Corrective Action Design Report Guidance

For Leaking Underground Storage Tanks Sites

Underground Storage Tank Section
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General Information

The primary objectives of corrective action in response to a high risk classification are both short-term and long- term. The short-term goal is to eliminate or reduce the risk of exposure at actual receptors which have been or are imminently threatened with exposure above target levels. The long-term goal is to prevent exposure to actual receptors which are not currently impacted or are not imminently threatened with exposure. To achieve these objectives, concentrations of applicable chemicals of concern must be reduced by active remediation to levels below the site-specific target level (SSTL) line at all points between the source(s) and the point(s) of exposure as well as to undertake such interim corrective action as necessary to eliminate or prevent exposure until concentrations below the SSTL line are achieved. If it is shown that concentrations at all applicable points have been reduced to below the SSTL line, the secondary objective is to establish that the field data can be reasonably relied upon to predict future conditions at points of exposure rather than reliance on the modeled data. Field data are considered reliable when monitoring indicates concentrations within the contaminant plume are steady or declining. Institutional controls and technological controls may be used to sever pathways or control the risk of receptor impacts. For the soil vapor and soil to water line pathways, these objectives are achieved by active remediation of soil contamination to below the target level at the point(s) of exposure or other designated point(s) of compliance as described in Tier 2 guidance. For a site classified as high risk or reclassified as high risk for the soil leaching to groundwater ingestion pathway, these objectives are achieved by active remediation of soil contamination to reduce the soil concentration to below the site-specific target level at the source.

The following document provides the guidance for preparing the Corrective Action Design Report (CADR) for sites classified as high risk. The CADR contains the technical information specific to the treatment chosen to remediate the site and a monitoring proposal designed to determine the effectiveness of remediation. A checklist has been provided which outlines the minimum requirements for CADR submittal. If more than one technology will be implemented at the site, all the information from all applicable technologies must be provided. If a section of the CADR does not appear to be applicable to the corrective action proposed, provide justification in the appropriate section of the CADR.

Comprehensive information on petroleum remediation techniques at underground storage tank site may be found on the Environmental Protection Agency's (EPA) website under the topic *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers*. More information regarding the remediation techniques discussed in this document may be obtained from the EPA's website.

The CADR must be submitted in the format required by the department. The Tier 1 and Tier 2 guidance documents should be consulted for acceptable sampling and assessment procedures. The CADR must be prepared and signed by a certified groundwater professional. Reports must also be signed by the responsible party. It is the responsibility of the tank owner or operator to ensure that the groundwater professional prepares a report appropriate for the conditions at the site. All groundwater and soil data obtained during the preparation of the CADR must be collected by or under the supervision of a certified groundwater professional.

Copies of administrative rules referenced in this document may be obtained from the DNR Underground Storage Tank Section webpage.

Note: Expedited corrective actions (e.g. soil over excavation or receptor removal or replacement) do not require submittal of a CADR, but may still be subject to separate permitting requirements.

Report Submittal

Unless a Tier 3 assessment is to be conducted, a CADR must be submitted to the department within 120 days of the date the DNR approves or is deemed to approve a Tier 2 Site Cleanup Report which indicated a high risk classification unless a different deadline is set by the department. CADRs must include a completed CADR cover page and a completed CADR checklist:

- ☐ Completed CADR cover page
- ☐ Completed CADR checklist
- ☐ I. Executive summary
- ☐ II. Comparison of two corrective action alternatives
- ☐ III. Justification for selected corrective action
- ☐ IV. Timetable and critical performance benchmarks
- ☐ V. System design
- ☐ VI. Pilot test
- ☐ VII. Operation and maintenance plan
- ☐ VIII. Start-up period plan
- ☐ IX. Groundwater summary corrective action map from the Tier 2 Site Cleanup Report
- ☐ X. Soil summary corrective action map from the Tier 2 Site Cleanup Report
- ☐ XI. Groundwater flow direction maps (current and historic)
- ☐ XII. Monitoring plan
- ☐ XIII. Waste management disposal plan
- ☐ XIV. Security / System protection
- ☐ Appendix A: Permits
- ☐ Appendix B: Justification
- ☐ Appendix C: Boring logs / well construction diagrams (Only those which have not been previously submitted to the DNR.)
- ☐ Appendix D: Laboratory analytical reports (Only those which have not been previously submitted to the DNR.)

