Guidance for Conducting Feasibility Studies

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For additional information on conducting feasibility studies on site-specific projects, contact the DEQ Project Manager for the project. For additional information on conducting feasibility studies in general, contact your DEQ Regional Office Cleanup Program Intake Coordinator.

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Table of Contents

1. Introduction

The objective of this guidance is to assist Oregon Department of Environmental Quality staff and other interested parties in conducting feasibility studies. Users of this guidance are encouraged to exercise professional judgment in applying this guidance and should be cognizant of how the feasibility study can affect the type and cost of the remedy. As a general guiding principle, the selection of remedial actions should be completed in the most efficient and cost- effective manner consistent with the requirements of statute and regulations.

The Feasibility Study (FS) is the process in which remedial action alternatives are developed and evaluated for the purpose of selecting an appropriate remedial action. This remedy selection process ensures that statutory and administrative rule requirements are met, provides the public with a foundation on which to provide comments on proposed remedies, and allows the Department to select or approve the most appropriate remedy for sites at which a release of hazardous substances has occurred. While this guidance focuses only on the FS, it should be understood that an FS is typically conducted in conjunction with a Remedial Investigation (RI) where the risk assessment shows unacceptable risk from the release or threat of release of one or more hazardous substances.

The Department also has developed guidance for conducting various elements of the RI including *Guidance for Identification of Hot Spots*, *Guidance for Consideration of Land Use in Environmental Remedial Actions*, and *Guidance for Beneficial Water Use Determinations at Environmental Cleanup Sites*. For information on these or other guidance policies call the Department's Land Quality (LQ) Division at (503) 229-5913 or 1-800- 452-4011 (toll free in Oregon). Information about cleanup guidance documents also can be found on the Department's web site at www.oregon.gov/deq/Hazards-and-Cleanup/env-cleanup/Pages/default.aspx.

1.1 Organization

This document is organized to follow the sequence of tasks typically conducted during an FS. Section 1 provides background information about the environmental cleanup process in the State of Oregon. Section 2 describes the process for developing remedial action alternatives, including the identification of remedial action objectives (RAOs) and general response actions, the identification and screening of remedial technologies and the assembly of remedial action alternatives. Section 3 describes the process for evaluating remedial action alternatives based on the requirement to achieve protection of human health and the environment, provide a balance of the remedy selection factors and the preference for treatment or excavation of hot spots of contamination.[1] Section 4 describes the process for recommending a remedial action alternative to the Department. Section 5 describes the process in which the Department selects or approves a remedial action.

[1] As provided in OAR 340-122-0090(4), "treatment or excavation of hot spots of contamination" as used in this guidance document means treatment of hot spots of contamination in water and, for hot spots of contamination in media other than water, treatment or excavation and off-site disposal at an authorized disposal facility or a combination of treatment and excavation and off-site disposal.

1.2 Requirements

An overview of Oregon's environmental cleanup process is presented in Figure 1-1. In this process, sites progress through a stepwise process of assessments and investigations until enough information has been obtained to support the selection or approval of a remedial action or, if appropriate, to support a recommendation of no further action. This process also allows for several streamlining options, which are discussed in Section 1.4.

The FS is a central component of Oregon's environmental cleanup process. (See OAR 340-122-0085.) An FS may be required when the baseline risk assessment determines that risk to human health or the environment exceeds acceptable risk levels.

The specific elements of the FS are diagrammed in Figure 1-2.[2] Under Oregon's environmental cleanup requirements [ORS 465.200 et. seq. and OAR 340-122-0010 et seq.], the FS must develop and evaluate a range of remedial action alternatives. Typically, this range includes a no action alternative, which evaluates baseline conditions; an alternative utilizing engineering and institutional controls; a treatment-based alternative; an alternative utilizing excavation and off- site disposal and an alternative(s) utilizing any combination of the preceding elements.

For each remedial action alternative, the FS must evaluate:

(a) The protectiveness of the alternative based upon the standards set forth in OAR 340- 122-0040;
(b) The feasibility of the alternative based upon a balancing of the remedy selection factors which include effectiveness; long-term reliability; implementability, implementation risk, and cost reasonableness; and
(c) The extent to which the remedial action alternative provides for treatment or excavation of hot spots of contamination. OAR 340-122-0085(4).

All remedial actions selected or approved by the Director must be protective, provide a balance of the remedy selection factors and satisfy the requirements for treatment or excavation of hot spots of contamination as specified in OAR 340-122-0090(4). Remedial actions for non-hot spots of contamination also must be protective and provide a balance of the remedy selection factors; however, the least expensive alternative shall be preferred unless there are proportionately greater benefits within one or more of the remedy selection factors associated with a more expensive alternative.

1.3 Applicability

Although an FS usually is required when the baseline risk assessment determines that risk to human health or the environment exceeds acceptable risk levels, Oregon's environmental cleanup program allows the use of generic risk-based concentrations (RBCs) as criteria to identify areas and/or volumes

[2] The Department generally follows the process developed by the U.S. Environmental Protection Agency (EPA) for completing an FS as described in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, (EPA/540/G-89/004). See Appendix A for a discussion of some of the similarities and differences between Oregon's environmental cleanup law and EPA's National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

of contaminated media at a facility that may pose a significant risk to human health. The generic RBCs were developed by DEQ using risk assessment methodology and exposure scenarios appropriate for the typical occupational or residential exposure settings. The generic RBCs may be used as remedial action objectives (RAOs) for an FS as described in Section 2.1 below, or to select remedies without completion of an FS. For example, simple sites with contamination limited to soil may not require a site-specific risk assessment or FS if the contaminated soils will be excavated to appropriate generic RBCs and disposed offsite at an authorized disposal facility. Similarly, an FS is not required for underground storage tank (UST) cleanups which follow the rules established in OAR 340-122-0205 through 0360, although in some cases an FS may be recommended for an UST site.

Oregon's environmental cleanup law also allows the Department to develop and approve generic remedies under OAR 340-122-0047. In utilizing generic remedies, the FS is streamlined by limiting the development and/or evaluation of other remedial action alternative or, in some cases, eliminated if the generic remedy includes a generic FS. The Department has completed guidance for *Generic Remedies for Soils Contaminated with PCBs* (1997). (However, because of new developments in toxicology and human health risk assessment, since adoption of the 1997 guidance, many numeric values contained within the document are outdated. Therefore the guidance for *Generic Remedies for Soils Contaminated with PCBs* should be used for general background information and reference purposes only.)

Finally, OAR 340-122-0070 provides for performance of a removal action where the Director determines a removal action will facilitate achievement of the protectiveness standard pursuant to OAR 340-122-0040. Removal actions may be performed or required if DEQ determines it is necessary to prevent, minimize, or mitigate damage to the public health, safety and welfare, and the environment that might result from the release or threat of release of hazardous substances. While an FS is not necessary for the performance of a removal action under the Cleanup Rules, the Department recommends the preparation of an engineering evaluation and cost analysis to provide sufficient information regarding the protectiveness and feasibility of removal action options. In general, removal actions are not a substitute for remedial actions or feasibility studies. However, consistent with the requirements of OAR 340-122-0070, the Director may select or approve removal actions that could impact the scope or need for subsequent remedial actions at individual facilities.

1.4 Streamlining the Feasibility Study

Section 1.3 describes circumstances when an FS might not be required. In other instances, the FS may be streamlined to expedite remedy selection. A summary of approaches to streamlining the FS is presented below:

- **EPA Presumptive Remedies:** Where information is readily available concerning effective and reliable remedial technologies, the FS can be streamlined by limiting the number of remedial technologies considered in developing remedial action alternatives. Specifically, the presumptive remedies developed by EPA, if applicable, often will be useful in minimizing the identification and screening of remedial technologies. For information on EPA's presumptive remedy policy, see *Presumptive Remedies: Policy and Procedures*, EPA 540-F-93-047, September 1993. Following is list of the EPA presumptive remedies:

    - *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*, EPA 540-R-96-023, October 1996.

