

Session A, Transferts de responsabilites Liability Transfer Mechanisms for Environmental Liabilities



Using Probabilistic Cost Models to Estimate Environmental Damages

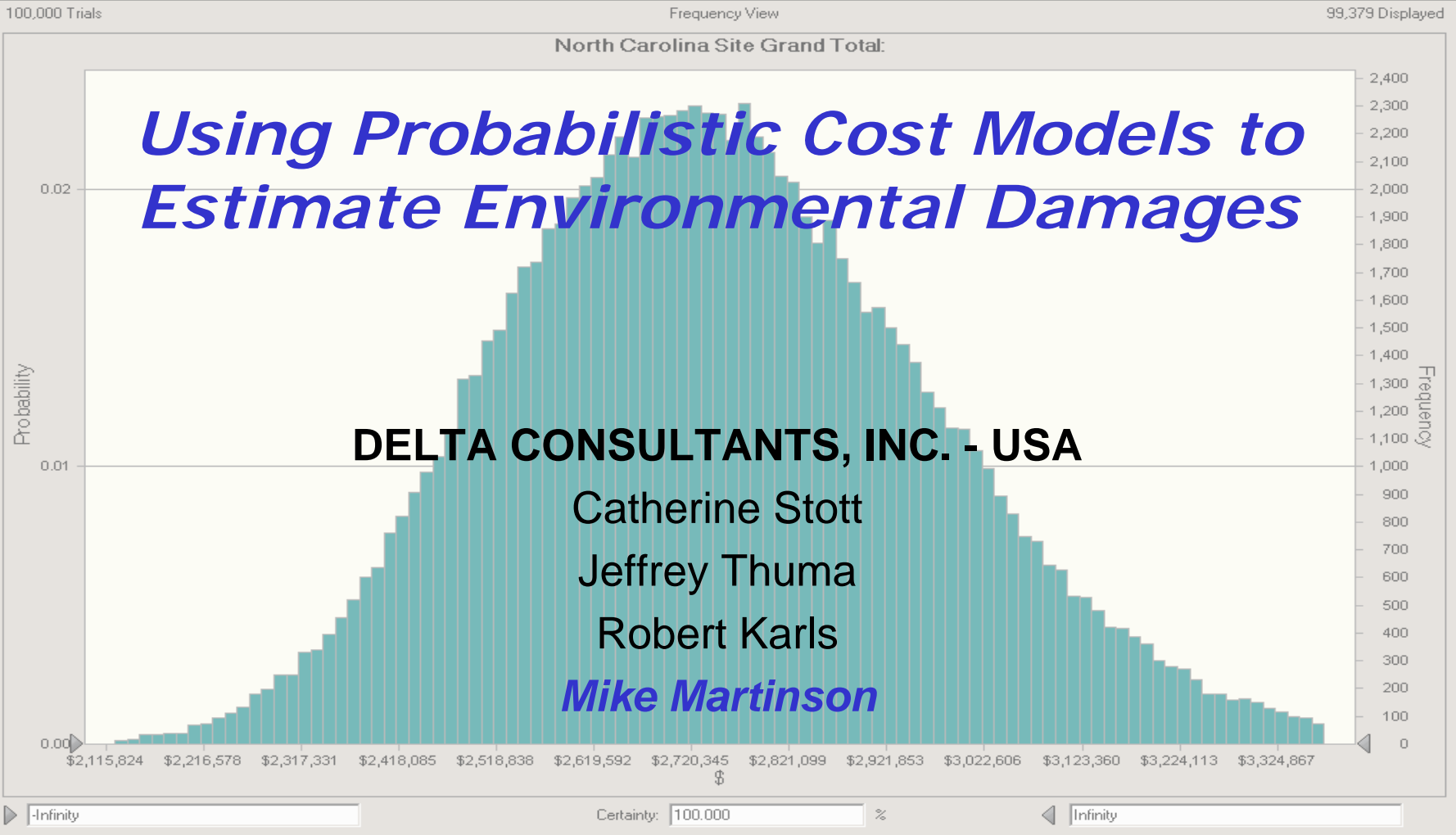
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SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

