificial geomembrane thick enough and impermeable enough that fluids will not likely go through it. Similar to soil or geomembrane liner for a pit [OAC 165: 10-9-1 (e)(7, 8)].

MCL — The Maximum Contaminant Level allowed in drinking water, as defined by the EPA.

Migration Pathway — A route by which substances can move from a source to a receptor. A pathway can be a) natural, such as movement with groundwater through interconnected soil or bedrock pores and fracture zones, or b) a man-made conduit, such as along an underground utility line. Examples of possible migration pathways include adjacent surface water, groundwater in local aquifer zones, abandoned well bores, porous soil, or fractured bedrock zones, shrink/swell clay cracks or fissures, underground utility line/pipeline underflow, etc.

Monitoring — Collecting evidence, including sampling data and/or photographs as necessary, for ±1 year (OAC 165:10-7-4(d)), to ensure and document that cleanup and/or restoration actions taken have been effective and that the site is ready for closure.

NAPL — *Nonaqueous phase liquid*, a liquid other than water that exists in the subsurface environment and does not all dissolve into the water. See free product.

No further action (NFA) — Status given to site when all necessary assessment, cleanup, and restoration actions are complete. PA will issue an NFA letter to an operator upon request when it concurs. However, final site closure is dependent on meeting all regulatory, consent order, or other agreed upon requirements (see Closure).

Oil and Grease An analysis of the amount of relatively nonvolatile hydrocarbons (as well as vegetable oils, animal fats, waxes, soaps, greases, and related materials) in a sample. The analysis is performed using a solvent on an aqueous or solid sample (water or soil sample, usually), extracting a solute, which is then measured by gravimetric analysis.

Organic Carbon The quantity of organic carbon in a soil sample as measured by wet oxidation of the sample. Once the total organic carbon is known, the weight percent or fraction organic carbon (f_{oc}) used in RBCA calculations can be determined.

OWRB The *Oklahoma Water Resources Board*, the state agency that sets the Oklahoma water quality standards the Commission must enforce. The OWRB also sets the rules for borings, monitoring and water wells, and licenses those persons allowed to drill, install, and properly abandon them.

PA The *Pollution Abatement* Department within the Oil & Gas Conservation Division.

PID *Photo-ionization Detector*. Gas is drawn into the instrument, where an ultraviolet bulb at a specific ev (electro-volt) level excites and ionizes the atoms of volatile organic compounds. Ions are attracted to a collector electrode, producing a signal that is read a concentration level.

Plume The pollutant's impact area. Most commonly applied to the area of an impacted ground water or surface water body that is generally moving downstream or downgradient from the source.

Pollutant Any material or substance that is present in water or soil at levels that may cause pollution impact(s). COCs (chemicals of concern) are often the pollutants referred to in a RBCA.

Pollution (From Corp Comm O&G rules) the "contamination of fresh water or soil, either surface or subsurface, by salt water, mineral brines, waste oil, oil, gas, and/or other deleterious substances produced from or obtained or used in connection with the drilling, development, producing, refining, transporting, or processing of oil or gas within the State of Oklahoma".

Point of Compliance The spill source area for the cleanup standards (Category cleanup levels or RBCA calculated RBSL/SSTLs); also means the receptor point for the Commission's enforcement of the state water quality standards.