- *Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites*, EPA/540/R-95/148, December 1995.
- *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites with Volatile Organic Compounds in Soils*, EPA 540-F-93-048, September 1993.
- *Presumptive Remedy: Supplemental Bulletin Multi-Phase Extraction (MPE) Technology for VOCs in Soil and Groundwater*, EPA 540-F-97-004, April 1997.
- *Presumptive Remedy for CERCLA Municipal Landfill Sites*, EPA 540-F-93-035, September 1993.
- *Presumptive Remedies: CERCLA Landfill Caps RI/FS Data Collection Guide*, EPA/540/F-95/009, August 1995.

Additional information on EPA's presumptive remedies can be found on EPA's Superfund web site at www.epa.gov/superfund or by calling the SUPERFUND Information Center at 1-800-424-9346.

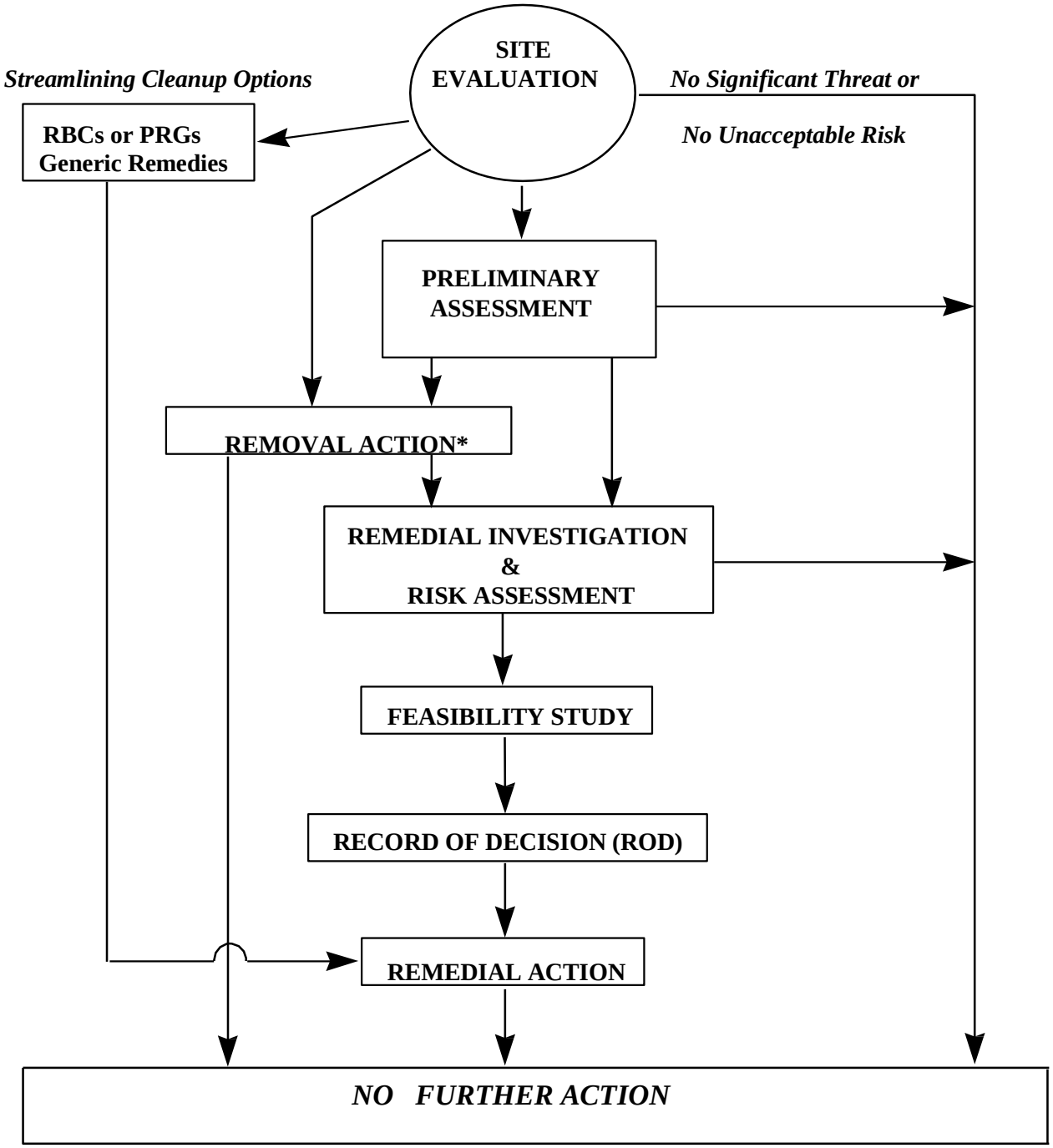
- **Limiting the General Response Actions:** The FS also can be streamlined by limiting the number of general response actions[3] for which site-specific remedial action alternatives are developed. OAR 340-122-0085(3) allows one or more general response actions to be eliminated if the resulting remedial action alternative(s) clearly would not be protective, feasible, or otherwise appropriate for the facility. The justification for the proposed elimination of general response actions need not be lengthy but should address factors pertinent to remedy selection criteria established in Oregon's environmental cleanup law.

- **Workplan Design:** The FS should be designed to provide sufficient information and analysis to allow the Director to approve or select remedies based on a comparative analysis of remedial action alternatives and Oregon's remedy selection criteria. The Department encourages approaches for completion of the FS which avoid unnecessary data collection and analysis. Consultation with the Department is recommended when making determinations on the extent of information and analysis necessary for an FS. A suggested formats for an FS workplan is presented in *Recommended format and content for a Remedial Investigation and Feasibility Study Scope of Work (Long Form)* (see *http://www.oregon.gov/deq/FilterDocs/RIFSScopeWorkLongForm.pdf*) and *Recommended format and content for a Remedial Investigation and Feasibility Study Scope of Work (Short Form)* (see *http://www.oregon.gov/deq/FilterDocs/RIFSScopeWorkShortForm.pdf*).

- **Media or Area-Specific Studies:** Subject to Department approval, an FS may be completed on a media or area-specific basis. Especially at complex sites, a media or area- specific approach to addressing contaminants may simplify the development and evaluation of an otherwise large number or complex assortment of remedial action alternatives.

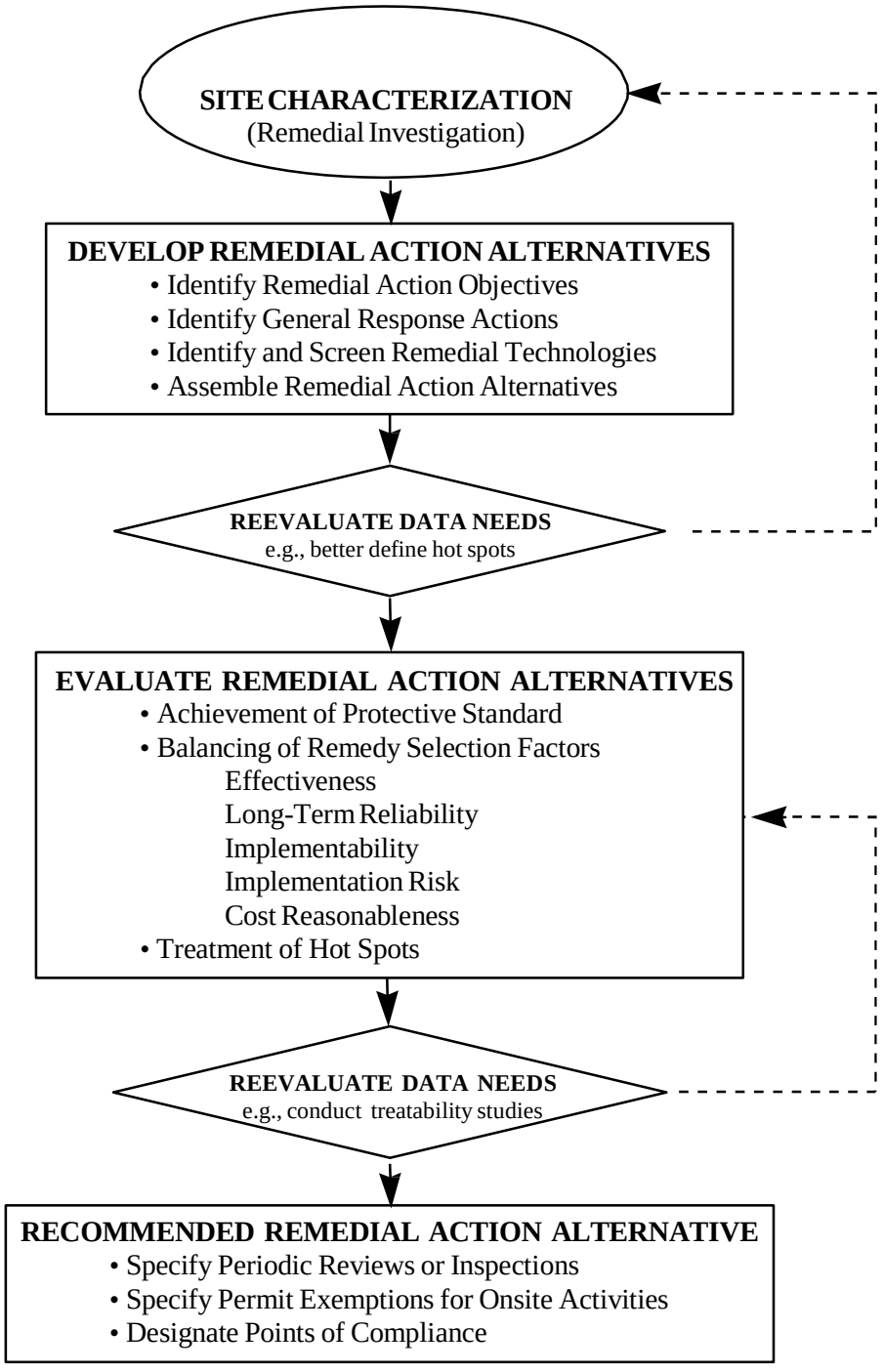
[3] For a description of general response actions, see Section 2.2.

