Reducing Cost Risk in Remedial Action Budgets Using Supplemental Cost Estimating Analyses

A Deeper Dive

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Overview

- Introduction to Remedial Action Cost Estimates
- Remedy Selection Cost Estimates
  - EPA Cost Estimating Guidance (FS and ROD)
  - Limitations of Remedy Selection Cost Estimates
  - Potential Consequences/Impacts to RA Implementation from Cost Risks
- Enhancement of Remedy Selection Cost Estimates
  - Establishing Selected Remedy Budget
  - Refining Selected Remedy Budget Based on Project-Specific Funding Information

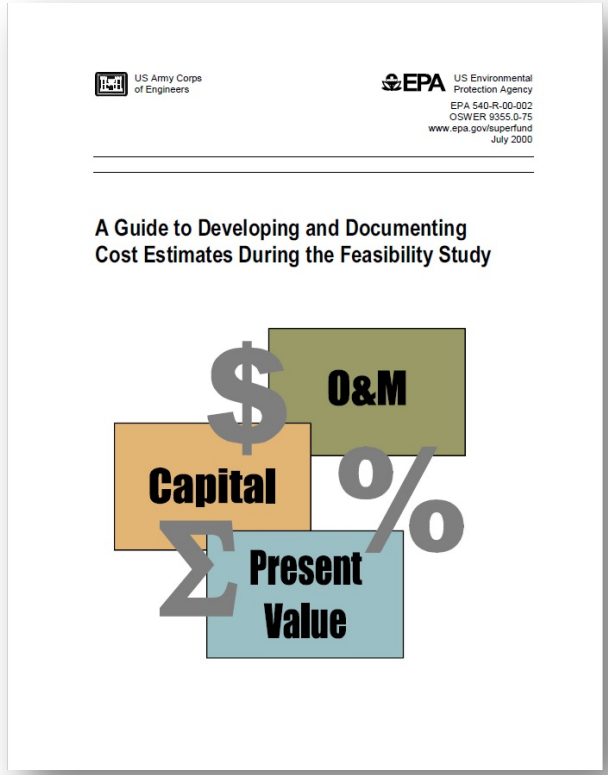
Introduction to Remedy Selection Cost Estimates

Alternative cost estimates initially developed during Feasibility Study (FS)

FS alternative cost estimates adapted for Record of Decision (ROD)

Remedy selection cost estimate from ROD used as starting basis for establishing Remedial Action (RA) budget

In some if not many cases, same estimate is used for all three!



EPA FS Cost Estimating Guidance

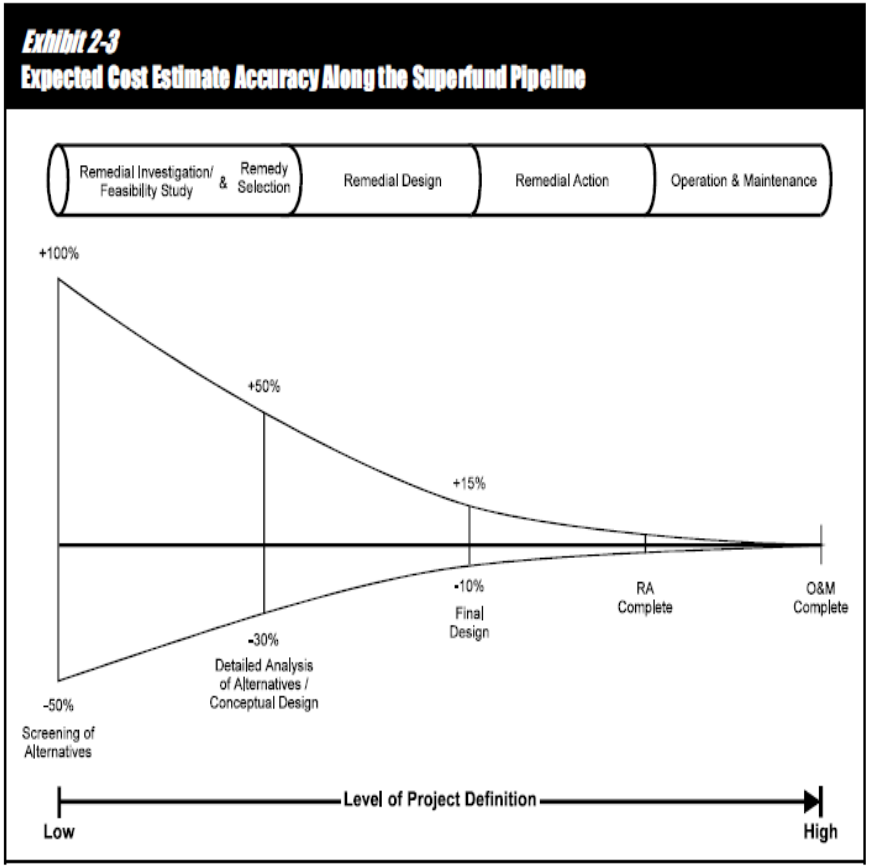
- Focus is evaluation and comparison of alternatives for remedy selection
  - Level of alternative scope definition is low (typically 1% to 15%)
  - Uses simplified methodology/estimating assumptions
- Estimates are order of magnitude (+50%/-30% of actual cost)
  - Typically Class 4 estimates as defined by AACE Recommended Practices and ASTM methods
  - Wide accuracy range inherent primarily due to methodology; does not account for project uncertainties or risks

EPA ROD Guidance

- Minimal differences from FS Cost Estimating Guidance for cost of the selected remedy, focusing on presentation
  - Same level of detail and methodology as FS cost estimates
  - EPA guidance does recommend escalating to a new base year if significant time has passed since FS alternative cost estimate preparation

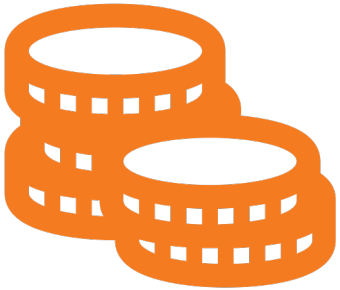
EPA RD/RA Handbook

- Detailed bottom-up cost estimate developed from design documents known as CWE
- Serves as the basis for all future (Intermediate or prefinal/final) stages of estimates and the RA IGCE
- Includes estimated contract cost, contingencies, escalation to midpoint of construction, and other pertinent allowances.



Limitations of Remedy Selection Cost Estimates for RA Budgeting

- **Low Level of Alternative Scope Definition (1% to 15%)**
  - Simplified work activities
    - Primarily for purposes of comparing differing alternatives
  - Simplified quantities
    - Quantity "drivers" related to simplified alternative scope
  - Limited analyses of project uncertainties and risks
    - Primarily sensitivity analyses for key components during alternative evaluation/comparison



- **Simplified Cost Approaches from EPA FS Cost Estimating Guidance**
  - Contingency and professional/technical services costs
    - Typically based on rule-of-thumb percentages
  - Duration of construction/ideal funding
    - Year "0" assumptions for capital costs; no consideration of funding limitations (i.e. partial funding spread out over time, delayed funding before RA start)
  - Present value
    - 7% real discount rate on current dollars for present value analysis, regardless of funding mechanism
  - Escalation/inflation, appreciation/depreciation
    - Not considered, constant dollar analysis for alternative comparison

Key takeaway: Remedy selection cost estimates are preliminary and simplified with respect to RA considerations, and per EPA guidance are not meant to be used for RA budgeting without adjustments.

