Remediation and Liability Cost Estimating

Ken Lyon
Advisian, WorleyParsons Group
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Consultant: We found contamination.
Site Owner/Operator: What will it cost to clean up?
Consultant: How long is a piece of string?
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Uncertainty In & Causes of Cost Estimate Over-Runs
Uncertainty In & Causes of Cost Over-Runs

- Phase 1 ESA not done or incomplete, APECs and/or COPCs missed
- Contamination poorly delineated, poor soil volume estimates
  - Insufficient boreholes and/or test pits
  - Poor sampling methodology
  - Vertical delineation not achieved
- Conceptual Site Model more complicated than realized
  - Data not fully or properly analysed
  - Fractured till or bedrock, LNAPL transport through fractures
  - Perched water tables, fluctuating water tables
  - Sporadic contaminant distribution ("jelly bean" maps)
Uncertainty & Causes cont’d

- Tier 2 approaches misunderstood
- Basis of estimate not well defined
- Insufficient remedial engineering system design and pilot testing, particularly with innovative technology & complicated CSMs
- Conceptual engineering design taken as detailed
- Proponent expectations & communication e.g. not allowing for uncertainty in estimates, consultant scope creep
- Weather conditions (particularly northern sites)
Uncertainty & Causes cont’d

Other

• Key staff changes, property owner/operator changes
• Compressed schedules
• Changes in remediation criteria
• Unexpected remedial process optimization required
• Inadequate confirmatory sampling
Cost Over-Runs: Soil Volume Estimates

- What do horizontal and vertical distribution of contamination look like?
- Were there limitations to the sampling method? Logging?
- Where are the APECs, how was contaminant released?
- Are there cross-sections? What controlled fate and transport? Is this consistent with apparent distribution?
- If there are inferred “jelly beans”, are they real?
- Was full delineation achieved? Is correlation with other parameters consistent? For LNAPL sites, did holes go to water or permafrost?
- Do excavation estimates account for side slopes and precision of equipment?
Uses of Cost Estimates
Uses of Remediation and Liability Cost Estimates

- **Regulatory Compliance**
  - Regulatory directives, regulated facilities, remediation and reclamation certificates
  - Alberta AER requirements for liability assessments

- **Financial Liability Reporting Requirements**
  - Publicly-traded private companies (Canadian Securities Administrators)
  - Government organizations (Public Sector Accounting Board)

- **Asset Management**
  - Baseline studies, site management, liability reduction/closure
  - Infrastructure management/protection
Uses cont’d

- **Asset Purchase/Sale**
  - Real estate transactions, purchase price discounts
  - Corporate mergers & acquisitions
  - Brownfields redevelopment

- **Infrastructure Pre-Design and Design Studies**
  - Alternatives screening
  - Construction cost estimates
  - Materials compatibility with contamination

- **Cost-Cap Insurance Underwriting**
Financial Liabilities

- Accounting Equation
  \[ \text{Assets} = \text{Liabilities} + \text{Equity} \]

- IFRS Framework and IASB definition (paraphrased)
  - present obligations arising from past events expected to arise in outflow of resources (payment)

- Public Sector Accounting Handbook (Section 3200.05)
  - present obligations arising from past transactions or events expected to result in future sacrifice of economic benefits
What if we’re not sure what the liability is?

- **Provision**
  - Liability of uncertain timing or amount
  - Payment is probable and can be estimated reliably
  - Environmental cleanups measured at most likely amount under Canadian guidelines

- **Contingent Liability**
  - Possible obligation depending on whether some future event occurs, or
  - Payment not probable or amount cannot be measured reliably

The Cost Estimating Toolbox
Fundamental Characteristics of Cost Estimates (AACE International)

- Primary Characteristic
  - Maturity level of project definition and end use of the estimate e.g. alternatives screening, conceptual design, detailed design, bid/tender