Presented at: INTERSOL 2008, Paris, 18 March 2008

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Today's Presentation:



Probabilistic Cost Model Applications

- **Litigation, Settlement & Mediation**
- **Environmental Reserve Setting**
- **Risk Transfer Transactions**
- **Remedial Approach Decision Making**

Traditional Cost Estimates: Single Number Estimate



TASKS	COST
Additional Investigation	
Source Area Soil Investigation	\$ 25,000
On-site Ground Water Investigation	\$ 40,000
Install Off-Site Ground Water Wells	\$ 45,000
Remedial Action	
Excavation of Source Area Soil	\$ 230,000
Long Term Ground Water Monitoring	
Annual Ground Water Monitoring	\$ 150,000
TOTAL	\$ 490,000

WHAT IF ...

*Off-site ground water wells are **not** needed?*

More soil needs excavation?

A ground water extraction system needs to be installed?

Ground water monitoring lasts for 10 years?

These factors are NOT incorporated into the cost presented.

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

MOST LIKELY COST ESTIMATE

Traditional Cost Estimates: Weighted Average Estimates



GIVES YOU A RANGE OF POTENTIAL COSTS: \$0.3 to \$1.7 M

TASKS	BEST CASE	MOST LIKELY	WORST CASE
Additional Investigation			
Source Area Soil Investigation	\$25,000	\$25,000	\$30,000
On-site Ground Water Investigation	\$40,000	\$40,000	\$40,000
Install Off-Site Ground Water Wells	\$0	\$45,000	\$45,000
Remedial Action			
Excavation of Source Area Soil	\$175,000	\$230,000	\$460,000
Install & Operate P&T System	\$0	\$0	\$950,000
Long Term Ground Water Monitoring			
Annual Ground Water Monitoring	\$100,000	\$150,000	\$250,000
TOTAL	\$340,000	\$490,000	\$1,775,000
Chance of Scenario Occurring	10%	60%	30%
Total x Chance Occurring =	\$34,000	\$294,000	\$532,500
WEIGHTED AVERAGE TOTAL		\$860,500	

EXPECTED VALUE

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Traditional Cost Estimates:

What Value Do You Use?



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

- Purpose of the Cost Estimate
- Comfort Level with Risk and Uncertainty
- Business Decision

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\$ 490,000 Most Likely value?

Range of \$ 340K to \$ 1.775M?

\$ 860,500 Weighted Average Result?



Probabilistic Cost Models:

Hierarchy of Approaches for Estimating Costs and Liabilities for Environmental Matters



*Increasing
Robustness &
Comprehensiveness*

Expected Value (EV):
The mean value
that represents a
probability-weighted
average over the range of
all possible values.

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From ASTM E 2137-06

Solution: Probabilistic Cost Model

DELTA

What is a Probabilistic Cost Model?

- A cost estimating simulation in which you assign probabilities and ranges to address uncertainty for critical values in the cost modeling framework
(Values = unit costs, quantities, chance of a task occurring)
- Then using a Predictive Modeling software, run a Monte Carlo simulation
(e.g., Crystal Ball®; <http://www.crystalball.com/>)

Like dice, Crystal Ball uses Excel to randomly sample the specified numbers within the specified ranges for each of the Assumptions