Stakeholder Perspectives on RA Implementation Budgets

- **Funding Streams**
  - Enforcement settlements directly with potentially responsible parties (PRPs)
  - Third party trusts from prior PRP settlements/court orders
  - Congressional/legislative appropriations

- **Funding Obligations**
  - Federal (Fund-lead): 90% of capital costs, no O&M costs (in most cases)
  - State (Fund-lead): 10% of capital costs, 100% of O&M costs (in most cases)
  - PRPs: up to 100% of capital and O&M costs (dependent on cost allocation determinations)
  - Trusts and other third parties: often no direct obligations, but perspective is to be "good stewards" of funds received

Key takeaway: Cost uncertainty and risk focus/tolerance may differ depending on the stakeholder due to funding streams and funding obligations

Potential Consequences/Impacts to RA Implementation from Unaddressed Cost Uncertainties

Scope Changes

- Enforcement settlements directly with potentially responsible parties (PRPs)
- Third party trusts from prior PRP settlements/court orders
- Congressional/legislative appropriations

Schedule Changes

- Delayed signing of RODs/ State Superfund Contracts/Enforcement Settlements
- Delayed or phased funding from Superfund national risk-based priority panel reviews
- Delays due to disputes in PRP cost allocations

Participation Changes

- Insufficient funding for third parties implementing portions of remedies (county or local governments, non-government organizations or advocacy groups, etc.)

Key takeaway: Simple measures taken during RA budgeting early in the process (often before RD/RA) can help to reduce (though not eliminate) potential for these consequences/impact as compared to direct use of a remedy selection cost estimate in a ROD.

Supplemental Cost Analyses Overview

Supplement analyses can be simple measures to improve projected costs from remedy selection cost estimates in RODs when creating the RA budget and IGCE, especially when done prior to RD

Types of Supplemental Analyses for Establishing RA Budgets

- Future value analyses
- Present value analysis (for interest bearing accounts)
- Sensitivity analyses
- Cost estimate risk analyses

Types of Supplemental Analyses for Refining RA Budgets (Based on Project-Specific Funding Information)

- All of the above, plus
- Cash flow analyses
- Alternate funding scenario analyses

Key takeaway: Each of these supplemental analyses have pertinent guidance and standards. Cost estimating professionals should be engaged for development of these analyses

Supplemental Analyses Tools:
The Deeper Dive

Deeper Dive- Supplemental Cost Analyses Tools

- The previous presentation focused on tools used to enhance selected remedy cost estimates from the ROD for RA budgeting
  - Even when that step has performed, there is value in confirming that the RA budget is still sufficient during initial phases of RD
    - Level of scope definition still low but new information leading to scope changes
    - Scope may not have changed but better definition of quantities for scoped activities
    - Often a new project team is interpreting the scope of activities in the ROD to develop the preliminary RD

- A subset of the previously presented supplemental cost analyses tools can be particularly helpful during early phases of RD to reaffirm or to re-baseline RA budgets when used in conjunction with a Basis of Estimate (BOE) document
  - Cost comparison table – a surficial analysis focusing on changes in scope or quantities between the FS/ROD and preliminary RA cost estimates during RD
  - Cost estimate risk analysis (CERA) – an in-depth analysis with added value in addressing project uncertainties and risks affecting RA budgeting
  - Other supplemental analyses tools are available and can be used to enhance RA budget estimates, but will not be discussed further in this presentation

Key takeaway: RA budgets established at the time of remedy selection should be re-evaluated with supplemental cost analyses tools during initial phases of RD to confirm they are still adequate.

Supplemental Analysis Tool: Cost Comparison Table

Cost Comparison Table

- Numerically compares the scope and associated quantities/unit costs by activity between two estimates
  - Typically between the ROD selected remedy cost estimate and preliminary RA cost estimate
    - Can also be used to compare with RA cost estimates in later phases of RD
- Identifies missing or changed scope, differing quantities, and changed unit costs
- Results depict the overall cost impacts to the project due to those factors
  - Ideal for projects with a lesser development of remedy selection cost estimates and preliminary RA cost estimates that preclude more in-depth cost analyses (i.e. CERA)
  - A BOE document for one or both estimates can greatly aid comparison

Cost Comparison Table - Case Study 1

Bunker Hill Mining and Metallurgical Complex Superfund Site OU3

East Fork Ninemile Creek Waste Consolidation Area

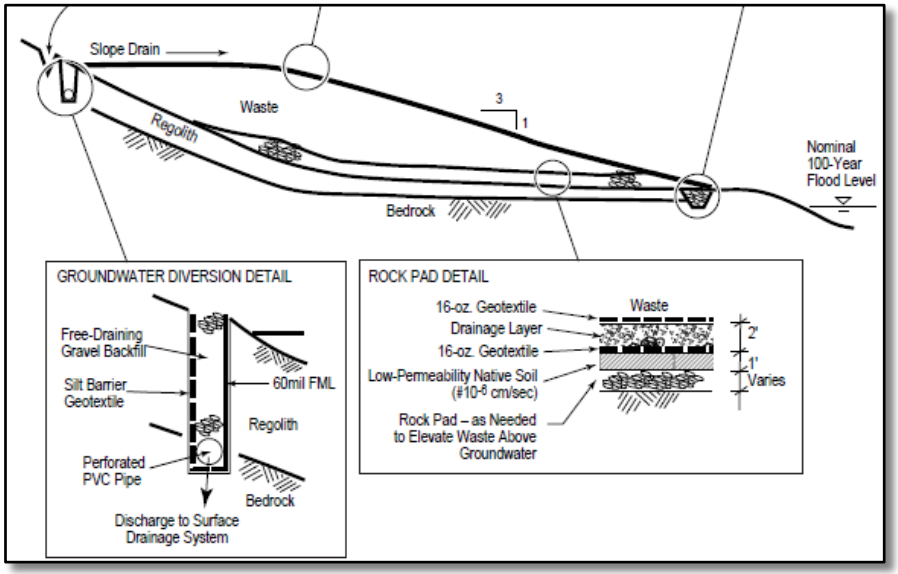
Scope:

- Implementation by a Trust managing a CERCLA enforcement settlement on behalf of the Federal government (Successor Coeur d'Alene Custodial and Work Trust)
- Initial development of repository
  - Excavate and stockpile soil and
  - Quarry rock
  - Construct buttresses
  - Construct drainage layer
  - Improve access roads
- 9 years of mine waste placement
- Placement of final cover