Potable water Water from wells or other sources usable for human consumption. By

	OWRB rules (OAC 785:45-7-3), PPWS (public and private water supply) wells includes those from ground water with TDS <3000 mg/l (ppm), and water from Special Source Aquifers regardless of TDS.
RBCA	*Risk Based Corrective Action*, a tiered decision-making approach for site assessment, risk assessment, and site management. This is a methodology for 1) determining the health risks from specific (analytically measured) concentrations of petroleum compounds in various media (soil, water, and air) at specified locations, and 2) determining the cleanup standards to be used, and the remediation necessary, at impacted sites.
RBSL	*Risk-Based Screening Level*, the chemical-specific concentration in environmental media that is considered to be protective of human health and the environment.
Receptor	A human or critical (essential) animal that can be sickened, injured or killed by any potentially harmful substance(s) released.
Receptor point (Receptor exposure point)	The location in space [e.g., point, area, or critical (essential) animal habitat], where a receptor may come in contact with a potentially harmful substance by, for example, inhaling vapors, touching or ingesting contaminated soil, or swimming in or drinking polluted water.
Release	See *spill*.
Remediation	The removal of pollutants from soil and/or water by adsorption, excavation, pumping, biological, chemical, or other means or combination of methods.
Request-for-Assistance (RFA) site	Those sites that are handled by a Field Inspector with the assistance of a PA Hydrologist. These sites may also be subject to all or part of this guidance, as appropriate.
Risk Characterization	The final step of a risk evaluation, which combines the results of the exposure and toxicity assessments in order to quantify the potential risks to human health and the environment.
Root Zone	The depth of soil which plant roots readily penetrate and in which the predominant root activity occurs. Vegetables typically have very shallow roots, while Bermuda grass, wheat, and alfalfa often have much deeper ones. For this guidance, PA considers only the upper 2 to 3 feet of soil where most plants roots grow.
Sensitive Areas	Residential areas (the yards and gardens of homes, as defined above) plus the grounds of schools, day care centers, sports fields and playgrounds, and similar areas with potentially high soil contact uses, if they are frequently

accessed by vulnerable adults or children.

Site — All area(s) impacted by a particular spill, or by multiple spills and leaks in a given vicinity related to a specific production or treatment facility or pipeline, and/or related historic site impacts. A site may consist of more than one impacted area.

SNARL — The EPA's *Suggested No Adverse Response Level*. This is the concentration of a chemical in water expected to not cause an adverse effect. For TPH affecting a well or other drinking water supply, the SNARL is set at the lowest of either health effect or taste and odor criteria. Petroleum can usually be smelled and/or tasted at levels far below those where adverse health effects will occur, so the SNARL for petroleum/TPH from a fresh source can be as low as 0.1 mg/l to preclude bad taste and/or smell.

Spill — The unpermitted or unauthorized surface or subsurface release, usually accidental, of substances including, but not limited to, petroleum hydrocarbons (gasoline, diesel, crude oil and/or condensate), brine, or drilling mud.

SSTL — *Site Specific Target Level* (as defined by the American Society for Testing and Materials), a risk-based remedial action target level for a chemical(s) of concern developed for a particular site under the Tier 2 and Tier 3 RBCA SSTL evaluations.

Stabilization — Implies that the area of petroleum hydrocarbons in the soil or ground water is not expanding (is not moving, or has natural remediation equaling or exceeding the rate of plume movement so that there is no net soil or groundwater plume migration) and poses no significant risk to receptors. Most commonly used at historic and other sites where problems related to COCs have been present for years.

TDS — *Total Dissolved Solids*, measured as mg/l in a laboratory analytical test from a sample dried at 180 °C, or measured in the field with a conductivity meter which reads as TDS (based on a standard conversion factor).

TPH — *Total Petroleum Hydrocarbons*, the quantity of extractable compounds detected in a sample of soil or water as measured by a detection method (GC, infrared, gravimetric) in a solvent extract of soil or water using DEQ's method(s) or TX 1005 extended to C_{35}; EPA method 418 is not acceptable[12].

