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Uncertainty Management: Expediting Cleanup Through Contingency Planning

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This guide is primarily intended for personnel with line management responsibility for Department of Energy (DOE) environmental restoration projects conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). It describes techniques for managing project uncertainty, including decision rules and contingency planning as outlined in the DOE/EPA "Principles of Environmental Restoration" workshop. Additional written guidance is available in DOE's *Remedial Investigation/Feasibility Study (RI/FS) Process, Elements, and Techniques Guidance* (DOE/EH-9400, December 1993) and DOE's *Phased Response/Early Action Guidance* (DOE/EH-0256, November 1995).

Introduction

Some degree of uncertainty in environmental restoration projects always exists. This inherent uncertainty may result from incomplete knowledge of the nature and extent of contamination, an inability to predict a technology's performance under site-specific conditions, or new or changing regulatory requirements. Although these inherent uncertainties present a significant challenge to effective project management, recognizing and planning for them helps to ensure that projects stay on schedule and within budget.

In order to effectively reduce and manage uncertainty prior to or during a response action, the project team must first determine which uncertainties are significant (i.e., can impact the implementation of the response action(s) under consideration). Once significant uncertainties are identified, the DOE, EPA and State project managers (i.e., the core team), must decide whether to reduce the uncertainty through data collection, or reach consensus on how best to "manage" the uncertainty through contingency planning. In short, this decision will require a balance between the cost of data collection (and decisional benefits gained) against the cost of planning for a potential deviation (i.e., uncertainty), and the cost / schedule impacts of modifying the design if the deviation occurs.

Outlined below are steps to follow once the core team decides to pursue managing an uncertainty through contingency planning.

Step One: Identify Expected Conditions and Potential Deviations

The core team should use their conceptual model developed for the site (or "problem") being addressed as a basis for identifying and evaluating expected conditions and potential deviations. An expected condition is any physical, chemical, technical, or regulatory condition that is expected to be encountered during implementation of the response action. For example, based on all available information [e.g., process history, preliminary assessment / site investigation (PA/SI)], the core team expects that contamination of Pu-238 greater than 75 pCi/g is confined to the soil and sediment from zero to four feet deep in the bed of an old, abandoned canal. However, given the possible releases of Pu-238 that could have occurred over a twenty year period, the core team identifies the potential presence of Pu-238 greater than 75 pCi/g below four feet, as a deviation that has a realistic probability of occurrence.

Step Two: Evaluate Deviations

Once potential deviations have been identified, the core team should determine what level of "pre-response" planning is appropriate by evaluating each deviation as to its possible impact on the implementation of the likely response(s), and its ability to negate achievement of response objectives.

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Typically, a qualitative evaluation of the factors discussed below is sufficient to determine how best to proceed:

- Probability deviation will occur: The core team should rank deviations based on their likelihood of occurrence (e.g., high, medium, low).[1] Using the example from above, the core team may determine there is a low probability that contamination of Pu-238 above 75 pCi/g extends below four feet since the two PA/SI samples taken did not exceed this level.

- Potential impacts of the deviation: The core team should evaluate each deviation in terms of its potential impacts on the response action(s) cost, schedule, and implementation requirements (e.g., site preparation / mobilization, material handling, transportation). Typically, this requires bounding the range of impacts and comparing this range to a tolerable threshold[2] around which the base design is being constructed. For example, should contamination of Pu-238 above 75 pCi/g extend below four feet, soil volumes requiring excavation will increase significantly. If the site's temporary storage facility can only absorb a 25% increase (the threshold) in soil volume before capacity is exceeded, termination of field activities may be necessary until additional temporary storage is made available.

- Time to respond: The core team should estimate the "lead" time to respond between occurrence of the deviation and the impact to the project. As before, this may be done qualitatively or quantitatively, depending on the significance of the potential impact of the deviation. The shorter the lead time to respond, the less time available to implement the contingent response if a deviation is detected. Consequently, a greater level of contingency plan development / design is usually required to modify the base design in a timely manner (e.g., special equipment is procured and brought out to the site in case deviation occurs).