Note: All maps and diagrams must include a north arrow and legend explaining all symbols used on the map or in the figure. When a groundwater flow map is required, please also include copies of historic groundwater flow maps.

Send one hard copy of the completed CADR to the Iowa Department of Natural Resources, LUST Coordinator, 502 E 9th St, Des Moines IA 50319-0034. For all new LUST sites with starting dates after January 1, 2022, an electronic copy of the CADR must also be submitted to ust.rbcasoftwaremtbe@dnr.iowa.gov.

Review Process

A submitted CADR is considered to be complete if it contains all the information and data required by the department's administrative rules and guidance. The report is considered accurate if the information and data are reasonably reliable based first on the standards in Chapter 135 and this guidance, and second, on generally accepted industry standards. The department must review the report within 90 days for purposes of completeness and accuracy. If a report is not reviewed within 90-days, the report is deemed to be approved for purposes of completeness.

Reclassification

Any site or pathway which is classified as high risk may be reclassified to low risk if in the course of corrective action the criteria for low risk classification are established. Remediation systems must be turned off, and conditions allowed to stabilize before monitoring can be considered as justification for a no action required classification. Any site or pathway which is classified as low risk may be reclassified to high risk if in the course of monitoring the conditions for high risk classification are established. Sites subject to department-approved institutional or technological controls are classified as no action required if all other criteria for no action required classification are satisfied and all supporting documentation has been provided.

Site Monitoring Reports

Site Monitoring Reports (SMRs) must be submitted semi-annually after the second and fourth quarters for remediation monitoring and at least annually for all other types of monitoring. Remediation monitoring may include groundwater sampling, influent/effluent sampling, etc.

Report Preparation

Cover Page

Complete the cover page of the CADR report including the site address, the address and contact information for the responsible party, and signatures of the responsible party and certified groundwater professional. Check all boxes of technologies proposed to be implemented at the site. The blank boxes may be used if the technology proposed is not listed in the table.

CADR Checklist

Complete the CADR checklist by checking the boxes for those items included in the CADR.

I. Executive Summary

This section should be no longer than one or two pages and briefly summarize the following:

Recommended corrective action: Describe the type(s) of corrective action proposed for the site.

Receptors to be addressed: List all receptors which must be addressed and include the site-specific target levels (SSTL) and chemicals of concern which exceed the SSTL lines for the receptors.

Estimated costs: Provide an estimate of how much it will cost to install, operate and maintain the proposed system.

- Installation & startup
- Annual operation and maintenance costs
- Total monitoring costs
- TOTAL estimated cost

Estimated operation time: Estimate the operation time, expressed in years, for proposed system or other corrective action technology to reach the SSTL at the site.

II. Comparison of Two Corrective Action Alternatives

Two principally applicable corrective actions: The CADR must identify at least two principally applicable corrective action options designed to meet the objectives in 135.12(3).

Estimated operation time: Estimate the operation time, expressed in years, for each alternative system or corrective action technology to reach applicable SSTLs at the site.

Estimated costs: Provide an estimate of how much it will cost to install, operate and maintain each alternate system or corrective action technology.

III. Justification for Selected Corrective Action

Cost comparison: The CADR must contain an analysis of the proposed corrective action's cost effectiveness in relation to other options. Justification should also be provided for why the selected corrective action technology should be considered consistent with industry standards and be effective to accomplish site-specific objectives.

Documentation: Provide supporting documentation for the selected corrective action in Appendix B: Justification.

IV. Timetable and Critical Performance Benchmarks

An outline of the projected timetable and critical performance benchmarks must be provided. Note: If at any time during the operation of the system, the timetable deadlines won't be met, provide justification to the department with an alternate date by which they will be met.