Cost Comparison Table - Case Study 1

FFS/ROD Cost Estimate Approach

- Typical Conceptual Design (TCD) Approach
  - Initial development of repository
  - Approach used due to the size and complexity of the overall site
  - Impractical to develop site-specific conceptual designs
- TCDs do not consider:
  - Location-specific considerations
  - Quantity-related considerations
    - Unit costs developed for one standard size design



EPA, 2010. Focused Feasibility Study Report, Upper Basin of the CdA River, Bunker Hill Mining and Metallurgical Complex Superfund Site

Cost Comparison Table - Case Study 1

ROD vs. RD Cost Comparison

- ROD Concept
  - "Waste Consolidation Area Above Flood Level, TCD C07"
    - Unit Cost = $14.70/CY
    - Based on a 1 acre consolidation area with capacity of approximately 40,000 CY
- RD Concept
  - East Fork Ninemile Waste Consolidation Area (EFNM WCA)
    - Unit Cost = $17.04/CY
    - Estimated Area: 23 Acres
    - Estimated Capacity: 1,000,000 CY

Key takeaway: Very different extents and capacities between ROD and RD. Comparison between unit costs from ROD and RD is "apples and oranges"

Cost Comparison Table - Case Study 1

ROD vs. RD Cost Comparison

FFS/ROD Cost Estimate – TCD Unit Cost Derivation

C07	**Waste Consolidation Area Above Flood Level**	**40,333**	**CY**	**$14.68**
	Haul to On-site Containment	40,333	CY	$1.56
	Site Preparation	1	AC	$3,324.79
	Grade at Repository	40,333	CY	$2.07
	Grade Surface Drainage Ditch	400	CY	$4.15
	Groundwater Collection & Diversion Trench	**3,000**	**SF**	**$10.92**
	Soil Excavation	289	CY	$8.40
	Rock Excavation	67	CY	$41.99
	Shoring (trench box)	300	LF	$2.72
	Waste	356	CY	$6.86
	Dewatering	300	LF	$6.79
	4" CPE Pipe	300	LF	$4.15
	Drain Rock	356	CY	$44.67
	Geotextile	400	SY	$2.68
	60mil FML	400	SY	$10.08
	Rock Pad	**0.8**	**AC**	
	Geotextile	7,744	SY	$2.68
	Low Permeability Native Soil Placement	1,291	CY	$11.59
	Drainage Layer Placement	2,581	CY	$11.59
	Haul Above Material	3,872	CY	$13.73
	Develop & Close Pit for Material Above	3,872	CY	$3.43
	Toe Drain for Rock Pad	**300**	**LF**	
	Excavation	266.67	CY	$4.20
	Haul Above Material	266.67	CY	$6.86
	4" CPE Pipe	300	LF	$4.15
	Drain Rock	266.67	CY	$44.67
	60mil FML	333.33	SY	$10.08
	Cap	**1.2**	**AC**	**$160,721.13**
	GCL Liner	5,808	SY	$5.97
	Vegetative Cover	2,904	CY	$19.55
	Hydroseed	5,808	SY	$0.41
	Low Permeability Native Soil Placement	968	CY	$11.59
	Drainage Layer Placement	1,936	CY	$11.59
	Haul Above Material	2,904	CY	$13.73
	Develop & Close Pit for Material Above	2,904	CY	$3.43
	16oz Geotextile	5,808	SY	$2.68
	Miscellaneous	1	LS	$63,426.69

EPA, 2010. Focused Feasibility Study Report, Upper Basin of the CdA River, Bunker Hill Mining and Metallurgical Complex Superfund Site

Cost elements not included in FS/ ROD cost estimate

60% RD Planning Cost Estimate

Cost Category Description	Constant Dollar Costs
Place Mine Waste	$7,589,500
Mobilization/Demobilization and General Conditions	$1,068,800
Clear and Grub	$103,500
Excavate and Stockpile Soil	$1,810,400
Excavate Quarry Rock	$3,268,800
Construct Buttresses	$523,700
Construct Base Drainage Layer	$619,900
Install Drainage Swales	$92,600
Other Erosion Control Measures	$348,900
Improve Access Roads	$164,500
Install Final Cap	$1,667,800
Project Cost (without Contingency)	$17,258,400
Scope/Bid Contingency (20%)	$3,451,500
Project Cost (PC)	$20,709,900

Cost Comparison Table - Case Study 1

ROD vs. RD Cost Comparison

- Conducted using the 60% Remedial Design Planning Cost Estimate

Comparison of EPA OU3 Interim ROD Amendment and 60% Design Planning Cost Estimate					
Estimate	Quantity	Direct Cost		Indirect/Contingency Cost	Total Construction Cost
		Unit Cost	Total Direct		
	BCY	$/BCY	$	$	$
EPA OU3 Interim ROD Amendment	942,000	14.70	$13,800,000	$9,700,000	$23,500,000
EFNM WCA 60% Design Planning Cost Estimate	1,013,270	17.04	$17,258,400	$3,451,500	$20,709,900
Cost Difference	-	-	***$3,458,400***	-	***-$2,790,100***

Note: The ROD cost estimate assumed that indirect/contingency costs were 70% of direct capital costs

Key takeaway: While the simplified TCD cost approach of the ROD cost estimate resulted in low direct capital costs, a higher indirect/contingency percentage was applied that allowed for avoiding a gross underestimate of cost for RA budgeting at the time of ROD.

Cost Comparison Table - Case Study 2

Captain Jack Superfund Site OU1, Surface Contamination Remedial Design

Scope:

- Implementation by the State of Colorado (CDPHE) as the lead agency and EPA as the supporting agency for the Site. (State-Led Remedial Action)
- Selected remedy for surface contamination
  - Onsite repository for contaminated soils
  - Excavation and placement of waste into the three constructed repository
  - Amending waste material by mixing lime
  - Diversion of surface water runoff
  - Implementation of access controls
- The ROD also states that “the Big-Five waste rock dump will be capped in place”.
  - No further information or cost included in the ROD for this action – important for this comparison

Cost Comparison Table - Case Study 2

ROD vs. RA Cost Comparison (30% RD Cost Estimate)

Repository

13	Surveying	1	LS	$6,500.00	$6,500.00
14	Grade Subgrade	9,500	SY	$0.67	$6,300.00
15	Compact Subgrade	6,320	CY	$1.91	$12,100.00
16	Lime Amendment	317	CY	$50.00	$15,800.00
17	Geosynthetic Clay Liner	85,536	SF	$1.04	$88,900.00
18	Gravel (Crushed Rock Apron)	283	CY	$15.44	$4,400.00
19	Final Cover System - Rooting/Seed Bed Layer	3,167	CY	$0.76	$2,400.00
20	Final Cover System - Topsoil	1,584	CY	$35.33	$56,000.00
21	Final Seeding	1.96	ACR	$1,136.44	$2,200.00
22	Providing Erosion Control Blankets	9,500	SY	$2.84	$27,000.00
23	Installing Lysimeter (2)	2	EA	$2,272.87	$4,500.00
				Total Cost:	**$226,100.00**