- Secondary Characteristics
  - Basis of estimate i.e. SWAG, parametric and/or deterministic
  - Type of estimate e.g. simple range, engineering estimate, probabilistic range
  - Effort/cost to prepare the estimate relative to project risk

Modified from AACEI (2011) Cost Estimate Classification System
# AACE International Classification System

<table>
<thead>
<tr>
<th>ESTIMATE CLASS</th>
<th>Primary Characteristic</th>
<th>Secondary Characteristic</th>
<th>Expected Accuracy Range</th>
<th>Preparation Effort</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Maturity Level of Project Definition Deliverables</td>
<td>End Usage</td>
<td>Methodology</td>
<td>Typical +/- range relative to index of 1 (i.e. Class 1 estimate)</td>
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<tr>
<td>Class 5</td>
<td>0% to 2%</td>
<td>Screening or feasibility</td>
<td>Stochastic (factors and/or models) or judgment</td>
<td>4 to 20</td>
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<tr>
<td>Class 4</td>
<td>1% to 15%</td>
<td>Concept study or feasibility</td>
<td>Primarily stochastic</td>
<td>3 to 12</td>
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<tr>
<td>Class 3</td>
<td>10% to 40%</td>
<td>Budget authorization or control</td>
<td>Mixed but primarily stochastic</td>
<td>2 to 6</td>
</tr>
<tr>
<td>Class 2</td>
<td>30% to 75%</td>
<td>Control or bid/tender</td>
<td>Primarily deterministic</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Class 1</td>
<td>65% to 100%</td>
<td>Check estimate or bid/tender</td>
<td>Deterministic</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes:  
[a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.  
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.
## Example Classification Systems

<table>
<thead>
<tr>
<th>AACE Int’l</th>
<th>ANSI Z94.0</th>
<th>Treasury Board, CEBC</th>
<th>WorleyParsons</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Order of Magnitude</td>
<td>D</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Budget Estimate</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Definitive Estimate</td>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>A</td>
<td>4</td>
</tr>
</tbody>
</table>

Bronsro (2012)
USEPA Superfund Cost Classification System

USEPA & USACE (2000)
A Guide to Developing and Documenting Cost Estimates During the Feasibility Study
Basis of Estimate - SWAG

www.quickmeme.com
Basis of Estimate

- Parametric - cost rates used for estimate are indirectly related to project, such as professional experience and judgment, and scaling factors (called “stochastic” by AACE International)
- Deterministic - cost estimates are directly related to project such as contractor estimates and bids, consultant proposals

Useful Website:
Federal Remediation Technologies Roundtable
http://www.frtr.gov/

Type of Estimate

- Simple range
- Single-point engineering estimate
  - typically with a +/- depending on project stage
  - Most likely scenario
- Probabilistic estimates
  - Probability-weighted average
  - Monte carlo distributions
Probabilistic Monte Carlo Simulations

Input Variables \( \Rightarrow \) Model Equation \( \Rightarrow \) Results Distribution

\[ F(x_i, y_i, z_i) = R_i \]

McKay et al. (2003) Reclamation Liability Costs of the Ekati Diamond Mine
Concluding Thoughts
Where Engineering Approaches Work and Where They Need to be Modified

Where engineering approaches work

- Definitions/considerations of the primary and secondary characteristics of estimates
- Emphasis on describing basis of estimate and uncertainty

Where engineering approaches need to be modified

- Recognition of much greater uncertainty in remediation and liability cost estimating
- Consideration of more types of estimate values at early stages of ESA and remediation process
And Finally….

- Pick a tool appropriate to the:
  - Project stage
  - End use of the estimate
  - Effort/cost to prepare the estimate relative to project size, complexity and risk

- Carefully think about and describe the basis of design and uncertainty in the estimate

- Communicate regarding what you are doing and why and get key stakeholder feedback
Thank you!

ken.lyon@advisian.com


ECHOS Environmental Remediation Assembly and Unit Cost books