V. Corrective Action Treatment Design

If the CADR proposes a treatment system, provide a detailed narrative description and proposed design of the engineering strategy and system(s), including:

- complete design criteria such as expected contaminant concentrations; total contaminant volumes; projected

flow rates and volumes; temperatures, pressures, etc., under varying conditions (seasonal and project phases); methods for all on-site collection, treatment, storage, and disposal;
- alarm and safety features to respond to malfunctions, potential overflows, etc.;
- type and location of utility services needed for the system; and
- general layout and process flow diagrams depicting the location of all collection, treatment, storage, and disposal activities.

If the CADR proposes remedial actions other than installation an operation of a treatment system (e.g. injection for chemical oxidation, bioremediation, carbon capture of contaminants) the following must be provided.

- complete design criteria for implementation of the remedial technology including expected contaminant concentrations and total contaminant volumes to be remediated;
- map or site diagram depicting the location of the proposed treatment area;
- description of the treatment material to be used including projected volumes; and
- description of the method for emplacement of treatment materials including injection rates, pressures, locations/grid spacings, etc.

VI. Pilot Test

A pilot test should be performed before the submittal of the CADR. The information gathered during the test must be included to show the effectiveness of the proposed system or other treatment plan. If a pilot test is not conducted, justification must be provided to ensure the remediation system chosen for the site will be successful.

VII. Operation and Maintenance Plan

For sites with remediation systems, an operation and maintenance (O & M) plan should outline the equipment operational parameters, specifications and operational tasks, monitoring, corrective actions, record-keeping techniques, health and safety measures, and reporting method and schedule. Designers or other responsible persons should begin to draft the plan when the CADR is prepared, and it should be updated to reflect changes outlined in the detailed plans, specifications and the construction documentation report. The plan should be updated during the operation of the system to reflect any changes in normal operation, and any failure of a corrective action described in the plan.

VIII. Startup Period Plan

After the remediation system is installed, it may be necessary to specify a start-up period to acclimate the system and make any adjustments that are needed to ensure optimal operation. Complete treatment may not occur during this period, but effluent discharge limits must be met during the period. It may be necessary to store effluent during the start-up period and re-treat and discharge it later. Start-up periods are usually necessary for some chemical treatment systems and for most biological methods.

For underground injection sites, the startup period plan should include the schedule for injection activities and, if applicable, associated extraction activities. Proposed initial monitoring and sampling activities should also be included in the plan as well as how injection rates will be monitored and necessary adjustments made during material placement.

IX. Groundwater Summary Corrective Action Map(s) from Tier 2 Site Cleanup Report

Provide a copy of the map(s) from the Tier 2 Site Cleanup Report and indicate the areas required to be cleaned up and the contaminant levels which must be achieved at the site.

X. Soil Summary Corrective Action Map(s) from Tier 2 Site Cleanup Report

Provide a copy of the map(s) from the Tier 2 Site Cleanup Report and indicate the areas required to be cleaned up and the contaminant levels which must be achieved at the site.

XI. Groundwater Flow Direction Maps

Provide current and historical groundwater flow maps for the site. Groundwater elevations must be measured on the same date to provide for accurate groundwater flow contouring.

XII. Monitoring Plan

Provide a monitoring plan which outlines all sampling points and parameters which are required to be monitored for annual monitoring and remediation monitoring. Monitoring results should be submitted using the appropriate sections of the Site Monitoring Report (SMR) in the application. Annual sampling should be conducted during the third calendar quarter with the SMR due by October 30th in accordance with the monitoring plan from the approved Tier 2 Site Cleanup Report. Remediation monitoring is required to be **conducted** at least quarterly with SMRs submitted semi-annually (after the second and fourth quarters). SMRs submitted for the fourth calendar quarter of each year should also include any high risk interim monitoring (conducted in the third calendar quarter) which is required in addition to the remediation monitoring.

The initial SMR submitted after a remediation system startup or other corrective action implementation should include documentation of the completed corrective actions and report any deviations from the plan provided in the CADR. The initial SMR must also include as-builts for remediation systems, remediation monitoring results, an initial progress summary, and a best management practices section.

Bedrock monitoring: When monitoring at non-granular bedrock sites, all groundwater monitoring wells at the site must be sampled. When monitoring at granular bedrock sites, a transition well and a sentry well for each applicable receptor must be sampled. Bedrock monitoring is required at least annually.