12 TPH – DEQ's GRO and DRO analyses are often approximately summed as TPH, even though there is a potential overlap in their analytical ranges and higher carbon number compounds above C_{28} are not included in most DRO analyses. The OK DEQ is establishing a new total TPH GC method, similar to Texas Method 1005,

TSS	*Total Soluble Salts*, the total amount of salts, expressed as ppm (mg/kg or mg/l), dissolved in water or in soil according to laboratory testing. This is approximately equivalent to TDS in water if the dissolved solids are salts.
VCP	*Voluntary Cleanup Program*
Waters of the State/Waters of the US	All "streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon this State or any portion thereof." As defined in OWRB rules, this includes all federally defined Waters of the US within Oklahoma's boundaries. As per the Federal Clean Water Act, impacts to the waters of the US that cannot be readily remediated must be placed into the CWA 305(b) report and/or on the CWA 303(d) list.
WHPA	Wellhead protection area delineated by DEQ. The WHPA must be of sufficient size, as calculated by likely groundwater travel time via an aquifer to a public drinking water supply well, to protect the well from possible harmful substances in an aquifer.
WQS	The Oklahoma Water Quality Standards established pursuant to Section 303 of the CWA, which serve as goals for water quality management planning and benchmark criteria for the NPDES/OPDES permitting process. Water Quality Standards consist of beneficial use classifications for navigable waters, water quality criteria to support those uses, and an antidegradation policy statement. Oklahoma's Water Quality Standards are found at OAC 785:45 or https://www.owrb.ok.gov/rules/index.php.
WQSIP	*Water Quality Standards Implementation Plan.* This document outlines how the Oil and Gas Conservation Division goes about enforcing the WQS established by the OWRB. It is available by calling the Pollution Abatement Department or is downloadable at https://oklahoma.gov/occ/divisions/oil-gas/pollution-abatement-department/water-quality-standards-implementation-plan.html.

which will cover the current GRO plus DRO extent and more (C_6 to $C_{38}\pm$), reported by at least three distinct ranges. This will become the method accepted by the Commission, Oil and Gas Division, when it is developed.

APPENDIX VI

OPTIONAL FORMS

Company Name_____	Facility/Site Name _____
Incident Number _____	Submittal Date _____

Initial Site Evaluation Report (This optional form may be used in Step 1 to document site information for the PA Department, for sites lacking full Field Inspector 1085 documentation)

Operator Information	
Company Mailing Address:	
City/State/Zip Code:	
Contact Name:	
Phone Number (s):	

Release Information	
Field Name or Unit (if applicable):	
Lease/Well Name and No.:	
Location of Site (qtr-qtr-qtr, Sec-Twp-Rng):	
Latitude and Longitude (if known):	
Address:	
Describe Cause and Nature of the Release:	
Liquid(s) Released:	☐ Crude oil (API° if known_____) ☐ Condensate (API° if known_____) ☐ Produced water (TDS if known_____) ☐ Other:
Water Body Affected (if any):	
Fish/Wildlife Kill Observed (Y/N):	

Summary of Action Taken

Path Forward Recommended by Operator/Company (Check one):	
☐	Cleaned up and restored to beneficial use. Requesting closure.
☐	Requires more work – submitting work plan.
☐	Complex site – request consultation with Pollution Abatement Department.

Company Name_____	Facility/Site Name _____
Incident Number _____	Submittal Date _____

Summary of Field and Laboratory Analytical Results
This optional form may be used to document Steps 2 and/or 5

Date	Sample location	[1]Sample type: Soil, [2]GW, SW	Field sample ID number	Sample depth or interval	Field or Lab analysis (F or L)	Analytical results (specify units)								
						[3]B	[3,4]T	[3,4]E	[3,4]X	[5]TPH (total)	[5]TDS / TSS			

[1]BTEX analyses are required for surface water, or groundwater samples in an aquifer within 330 feet of a drinking water well (automatically Category I standards).
[2]GW = Ground Water, SW = Surface Water.
[3]Benzene (B), toluene (T), ethylbenzene (E) and xylenes (X).
[4]TEX analyses are not required for any soils, only for surface waters and Category I ground water.
[5]TPH = Total Petroleum Hydrocarbons, TDS = Total Dissolved Solids, TSS = Total Soluble Salts.

PA Staff will often request copies of the actual laboratory analytical reports.