Included Consolidation Configuration Option 1 and Cover Option 1

0006.04	CBC Adit Portal Extension	113	LF	$640.41	$72,366.00
0007.01	Consolidate Excavated Waste Rock	37,746	LCY	$1.91	$72,217.00
0007.02	Amending Waste Rock/Fill	199,350	SF	$0.13	$26,457.00
0008.01	Geosynthetic Clay Liner Installation	99,675	SF	$1.14	$113,186.00
0008.02	Placement of Drainage Layer	4,431	LCY	$28.69	$127,120.00
0008.03	Placement Thermal Barrier	9,846	LCY	$1.61	$15,838.00
0008.04	Placement of Topsoil/Growth Media	4,923	LCY	$15.66	$77,106.00
0008.05	Amending Topsoil/Growth Media	99,675	SF	$0.47	$46,630.00
0008.06	Dust Control	14,769	LCY	$0.26	$3,778.00
0008.07	Survey - Post-Cover Placement	2.3	ACR	$803.04	$1,847.00
				Total Cost:	**$556,545.00**

Site Capping and Reclamation

28	Providing Decon Area and Subsequent Removal	1	LS	$27,000.00	$27,000.00
29	Final Grading Excavated Areas	36,111	SY	$0.67	$24,100.00
30	Revegetation	15	ACR	$1,704.65	$25,600.00
				Total Cost:	**$76,700.00**

0003.05	Restore Big Five Waste Rock Pile	1	LS	$12,407.00	$12,407.00
0004.03	Restore Big Five to Captain Jack Mill Area	1	LS	$3,203.00	$3,203.00
0005.05	Restore White Raven Area	1	LS	$64,333.00	$64,333.00
0006.07	Restore Captain Jack Mill Area	1	LS	$132,893.00	$132,893.00
				Total Cost:	**$212,836.00**

Cost Comparison Table - Case Study 2

- ROD did not identify a specific cover system for the Big Five mine dump:
  - Three different cover designs were developed and compared
    - Low permeability cover system as prescribed by the ROD for other locations within the Site
    - A simple soil cover system
    - A hardened rock cover system
  - Simple soil cover system was selected based on effectiveness, implementability, relative cost, and durability
- During RD, selected cover system to be incorporated over the excavated and regraded Big Five mine dump required additional assessment for stability:
  - Option 1: Regrade with Geogrid-Reinforced Cover
  - Option 2: Regrade to Stable Slope
  - Option 3: Regrade with Retaining Wall
  - Option 4: Regrade with Higher Retaining Wall to Maximize Top Area

Cost Comparison Table - Case Study 2

ROD vs. RA Cost Comparison (30% RD Cost Estimate)

- Comparison of probable construction costs between each option was done
  - This cost was not accounted for in the ROD
  - Option 2 (Regrade to Stable Slope) was selected based on technical considerations

Option 1	Option 2	Option 3	Option 4
$147,900	$126,100	NA	NA
$24,600	$38,200	$81,100	$173,000
NA	$28,200	NA	NA
NA	NA	$200,000	$1,212,800
$15,600	$16,300	$17,100	$17,100
$94,000	NA	NA	NA
$58,300	$61,000	$57,600	$57,700
$67,200	$70,200	$73,600	$73,700
$408,000	~~**$340,000**~~	**$429,000**	**$1,534,000**

Cost Comparison Table - Case Study 2

ROD vs. RA Cost Comparison (30% RD Cost Estimate)

Site Capping and Reclamation

28	Providing Decon Area and Subsequent Removal	1	LS	$27,000.00	$27,000.00	0003.05	Restore Big Five Waste Rock Pile	1	LS	$12,407.00	$12,407.00
29	Final Grading Excavated Areas	36,111	SY	$0.67	$24,100.00	0004.03	Restore Big Five to Captain Jack Mill Area	1	LS	$3,203.00	$3,203.00
30	Revegetation	15	ACR	$1,704.65	$25,600.00	0005.05	Restore White Raven Area	1	LS	$64,333.00	$64,333.00
						0006.07	Restore Captain Jack Mill Area	1	LS	$132,893.00	$132,893.00
				Total Cost:	**$76,700.00**					**Total Cost:**	**$212,836.00**

ROD vs. RA Cost Comparison (100% RD Cost Estimate)

Site Capping and Reclamation

28	Providing Decon Area and Subsequent Removal	1	LS	$27,000.00	$27,000.00	0002.03	Decontamination Pad	1	LS	$6,941.00	$6,941.00
29	Final Grading Excavated Areas	36,111	SY	$0.67	$24,100.00	0010.00	All Work to Amend Top One Foot of Mine Waste Materials with Lime	4	ACR	$10,939.25	$43,757.00
30	Revegetation	15	ACR	$1,704.65	$25,600.00	0011.04	Restore Big Five Waste Rock Pile Area	1	LS	$122,812.00	$122,812.00
						0011.05	Restore White Raven Area	1	LS	$22,641.00	$22,641.00
						0011.06	Restore Captain Jack Mill Area	1	LS	$161,669.00	$161,669.00
						0020.04	Post Survey of Restoration at CJ Mill Area	2.6	ACR	$918.85	$2,389.00
						0020.05	Post Survey of Restoration at White Raven Area	1.1	ACR	$919.09	$1,011.00
						0020.06	Post Survey of Restoration at Big Five Area	2.4	ACR	$918.75	$2,205.00
						0011.07	Install Access Prevention Signs	1	LS	$2,942.00	$2,942.00
						0011.09	Preliminary and Final Inspections of Vegetation Estabilishment	16.0	HR	$201.88	$3,230.00
						0012.00	All Work to Haul and Place Offsite Riprap	750	CY	$108.31	$81,235.00
						0017.00	All Work for Watering Revegetation	500	KGAL	$24.68	$12,338.00
						0018.00	All Work for Tree Sapling Planting at Ertl Property	70	EA	$216.64	$15,165.00
				Total Cost:	**$76,700.00**					**Total Cost:**	**$478,335.00**

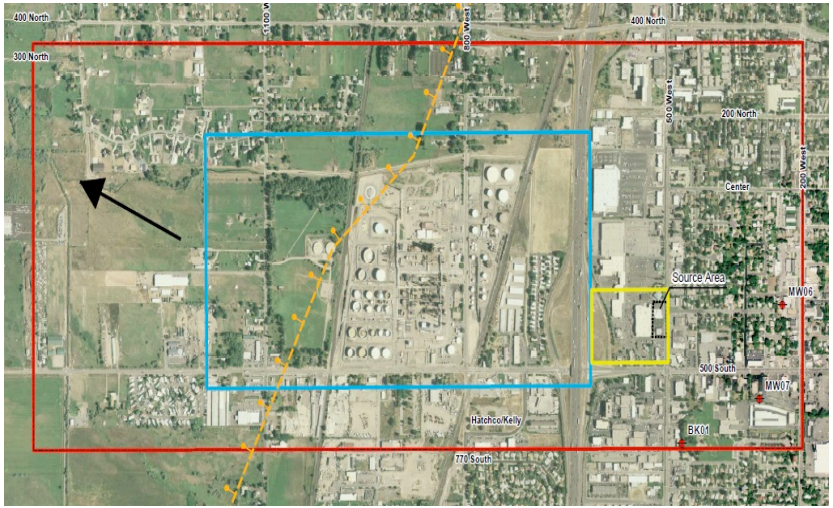
Key takeaway: Cost elements reflecting the scope were not accounted for in the ROD estimate and if the ROD estimate were to be used for RA budgeting it would have resulted in a gross underestimation of cost for RA budgeting at the time of ROD.