High risk interim: Interim monitoring begins once a Tier 2 Site Cleanup Report is submitted and continues until the site is classified as no action required. Groundwater samples must be taken from a source well, a transition well and a guard well. Interim monitoring is required at least annually.

High risk remediation: Remediation monitoring is performed following implementation of any active remediation and must be conducted during the operation of an **active** remediation system. The certified groundwater professional must provide a specific monitoring plan and schedule for the site in the CADR. Remediation monitoring may include groundwater sampling, influent/effluent sampling, etc. Remediation monitoring is required to be **conducted** at least quarterly with SMRs submitted semi- annually after the second and fourth quarters during active system operation. The initial SMR submitted after a remediation system has been started should include a construction documentation section, an initial progress summary, monitoring plan from the Tier 2 Site Cleanup Report and a best management practices section. SMRs submitted for the fourth calendar quarter of each year should also include any high risk interim monitoring conducted in the third calendar quarter which is required in addition to the remediation monitoring.

Construction documentation: If a treatment system is constructed, the as-built plans should be presented in the construction documentation section. This should be submitted to the DNR as part of the **initial** Site Monitoring Report. Include the following:

- As-built plans
- Description of the installation
- Certification that the design and construction was in accordance with the plans and specifications listed in the CADR with a description of any deviations
- Results of any testing or monitoring conducted as part of the construction/testing of the system

Other corrective action documentation: If corrective action other than installation of a remediation system is performed the initial SMR submitted after implementation should include the following:

- Description of the corrective action activities completed (e.g. treatment area, material used, volumes)
- Certification that the design and construction was in accordance with the plans and specifications listed in the CADR with a description of any deviations
- Results of any testing or monitoring conducted as part of the remediation activities

Progress summary: A progress summary detailing all corrective action activities must be submitted to the DNR at least semi-annually during the operation of an active remediation system. The summary should be submitted as part of the SMR and provide a general discussion of recent activities, all monitoring data for the reporting period, and show the progress to date toward attainment of the cleanup goals established in the CADR. The progress summary should include

the following items:

1. Operation summary
   - A summary of system operations during the reporting period including documentation of the volume of contaminants recovered, volumes disposed of or recycled, and any equipment problems, down time, repairs, modifications made to the system, and replacements; The DNR should be informed of any system shut-down.

2. Effectiveness
   - A discussion of the efficiency and effectiveness of the corrective action strategy to date and any recommendations for modification of the existing system, or if it is determined the system will not work at this site, provide a proposal to replace existing system with an alternate technology(ies).
   - Copies of all laboratory data for soil, soil vapor and groundwater sampling conducted during the reporting period, including Chain of Custody forms and any pertinent QC/QA information;
   - Graphs that include data through the life of the project are very useful to evaluate trends. An example is a graph indicating total contaminant removal with time on the X axis and cumulative contaminant removal on the Y axis;
3. Other information
   - Any other pertinent information or data.

XIII. Waste Management Disposal Plan

Provide a plan for disposal of the different forms of waste produced by the remediation system. Include estimated volumes of soil, process water, sludge and free product.

Wastewater discharges to storm sewers: The following are treatment system effluent limitations for storm sewer discharges. The discharge limitations are only applicable to systems treating water contaminated as a result of a gasoline release.

Benzene	5 parts per billion (ppb)
Total benzene, toluene, ethylbenzene & xylenes (BTEX)	100 ppb
pH	6 minimum - 9 maximum

To obtain approval for a discharge to a storm sewer for a gasoline related release, provide:

1. A map showing discharge points of the treatment system into the storm sewer and the storm sewer's discharge point into the receiving stream.
2. Documentation indicating the treatment system is sufficiently designed to assure the effluent is within the limitations for benzene and total BTEX.
3. A letter or other form of certification from the entity owning the sewer approving the use of the sewer as a discharge point.

Wastewater discharges to sanitary sewers: The following are treatment system effluent limitations for sanitary sewer discharges. The discharge limitations are only applicable to systems treating water contaminated as a result of a gasoline release.