Company Name	Facility/Site Name
Incident Number	Submittal Date

Category or Stabilization Report

This optional form may be used to document Steps 1 and 6

Results and Path Forward Recommended by Operator/Company

Enter Category from Index Table (Attach) ☐ Are all sample concentrations ≤ the cleanup levels for the category indicated above? (circle one) Y N (Explain at right)	

Maps Included with this Submittal	
"X" if included	**Description**
☐	☐ topographic map ☐ area geologic map ☐ USDA-NRCS soil survey map **or** ☐ aerial photo showing site location
☐	Sketch or map of release area with location(s) of: ☐ E&P facilities ☐ site features ☐ buildings ☐ buried utilities ☐ land uses ☐ drinking water wells ☐ surface water bodies ☐ soil sample locations **and** ☐ monitoring wells in the vicinity of the release area
☐	Additional maps needed/requested by PA (list):

Attachments Included with this Submittal	
"X" if included	**Description**
☐	Initial Site Evaluation Report (Step 1)
☐	Index Table(s) (Step 1)
☐	Summary of field and laboratory analytical results (Step 2)
☐	Excavation or boring logs (Step 2, Sampling data section 2b)
☐	Laboratory analytical reports (if requested by PA)
☐	Representative cross section(s) showing the stratigraphy of the site and the extent of impacts based on soil boring logs (if agreed to be provided to PA).
☐	Free product evaluation plan (if needed, Step 2, Sampling data section 3f)
☐	Groundwater monitoring information (if needed, see Step 2, Sampling data section 3g)
☐	Documentation of plume stabilization (if needed, see Step 6)
☐	Documentation that all regulatory (e.g. monitoring, proper abandonment of borings and monitoring wells), consent order, and/or other agreed upon requirements are met

Company Name _____	Facility/Site Name _____
Incident Number _____	Submittal Date _____

RBCA Report

This optional form may be used to document Step 5

Results and Risk Management Approach Recommended by Operator/Company

Indicate which analysis was performed (Circle One): Tier 1 Modified Tier 1 Tier 2 Tier 3	

Action being taken (check boxes that apply below and explain above):	
☐	Close at ☐ RBCA Tier 1 RBSLs **or** ☐ Modified RBCA Tier 1 RBSLs
☐	Close at RBCA Tier 2 SSTLs
☐	Close at RBCA Tier 3 SSTLs
☐	Remediate to: ☐ Tier 1 ☐ Modified Tier 1 ☐ Tier 2 ☐ Tier 3 RBSLs/SSTLs levels
☐	Other (e.g., plume stabilization, institutional controls, technical impracticability, etc. Itemize and explain above. Attach additional reports or justification if needed or requested by PA):

Company Name_____	Facility/Site Name _____
Incident Number _____	Submittal Date _____

RBCA Report

This optional form may be used to document Step 5

Maps Included with this Submittal

"X" if included	Description
☐	☐ topographic map ☐ area geologic map ☐ USDA-NRCS soil survey map **or** ☐ aerial photo showing site location
☐	Sketch or map of release area with location(s) of: ☐ E&P facilities ☐ site features ☐ buildings ☐ buried utilities ☐ land uses ☐ drinking water wells ☐ surface water bodies ☐ soil sample locations **and** ☐ monitoring wells in the vicinity of the release area
☐	Additional maps as necessary (list):

