

# Remedial Alternatives Analysis

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(Updated April 2013)

## Remedial Alternatives Analysis

### Introduction

Following a remedial investigation report, owners and operators (O/Os) must screen and select remedial (cleanup) alternatives and propose a selected alternative to DEQ for approval prior to initiating a cleanup corrective action plan (CAP). O/Os and DEQ project managers (PMs) will choose appropriate cleanup strategies through remedial alternatives analyses (RAAs). RAAs compare cleanup alternatives, evaluate which one would be most appropriate for the release, and explain why the proposed alternative was selected. Administrative Rules of Montana (ARM) require O/Os to consider cost, performance, reliability, implementation, safety, and effects on public health and the environment when selecting cleanup alternatives. ARM 17.56.605(3) states:

The owners and operators must screen and select cleanup alternatives to develop a matrix evaluation of cleanup alternatives which considers cost, performance, reliability, implementation, safety and effects on public health, and the environment. Information on all cleanup alternatives, with an explanation of why any alternative was selected, must be included in the cleanup plan. Cleanup alternatives may include, but are not limited to the following types of action:

- (a) Take no further action;
- (b) Excavate the contaminated soil and/or treat and/or dispose of the same;
- (c) In-place soil treatment;
- (d) Product recovery;
- (e) Groundwater removal and treatment;
- (f) Groundwater gradient control (hydrodynamic);
- (g) Vapor control measures;
- (h) Enhanced biodegradation;
- (i) Drinking water supply replacement; and
- (j) Relocation of affected residences and/or businesses.

### Evaluation Criteria

Guidelines for applying the six evaluation criteria to prospective cleanup alternatives are described below:

#### 1. Cost

DEQ considers present and reasonably anticipated future uses when selecting remedial actions that are cost-effective. Cost-effectiveness can be determined through an analysis of incremental costs, incremental risk reduction, and other benefits of the alternatives considered, taking into account the total anticipated short-term and long-term costs of the remedial action alternatives considered, including the total anticipated cost of operation and maintenance activities. The RAA should include a demonstration that each proposed remedial action is cost-effective for the amount of risk reduction achieved. Actual estimated costs should be provided. Regardless of cost differences, to be selected the remedial action must compare favorably to other remedial actions based on the other five criteria.

#### 2. Performance

The performance of each remedial alternative can be measured by how effectively it will achieve cleanup requirements. Cleanup requirements can be divided into two broad categories: protection of human health and the environment, and compliance with applicable and relevant environmental

requirements, criteria or limitations (ERCLs). When comparing remedial alternatives, O/Os should consider these two criteria separately.

a. Protection of Human Health and the Environment

Remedial alternatives should attain a degree of cleanup and control of further release of contaminants that assures protection of public health, safety, and welfare and of the environment. The RAA must describe how each remedial action evaluated renders the release protective for current and reasonably anticipated future uses. For instance, the remedial action may include soil removal to cleanup levels that are protective of both the groundwater and future residential users based on a facility-specific risk analysis. Another remedial action might include replacing contaminated well water by connecting an affected residence to a community water supply; the drinking water provided to the residence would be protective of current and future residents.

b. Environmental Requirements, Criteria, or Limitations

The RAA must include a description of both applicable and relevant state and federal ERCLs and evaluate how well each proposed remedial action will attain compliance with the identified ERCLs. ERCLs are generally of three types: action-specific, contaminant-specific, and location-specific.

- Action-specific requirements are those that are triggered by the performance of a certain activity as part of a particular remedial action. For example, excavation and disposal of contaminated soil requires solid waste considerations.
- Contaminant-specific requirements are those that establish an allowable level or concentration of a hazardous or deleterious substance in the environment. Examples include Water Quality Bulletin #7 (WQB-7) promulgated under Montana's Water Quality Act, which lists maximum concentrations of petroleum constituents in groundwater and surface water.
- Location-specific requirements are those that serve as restrictions on the concentration of a hazardous or deleterious substance or the conduct of activities solely because the facility is in a specific location or the action affects specified types of areas. Location-specific requirements relate to facilities with potential historical, cultural, or ecological significance, or facilities located near wetlands, floodplains, surface water, endangered species habitat, or migratory bird habitat.