Benzene	50 parts per billion (ppb)
Total benzene, toluene, ethylbenzene & xylenes (BTEX)	750 ppb
pH	6 minimum - 9 maximum

To obtain approval for a discharge to a sanitary sewer of a gasoline related release, provide:

1. Documentation indicating the treatment system is sufficiently designed to assure the effluent is within the limitations for benzene and total BTEX.
2. A letter or other form of certification from the entity owning the sewer approving the use of the sewer as a discharge point.

Sanitary and storm sewer discharge limitations have not been established for systems treating water contaminated with petroleum products other than gasoline. At present, the discharge limitations are determined on a case-by-case basis. The DNR must have the following information to establish a discharge limit:

1. If a surface discharge is being considered, a map showing the discharge point of the treatment system into the storm sewer and the storm sewer's discharge point into the receiving stream.
2. Expected effluent levels of benzene, toluene, ethylbenzene and xylenes from the treatment system.
3. A letter or other form of certification from the entity owning the sewer approving the use of the sewer as a discharge point.
4. Maximum design flow for the proposed treatment system.

Some larger communities manage their own sanitary sewer programs. These communities have the authority to establish sanitary discharge limitations different from those discussed above. In those situations, you must provide:

1. Discharge limitations established by the community.
2. Documentation that the treatment system is sufficiently designed to prevent the effluent from exceeding the discharge limitations.
3. A letter or other form of certification from the entity owning the sewer approving the discharge use.

XIV. Security/System Protection

Describe the type of security system to be placed at the site to protect against vandalism and inclement weather. Lock all structures housing parts of the remediation system. All monitoring and recovery wells must have locking caps. The keys for the wells and structures housing the remediation system should remain at the site. If this is impossible, provide a name, address and daytime phone number of a contact person who will hold the keys.

Appendix 1: Permits

Permitting of Underground Injection

The emplacement of materials whether solid, liquid or gas into the subsurface via a well (including direct push technology) for purposes of remediation is regulated by the Underground Injection Control (UIC) Program as a Class V injection well. Decisions to authorize these operations are based on the following criteria: whether the injectate could cause a violation of the Primary Drinking Water Regulations under 40 CFR §141 or otherwise adversely affect the health of humans; the duration of the project; the frequency of injection; and the volume of fluids to be injected.

The State of Iowa has elected not to obtain primacy of the UIC program. Therefore, when injection is selected as the remediation method at a LUST or other corrective action site in Iowa, EPA Region 7 approval is required prior to initiating the injection. A plan describing the activities that will occur at the site – including plume location, ground water flow, injection point locations, volumes of fluids to be injected and information on the injection product to be used for the remediation – must be submitted to EPA Region 7 at least 30 days before any operations can begin. In most cases, submission to EPA Region 7 of the Corrective Action Design Report (CADR) that was provided to DNR will meet EPA's needs. This 30-day advance notification provides EPA the necessary time to determine whether an injection can be authorized by the UIC program, and if so, how that authorization can be achieved (e.g. Permit or Authorization by Rule).

The only exception to this advance notification requirement relates to the limited injection/emplacement of air, oxygen or hydrogen into contaminated zones located in the unconfined surficial aquifer of sites in order to stimulate remediation. These wells are allowed to operate under 40 CFR §144.24 without the need for permitting or a 30-day advance notification, providing that inventory information is submitted to EPA Region 7 using the EPA Region 7 Shallow Injection Well Registration Form. However, the use of this process in a confined aquifer setting or in combination with other gases (such as methane or propane) or other remediation materials remains subject to the minimum 30-day advance notification requirement. The inventory information to be provided includes: the facility's name and location; DNR registration number and project officer's name; the name, address and telephone number of the facility owner and/or its legal contact; the ownership of the facility; the nature and type of injection well(s); and the number of injection wells to be installed. This information should be submitted in advance of well installation.

Send information for projects needing advance approval, or projects providing inventory information, to:

Attention: Iowa UIC Program Coordinator Drinking Water Management Branch Water, Wetlands & Pesticides Division U.S. EPA - Region 7
11201 Renner Boulevard
Lenexa, Kansas 66219

This information may also be provided electronically, to: r7_uic_program@epa.gov

Any injection of materials into the subsurface in Iowa that is done without prior approval from EPA Region 7 or the submission of inventory information is considered to be an unauthorized and may be subject to penalties up to $10,000 per day per violation. In addition to contacting EPA Region 7, the DNR Water Quality Bureau must be contacted for state approval of injection activities, which may also require an operating permit.