  Alternatively, if a long lead time is expected, then a less detailed contingency plan may be appropriate.

[1] The core team needs to carefully consider whether a deviation having a high probability of occurrence is better characterized as an expected condition rather than a potential deviation.

[2] This threshold is the maximum change in the expected conditions that the base design (for the response action) can accommodate before a contingent response(s) is required.

Step Three: Develop Appropriate Contingency Plans

Once the core team determines the appropriate level of "pre-response" contingency plan for each specified deviation, development of contingency plans can begin. Based on the required level of detail, a contingency plan should include a strategy for what needs to be accomplished to effectively manage and respond to a deviation. Specifically, the core team should define the necessary design modifications and / or actions required in the field to manage the deviation (e.g., modify excavation approach, provide higher level of personnel protection equipment (PPE), construct short-term storage area). Ultimately, the objective is to ensure the required scope of the contingency plan can be documented for procurement purposes and preplanning is sufficient to allow rapid, effective responses to deviations.

Additional considerations in developing contingency plans are discussed below[3]:

- Implementability: Based on the evaluation in step two, the core team should determine the necessary level of development / design to ensure the contingency plan can be easily implemented and will reliably address the deviation. As the probability that a deviation may occur increases, or as a shorter lead time to respond is required, a more developed contingency plan may be necessary to ensure rapid implementation. [NOTE: In some cases, the design of the contingency plan may need to be integrated into the base design.] Likewise, the greater the potential impacts of the

[3] These same factors are useful to determine the most suitable contingency plan in the case where several contingency options exist.

deviation (e.g., occurrence of the deviation will require termination of field activities), the higher degree of confidence required that the contingency plan is implementable.

- Effectiveness: The contingency plan should provide a similar level of protectiveness as the selected response (i.e., achieves the established response objectives) and any applicable or relevant and appropriate environmental standards (ARARs). For example, monitoring[4] may indicate that in addition to Pu-238, metals regulated under RCRA's Land Disposal Restriction (LDR) are present. Should LDR Toxicity Characteristic metal waste be encountered during excavation, a contingency plan for treatment (e.g., immobilization) to achieve regulatory levels required for disposal needs to be in place.

- Cost: Once expected conditions and deviations are identified, the impacts and likelihood of occurrence of a deviation should be evaluated against the costs of implementing a contingency plan. Again, as the probability that a deviation will occur increases, the cost of incorporating the contingency plan into the base design may be less than incurring the additional cost impacts of modifying the design later when the deviation occurs. For example, if Pu-238 concentrations exceed waste acceptance criteria (WAC) for the proposed disposal facility, downtime costs incurred until additional storage and an alternative disposal site are found could well exceed the costs of ensuring these contingent responses are in place before the excavation begins.

Step Four: Develop Associated Monitoring Plan

A monitoring plan should be developed for each deviation in order to determine when the deviation has occurred and when to implement the corresponding contingency plan. Decision rules (see Highlight 1) are an effective tool to specify monitoring requirements (how much and what type of data to collect) to detect specific deviations and link those monitoring requirements to specified contingency plans.

[4] As used here, monitoring refers to any sampling performed during the response action to determine when a deviation has occurred.

Decision rules define the criteria necessary for triggering action and therefore the core team must precisely define these criteria in order to clearly define the boundaries for taking action.

HIGHLIGHT 1: Example Decision Rules

If the concentration of radon in air exceeds *x* pCi/L at any monitoring station along the working fence line during remediation, then a mechanical ventilator will be used until the concentration decreases below *x* pCi/L.

If a alpha/beta/gamma surface scan during scabbling indicates radiological contamination above established criteria exceeds a depth of 2 inches in more than 25% of the area decontaminated, then decontamination will cease and the building will be demolished and disposed as low-level radioactive waste.