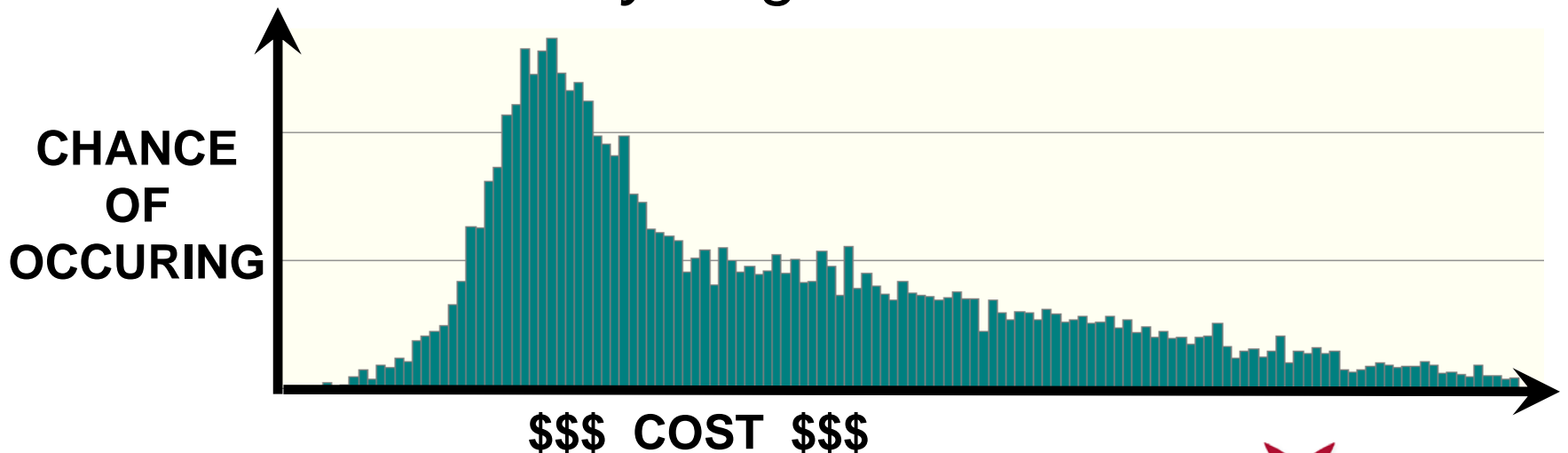


What does a Probabilistic Cost Model Provide?



The FULL RANGE of POSSIBILITIES

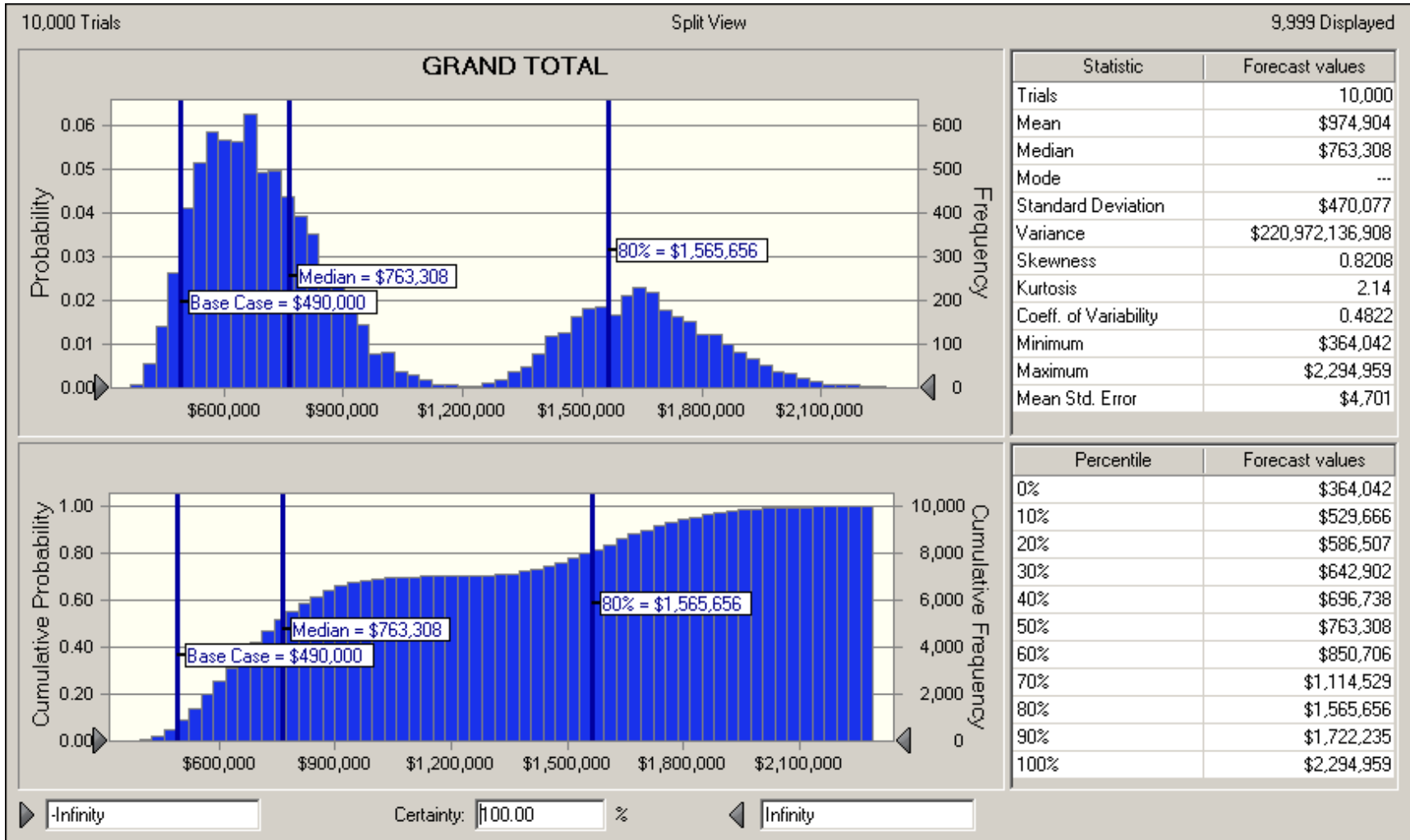
Instead of getting a snap-shot view of the “most likely” cost, you can see the worst case number, the “if-everything-happens-perfect” number, and *everything in between.*