Figure 1-1
Environmental Cleanup Process



* Removal actions may be taken at any step of the environmental cleanup process prior to issuance of a Record of Decision (ROD).

Figure 1-2
Elements of the Feasibility Study



2. Development of Remedial Action Alternatives

This section describes the process for developing remedial action alternatives. Typically, this process includes the identification of Remedial Action Objectives (RAOs) and general response actions; the identification and screening of remedial technologies; and the assembly of remedial action alternatives. For additional guidance on the development of remedial action alternatives, see EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004.

2.1 Identification of Remedial Action Objectives

Remedial Action Objectives (RAOs) are medium-specific goals for protecting human health and the environment. RAOs provide the framework for developing and evaluating remedial action alternatives, since any remedy which the Department selects or approves must achieve these site- specific RAOs.

RAOs should be developed based on information gathered during the RI and baseline risk assessment. The RAOs should be fairly specific, but not so specific that the range of remedial action alternatives will be too limited. RAOs should be refined as more information becomes available. The two primary criteria which must be considered when developing RAOs include:

- Remedial actions must achieve the standards for "protectiveness" specified in OAR 340- 122-0040(2). These standards are the acceptable risk levels defined in OAR 340-122- 0115. Furthermore, remedial actions shall prevent or minimize future releases of hazardous substance in the environment, and shall not result in greater environmental degradation than that existing when the removal or remedial action are commenced, unless short-term degradation is approved by the Director.
- Remedial actions must treat or excavate hot spots of contamination to the extent feasible based on the remedy selection balancing factors. Hot spots are defined in OAR 340-122- 0115.

RAOs should be developed for each impacted medium and specify the following:

- The contaminant(s) of concern.
- Exposure routes and receptors for the current and reasonably anticipated land and water use(s) in the locality of the facility. These should have been identified in the Conceptual Site Model developed during the RI and baseline risk assessment.
- RBCs for human and/or ecological receptors.
- Hot spot concentrations.

Examples of RAOs are presented in Table 2-1.

RBCs and hot spot threshold levels should be specified for each exposure route and receptor type. This additional information may be useful in identifying exposure pathways posing the greatest risk to human health or the environment and the evaluation of remedial technologies capable of eliminating or reducing exposure and associated risks posed by these pathways.

DEQ suggests that the RAOs, RBCs, and hot spot threshold levels be developed with input and preliminary concurrence from DEQ Project Managers prior to proceeding with the next steps in the FS process.

2.2 Identification of General Response Actions

General response actions describe those actions that will satisfy the remedial action objectives. The FS must develop a range of remedial action alternatives acceptable to the Department. As specified in OAR 340-122-0085(2), this range is based on the following general response actions:

No action: A "no action alternative" serves as a baseline for comparison of other potential remedial actions. Actions taken to reduce the potential for exposure (e.g., site fencing, deed restrictions, etc.) should not be included as a component of the no action alternative.

Engineering and/or institutional controls: Engineering controls are **physical** measures which prevent or minimize exposure to hazardous substances or reduce the mobility or migration of hazardous substances. In contrast, institutional controls are **legal** or **administrative** measures or actions which reduce exposure to hazardous substances. Sites which permanently incorporate engineering or institutional controls into their remedial action will remain on the Department's Inventory of Sites Requiring Further Action (Inventory).[4]

Treatment: Treatment is defined as the permanent and substantial elimination or reduction in the toxicity, mobility or volume of hazardous substances with the use of in situ or ex situ remedial technologies. Treatment may be performed either onsite or off- site treatment also may include "monitored natural attenuation", as described in *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, US EPA, OSWER Directive 9200.4-17, November 1997. However, for groundwater and surface water, dilution by itself does not qualify as treatment. In most cases, the identification and evaluation of a variety of treatment technologies (given the types of contaminants, contaminated media, and other site conditions) is necessary to avoid premature and/or inaccurate conclusions regarding the feasibility of treatment.

Excavation and off-site disposal: With excavation and off-site disposal, excavated soil, solid waste and hazardous waste are managed at a facility authorized for such disposal under state or federal law. Treatment of excavated material prior to off-site disposal may be required in conjunction with applicable solid and hazardous waste requirements.

Any combination of the above, as appropriate: Typically, remedies selected or approved by the Director will include components of several general response actions. As an example, for hot spots of contamination in soil, a remedial action alternative should be developed that includes treatment and/or excavation and off-site disposal to the hot spot threshold while incorporating engineering and/or institutional controls to reduce exposure to the remaining non-hot spot contamination. If treatment to the hot spot level is not likely to be feasible, another remedial action alternative should be developed which includes partial treatment of the hot spot, partial or complete excavation and off-site disposal of the hot spot, or any other remedial action alternative appropriate for the given site conditions.

2.3 Identification and Screening of Remedial Technologies

After the general response actions have been identified, potentially suitable remedial technologies should be identified and screened based on the RAOs and available information from the RI, including the concentrations and physical properties of the contaminants of concern and the physical characteristics of the site. A substantial amount of information has been developed by EPA and other organizations which is useful for identifying and screening remedial technologies. Some resources include:

- EPA's Cleanup Information Forum (CLU-IN), available via the Internet at https://clu-in.org/.

[4] As required by ORS 465.225(1)(b) and 465.230(2).

- Interstate Technology and Regulatory Cooperation Work Group (ITRC), available via the Internet at www.itrcweb.org/.
- Global Network of Environmental Technologies (GNET), available via the Internet at https://www.gnest.org/.
- National Academy of Sciences, www.nationalacademies.org/publications/.
- *Remediation Technology Screening Matrix and Reference Guide*, EPA 1993, EPA 542-B-93-005.
- Site Remediation Technology InfoBase: A Guide to Federal Programs, Information Resources, and Publications on Contaminated Site Cleanup Technologies, EPA 542-B-00-005, June 2000.
- EPA's Technology Innovation Program; available via the Internet at www.epa.gov/clusters-program.
- US Army Corps of Engineers, Research and Development Center; available via the Internet at www.erdc.usace.army.mil/About/.
- US Army Corps of Engineers, Engineer Manuals, available via the Internet at http://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals/.
- The Air Force Civil Engineer Center; available via the Internet at www.afcec.af.mil/Home/Environment/.
- Naval Facilities Engineering Command, Engineering Service Center, Environmental Services Division, Environmental Restoration and Base Realignment and Closure; available via the Internet at www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/ev/erb.html
- Sources referenced in Appendix D of EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA/540/G- 89/004).

In order to identify the most suitable remedial technology(ies) for a given remedial action alternative, remedial technologies should be screened based on a cursory evaluation of the technology relative to the remedy selection balancing factors. Those remedial technologies that are clearly not feasible (e.g., not effective or implementable or are substantially more costly than other technologies for a given general response action) should be eliminated from further consideration and their elimination documented in the FS report.