3. Reliability

The RAA must evaluate whether each remedial action would be effective and reliable in the short term because it would not result in a further release of contamination or an increase in the risks posed during the cleanup. Short-term adverse effects may include air emissions or mobilization of contaminants into groundwater or surface water via runoff. The RAA should also evaluate whether each remedial action is effective and reliable in the long-term because it includes measures to maintain acceptable risk levels on a long-term basis. Assuring long-term effectiveness may require remedial actions such as the implementation of institutional controls (e.g., restrictive covenants) and assurance that facility usage will not change and that controls are in place to guarantee this.

4. Implementation

The RAA must include a demonstration how each proposed remedial action can be implemented. Remedial actions that include impracticable components cannot be selected. For example, a soil vapor extraction system may be a proven effective remedial technology for certain petroleum

products in certain types of soil but not for others. Implementation of proposed remedial actions must be compared. Razing several buildings to excavate contamination would score a low implementation factor, whereas excavating shallow contamination in an undeveloped field would score a higher implementation factor.

**5. Safety**

The RAA must include a description of how each proposed alternative would not produce unacceptable safety hazards through its implementation. The RAA should also discuss what measures would be taken to mitigate safety hazards during implementation. For instance, working in or near a busy highway can cause safety hazards to cleanup workers and motorists. This hazard could be mitigated by implementing a traffic control approved by the Department of Transportation.

**6. Effects on public health and the environment**

The RAA must include a description of how each proposed remedial action mitigates the risks presented at the facility. Mitigation of risks can be shown by describing how a remedial action reduces the levels of contaminants to which humans and ecological receptors would be exposed. This requirement can be addressed by describing how proposed cleanup levels and/or standards would be achieved and affirming that these cleanup levels represent risks that are allowable by DEQ. Alternatively, risks could be mitigated with remedial actions that block the pathways by which exposure could occur via the replacement of water supplies or modifications of land use.

**Remedial Alternatives Comparison**

The RAA must include text and a summary table providing a comparison of the proposed remedial action to other reasonable alternatives based on the six criteria included in ARM 17.56.605(3). This section is meant to provide a truncated feasibility study type of analysis. The text should provide a brief description of the alternative and discussion regarding how it would or would not meet each of the six (?) criteria. The table should provide a concise summary of the comparison. The following table shows a summary of the type of information that should be included for each alternative.

<b>Criteria</b>	<b>Evaluation of Criteria Relative to Alternative</b>
Cost-effectiveness	Provide alternative costs and discuss the level of risk reduction achieved by this expenditure of money
Performance (a) Protectiveness	Whether the alternative is protective of public health, safety and welfare and the environment
(b) Compliance with ERCLs	Whether the alternative complies with all ERCLs
Reliability	Whether the alternative is effective and reliable in the short- and long-term
Implementation	Whether the alternative can be implemented and the ease or difficulty of implementation
Safety	Whether the alternative exposes the public to hazards during its implementation
Effects on public health and the environment	Whether the alternative mitigates exposure risk to public health, safety and welfare and the environment

The attached example provides a typical comparison of alternatives including a summary table. This is only an example and the remedial actions evaluated for any given release will vary.

**Sampling or Treatability Studies**

The RAA must include a description of any sampling or treatability studies that will be required before or during implementation of the proposed remedial action. For example, if an appropriate nutrient mixture must be developed prior to implementation of an enhanced bioremediation cleanup, a description of the treatability studies associated with its development should be included. It is advisable that the O/O conduct the majority of the sampling and treatability studies necessary for the remedial action prior to submittal of the RAA to ensure that adequate information will be available to indicate that the remedial action is appropriate.

#### Confirmation Sampling

The RAA must also include a description of the confirmation sampling that will be conducted following the cleanup to verify that cleanup levels have been met. Details on this necessary sampling should include sample collection methods, location, frequency, analytical parameters, and quality assurance/quality control procedures.