Attachments Included with this Submittal

"X" if included	Description
☐	Initial Site Evaluation Report
☐	Index Table(s) (if not previously submitted or if changed, see Step 1)
☐	Conceptual Site Model (see Step 5): ☐ Narrative ☐ Graphical ☐ Drawing ☐ Other
☐	Description of impacts to soil, GW and SW and site hydrogeology (including excavation or boring logs)
☐	Summary of field and laboratory analytical results
☐	Documentation justifying RBSLs or SSTLs: ☐ Printouts of parameters used, and calculated RBSLs from OK RBCA Spreadsheet (Modified Tier 1 and Tier 2) or ☐ Other documentation
☐	Laboratory analytical reports (if requested by PA)
☐	Representative cross-section(s) showing the stratigraphy of the site and the extent of impacts based on soil boring logs (if agreed to be provided to PA)
☐	Free product evaluation (if needed, similar to Step 2 Sampling data section 3f)
☐	Groundwater monitoring information (if needed, similar to Step 2 Sampling data section 3g)
☐	Documentation of plume stabilization (if needed, similar to Step 6)
☐	Remediation plan (if needed or requested by PA)
☐	Post-action monitoring plan (if needed)
☐	Documentation of proper abandonment of boring and monitoring wells (see Step 2, Sampling data sections 5e & 6h) per OWRB rules

Company Name_____	Facility/Site Name _____
Incident Number _____	Submittal Date _____

RBCA Sampling Report - This optional form may be used to document Step 5

Chemical of concern	Media type[1]	Concen-tration (indicate units)	Land use[2]	RBSL/ SSTL	Exposure Pathway(s)	Method used to determine RBSL/SSTL

[1]**Surface soil (SS), Subsurface soil (SB), Ground water (GW) Surface water (SW)**

[2] **Commercial (C), Industrial (I), Residential (R), Agricultural (A), Other (O) (list others)**

Note: For all sensitive areas as defined in Step 3, use residential land use. PA Staff will often request copies of the lab analytical reports.

APPENDIX VII

GUIDANCE FOR SPILLS OF OTHER MATERIALS FROM PIPELINES, TANK FARMS, AND PRODUCTION/TREATMENT EQUIPMENT

GUIDANCE FOR SPILLS OF OTHER MATERIALS FROM PIPELINES, TANK FARMS, AND PRODUCTION/TREATMENT EQUIPMENT

The Oil and Gas Conservation Division also oversees the cleanup of spills and leaks at oil and gas or pipeline sites of substances other than crude and condensate. These include:

Ammonia (NH_3) Most should dissipate in the atmosphere fairly quickly (explosion precautions should be taken and breathing and skin protection worn as needed). In soil, ammonia leaked from pipelines will bind to the soil if there is moisture available. The pH will change as NH_3 levels increase. Crops and soil bacteria may be killed. Compounds corrosive to equipment can also be created. The possible effects of remnant ammonia on soil and vegetation or roots, and in nearby surface waters, where an excess nutrient level can cause algal blooms and suffocate fish, should also be considered in any remediation plan.

Diesel Usually in the C_{12} to C_{24} carbon range. Use the crude oil TPH cleanup number from the cleanup table, for Sensitive Areas, or from RBCA calculations.

Gasoline Similar to light condensates, except that oxygenates like MTBE will also have to be addressed.

Glycol Readily biodegradable if the right bacteria and conditions are present.

Jet Fuel Its carbon range overlaps the border between condensate and crude. The lowest TPH cleanup number of either condensate or crude in the Cleanup Table, Sensitive Areas, or from RBCA calculations, should be used.

Kerosene Its main C_9 to C_{16} range overlaps the border between condensate and crude. The lowest TPH cleanup number of either condensate or crude in the Cleanup Table, Sensitive Areas, or from RBCA calculations, should be used.

Natural Gas Most hydrocarbons in this carbon range should dissipate in the atmosphere fairly quickly (explosion precautions should be taken and breathing protection worn as needed). Liquids remaining behind will be condensate. Oxygen in the soil may have been displaced by the methane/natural gases, killing the normal bacterial populations and making bioremediation more difficult. Plants will often die also. If this occurs, returning the site to a natural state should be part of the remediation and beneficial use restoration.

APPENDIX VIII

ASSESSMENT AND CLEANUP GUIDELINES FOR NEW OR HISTORIC PRODUCED WATER/BRINE SPILLS

Responding to and Remediating Produced Water/Brine Spills[13]

1. Report new ≥10 BBL releases to soil, and any release to water (surface or groundwater) to OCC District Field Operations staff.