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

Probabilistic Cost Model (PCM)

Typical Results



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

Probabilistic Cost Model (PCM)

"Most Likely" Cost Inputs



A. Additional Investigation

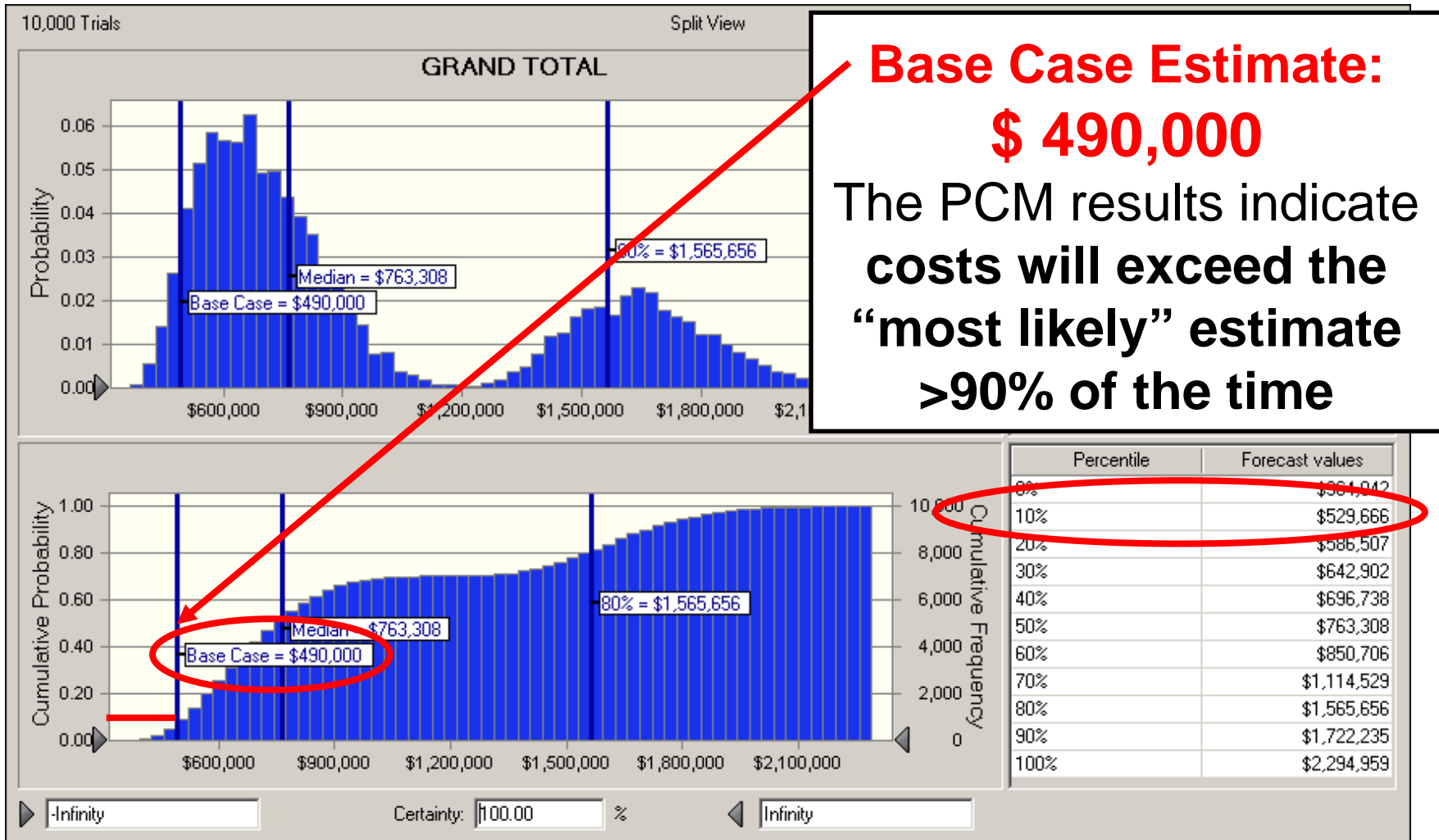
Item	Units	Unit Cost			Quantity			Subtotal
		Most Likely	Low	High	Most Likely	Low	High	
Labor - Internal								
Senior Reviewer	hr	\$ 150.00						\$ -
Project Manager	hr	\$ 111.00	\$ 95.00	\$ 120.00	8	0	16	\$ 888.00
Project Hydrogeologist	hr	\$ 69.00	\$ 60.00	\$ 80.00	16	0	24	\$ 1,104.00
Project Engineer	hr	\$ 90.00						\$ -
Staff Hydrogeogist	hr	\$ 66.00						\$ -
Staff Engineer	hr	\$ 72.00						\$ -
Field Technican (field)	hr	\$ 60.00	\$ 50.00	\$ 75.00	30	0	50	\$ 1,800.00
Drafting	hr	\$ 60.00	\$ 50.00	\$ 75.00	6	0	6	\$ 360.00
Admistrative Support	hr	\$ 60.00	\$ 50.00	\$ 75.00	4	0	4	\$ 240.00
Other Labor 1	hr	\$ 45.00						\$ -

	Units	Most Likely	Low	High	Most Likely	Low	High	Subtotal
Water sample kit and bailer	ls	\$ 8.00	\$ 7.00	\$ 9.00	50	40	64	\$ 400.00
Vehicle	mile	\$ 0.50	\$ 0.50	\$ 0.50	1,500	1,288	2,000	\$ 750.00
PIO	day	\$ 100.00	\$ 100.00	\$ 100.00	24	24	30	\$ 2,400.00
Water Level meter	ls	\$ 15.00	\$ 15.00	\$ 15.00	4	4	6	\$ 60.00

Analytical - Water, BTEX, TPH-G	each	\$ 100.00	\$ 80.00	\$ 120.00	48	30	64	\$ 4,800.00
Purge water disposal	ls	\$ 250.00	\$ 100.00	\$ 400.00	4	4	4	\$ 1,000.00
Carbon replacement	ls	\$ 1,000.00	\$ 800.00	#####	3	1	5	\$ 3,000.00
Analytical - Air	each	\$ 100.00	\$ 80.00	\$ 200.00	24	12	36	\$ 2,400.00

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

PCM Results: Base Case



Probabilistic Cost Model (PCM)