Air Discharge Permits

Currently, no air discharge permits are required in Iowa for LUST remediation systems, except in Polk and Linn Counties.

Polk County contact for air discharge requirements:

Polk County Public Works Department Air Quality Division
5855 NE 14th St
Des Moines IA 50313-1296
515-286-3705

Linn County contact for air discharge requirements:

Air Quality Division, Linn County Health Department
1020 6th St SE
Cedar Rapids IA 52401
319-892-6000

Appendix 2: Technical Factors

Data regarding vapor pressures, boiling point ranges, Henry's law constants, solubilities, etc. can be found in the CRC Handbook of Chemistry and Physics as well as in the Tier 2 Site Cleanup Report Guidance appendices.

Intrinsic Permeability

The measure of intrinsic permeability is one of the most important indicators of whether certain treatment technologies will be successful at a site. Intrinsic permeability is a measure of the ability of soils to transmit fluids (liquid or gas). Intrinsic permeability ranges over 12 orders of magnitude (from 10^{-16} to 10^{-3} cm^2) for the wide variety of earth materials, although a more limited range applies for common soil types (10^{-13} to 10^{-5} cm^2). Intrinsic permeability is best determined from field tests, but can be estimated within one or two orders of magnitude from soil boring logs and laboratory tests. Coarse-grained soils (e.g., sands) have greater intrinsic permeability than fine- grained soils (e.g., clays or silts). Note that the ability of a soil to transmit air is reduced by the presence of soil water, which can block the soil pores and reduce air flow. This is especially notable in fine-grained soils, which tend to retain water.

Intrinsic permeability can be determined in the field by conducting permeability tests or in the laboratory using soil core samples from the site. Procedures for these tests are described by the EPA (U.S. Environmental Protection Agency. *Guide for Conducting Treatability Studies Under CERCLA: Aerobic Biodegradation Remedy Screening*. Washington, DC: Office of Emergency and Remedial Response. EPA/540/2-91/013A, 1991). At sites where the soils in the saturated zone are similar to those in the unsaturated zone, hydraulic conductivity of the soils may be used to estimate the permeability of the soils. Hydraulic conductivity is a measure of the ability of soils to transmit water. Hydraulic conductivity can be determined from aquifer tests, including slug tests and pumping tests. You can convert hydraulic conductivity to intrinsic permeability using the following equation:

$$k = K(\mu/\rho g)$$

where: k = intrinsic permeability (cm^2)
K = hydraulic conductivity (cm/sec)
μ = water viscosity (g/cm x sec)
ρ = water density (g/cm^3)
g = accelerator due to gravity (cm/sec^2)

At 20°C: $\mu/\rho g = 1.02 \times 10^{-5}$ cm/sec
To convert k from cm^2 to darcy, multiply by 10^8
To convert K in m/d to k in cm^2, multiply by 1.33×10^{-8}
To convert k in cm^2 to K in m/day, multiply by 7.52×10^7

Pore Volume Calculations

Pore volume is the total volume of pore space in a given volume of rock or sediment. Pore volume usually relates to the volume of air or water that must be moved through contaminated material in order to flush the contaminants. Pore volume calculations are used along with extraction flow rate to determine the pore volume exchange rate and, therefore, oxygen delivery rate. The exchange rate is calculated by dividing the soil pore space within the treatment zone by the design vapor extraction rate. The pore space within the treatment zone is calculated by multiplying the soil porosity by the volume of soil to be treated. Some literature suggests that one pore volume of soil vapor should be extracted at least weekly for effective remedial progress.

You can calculate the time required to exchange one pore volume of soil vapor using the following equation:

$$E = \frac{\varepsilon V}{Q}$$

where: E = pore volume exchange time (hr)
ε = soil porosity (m^3 vapor/m^3 soil)
V = volume of soil to be treated (m^3 soil)

Q = total vapor extraction flowrate (m^3 vapor/hr)

$$E = \frac{(m^3 vapor/m^3 soil) \times (m^3 soil)}{(m^3 vapor/hr)} = hr$$