Cost Comparison Table - Case Study 3

Bountiful/Woods Cross 5th South PCE Plume NPL Site, OU2

Scope:

- Scope of RA per the ROD includes:
  - Contaminant source area treatment
  - Downgradient plume hydraulic containment
- Technologies to be used in the RA included:
  - ICs to restrict use of the aquifer as a drinking water source
  - Alternative drinking water supply to impacted residents
  - Enhanced anaerobic bioremediation
  - SVE to address residual COC mass
  - Excavation of source area soils
  - Groundwater extraction and reinjection wells
  - Monitoring groundwater and Five-year reviews



Cost Comparison Table - Case Study 3

FS Addendum Cost (2006) vs. RA Cost Estimate Comparison (2009)

RA Work Plan Tasks	FS Addendum Cost	2009 RA Costs	Cost Difference
RAC 8 Contractor Administration Costs	$0	$441,530	$441,530
Contractor Work Plans	$49,168	$698,757	$649,589
Mobilization/Demobilization (Base Work)	$20,677	$14,453	($6,224)
Installation of Extraction Wells & Pump Tests (Base Work)	$173,577	$150,007	($23,570)
Treatment System Site Work, Building, and Yard Piping	$601,368	$1,977,711	$1,376,343
Contractor Excavation/Piping (Optional Work)	$0	$917,781	$917,781
Installation of Extraction Wells & Pump Tests (Optional Work)	$0	$186,717	$186,717
Pre-design data collection	$272,500	$0	($272,500)
Alternate Water Supply	$121,678	$0	($121,678)
Monitoring Well Installation	$243,680	$0	($243,680)
Soil Vapor Probe Installation	$7,785	$0	($7,785)
Piezometer Installation	$28,432	$0	($28,432)
Treatability Testing	$163,500	$0	($163,500)
Reinjection Well Installation	$270,081	$0	($270,081)
Design Modeling	$32,700	$0	($32,700)
GWTF System Startup Testing	$0	$84,864	$84,864
O&F Period Reporting	$0	$172,355	$172,355
Year One O&M	$193,635	$176,952	($16,683)
Total Cost:	**$2,178,781**	**$4,821,127**	**$2,642,346**

Cost Comparison Table - Case Study 3

FS Addendum Cost (2006) vs. RA Cost Estimate Comparison (2009)

RA Work Plan Tasks	2009 RA Costs	FS Addendum Cost	Cost Difference
Treatment System Site Work, Building, and Yard Piping	$1,977,711	$601,368	$1,376,343

Key Cost Differences:

- Larger treatment system building and costs for startup testing
- Sanitary sewer and potable water connections, earthwork and yard piping from the treatment building to each extraction well
- Erosion and dust control, surveying, detailed site preparation and site restoration efforts

Cost Comparison Table - Case Study 3

FS Addendum Cost (2006) vs. RA Cost Estimate Comparison (2009)

RA Work Plan Tasks	2009 RA Costs	FS Addendum Cost	Cost Difference
Contractor Excavation/Piping (Optional Work)	$917,781	$0	$917,781
Installation of Extraction Wells & Pump Tests (Optional Work)	$186,717	$0	$186,717

Key Cost Differences:

- FS Addendum Estimate did not assume any optional work for additional length of earthwork and yard piping.
- The additional distance determined during RD was approximately 4,900 LF of earthwork and yard piping. FS Addendum Estimate did not include these costs.

Key takeaway: Given uncertainties regarding groundwater treatment, additional contingencies should be accounted for in the ROD estimate if used for RA budgeting.

Cost Comparison Table - Case Study 4

Gilt Edge Mine Superfund Site OU1, Primary Mine Disturbance Area

Scope:

- Implementation by U.S. EPA Region 8 (EPA) as the lead agency and State of South Dakota Department of Environment and Natural Resources (SD DENR) as the supporting agency for the Site (Fund-Lead Remedial Action).
- Selected remedy for primary mine disturbance area include:
  - Excavation of mine wastes and water treatment plant (WTP) sludge placed in open pits and ponds and within stream corridors during surface mining
  - Onsite consolidation of mine wastes within open pits and capping of pit backfills
  - Onsite consolidation of ARD and WTP sludge within a location isolated from groundwater (initially a selected open pit with favorable geology; modified to a lined impoundment)
- The RA for OU1 has been partially implemented
  - U.S. Army Corps of Engineers Omaha District administered implementation of the first phase of RA using funding from enforcement settlements

Cost Comparison Table - Case Study 4

ROD Selected Remedy Cost vs. Modified Remedy Cost from OU1 ESD

Table 6. Cost Comparison between the OU1 ROD Remedy and Modified Remedy Components.

Remedy Component	OU1 ROD Remedy 2008		OU1 ROD Remedy 2011 Revised Costs		Modified Remedy	
	Capital Cost	Annual O&M Cost	Capital Cost	Annual O&M Cost	Capital Cost	Annual O&M Cost
WTP Modifications	$553,000	NA	$678,000	NA	NA	NA
Earthwork and Capping	$57,434,000	NA	$63,475,000	NA	$60,021,000	NA
Anchor Hill Pit- Backfilling and Cover System Construction	NA	NA	NA	NA	$5,858,000	NA
Alternate ARD Storage (Impoundment at HLP)	NA	NA	NA	NA	$2,524,000	NA
Union Hill/Coverage of Dakota Maid and Sunday highwalls	NA	NA	NA	NA	$13,079,000	NA
Parent Ground Amendment	NA	NA	NA	NA	$235,000	NA
Rinsate Water Collection Basins (versatility for rinsate capture or localized treatment)	NA	NA	NA	NA	$6,129,000	
O&M for OU1	NA	$43,000		$80,000	NA	$50,000
WTP O&M -OU2	NA	Not Calculated in ROD	NA	$236,000	NA	$174,000
Site Management O&M -OU2	NA	Not Calculated in ROD	NA	$304,000	NA	$218,000
Onsite Labor/Staff Support -OU2	NA	Not Calculated in ROD	NA	$970,000	NA	$592,000
Maintenance Supplies -OU2	NA	Not Calculated in ROD	NA	$71,000	NA	$54,000
Total Costs	**$57,987,000**	**$43,000**	**$64,153,000**	**$1,661,000**	**$87,846,000**	**$1,088,000**

Key takeaway: Although the cost comparison table is for the purposes of an ESD, this was prepared during the preliminary phases of RD and was considered in part during RA budgeting using enforcement settlement funds.