Of particular importance in decision rule development is ensuring data quality and quantity are acceptable to the core team for making a decision of whether a deviation has occurred and the necessity of implementing a contingency plan. Similarly, the core team should determine an acceptable level of uncertainty associated with a decision to terminate the response (i.e., the error that is acceptable in analytical methods to verify remediation goals have been met in order to close the site). A table is useful in linking the expected condition to the evaluation of deviations and development of contingency plans (see Highlight 2).

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HIGHLIGHT 2: EXAMPLE UNCERTAINTY ANALYSIS TO DEFINE CONTINGENCY PLAN

EXPECTED CONDITION	REASONABLE DEVIATION	EVALUATION			MONITORING PLAN	CONTINGENCY PLAN
		PROBABILITY OF OCCURRENCE	TIME TO RESPOND	IMPACT		
Pu-238 contamination in the soil does not reach the existing sanitary sewer line under the north canal.	Contamination extends to within 5 feet of sewer lines requiring excavation of soil around sewer pipe, causing structural instability in the pipe.	Low. Existing information does not suggest contaminants have migrated to this depth.	Long. Excavation can move to other areas but deviation must eventually be resolved to prevent schedule delays.	Medium. Excavation cannot continue around the sewer line.	Screen selected samples 5 feet above the sewer line using an on-site lab to determine if 25 pCi/g cleanup goal is met.	•Reroute sewer •Shore pipeline •Excavate in area adjacent to the pipeline until additional logistics are in place
During excavation, fugitive dust will not exceed air quality control standards.	Fugitive dust exceeds air quality control standards.	Medium. Area experiences variable weather conditions (i.e., strong winds) during this time of year. Cobbly, sand-like soil has low moisture content.	Short. Must be resolved quickly to prevent schedule delay.	High. Excavation cannot continue if fugitive dust standards are exceeded.	Tenax tubes will be placed around the perimeter of the excavation site.	•Provide spray tanks and hoses at the excavation site •Spray excavation site
Excavation will not exceed a depth of 20 feet and slopes will remain stable.	Slopes of excavation site become unstable and begin to sluff off.	Medium. Site has been disturbed (previously backfilled to a depth of 10 feet) and therefore may not be stable.	Short. Excavation slope must be modified quickly due to health and safety risks.	High. Will impact cost and schedule, depending on severity of sluffing, due to additional soil requiring removal.	Visual inspection will indicate unstable soil conditions. Geologist will log the soil type and compare it to the expected geological conditions.	• Modify excavation slope • Shore excavation
Pu-238 concentrations in canal do not exceed waste acceptance criteria (WAC) for disposal site.	Pu-238 concentrations in the canal exceeds WAC.	Low. Limited Field Investigation (LFI) information does not suggest contaminants exceed WAC.	Short. Must be resolved quickly to prevent schedule delay.	High. Depending on volume exceeding WAC, project cost and schedule may exceed the project baseline if the necessary disposal is not available.	Use field screening to identify Pu-238 levels above 300 pCi/g. Collect 5 grab samples from a $50ft^2$ area for lab analysis to determine if WAC have been exceeded.	•Segregate and store separately •Provide additional storage • Have alternative disposal site identified and available
Th-232 concentrations do not necessitate personnel protection equipment (PPE) above Level B.	Th-232 concentrations require Level A PPE.	Low. Recent readings with field instrumentation do not suggest Th-232 concentrations will require PPE higher than Level B.	Short. If the response action is to continue, appropriate PPE must be provided.	High. Excavation cannot continue until PPE is upgraded.	Use field instrumentation to determine if Th-232 concentrations exceed Level B PPE requirements.	•Have higher PPE protection levels available at the excavation site
No Land Disposal Restricted (LDR) waste is encountered during excavation.	LDR waste is encountered during excavation.	Medium. Previous sampling did not indicate LDR waste, but based on process history this is a possibility.	Short. Waste must be separated immediately.	Medium. Excavation can continue but appropriate material handling and treatment before disposal is needed.	XRF scan of every 5 x 5 lift section will indicate metals above LDR trigger levels.	•Remove and segregate LDR waste •Ensure adequate storage capacity exists •Ensure treatment capacity exists