Since a detailed evaluation of remedial alternatives will take place later (see Section 3), the emphasis at this point in the FS is on a cursory evaluation of remedial technologies for the purpose of developing an appropriate range of remedial action alternatives. Table 2-3 gives an example format for presenting identified remedial technologies and their screening. In this example, each technology is rated as low, medium or high with respect to three of the remedy selection factors: effectiveness, implementability and cost. If useful for screening purposes, this evaluation also could have included a comparison of the other two remedy selection factors, long-term reliability and implementation risk or any other relevant information (e.g., information on the ability of the remedial technology to meet the treatment preference for hot spots).

DEQ suggests that the results of this technology screening step be presented to the DEQ Project Managers for input and feedback before proceeding to the next steps in the FS process.

2.4 Assembly of Remedial Action Alternatives

In this final step of the alternative development process the remedial technologies are combined or assembled into viable site-specific remedial action alternatives. Except as discussed below, for each general response action, at least one remedial action alternative should be assembled using technologies that will meet the site-specific RAOs. For complex sites, it may be useful to assemble alternatives on a media-specific or area-specific basis.

Oregon's environmental cleanup law allows the Department to eliminate from development or evaluation those remedial action alternatives(s) which would not be protective of human health or the environment or do not balance the remedy selection factors or do not treat hot spots of contamination. Elimination of any remedial action alternative at this point in the FS should be justified by results of the RI or other readily available information and should be based on obvious conclusions regarding the alternative's protectiveness and feasibility. Remedial alternatives that are eliminated should be identified in the FS Report with the justification for their elimination

provided. The following provides examples of when it may be appropriate to eliminate a remedial action alternative.

Treatment: For sites containing hot spots of contamination in water, the FS must include an evaluation of treatment-based alternatives. For sites containing hot spots of contamination in media other than water, the FS must include an evaluation of a treatment-based alternative and/or an excavation and offsite disposal alternative. For sites that do not contain hot spots of contamination, a remedial alternative involving treatment should be identified, but may be eliminated in an initial screening if it is clearly not feasible (i.e., based on one or more of the remedy selection factors).

Excavation and off-site disposal: Remedial actions relying upon excavation and off-site disposal can be eliminated from further evaluation if, for example, site contaminants cannot be legally managed at an off-site disposal facility due to land disposal restrictions under the Resource Conservation and Recovery Act (RCRA).[5] Excavation and off-site disposal also may be eliminated if it is clearly inappropriate for the contaminated media (e.g., contamination limited to depths beyond conventional soil excavation techniques or limited to groundwater).

Engineering and/or institutional controls: Remedial action alternatives that rely upon engineering and institutional controls may be eliminated from development and evaluation, if the responsible party intends to use treatment or excavation and off-site disposal, to achieve acceptable risk levels and restore any significant adverse impacts on beneficial water uses. In addition, engineering and/or institutional controls may be eliminated if they are not implementable. For example, it may not always be possible to obtain deed restrictions for off-site properties (i.e., neighboring properties owned by parties not responsible for the contamination).

Note: Site-specific RAOs should be more specific than the generalized RAOs presented in Table 2-1 below. As an example, the RAOs for human exposure to contaminated soil should state the specific exposure routes and identify protective risk-based concentrations and hot spot thresholds. Also, site-specific RAOs should specify the contaminants of concern which the RAOs are based upon.

[5] Off-site treatment at the landfill to meet land disposal restrictions or improve engineering properties of the waste does constitute treatment.

Table 2-1
Examples of Generalized Remedial Action Objectives

Medium	Remedial Action Objectives
Soil	• **Human Health:** Prevent exposure to soil posing a Hazard Index greater than 1 and a lifetime excess cancer risk greater than $1x10^{-6}$ for individual carcinogens, or greater than $1x10^{-5}$ for multiple carcinogens. • **Ecological:** Prevent adverse impact from soil to individuals of a threatened or endangered species, and significant adverse impact to populations of ecological receptors. • **Migration:** Prevent migration of contaminants which would result in greater environmental degradation than that existing upon implementation of remedial action. • **Hot Spots of Contamination:** Treat hot spots of contamination to non-hot spot levels in soil by reducing their concentration, volume or mobility through treatment or excavation and offsite disposal.
Ground-water	• **Human Health**: Prevent exposure to water posing a Hazard Index greater than 1 and a lifetime excess cancer risk greater than $1x10^{-6}$ for individual carcinogens, or greater than $1x10^{-5}$ for multiple carcinogens. • **Ecological:** Prevent adverse impact from groundwater to individuals of a threatened or endangered species, and significant adverse impact to populations of ecological receptors. • **Migration:** Prevent migration of contaminants which would result in greater environmental degradation than that existing upon implementation of remedial action. • **Hot Spots of Contamination:** Treat hot spots of contamination to non-hot spot levels in groundwater by reducing their concentration, volume or mobility.
Surface Water	• **Human Health:** Prevent exposure to surface water posing a Hazard Index greater than 1 and a lifetime excess cancer risk greater than $1x10^{-6}$ for individual carcinogens, or greater than $1x10^{-5}$ for multiple carcinogens. • **Ecological:** Prevent adverse impact from surface water to individuals of a threatened or endangered species, and significant adverse impact to populations of ecological receptors. • **Hot Spots of Contamination:** Treat hot spots of contamination to non-hot spot levels in surface water by reducing their concentration, volume or mobility.
Sediment	• **Human Health:** Prevent exposure to sediments posing a Hazard Index greater than 1 and a lifetime excess cancer risk greater than $1x10^{-6}$ for individual carcinogens, or greater than $1x10^{-5}$ for multiple carcinogens. • **Ecological:** Prevent adverse impact from sediment to individuals of a threatened or endangered species, and significant adverse impact to populations of ecological receptors. • **Migration:** Prevent migration of contaminated sediments or dissolution of contaminants that greater environmental degradation than that existing upon implementation of remedial action. • **Hot Spots of Contamination:** Treat hot spots of contamination to non-hot spot levels in sediments by reducing their concentration, volume or mobility through treatment or excavation (dredging) and offsite disposal.
Non-Aqueous Phase Liquids	• **Migration:** Prevent migration of NAPLs that would result in greater environmental degradation than that existing upon implementation of remedial action. • **Hot Spots of Contamination:** Treat hot spots of contamination to non-hot spot levels by reducing their concentration, volume or mobility.
Drummed Waste	• Characterize the waste as hazardous or solid waste, remove and/or manage all drummed waste in a manner consistent with federal and state requirements.
Solid Debris	• Characterize the waste as hazardous or solid waste, remove and/or manage all debris in a manner consistent with federal and state requirements.

Table 2-2
Examples of Remedial Technologies

Biological Treatment Land Farming Composting Bio-Slurry Bioventing Enhanced Biodegradation Phytoremediation Bioreactors Biofilters Constructed Wetlands **Disposal** Solid Waste Landfill Hazardous Waste Landfill TSCA Waste Landfill On-Site Disposal Infiltration **Engineering Controls** Soil Cap Asphalt Cap Impermeable Cap Fencing Hydraulic Barriers Hydraulic Containment Drainage Controls Alternative Water Supplies **Institutional Controls** Access Restrictions Water Use Restrictions Land Use Restrictions Activity Restrictions **Natural Attenuation** Physical Attenuation Geochemical Attenuation Biological Degradation	**Physical/Chemical Treatment** Soil Washing Soil Sieving Filtration Solvent Extraction Carbon Adsorption Ion Exchange Reverse Osmosis Chemical Precipitation Dewatering Stabilization/Solidification Aeration Air Stripping UV Oxidation Catalytic Oxidation Chemical Oxidation **Removal** Excavation Groundwater Extraction Interceptor Trenches Dredging Vapor Extraction **Thermal Treatment** Incineration Thermal Desorption Steam Injection Vitrification Thermal Oxidation Six Phase Heating

Note: The preceding is only a partial list. Some technologies not included in this list, in particular, may be appropriate for individual sites.