Supplemental Analysis Tool: Cost Estimate Risk Analysis (CERA)

Cost Estimate Risk Analyses

- Numerically analyzes the effects of project risks on project cost (and project schedule, if desired)
  - Uses quantitative Monte Carlo analysis to reflect the effects of project risks and cost estimate uncertainties
- Results depict the overall cost impacts of project risk at various levels of statistical confidence for the base estimate
  - The ROD remedy selection cost estimate originally used for RA budgeting is analyzed, but can also use the RA estimates from RD if available
- Ideal for projects with sufficient development of remedy selection cost estimates or RA cost estimates that individual project risks can be evaluated numerically
  - A Basis of Estimate document greatly aids in understanding the uncertainties and assumptions made for costs in the base estimate

Cost Estimate Risk Analyses - Case Study 4

Gilt Edge Mine Superfund Site OU1, Primary Mine Disturbance Area

Scope:

- Implementation by U.S. EPA Region 8 (EPA) as the lead agency and State of South Dakota Department of Environment and Natural Resources (SD DENR) as the supporting agency for the Site (Fund-Lead Remedial Action).
- Selected remedy for primary mine disturbance area include:
  - Excavation of mine wastes and water treatment plant (WTP) sludge placed in open pits and ponds and within stream corridors during surface mining
  - Onsite consolidation of mine wastes within open pits and capping of pit backfills
  - Onsite consolidation of ARD and WTP sludge within a location isolated from groundwater (initially a selected open pit with favorable geology; modified to a lined impoundment)
- The RA for OU1 has been partially implemented
  - U.S. Army Corps of Engineers Omaha District administered implementation of the first phase of RA using funding from enforcement settlements
- Risk Strategics, LLC assisted the project team to develop the cost estimate risk analysis during the initial phases of RD

Cost Estimate Risk Analyses - Case Study 4

TABLE ES-2. RELATIVE CONTRIBUTION TO OVERALL PROJECT RISK

Risk Number/Name[1]	Individual Project Risk Level	Contribution to Overall Project Risk[2,3]
26 - Unknown Procurement Strategy	High	22.6%
7 - Excavation Volumes	High	17.1%
17 - Budget Constraints	High	15.3%
27 - SIOH Assumption	High	12.7%
29 - Excavation Equipment Size and Productivity	High	5.6%
25 - Level of Design Development	High	5.4%
15 - Diesel Costs	High	4.6%
10 - Differing Stakeholder Risk Tolerance	High	3.9%
32 - Stormwater Diversion Standards	Moderate	3.3%
36 - Borrow Areas	Moderate	3.3%
13 - Geomembrane/Geocomposite Costs	Moderate	2.5%

TABLE ES-1. INDIVIDUAL PROJECT RISK PRIORITY SUMMARY

Description and Recommended Level of Risk Management Attention	Project Risk Management Priority	Number of Project Risks Identified
High level risks are the highest priority for the project and may significantly affect the project schedule, cost, and/or other objectives. These risks should be proactively managed by developing and implementing risk response plans.	HIGH	15
Moderate level risks are not completely under control and may require risk response plans and increased project management attention in the future. These risks should be placed on a watch-list and reviewed at least monthly by the project team to determine if conditions or knowledge have changed risk priority.	MODERATE	13
Low level risks can be kept under control without a specific risk response plan or increased project management attention. These risks should be placed on a watch-list and reviewed at least monthly by the project team to determine if conditions or knowledge have changed risk priority.	LOW	9
Total Number of Risks Identified:		37

Key takeaway: Cost estimate risk analysis includes identifying those activities or items that have significant potential project risks that could lead to cost uncertainty. In this case the highest project risk contributing to cost growth were not directly costed in the RA cost estimate (i.e. unknown procurement strategies and budget constraints)

Cost Estimate Risk Analyses – Case Study 4

TABLE ES-3. OVERALL COST ESTIMATE RISK ANALYSIS SUMMARY

Statistical Confidence Level	Cost Forecast Including Contingency[1]	Contingency Required for Confidence Level ($)[2]	Contingency Required for Confidence Level (%)
0%	$44,683,000	($11,286,000)	-20.2%
5%	$57,043,000	$1,074,000	1.9%
10%	$58,979,000	$3,010,000	5.4%
15%	$60,384,000	$4,415,000	7.9%
20%	$61,532,000	$5,563,000	9.9%
25%	$62,559,000	$6,590,000	11.8%
30%	$63,513,000	$7,544,000	13.5%
35%	$64,417,000	$8,448,000	15.1%
40%	$65,309,000	$9,340,000	16.7%
45%	$66,183,000	$10,214,000	18.2%
50%	$67,065,000	$11,096,000	19.8%
55%	$67,977,000	$12,008,000	21.5%
60%	$68,927,000	$12,958,000	23.2%
65%	$69,931,000	$13,962,000	24.9%
70%	$70,994,000	$15,025,000	26.8%
75%	$72,141,000	$16,172,000	28.9%
80%	$73,433,000	$17,464,000	31.2%
85%	$74,936,000	$18,967,000	33.9%
90%	$76,765,000	$20,796,000	37.2%
95%	$79,312,000	$23,343,000	41.7%
100%	$96,998,000	$41,029,000	73.3%

Notes:

1. The Intermediate Remedial Action Cost Estimate For Earthwork is $55,968,770 excluding contingency.

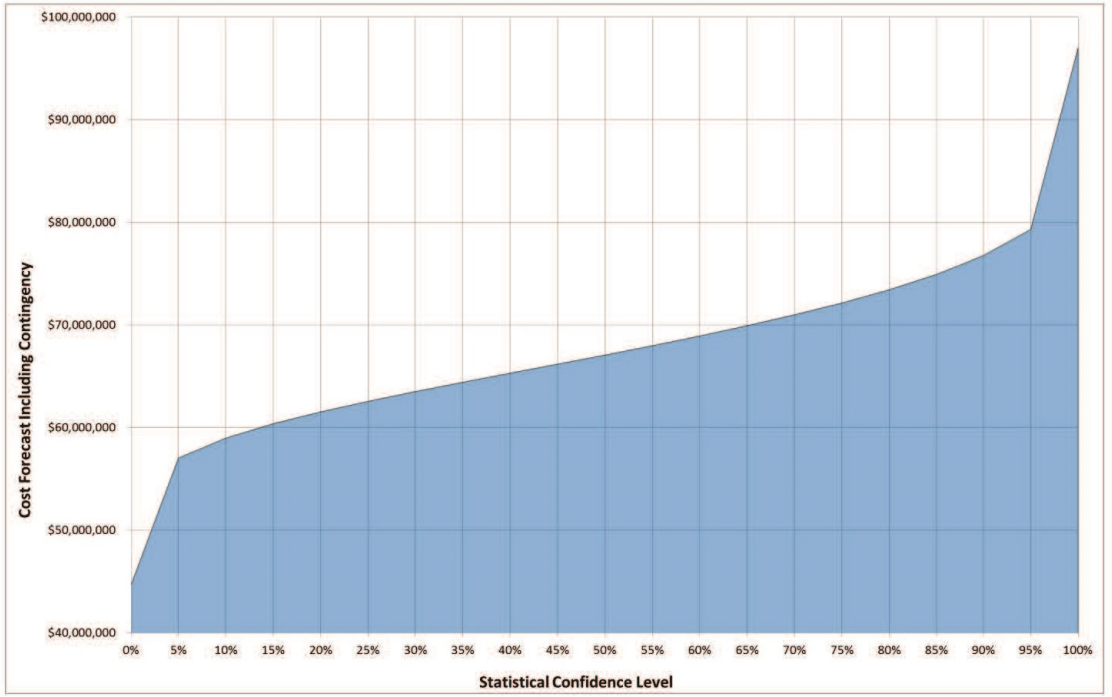


Figure ES-1. Overall Cost Estimate Risk Analysis Summary

Key takeaway: Since the highest project risk contributing to cost growth were not directly costed in the RA cost estimate, if that cost would have been used for RA budgeting there is a likelihood that the budget would have exceeded. This CERA allows the lead agency to select an adequate amount of contingency given the uncertainty for RA budgeting.

Cost Estimate Risk Analyses - Case Study 5

Libby Asbestos Superfund Site- OU4 through OU8

Scope:

- Scope of remedial action is removal of contaminated soil and building materials to meet cleanup criteria and onsite disposal of those materials
- Implementation of RA by the Federal government using an enforcement settlement
- O&M responsibilities ultimately borne by State of Montana as well as local (county and city) governments
- Risk Strategics, LLC assisted the project team to develop the cost estimate risk analysis during the remedy selection process

Cost Estimate Risk Analyses - Case Study 5

Table 4. Distribution Risks by RBS Category

Risk Category	Number of Risks	Percent of Total
Construction	16	37.2%
External	6	14.0%
Institutional Controls Processes	6	14.0%
Design	3	7.0%
Procurement	3	7.0%
Project Management & Organizational	3	7.0%
Information Technology	3	7.0%
Administrative Processes	2	4.7%
Change in Requirements	1	2.3%
TOTAL	43	100.0%

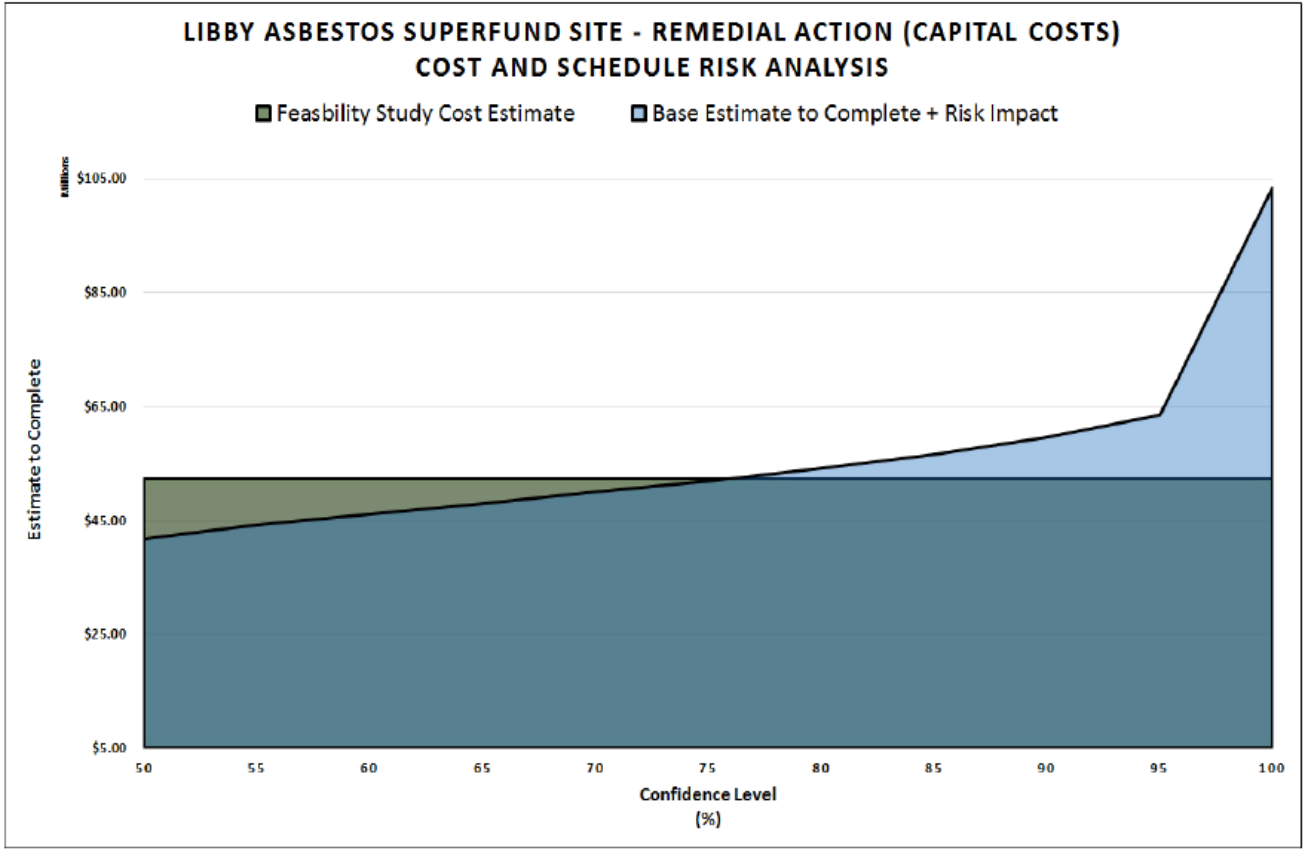
Table 5. Risk Severity Level Summary

Risk Severity Level	Potential Impact to Cost	
	Number of Risks	Percent
High	10	23.3%
Moderate	8	18.6%
Low	25	58.1%
TOTAL	43	100%

Key takeaway: In this case the second and third highest project risks contributing to cost growth were not directly related to the construction activities in the RA cost estimate (i.e. external and ICs processes).