#### Standardized CAP and Report Formats Are Not Applicable to all Remedial Alternatives Analyses

The standardized CAP and report formats discussed in this guidance are available for use at selected release sites; however, they may not address the needs of every release. O/Os should conform to standardized formats in this guidance whenever possible to facilitate review of documents and to ensure adequate information will be collected to make proper decisions to safeguard human health and the environment. When a PM determines non-standard site-specific CAPs and/or reports will be necessary, the PM will clearly outline precisely what will be required and use as much of the standardized CAP and report formats as possible. Only the DEQ PM can approve modification to the CAP and report formats in this guidance or the use of site-specific CAPs and reports. Approval to use CAP and report formats must be granted by DEQ before the work is conducted and not after the fact. O/Os are encouraged to contact the PM to clarify any portion of a work request they do not fully understand or to confer on draft work products as they are being prepared.

## Comparison of Remediation Proposal Alternatives

This example of a Remedial Alternatives Analysis (RAA) represents fictitious information for a fictitious petroleum release and the representative text is only intended to be an example of the document format. When developing a RAA for a specific release, use only the format provided herein and develop the analysis for each proposed remedial alternative specific to the release.

ARM 17.56.605(3) requires the comparison of a remediation proposal to reasonable alternatives. Based on the information available about the facility and knowledge and experience with remedies at other similar facilities, four remedial alternatives have been identified as the most reasonable alternatives for the facility.

- Alternative 1: No Action (this alternative is retained as a basis for comparison to other alternatives)
- Alternative 2: Excavation and Treatment of Contaminated Soil at a Local Landfarm
- Alternative 3: Excavation and Disposal of Contaminated Soil at a Licensed Landfill
- Alternative 4: In-situ Treatment of Contamination Using Fenton's Reagent

These four alternatives have been evaluated based on the following six criteria included in ARM 17.56.605(3).

- Cost-effectiveness – The proposed remedial action must be cost-effective relative to the risk reduction it would achieve.
- Performance
  - Protectiveness – The proposed remedial action must be demonstrated protective of public health, safety and welfare and the environment.
  - Compliance – The proposed remedial action must comply with applicable and relevant state and federal environmental requirements, criteria, or limitations.
- Reliability – The proposed remedial action must be effective and reliable in the short- and long-term
- Implementation – The proposed remedial action must be practicable and implementable.
- Safety – The proposed remedial action does not expose the public to hazards during its implementation.
- Effects on public health and the environment – The proposed remedial action must be demonstrated to mitigate exposure to risks to public health, safety and welfare and the environment to allowable levels.

### Alternative 1: No Action

The no-action alternative would leave the facility in its present condition without further remediation, monitoring, or institutional controls. The no-action alternative is used as a baseline against which other remedial options may be compared.

Cost-effectiveness – The no-further-action alternative has no cost but will not reduce risks.

#### Performance

Protectiveness – This alternative is not protective of public health, safety and welfare and the environment as it will not prevent contact with impacted soil, surface water or sediment, or prevent runoff to surface water or contaminants leaching to groundwater.

Compliance – The no-action alternative does not comply with ERCLs as it will not prevent leaching to groundwater or runoff to surface water that could result in exceedance of WQB-7 standards. In addition, the no-action alternative includes leaving contaminated material in a floodplain.

Reliability – This alternative is not effective and reliable in the short- or long-term.

Implementation – This alternative is practicable and implementable.

Safety – This alternative does not cause any hazards through its implementation.

Effects on public health and the environment – This alternative does not mitigate exposure risks to public health, safety and welfare and the environment.

#### Alternative 2: Excavation and Treatment of Contaminated Soil at a Local Landfarm

This is the proposed remedial action described in detail in Section XX. It involves excavating, hauling, and placing all soil contaminated above cleanup levels into an approved offsite landfarm. Long-term operation and maintenance of the landfarm will ensure destruction of contaminants. The landfarm site will be restored following successful soil treatment.

Cost-effectiveness – This alternative will cost approximately \$100,000 to implement, which is cost-effective relative to the level of long-term risk reduction achieved.

#### Performance

Protectiveness – This alternative is protective of public health, safety and welfare and the environment because all contaminated materials will be treated in an approved landfarm where contaminants will be destroyed.

Compliance – This alternative complies with all applicable and relevant ERCLs.

Reliability – This alternative is effective and reliable in the short- and long-term because it will be conducted with adequate controls to prevent the spread of contamination during excavation and the landfarm will be operated to destroy contaminants.

Implementation – This alternative is practicable and implementable because the technology exists to remove the contaminated soil and treat it in the landfarm.