Table 2-3
Recommended Format for Tabulating Identified Technology and Screening Results*

Identified Remedial Technologies (the following are examples)	Relevant Screening Criteria**			Comments	Retained yes/no
	Effectiveness L/M/H	Implementability L/M/H	Cost L/M/H		
Institutional Controls					
Land use restrictions limiting activities at the site to industrial uses.					
Engineering Controls					
Soil cap					
Asphalt cap					
Impermeable cap					
Removal					
Excavation & off-site disposal					
Physical Treatment					
Soil washing					
Stabilization					
Chemical Treatment					
Chemical oxidation					
Thermal Treatment					
Incineration					
Thermal desorption					
Biological Treatment					
Aerobic Degradation					

***The example technologies shown in this table are intended for only for illustrative purposes**.
** Other relevant screening criteria may include long-term reliability or implementability.

L/M/H indicates Low/Medium/High.

3. Evaluation of Remedial Action Alternatives

This section describes the process for evaluating remedial action alternatives. This process includes both an individual and comparative evaluation of alternatives. The individual evaluation consists of an evaluation of each remedial action alternative against 1) the protectiveness requirement; 2) a balancing of the remedy selection factors; and 3) the preference to treat or excavate hot spots of contamination, if present. The RAOs developed earlier in the FS are used as quantitative indicators of protectiveness and hot spot treatment levels. The purpose of the individual evaluation is to demonstrate how well each of the remedial action alternatives satisfies the remedy selection criteria. Often, it is useful to present the individual evaluation of remedial action alternatives in table format where each remedial action alternative is presented along with a short description of its protectiveness, effectiveness, long-term reliability, implementability, implementation risk, cost reasonableness and the extent that it treats hot spots of contamination. The evaluation of alternatives with respect to the balancing factors must include all of the criteria identified for each balancing factor as applicable, which are presented in detail in Section 3.3.

As information is compiled on individual alternatives, the alternatives should be compared to each other. The purpose of the comparative evaluation is to provide a relative evaluation so that the alternative which best satisfies the evaluation criteria can be identified and recommended to the Department for selection or approval.

3.1 Protectiveness

Oregon's environmental cleanup law requires that all remedies be protective of human health and the environment, as demonstrated through a residual risk assessment.[6] As specified in OAR 340-122-0084(4), the residual risk assessment shall be conducted prior to selection or approval of the remedial action, and shall include:

> *(a) A quantitative assessment of the risk resulting from concentrations of untreated waste or treatment residuals remaining at the facility at the conclusion of any treatment or excavation and off-site disposal activities taking into consideration current and reasonably likely future land and water use scenarios and the exposure assumptions used in the baseline risk assessment; and*
> *(b) A qualitative or quantitative assessment of the adequacy and reliability of any institutional or engineering controls to be used for management of treatment residuals and untreated hazardous substances remaining at the facility.*
> *(c) The combination of (a) and (b) constitute a residual risk assessment that must demonstrate to the Department that acceptable levels of risk as defined in OAR 340-122-0115 would be attained in the locality of the facility.*

The residual risk assessment is not a separate deliverable nor a standalone exercise. Rather, it provides information relating to the evaluation of the balancing factors "effectiveness" and "long-term reliability" (see Section 3.3.1 and 3.3.2). If a remedial action alternative is effective and reliable over the long-term, it is by necessity protective. Simply stated, the residual risk assessment provides a **quantitative** assessment of the risk remaining at the site (a criterion of effectiveness) and a, typically, **qualitative** assessment of the adequacy (a criterion of effectiveness) and reliability (a criterion of long-term reliability) of engineering and/or institutional controls in managing this risk over the long-term.

For remedial actions consisting only of treatment or excavation and off-site disposal, the residual risk assessment provides only the quantitative assessment of the risk from treatment residuals or untreated wastes remaining at the

[6] See OAR 340-122-0040(2)(a).

site. For remedial actions consisting of only engineering and/or institutional controls, the baseline risk calculated in the baseline risk assessment is the risk remaining at the site (i.e., from untreated wastes). The assessment of engineering and institutional controls' adequacy and reliability is typically a qualitative assessment based on professional judgement taking into consideration the performance history of these controls. In order for this alternative to be protective, the engineering and institutional controls must adequately and reliably manage this risk over the long-term. A monitoring plan, periodic evaluation and reporting, and corrective measures may be required to maintain the protectiveness of the remedy.

3.2 Hot Spots

3.2.1 Identification of Hot Spots

Oregon's environmental cleanup law provides definitions of hot spots in water and media other than water (e.g., soil, sediments and sludges), see the Department's current generic RBC *Hot Spot Concentrations Table*. For a more thorough discussion of hot spots identification, see the Department's *Guidance for Identification of Hot Spots*.

The identification of hot spots occurs during the RI for media other than water, based on concentration and mobility of contaminants. For groundwater or surface water where a significant adverse effect on the beneficial use(s) has been identified, the FS must evaluate whether treatment is reasonably likely to restore or protect the beneficial use(s) of water within a reasonable time. If treatment is determined to be able to restore or protect the beneficial use(s) within a reasonable time, the groundwater or surface water contamination must be identified as a hot spot. Engineering controls involving hydraulic control, which typically involve ex-situ treatment, can usually protect beneficial water uses within a reasonable time frame, and therefore should be developed and fully evaluated where groundwater beneficial uses exist within a LOF.

An additional evaluation of hot spots of contamination in media other than water is completed in the FS to evaluate whether the hazardous substances in that media can be reliably contained. If it is determined that the hazardous substances cannot be reliably contained, the impacted media must be identified as a hot spot. The evaluation of reliability (i.e., long-term reliability) is discussed in Section 3.3.

3.2.2 Preference for Treatment or Excavation of Hot Spots

Oregon's environmental cleanup law requires that all remedies treat or excavate hot spots of contamination to the extent feasible. The evaluation of feasibility is based on the five remedy selection factors; however, a "higher cost threshold" is applied to the cost reasonableness for treating hot spots. General principles for applying the higher cost threshold are discussed in Section 3.3.5.

Treatment of Hot Spots in Water

OAR 340-122-0115(5) defines significant adverse effect as current or reasonably likely future exceedance of:

> *(a) Applicable or relevant federal, state or local water quality standards, criteria, or guidance;*
> *(b) In the absence of applicable or relevant water quality standards, criteria, or guidance, the acceptable risk level; or*
> *(c) If subsections (a) and (b) of this section do not apply, the concentration of a hazardous substance indicated by available published peer-reviewed scientific information to have a significant adverse effect on a current or reasonably likely future beneficial use of water.*

An example of applicable standards for drinking water are the National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs). Appendix C of the *Department's Guidance for Identification of Hot Spots* identifies potential standards for use in identifying significant adverse effects on beneficial uses of water.

For hot spots in groundwater or surface water, the FS must evaluate the feasibility of treatment to levels that will no longer produce significant adverse effects on the beneficial use(s) of the water. Although the significant adverse effect level is not necessarily equivalent to the acceptable risk level, all remedies must achieve protective levels (i.e., acceptable risk levels). As such, Oregon's environmental cleanup law and rules require:

- Where the significant adverse effect level is **more** stringent than the acceptable risk level, the FS shall evaluate the feasibility of treatment to the significant adverse effect level while applying the higher cost threshold for treatment.

- Where the significant adverse effect level is **less** stringent than the acceptable risk level, the FS shall evaluate the feasibility of treatment to 1) the significant adverse effect level while applying the higher cost threshold for treatment then 2) the acceptable risk level, without application of the higher cost threshold for treatment.

Treatment of Hot Spots in Media other than Water

OAR 340-122-0115(31)(b) defines hot spots in media other than water as hazardous substances that present a risk to human health or the environment exceeding the acceptable risk level **and** exceed any of the following criteria:

> *(A) Are present in concentrations exceeding risk-based concentrations corresponding to:*
> *(i) 100 times the acceptable risk level for human exposure to each individual carcinogen;*
> *(ii) 10 times the acceptable risk level for human exposure to each individual non-carcinogen;*
> *(iii) 10 times the acceptable risk level for individual ecological receptors or populations of ecological receptors to each individual hazardous substance;*
> *(B) Are reasonably likely to migrate to such an extent that [a significant adverse effect on beneficial use(s) of water] or the conditions specified (A) or (C) would be created or*
> *(C) Are not reliably containable, as determined in the feasibility study.*

For hot spots in media other than water, the FS must evaluate the feasibility of treatment and/or excavation and off-site disposal to the point where the concentration or condition producing the hot spot would no longer occur while applying the higher cost threshold for treatment and/or excavation and off-site disposal, then the FS must evaluate the feasibility of treatment and/or excavation and off-site disposal to the acceptable risk level without application of the higher cost threshold for treatment.