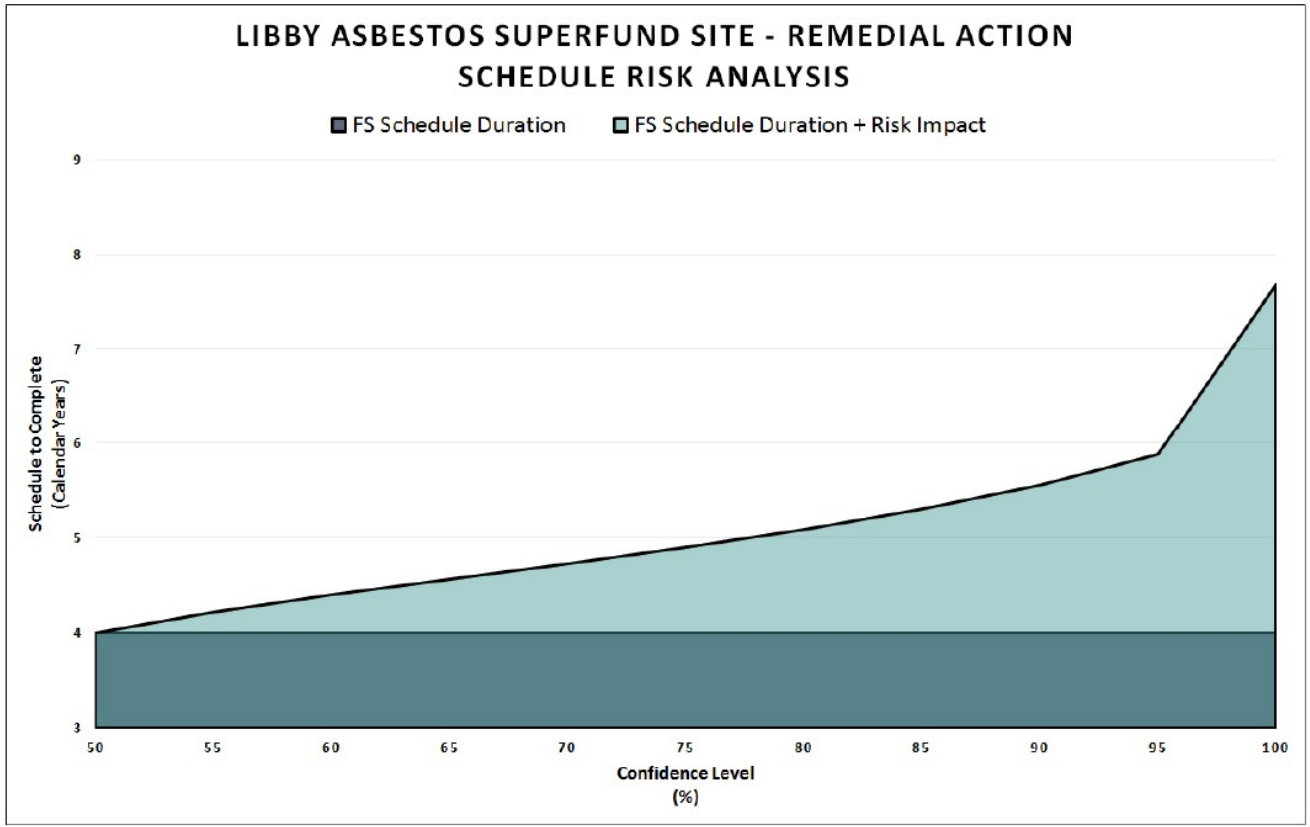
Cost Estimate Risk Analyses – Case Study 5

Confidence Level (%)	Base Estimate to Complete[1] + Risk Impact	Risk Impact ($)	Risk Impact (%)
50	$41,807,061	($1,761,939)	-4.0%
55	$44,147,070	$578,070	1.3%
60	$46,166,399	$2,597,399	6.0%
65	$48,026,545	$4,457,545	10.2%
70	$49,957,067	$6,388,067	14.7%
75	$51,945,746	$8,376,746	19.2%
80	$54,068,368	$10,499,368	24.1%
85	$56,582,188	$13,013,188	29.9%
90	$59,530,122	$15,961,122	36.6%
95	$63,587,304	$20,018,304	45.9%
100	$103,505,194	$59,936,194	137.6%



Cost Estimate Risk Analyses – Case Study 5

Confidence Level (%)	Risk Impact at Confidence Level (Calendar Years)	Risk Impact at Confidence Level (%)
50	0.0	-0.1%
55	0.2	5.3%
60	0.4	10.0%
65	0.6	14.2%
70	0.7	18.4%
75	0.9	22.7%
80	1.1	27.2%
85	1.3	32.6%
90	1.6	38.8%
95	1.9	47.1%
100	3.7	92.1%



Cost Estimate Risk Analyses - Conclusions

- **Key Takeaways**
  - A cost estimate risk analysis allows agencies **based on their risk tolerances** to select a project cost at a specific confidence level for RA budgeting purposes, given project risks.
  - Cost engineering guidance for CERAs generally recommends budgeting based on the 80% level of statistical confidence.
  - Because these CERAs were conducted early in the RD process after remedy selection, it allowed the agency to consider an adequate amount of additional budgeting given project uncertainty and risk.

Supplemental Cost Tool: Basis of Estimate (BOE) Document

Basis of Estimate (BOE) Document

AACE® International Recommended Practice No. 34R-05 defines the BOE as:

"the one deliverable that defines the scope of the project, and ultimately becomes the basis for change management"

Typical content of a BOE document:

- Purpose
- Project Scope Description
- Methodology
- Estimate Classification
- Design Basis
- Planning Basis
- Cost Basis
- Allowances
- Assumptions
- Exclusions
- Exceptions
- Risks and Opportunities
- Containments
- Contingencies
- Management Reserve
- Reconciliation
- Benchmarking
- Estimate Quality Assurance
- Estimating Team
- Attachment

Key takeaway: Many cost estimates are prepared without a BOE document; this can lead to subjective interpretation of the estimate based on perspective rather than agreed-to assumptions or facts

Basis of Estimate (BOE) Document

When the BOE document is prepared correctly:

- Any person can understand and assess the estimate, independent of any other supporting documentation
- States the purposes of the estimate clearly and concisely
- States the project scope, pricing basis, allowances, assumptions, exclusions, cost risks and opportunities, and any deviations from standard practices
- Documented record of pertinent communications that have occurred and agreements that have been made between the estimator and other project stakeholders

Basis of Estimate (BOE)

Basis Of Estimate (BOE) Development Key Points *

- Be complete but be concise
- Be able to support your facts and findings
- Identify estimating team members
- Provide a record
- Describe the techniques and data used to develop the cost estimate
- Identify other projects that were referenced
- Make every effort to develop the BOE while the estimate is being prepared
- BOE is the only document used to judge the quality of the estimate
- Perform Quality Assurance and Quality Control Reviews

Key takeaway: The BOE document is the document that is used to judge the adequacy and quality of the estimate; without it adequacy and quality of the estimate is subjective

* AACE® International RP No. 34R-05 and DOE Cost Estimate Development Handbook (EM-CE&A G 002)

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- Bunker Hill Mining and Metallurgical Complex Superfund Site - OU3
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- Bountiful/Woods Cross Superfund Site - OU2
- Gilt Edge Mine Superfund Site - OU1
- Libby Asbestos Superfund Site - OUs 4 through 8

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Reducing Cost Risk in Remedial Action Budgets Using Supplemental Cost Estimating Analyses: A Deeper Dive

QUESTIONS?

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