Safety – This alternative does not cause any hazards through its implementation because safeguards will be taken to protect on-site workers and the public.

Effects on public health and the environment – This alternative mitigates exposure to risks by reducing contaminant concentrations remaining onsite to allowable levels. Placing contaminants

on an uncontaminated landfarm site will increase risks at that location in the short-term, but ultimate destruction of the contaminant chemicals will reduce the overall risks in the long-term.

### Alternative 3: Excavation and Disposal of Contaminated Soil at a Licensed Landfill

This is the proposed remedial action described in detail in Section XX. The remedial action involves excavating, hauling, and placing all soil contaminated above cleanup levels into a licensed landfill.

Cost-effectiveness – This alternative will cost approximately \$600,000 to implement, which is not cost-effective relative to Alternative 2. The cost difference lies primarily in the longer transportation distance to the landfill and the tipping fees charged.

#### Performance

Protectiveness – This alternative is protective of public health, safety and welfare and the environment because all contaminated materials will be removed and placed in a licensed landfill.

Compliance – This alternative complies with all applicable and relevant ERCLs.

Reliability – This alternative is effective and reliable in the short- and long-term because it will be conducted with adequate controls to prevent the spread of contamination during excavation and the landfill will be operated in compliance with its permit requirements.

Implementation – This alternative is practicable and implementable because the technology exists to remove the contaminated soil and haul it to the landfill.

Safety – This alternative will not cause any hazards through its implementation because safeguards will be taken to protect on-site workers and the public.

Effects on public health and the environment – This alternative mitigates exposure to risks by reducing contaminant concentrations remaining onsite to allowable levels.

### Alternative 4: In-situ Treatment of Contamination Using Fenton's Reagent

This is the proposed remedial action described in detail in Section XX. The remedial action involves injection of chemicals into the contaminated soil at the site to destroy the contamination in place through an oxidation reaction.

Cost-effectiveness – This alternative would cost approximately \$75,000 to implement, which is cost-effective relative to Alternatives 3 and 4.

#### Performance

Protectiveness – This alternative is protective of public health, safety and welfare and the environment because all contaminated materials will be destroyed.

Compliance – This alternative complies with all applicable and relevant ERCLs.

Reliability – This alternative is effective and reliable in the short- and long-term because contaminants will be destroyed and this is a proven technology. There have been instances of

this technology not reaching all of the in-situ contamination and needing repeat applications or not being able to achieve performance goals.

Implementation – This alternative is practicable and implementable because Fenton’s reagent is a proven technology when applied under proper conditions.

Safety – This alternative is not safe as it could cause undue risk during implementation. Fenton’s reagent reactions have been known to heat subsurface soils and force potentially explosive vapors into man-made structures. Because several buildings are located adjacent to the contaminated area, this alternative could cause an unacceptable fire and explosion hazard.

Effects on public health and the environment – This alternative mitigates exposure risks by reducing contaminant concentrations remaining onsite to allowable levels.

Summary of Alternatives Comparison

Alternative 1 was retained for comparative reasons but does not meet the six criteria included in ARM 17.56.605(3). Alternative 3 meets the evaluation criteria; however, it does not provide a greater level of incremental risk reduction for the additional cost above Alternative 2 due to the added cost of transport and disposal. Alternative 4 is cost effective and will achieve performance goals, but it will produce safety hazards during its implementation. Alternative 2 meets all of the evaluation criteria, is more protective of human health and the environment than Alternative 3 because it destroys the contaminant chemicals, and is more cost-effective relative to risk reduction than Alternative 3. Based on this analysis, Alternative 2, excavation and treatment at a local landfarm, is the proposed remedial action for the facility. The table below summarizes this evaluation.

Alternative	Evaluation Criteria						
	Cost-Effective	Performance		Reliable	Implementation	Safety	Effects on public health and the environment
		Protective	Complies with ERCLs				
1. No Action	Yes \$0	No	No	No	Yes	Yes	No
2. Removal & Treatment at Offsite Local Landfarm	Yes \$100,000	Yes	Yes	Yes	Yes	Yes	Yes
3. Removal & Disposal at Licensed Landfill	No \$600,000	Yes	Yes	Yes	Yes	Yes	Yes
4. In-situ Destruction of Contamination using Fenton’s Reagent	Yes \$75,000	Yes	Yes	Potentially	Yes	No	Yes

An RAA can be included as part of a Remedial Investigation report or it can be prepared as a separate stand-alone report. The PTS project manager will provide guidance on how to prepare and submit the RAA information and, in consultation with the O/O, as to which remedial actions should be evaluated in the RAA.