3.3 Remedy Selection Balancing Factors

Oregon's Environmental Cleanup Law requires the feasibility of the remedial action alternatives to be assessed based upon a balancing of five remedy selection factors. These balancing factors include effectiveness, long-term reliability, implementability, implementation risk and reasonableness of cost. Following are the criteria to be used in assessing each of these balancing factors.

3.3.1 Effectiveness

OAR 340-122-0090(3)(a) states that each remedial action alternative shall be assessed for its effectiveness in achieving protection, by considering all of the following criteria, as appropriate:

> *(A) Magnitude of risk from untreated waste or treatment residuals remaining at the facility absent any risk reduction achieved through onsite management of exposure pathways, as determined in OAR 340-122-0084(4)(a). The characteristics of the residuals shall be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade;*

(B) Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the facility, as determined in OAR 340-122-0084(4)(b);
(C) With respect to hot spots of contamination in water, the extent to which the remedial action restores or protects existing and reasonably likely future beneficial uses of water;
(D) Adequacy of treatment technologies in meeting treatment objectives;
(E) Time until the remedial action objectives would be achieved; and
(F) Any other information relevant to effectiveness.

In general, effectiveness provides an assessment of the remedial action alternative's ability to achieve the desired level of protection or restore any significant adverse effects on beneficial use(s) of water as quickly as possible. Effectiveness measures the performance of the alternative up to the point in time that remedial action objectives are achieved and implementation is complete. Whether the alternative can maintain these objectives over the long-term is assessed by the balancing factor long-term reliability. For example, an asphaltic cap may be immediately effective at achieving protection by adequately preventing exposure to subsurface contamination. However the long-term reliability of the cap would need to be evaluated to determine whether the required level of protection would be maintained over time.

As stated in Section 3.1, the **quantitative** assessment of part A of this rule, t*he magnitude of risk from untreated waste or treatment residuals,* and the **qualitativ**e assessment of part B, *the adequacy of any engineering and institutional controls*, are components of the residual risk assessment. With the Department's approval, when evaluating a remedial action alternative's effectiveness, the anticipated post treatment or residual concentrations, mass or volume may be used as surrogates for the "magnitude of risk" remaining at the facility.[7] However, as noted in Section 4.0, a complete residual risk assessment must be conducted prior to presenting the recommended alternative to the Department.

With respect to hot spots in groundwater or surface water for which the current or reasonably likely future beneficial use(s) includes drinking water, a remedial action alternative would not be considered effective if it would not reduce contaminant concentrations to levels below National Primary Drinking Water Standards Maximum Contaminant Levels (MCLs) or other applicable or relevant water quality standards, criteria or guidance. Variability (e.g., seasonally or annually) in water flow and water use should be considered in the evaluation of effectiveness.

3.3.2 Long-Term Reliability

OAR 340-122-0090(3)(b) states that each remedial action alternative shall be assessed for its long-term reliability, by considering all of the following criteria, as appropriate:

(A) Reliability of treatment technologies in meeting treatment objectives;
(B) Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, taking into consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure;
(C) Nature, degree, and certainties or uncertainties of any necessary long-term management (e.g., operation, maintenance, and monitoring); and
(D) Any other information relevant to long-term reliability.

In general, long-term reliability provides an assessment of the remedial action alternative's ability to maintain the required level of protection over the long-term after it has been implemented. When evaluating treatment-based alternatives such as solidification or stabilization, the evaluation of long-term reliability focuses on the

[7] Use of concentration, mass or volume as a surrogate for risk presumes that there is a direct relationship between these parameters and risk (e.g., risk = concentration x exposure factors x toxicity).

technology's ability to maintain the contaminated media in a non-toxic or non-mobile state. When evaluating alternatives utilizing engineering and institutional controls, the evaluation of long-term reliability focuses on the control's ability to continue to prevent exposure to the contaminated media (e.g., the potential for the control to degrade or be modified thereby resulting in exposure to the residual contamination being managed by the control). Alternatives that completely and permanently destroy the hazardous substances would have the highest level of long-term reliability since it would be impossible for a successfully implemented remedy to fail. However, these treatment-based alternatives may rank low on the implementability balancing factor if they are likely to be plagued with mechanical problems during construction and implementation.

The assessment of long-term reliability is typically a **qualitative** assessment. As stated in Section 3.1, the assessment of part B of this rule, *the reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances*, is provided in the residual risk assessment.

With respect to hot spots in groundwater or surface water for which the current or reasonably likely future beneficial use(s) includes drinking water, a remedial action alternative would not be considered reliable over the long-term if contaminant concentrations will not be consistently and reliably below MCLs or other applicable or relevant water quality standards, criteria or guidance. As with effectiveness, variability in water flow and water use should be considered in the evaluation of long-term reliability.

3.3.3 Implementability

OAR 340-122-0090(3)(c) states that each remedial action alternative shall be assessed for the ease or difficulty of implementing the remedial action, by considering all of the following criteria, as appropriate:

> *(A) Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays;*
> *(B) The ability to monitor the effectiveness of the remedy;*
> *(C) Consistency with federal, state and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies;*
> *(D) Availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-site treatment, storage, and disposal capacity and services, and availability of prospective technologies; and*
> *(E) Any other information relevant to implementability.*

The assessment of implementability is intended to determine whether, or with how much difficulty, the remedial action alternative can be implemented and whether the alternative's continued effectiveness can be assessed and verified. Remedies which cannot be implemented will not be selected or approved by the Department.

One example of a legal difficulty is the reliance of a remedial action alternative on institutional controls that constrain the property rights of an adjacent property owner or nearby water right holder. Without the voluntary agreement of the affected parties, the remedial action alternative might not be implementable. An example of a practical or technical difficulty is the potential mechanical problems associated with complex remedial action alternatives. If these problems are likely to result in significant delays or might prevent the remedial action alternative from meeting the remedial action objectives, the remedial action alternative might not be implementable.

3.3.4 Implementability Risk

OAR 340-122-0090(3)(d) states that each remedial action alternative shall be assessed for the risk associated with implementing the remedial action, by considering all of the following criteria, as appropriate:

> *(A) Potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;*

(B) Potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
(C) Potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
(D) Time until the remedial action is complete; and
(E) Any other information related to implementation risk.

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase (i.e., up to the point that remedial action objectives are met). Under this criterion, alternatives should be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. Implementation risk, also referred to as short-term risk, typically is a **qualitative** assessment of the various risks or impacts that may result while implementing the remedy and the ability to manage those risks.

3.3.5 Reasonableness of Cost

OAR 340-122-0090(3)(e) states that each remedial action alternative shall be assessed for the reasonableness of cost, by considering all of the following criteria, as appropriate:

(A) Cost of the remedial action including:
(i) Capital costs, including both direct and indirect costs;
(ii) Annual operation and maintenance costs;
(iii) Costs of any periodic review requirements; and
(iv) Net present value of all of the above;
(B) Degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management;
(C) With respect to hot spots of contamination in water, the degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water;
(D) The degree of sensitivity and uncertainty of the costs; and
(E) Any other information relevant to cost-reasonableness.

In practice, the assessment of reasonableness of cost ordinarily is a two part assessment. First, the cost of each remedial action alternative is estimated using standard engineering procedures. These estimated costs should be reasonably accurate, typically within +50% to -30% of actual cost if the alternative were to be implemented. Appendix B provides a more thorough discussion of the criteria to be assessed in estimating cost.

Second, the degree to which the costs are "proportionate to the benefits" is determined. This part of the cost reasonableness assessment should not necessarily be viewed as a rigorous cost benefit analysis.[8] More typically, this assessment may be performed by **qualitatively** comparing the various remedial action alternatives to each other. In general, alternatives that are protective, (i.e., effective and reliable)[9]; can be readily implemented with minimal impacts to the community, workers, and the environment; and have a lower cost will be regarded as having a greater level of cost reasonableness.