2. Prevent further discharge or release**.**

3) Use containment (e.g., temporary dikes, pits, or tanks) to minimize area affected.

4) Remove (adsorbent material, vacuum system) fluids from the surface ASAP; *even within a diked area;* properly inject them into Class II or other permitted well.

5) Flushing the spill areas with fresh water may facilitate the removal of saltwater from the soil surface unless the soil is high in clays; then avoid fresh water.

6) Till in soil amendments such as hay, fertilizer, and/or gypsum (see next page).

Soil - New Release or Historic Impact

Sampling

Soil samples (composites) should be collected of both highly affected and less affected areas for lab analysis to determine whether soil remediation or removal is needed. Field kit tests can help you define these areas A background sample from outside the affected area must also be collected.

1. If sampled promptly, only surficial samples may be needed.
2. However, collect soil samples at one-foot depth intervals to a depth of at least three feet if:
   - more than one week has passed,
   - ample rainfall has occurred, or if
   - plowed or sandy soils are present.

3. Lab soil samples should be placed in suitable containers, chain-of-custody records completed, and the samples sent to a qualified (e.g., in NAPT program) lab.
4. The samples should be analyzed for salinity parameters (e.g., OSU's Comprehensive Salinity package) including TDS or TSS (Total Soluble Salts), EC, ESP, SAR, Na, Ca, Cl, B, etc.

Remediation

Sample analysis exceeding 2640 ppm TDS or TSS usually indicate the need for soil remediation or removal. Remediation can take one to several years, depending on soil type (longer for clays) and site conditions; soil amendments usually speed the process.

If the ESP (exchangeable sodium percentage) is high (see chart),

13 Produced Water/Brine spills can occur alone or in combination with spilled petroleum.

- Add calcium (gypsum or calcium nitrate [$Ca(NO_3)_2$]) to most soils to help in sodium removal, but do NOT use calcium nitrate over shallow aquifers!
- Lots of fine ground limestone (e.g., chat) works on high acid soils
- Adding organic matter (straw or low-salt manure) conditions soil to improve salt leaching.
- If more than five tons of gypsum is used, split treatment into separate applications 3 to 6 months apart

If soil removal is selected,

- Excavate and remove soils with a TDS or TSS level of ≥2640 ppm to ~3 feet deep.
- Dispose of excavated material as per Corporation Commission Rule OAC 165:10-7-26 or 165:10-9-1.
- The area must then be restored to its original use by backfilling with compatible soil and establishing suitable vegetation.

Water - New Release or Historic Impact

- If groundwater is reachable by crop roots or the shallow aquifer could be affected, it should also be sampled (e.g., OSU Irrigation Water test) via a monitoring well or geoprobe.
- Remediation may be necessary; see the chart, below.

If surface water is nearby, it should be sampled.

- If affected, onsite treatment or collection and proper disposal may be necessary.
- Restore the water body to the previous beneficial use ASAP.

Numerical Cleanup Levels and Treatment for Produced Water/Brine Spills

Salinity –Soil

The treatment for high EC/TSS is usually accomplished through soil leaching.

- Uptake by salt-tolerant plants can assist in this process (use lab tests or field kits to monitor progress).
- Tilling in organic matter (e.g., hay, or low-salt manure) improves soil tilth for leaching to expedite the process.
- High ESP sodic soils need added calcium, usually as crushed or powdered gypsum.
- For deep salt impacts, protect surface soils from salt rise by placing a layer of powdered gypsum @2-3’ (~below crop roots) to create capillary break.