**Standardized Corrective Action Plan for a Remedial Alternatives Analysis (CAP RAA-01)**  
Montana Department of Environmental Quality Petroleum Technical Section (PTS)

The following lists minimal requirements for a Remedial Alternatives Analysis Corrective Action Plan. Omit any section describing tasks that have not been requested by DEQ and note the omission in the RAA report.

1. Cover Letter (should be no longer than one page)
  - 1.1 Date
  - 1.2 Responsible party's name and mailing address
  - 1.3 Contact person's name and mailing address (if different from above)
  - 1.4 Subject line with the following information:
    - Title (Corrective Action Plan **and Budget** for Remedial Investigation) for the petroleum release at (facility name, street address, town), Montana (Zip code); DEQ Facility ID (number) and Release (number)
  - 1.5 Introductory paragraph containing reference to DEQ's request for a corrective action plan and general scope of work to be conducted
  - 1.6 Consultant's name, address and phone number (if not on letterhead)
  - 1.7 Name of person who prepared the workplan
2. Background Narrative (should be used as Section 4.0 of the RAA report)
  - 2.1 When, how, and by whom contamination was discovered
  - 2.2 Type of products stored at site
  - 2.3 Type of contamination
  - 2.4 When and who reported the release to DEQ
  - 2.5 Summary of initial actions undertaken and by whom
  - 2.6 Summary of regulatory history
  - 2.7 Current site status: what work has already been done and what do we already know about the release and its potential threats to human health and the environment?
3. Summary of Site Conditions
  - 3.1 What is the local soil type and how will it affect contaminant fate and transport?
  - 3.2 Is a community water supply in place or do residents use individual wells?
  - 3.3 What is the depth to first groundwater?
  - 3.4 What are the contaminants of concern or potential concern?
4. Purpose and Objectives of RAA  
Specific goals of this alternatives analysis.
5. Maps
  - 5.1 Facility sketch/map. A true scale digitized base map is preferred. If a true scale map has not yet been prepared, then a "best estimate" site sketch may be acceptable for simple sites.
  - 5.2 Isopleth map of contaminants of concern. (If multiple contaminants are to be addressed in the RAA, one map for each contaminant is appropriate)
  - 5.3 Geologic cross-sections (only if this information is relevant to the evaluation of proposed remedial alternatives)

6. Proposed Work

- 6.1 Identification of remedial alternatives to evaluate (list the alternatives evaluated)
- 6.2 Discuss remedial alternatives with PRS project manager.
- 6.3 Conduct and document screening evaluation of each alternative
- 6.4 Comparative analysis between remedial alternatives
- 6.5 Pilot, bench or field tests; and treatability studies
- 6.6 Report Preparation

## 7. Schedule

Include times when phases of work will begin, when they will be completed, and when information and reports will be provided to DEQ. If specific dates cannot be determined until after the CAP is approved, then provide generic timeframes.

## 8. Budget

## 9. Appendices

- 9.1 Quality assurance/quality control (QA/QC) plan for all methods and sampling proposed (may be on file with DEQ)
- 9.2 Standard operating procedures (SOPs) for all methods and sampling proposed (may be on file with DEQ)
- 9.3 Disposal of investigation derived waste plan.

## **Standardized Report Format for a Stand-Alone Petroleum Release Site Remedial Alternatives Analysis (Report RAA-01)**

Montana Department of Environmental Quality Petroleum Technical Section (PTS)

The following lists minimal requirements for a Remedial Alternatives Analysis Corrective Report. Some of the listed sections may not apply to the scope of work conducted under the approved RAA CAP for the release. Omit any section in the Standardized RAA Report which does not apply to the scope of work conducted under the RAA CAP, and provide an explanation for the omission in the RAA Report.

An alternatives analysis may also be prepared and submitted to DEQ as either stand-alone reports, or it may be included in the Remedial Investigation Report (RI-01). The PRS project manager will provide specific guidance on how to prepare and submit alternatives analysis information and on which remedial alternatives to evaluate.