OAR 340-122-0090(4) provides overarching principles relating to cost reasonableness which the Director of DEQ shall use to select or approve a protective remedial action alternative. These criteria include:

- For hot spots of contamination in water, treatment to the extent treatment is feasible considering the treatment criteria in OAR 340-12-0085(5) and the balancing factors set forth in OAR 340-122-0090(3);
- For hot spots of contamination in media other than water, treatment or excavation and offsite disposal at an authorized facility or the combination of treatment or excavation, to the extent such measure are

[8] Although, the Department would welcome suggestions for innovative approaches to assessing the relationship between cost and benefit on a site specific basis.
[9] And, for water hot spots, restore the beneficial uses of water.

feasible considering the criteria in OAR 340-122-0085(7) and the balancing factors set forth in OAR 340-122-0090(3);
- The cost of a remedial action shall not be considered reasonable if the costs are disproportionate to the benefits created through risk reduction or risk management;
- A higher threshold shall be applied in evaluating the reasonableness of costs for treating hot spots of contamination, whether such treatment occurs onsite or in conjunction with excavation and off-site disposal; and
- Subject to the preference for treatment of hot spots of contamination, where two or more remedial action alternatives are protective, the least expensive alternative shall be preferred, unless the additional cost of a more expensive remedial action alternative is justified by proportionately greater benefits within one or more of the [remedy selection balancing] factors set forth in OAR 340-122-0090(3).

In short, these principles can be summarized as a preference to treat hot spots of contamination and a preference for the least costly, protective alternative for non-hot spots of contamination.

This "preference", however, is subject to all five remedy selection balancing factors (i.e., effectiveness, long-term reliability, implementability, implementation risk, and cost reasonableness). For example, in certain instances a more expensive alternative using excavation and off-site disposal may be justified for non-hot spots if this alternative would result in significantly greater long-term reliability than an alternative using engineering and institutional controls.

Although no limiting value has been established for the "higher cost threshold" for treating hot spots of contamination, the Department generally expects that hot spots of contamination will be treated to non-hot spot levels (i.e., to concentrations or conditions which would not produce a hot spot). However, in situations where treatment to these levels is cost prohibitive or technically infeasible, another protective remedial action alternative will be selected. This alternative may include partial treatment of the hot spot, containment of the hot spot, or any other remedial action alternative appropriate for the given site conditions.

4. Recommendation of the Remedial Action

The FS should recommend a remedial action alternative from those developed and evaluated in the FS. Any person who proposes one remedial action alternative over another has the burden of demonstrating to the Department, through the RI and FS, that such remedial action alternative, as specified in OAR 340-122-0090(1):

(a) Is protective of present and future public health, safety and welfare and of the environment, as specified in OAR 340-122-0040;
(b) Is based on a balancing of remedy selection factors, as specified in OAR 340-122-0090(3); and
(c) Satisfies the requirements for hot spots of contamination, as specified in OAR 340-122-0090(4).

Furthermore, subject to the preference for treatment of hot spots, the least expensive, protective alternative shall be preferred, unless the additional cost of a more expensive alternative is justified by proportionately greater benefits within one or more of the remedy selection factors.[10]

Prior to presenting the recommended alternative to the Department, a complete residual risk assessment must be performed for this alternative including a quantification of the *magnitude of risk resulting from untreated waste or treatment residuals remaining at the facility* (i.e., the risk being managed by any engineering or institutional controls), as specified in OAR 340-122-0084(4)(a).

[10] As specified in OAR 340-122-0090(4)(d) and discussed in Section 3.3.5 of this guidance.

In addition, the following items should be addressed for any recommended alternative.

4.1 Periodic Reviews

Any recommended remedial action alternative should specify a schedule for periodic review or inspections by the Department and/or other parties, as necessary to ensure the effectiveness and long-term reliability of the alternative in maintaining the required level of protection.

4.2 Permit Exemptions for Onsite Activities

For any recommended remedial action, Oregon's environmental cleanup law requires the responsible party to:

a) *Identify the extent to which the remedial action would be conducted onsite;*
b) *Identify all state and local permits, licenses or other authorizations or procedural requirements that would be exempted pursuant to ORS 465.315(3);*
c) *Describe any consultation with affected state or local government bodies; and*
d) *Identify applicable substantive requirements of the affected state or local laws and how they would be addressed.* OAR 340-122-0085(9).

This information will be used by the Department to delineate the extent to which the recommended remedial action would occur onsite for the purpose of exempting the onsite portion of the remedial action [see ORS 465.315(3) and DEQ's *Description of "Permit Exemption" Provisions*, July 1998].

4.3 Designation of Points of Compliance

Any recommended remedial action should specify applicable points of compliance for measuring attainment of the RAOs.[11] As specified in OAR 340-122-0090(7)(c), points of compliance shall be established as close as possible to the source of the release, and also may be established at other points relevant to the exposure pathways and receptors evaluated in the baseline risk assessment and/or residual risk assessment. In situations where drinking water use has been significantly adversely effected, the points of compliance should be located in a manner that ensures contaminant concentrations in the drinking water supply are reliably and consistently below National Primary Drinking Water Standards Maximum Contaminant Levels (MCLs) or other applicable or relevant standards. Furthermore the location(s) of the points of compliance should be based on variable conditions, such as seasonal variations in water use or climate, as they effect water demand and availability.

5. Selection or Approval of the Remedial Action

The FS is paramount in providing the information necessary for the Director to select a remedy or approve a recommended remedy. In particular, Oregon's environmental cleanup law requires the Director to select or approve a remedial action that is based on the administrative record, which includes the RI and FS.

The preceding sections of this guidance discussed the types of information necessary to support the Director's selection or approval of a remedial action. In addition, as specified in OAR 340- 122-0090(6), the Director shall consider current and reasonably anticipated future land uses at the facility and surrounding property, including:

[11] Note that the ability to monitor the effectiveness of the remedy is a criterion for evaluating an alternative's implementability.

(a) Current land use zoning;
(b) Other land use designations;
(c) Land use plans as established in local comprehensive plans and land use jurisdiction; and implementing regulations of any governmental body having land use jurisdiction; and
(d) Concerns of the facility owner, neighboring owners, and the community.

In effect, this rule reinforces the importance of land (and water) use in remedy selection.

Information and analysis of current and reasonably likely future land use typically is addressed relatively early in the environmental cleanup process (for example, during the RI), see the Department's *Guidance for Consideration of Land Use*. However, in the event of changed land use conditions—or new information relevant to current or reasonably likely future land use determinations, as presented during the public notice and comment period—the Director will consider this information in selecting or approving the remedy. Changes in land use are critical components of the remedial planning process and should be fully incorporated into the administrative record which may require revisions or addenda to the risk assessment and FS prior to selection or approval of a remedial action.

5.1 Staff Report

The Department will prepare a Staff Report, typically after the recommended alternative has been presented to the Department. The Staff Report will summarize the site and investigation information; describe the nature and extent of contamination; identify the receptors and the risk; briefly discuss the alternatives evaluated; and identify the Department's recommended alternative based on the criteria described above. The Staff Report, presenting the Department's recommended alternative, is subjected to an internal peer and management review, and then made available for public review and comment.

Where appropriate, a Proposed Plan may be substituted for the Staff Report. The Proposed Plan is a short document, written in lay terms, that briefly summarizes the information that is or would be presented in the Staff Report.

5.2 Public Notice and Participation

Prior to the required public involvement process, the Department may choose to develop and implement public outreach efforts such as holding informational meetings or attending neighborhood association meetings to explain the remedial process, provide information about the site and to address any preliminary public concerns and issues.

The requirements for public notice and participation are described in ORS 465.320 and OAR 340-122-0100. In short, the Department's Staff Report, describing the proposed remedial action, is available for public comment for a minimum of 30 days. The public comment period may be longer if requested or where there is significant public interest.

As provided by statute and rule, a reasonable effort is to be made to identify and notify interested and affected community organizations, nearby property owners and other interested and affected parties of the recommended remedy. State law also requires publication of the proposed action in a local paper of general circulation and in The Oregon Bulletin (formerly the Secretary of State's Bulletin).