EC*/ESP@/TSS# Cleanup Table for Brine Contaminated Soils				
	EC ≤ 4000 or TSS ≤ 2640	EC ≤ 6000 or TSS ≤ 3960	EC ≤ 8000 or TSS ≤ 5280	EC > 8000 or TSS > 5280
ESP 0-15	Most plants can grow normally; Cleanup/leaching rarely needed	No treatment needed for cereal grains (e.g., wheat) and grasses. Treatment needed to grow legume crops (e.g., soybeans), most fruits, some vegetables, rice, and alfalfa.	No treatment for salt tolerant grasses (e.g., Bermuda). Treatment needed to grow legumes, fruits, cereal grains, alfalfa, vegetables.	Soil treatment or replacement, to about 3' deep, needed for almost all uses
ESP >15 *Sodic soils*	To leach excess sodium, you need to add calcium++			soil replacement to ~3' needed.

* Electrical Conductivity, µmhos/cm (1000 µmho =1 mmho)

@ Exchangeable Sodium Percentage, %

Total Soluble Salts, in parts per million (ppm, mg/kg, mg/L)

++ Mix Gypsum or calcium nitrate into typical soils; add fine ground limestone (e.g., powdered chat) to high acid soils. Do NOT use calcium nitrate over shallow aquifers

Salinity - Water

Remediation for salinity contaminated water usually consists of:

- Removing the most impacted water and treating it (ion exchange resins, reverse osmosis) or
- Injecting it into a Class II well or other authorized injection well.
- Natural inflow of clean surface and/or groundwater will dilute the remainder to acceptable levels.

Salinity Cleanup Standards for Surface Water and Groundwater – most uses		
Surface Water	OWRB standards	OAC Title 785 Chapter 45-Appendix F https://oklahomarules.blob.core.windows.net/titlepdf/Title_785.pdf
Surface and ground water for irrigation	OSU guidelines	OSU F-2401 Classification of Irrigation Water Quality http:// pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2223/F-2401web.pdf. SAR ≤4; EC ≤4 mmhos/cm, varies with Na percent.
Ground water at water well	EPA standards	EPA secondary drinking water standards include 250 ppm chlorides. https://www.epa.gov/sdwa/secondary-drinking-water-standards-guidance-nuisance-chemicals#table
Groundwater	Other uses	Make sure groundwater will meet standards when it gets to the well or stream

Recommended Maximum Salt (as TSS/TDS) in Animal Drinking Water (young may need lower limits)			
Poultry	Dairy cows, horses, swine	Beef Cattle	Sheep, goats
3,000 ppm, mg/L	7,000 ppm, mg/L (Cl & sodium–300mg/L cows; 500 horses)	10,000 ppm, mg/L	12,000 ppm, mg/L

Boron (sometimes present in produced water/brine spilled)

- Vegetation may not recover well if boron above action levels is found after a spill.
- Boron must be leached out to return to beneficial (crop) use.
- Contaminated irrigation water (or shallow groundwater within the deep root zone) above the levels specified should be remediated (leaching etc.) before use on crops.

Maximum **Boron Limits Table14 for High-Boron Brine Spills to Soil or Ground/Irrigation water					
Boron concentrations in soil and water indicate the maximum range each plant/group will tolerate					
≤1.1 soil ≤0.75 water	≤1.5 soil ≤1 water	≤3 soil ≤2 water	≤6 soil ≤4 water	≤9 soil ≤6 water	≤15 soil ≤10 water
• Blackberry (best <0.5ppm) • Grape • Most other fruits • Nut trees • Onion	• Grain crops (e.g., wheat, milo) • Corn • Pumpkin • Beans • Sunflower • Oats • Peanut • Strawberry	Vegetables like • Pepper • Peas • Carrot • Potato • Cucumber	• Clover • Oats • Bluegrass • Lettuce • Cabbage • Melon • Squash	• Sorghum • Alfalfa • Tomato • Vetch • Beet • Most grasses	• Cotton • Asparagus

**Boron (B) measured in ppm, mg/L, or mg/kg. Very few crops will tolerate boron above 10 ppm in water.

14 Source - Western Fertilizer Handbook, Eighth Edition; California Fertilizer Association; Interstate Publishers, Inc.