The following format is required for a stand-alone Remedial Alternatives Analysis Report. When a Remedial Alternatives Analysis is being reported as part of a Remedial Investigation Report (RI-01), only Sections 8 and 9 from this report format should be completed and included as Section 19 of the RI-01 report.

1. Title Page
  - 1.1 Title of report ["Alternatives analysis for..."]
  - 1.2 Facility name.
  - 1.3 Facility address.
  - 1.4 DEQ Facility ID Number and Release Number.
  - 1.5 Responsible parties name, mailing address and phone number.
  - 1.6 Consultant's name, address and phone number.
  - 1.7 Contact person's name, mailing address and phone number (if different from above).
  - 1.8 Date report prepared.
  - 1.9 Title and date of approved RAA CAP
2. Executive Summary
  - 2.1 Executive summary of the report that highlights the alternatives evaluated, the alternative proposed, and the reasons for selecting it.
3. Table of Contents
  - 3.1 Includes titles of report sections and page numbers (please use naming/numbering methodology for main sections listed herein).
  - 3.2 Lists of tables and figures.
  - 3.3 List of appendices.
4. Background (repeated from RI report)
  - 4.1 When, how, and by whom contamination was discovered.
  - 4.2 Type of products stored at site.
  - 4.3 Type of contamination.

- 4.4 When and who reported the release to DEQ.
  - 4.5 Summary of initial actions undertaken and by whom.
  - 4.6 Summary of regulatory history.
  - 4.7 Current site status. What work has already been done and what do we already know about the release and its potential threats to human health and the environment?
5. Remedial Investigation Findings  
Briefly summarize the findings of the remedial investigation.
6. Purpose and Objectives of Report – Specific goals of this report.
6. Maps and Site Technical Background  
Provide a brief summary of contaminant plume(s) and site conditions that directly affect remedial actions or are pertinent to the selection and potential implementation of remedial alternatives evaluated. This may include the following information from the Remedial Investigation Report:
- 6.1 Location map
  - 6.2 Site history
  - 6.3 Extent and magnitude of contamination
  - 6.4 Isopleth map of contaminants of concern. (If multiple contaminants are to be addressed in the RAA, one map for each contaminant is appropriate)
  - 6.5 Soil and groundwater information
  - 6.6 Soil and structure vapor information
  - 6.7 Migration pathways and exposure potential
  - 6.8 Potential receptors
  - 6.9 Utility information
  - 6.10 Geologic cross-sections (only if this information is relevant to the evaluation of proposed remedial alternatives)
7. Remedial Alternatives Analysis
- 7.1 Identify volume and area of contaminated media
  - 7.2 Description of Remedial Actions Being Evaluated
    - 7.2.1 Discussion of how remedial actions were chosen for further evaluation.
    - 7.2.2 Detailed description of each remedial action proposed.
  - 7.3 Evaluation and Comparison of Proposed Remedial Actions
    - 7.3.1 Discussion of how each remedial alternative achieves comparison criteria
      - 7.3.1.1. Cost
      - 7.3.1.2. Performance - Protection of human health and the environment
      - 7.3.1.3. Performance - Environmental Requirements, Criteria, or Limitations
      - 7.3.1.4. Reliability
      - 7.3.1.5. Implementation
      - 7.3.1.6. Safety
      - 7.3.1.7. Effects on public health and the environment
    - 7.3.2 Table summarizing comparison of remedial alternatives against evaluation criteria
    - 7.3.3 Discussion and selection of best remedial action based on comparison of

evaluation criteria.

7.4 Implementation Considerations

7.4.1 Sampling or treatability studies required to finalize the proposed remedial action design.

7.4.2 Confirmation sampling required to confirm compliance with cleanup goals following completion of the proposed remedial action.

20. Recommendations

20.1 Additional data collection, treatability studies, or evaluation of additional remedial alternatives.

20.2 Design, construction, or implementation of selected remedial alternative (including proposed schedule).

20.3 Immediacy of corrective action if required.

20.4 Projected future monitoring needs.

20.5 Signature page (signed and dated).

21. Limitations

22. References (including all sources of information)

Appendices (include only those that apply)