If significant public involvement is identified or expected, additional efforts to involve the public in the remedy selection process (e.g., public meetings) may be required. For example, upon written request by 10 or more persons or a group having 10 or more members, a public meeting at or near the facility for the purpose of receiving verbal comment regarding the proposed action is required. For projects where there is significant public interest, a public meeting and/or hearing should be planned even before a request is made to avoid the need for a second public notice and unnecessary delays.

The Director must consider any written or verbal comments received before approving a remedial action. In addition, if there are substantive changes to the remedy as a result of public input, another public comment period may be warranted.

5.3 Record of Decision

Once the public comment period is completed, the Staff Report is finalized into a Record of Decision. The Record of Decision is similar to the Staff Report with the exception of an additional section which presents a summary of the public participation activities, a summary of comments received and the Department's responses, a discussion of how the selected remedy meets the requirements in Oregon's environmental cleanup law, and a description of any significant changes to the Department's recommended remedial action alternative as a result of public comment. The Record of Decision becomes effective and enforceable upon final approval by the appropriate Regional Cleanup Program Manager.

Appendix A – Comparison of the NCP and Oregon's Environmental Cleanup Law

The following is a brief comparison of EPA's National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and Oregon's environmental cleanup law. EPA uses the NCP as the basis for selecting remedies at sites addressed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). For more information on the NCP, see 40 CFR 330.

Protection of Human Health and the Environment

The NCP requires remedies to meet two "threshold" criteria: 1) overall protection of human health and the environment and 2) compliance with applicable and relevant or appropriate requirements (ARARs). Factors that are considered in determining overall protection include, a protective risk range of 10^{-4} to 10^{-6} for known or suspected carcinogens, a Hazard Index of 1 for non-carcinogens and no significant adverse impact on ecological receptors. Typical ARARs include the Safe Drinking Water Act maximum contaminant levels (MCLs), non-zero maximum contaminant level goals (MCLGs) and water quality criteria established under the Clean Water Act. However, ARARs may be waved in certain situations.

Oregon's environmental cleanup law requires all remedies to be protective of human health and the environment. Protectiveness is defined as meeting specific acceptable risk levels specified in OAR 340-122-0115 for individual carcinogens (10^{-6}), multiple carcinogens (10^{-5}), non-carcinogens (Hazard Index of 1), individual ecological receptors and populations of ecological receptors. Furthermore, these levels are based on exposures resulting from current and reasonably likely future land and water uses.

Remedy Selection Balancing Factors

The remedy selection balancing factors specified in the NCP are:

1. Long-term effectiveness and permanence;
2. Reduction of toxicity, mobility, or volume through treatment;
3. Short-term effectiveness;
4. Implementability; and
5. Cost.

With two important modifying criteria:

6. Community acceptance, and
7. State acceptance.

The remedy selection balancing factors specified in the Oregon's environmental cleanup law are:

1. Effectiveness;
2. Long-term reliability;
3. Implementability;
4. Implementation risk; and
5. Reasonableness of cost.

Principal Threats and Hot Spots of Contamination

The NCP specifies that principal threats be *treated* wherever practicable. Principal threats are generally defined as areas contaminated with high concentrations of toxic compounds, liquids and other highly mobile materials or contaminated media that pose significant risk of exposure or media containing contaminants several orders of magnitude above health-based levels.

Oregon's environmental cleanup law requires that hot spots of contamination be treated to the extent feasible. OAR 340-122-0115(31)(a) states that, for groundwater or surface water, hot spots of contamination are defined as hazardous substances having a significant adverse effect on beneficial uses of water or waters to which the hazardous substances would be reasonably likely to migrate *and* for which treatment is reasonably likely to restore or protect such beneficial uses within a reasonable time, as determined in the feasibility study. OAR 340-122- 0115(31)(b) states that, for media other than water, hot spots are defined as hazardous substances which present a risk to human health or the environment exceeding the acceptable risk level *and*:

(A) Are present in concentrations exceeding risk-based concentrations corresponding to:
  (i) 100 times the acceptable risk level for human exposure to each individual carcinogen;
  (ii) 10 times the acceptable risk level for human exposure to each individual non- carcinogen;
  (iii) 10 times the acceptable risk level for individual ecological receptors or populations of ecological receptors to each individual hazardous substance;

(B) Are reasonably likely to migrate to such an extent that the conditions specified in OAR 340-122-0115(31)(a) or OAR 340-122-0115(31)(b)(A) or (b)(C) would be created; or

(C) Are not reliably containable, as determined in the feasibility study.

Appendix B – Estimating Costs for Remedial Action Alternatives

Oregon's environmental cleanup law requires remedial action alternatives be evaluated based on their cost. As specified in OAR 340-122-0090(3)(e)(A), the estimation of a remedial action alternative's cost shall include:

(i) Capital costs, including both direct and indirect costs;
(ii) Annual operation and maintenance costs;
(iii) Costs of any periodic review requirements; and
(iv) Net present value of all of the above.

The following summary provides general information on estimating remedial action costs. Additional, more detailed information can be found in the following EPA guidance documents: *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/006, October 1988 and *Remedial Action Costing Procedures Manual*, EPA-600- 8-87-049, October 1987. Also, see EPA's website at https://www.epa.gov/superfund/cost-remedy-selection-process.

Estimating remedial action costs should include the entire cost of the remedial action alternative, including the cost of mobilization, treatment, disposal, site restoration, monitoring, and operation and maintenance. Costs should be limited to those incurred by the party implementing the remedy, including any Department oversight costs and the costs of any periodic review or monitoring. In contrast, the estimated cost of a reduced property value, for example, should not be considered in this evaluation (e.g., estimated property value losses due to reliance on engineering or institutional controls). Minimally, estimated remedial action costs should provide for a relative comparison of costs between alternatives. These estimated costs should be reasonably accurate, typically within +50% to -30% of actual cost if the alternative were to be implemented.

Capital Costs

Capital costs consist of direct (construction) and indirect costs (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor and materials necessary to install remedial actions. Indirect costs include expenditures for engineering, financial and other services that are not part of actual installation of remedial alternatives. Costs that must be incurred in the future as part of the remedial action should be identified and noted for the year in which they will occur. The distribution of costs over time often will be a critical factor in making tradeoffs between capital intensive technologies and less capital-intensive technologies.

Operation and Maintenance Costs

Annual operation and maintenance (O&M) costs are post construction costs necessary to ensure the continued protectiveness and effectiveness of a remedial action. Examples of O&M costs include treatment system operating costs, administrative costs, maintenance materials and labor costs and monitoring costs following implementation of the remedial action.

Periodic Review Costs

For remedial action alternatives that require long-term management of site risk (e.g., engineering or institutional controls), the Department expects that periodic reviews will be required to ensure the remedy remains protective or assumptions used in the baseline and residual risk assessments remain valid. Periodic reviews will typically be performed on an annual, two year or five year basis. Periodic review costs also should include oversight costs paid to the Department.

With Department approval, periodic review costs may be excluded from the cost estimate if they are anticipated to comprise only an insignificant portion of a remedial action alternative's overall cost or if the period review costs are anticipated to be the same for all remedial action alternatives under evaluation.

Net Present Value and Future Worth

A net present value and future worth analysis must be performed to estimate the current value of future costs. Future costs are discounted relative to a common base year. Typically the base year is the current year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure that if invested in the base year and disbursed as needed, would be sufficient to cover the future costs of the remedial action.

When estimating future costs, a discount rate should be selected. A discount rate is used to account for the time value of money. In other words, it is a way of quantitatively estimating the "net present value" of future costs relative to short-term costs. DEQ recommends evaluating the net present value of anticipated remedial action costs using different assumed discount rate factors. Given economic conditions at the time of publication of this guidance, DEQ suggests using a 3% and a 7.5% discount rate.

DEQ will consider other assumed discount rate(s), but you should provide an explanation for any alternative discount rate analyses. The length of time over which future costs should be estimated is until the remedial action is completed or 30 years, whichever is less. Costs incurred beyond 30 years typically do not have a significant effect on the net present value of the remedial action.

For additional guidance pertaining to application of discount rates for estimating net present value see:

> *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, EPA 540- R-00-002; July 2000. https://semspub.epa.gov/work/HQ/174890.pdf.
>
> *Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cast Analysis*, OSWER Directive 9355.3-20, USEEPA 1993.