"Three-Point Range" of Cost Inputs



A. Additional Investigation

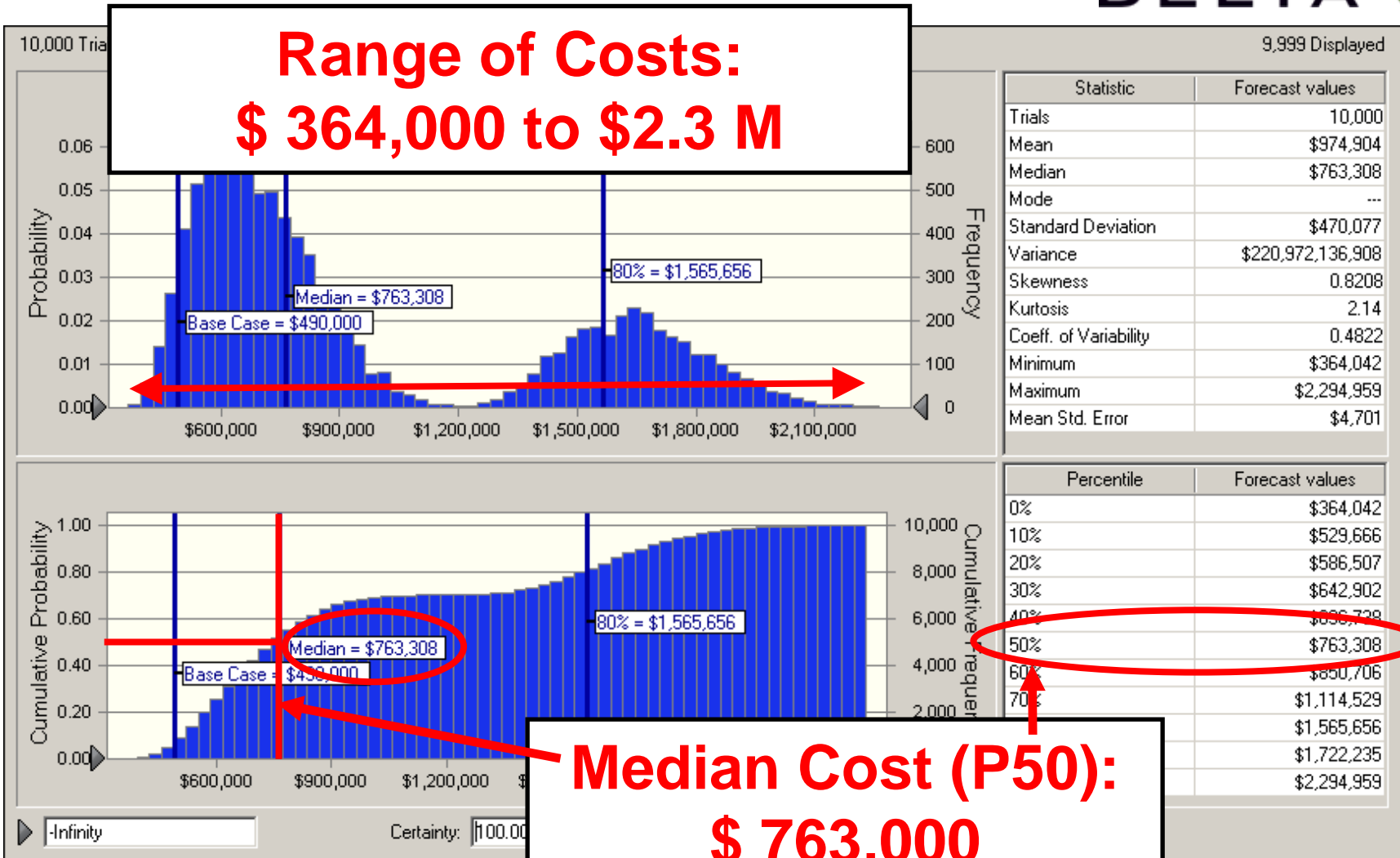
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PCM Results: Range & Median



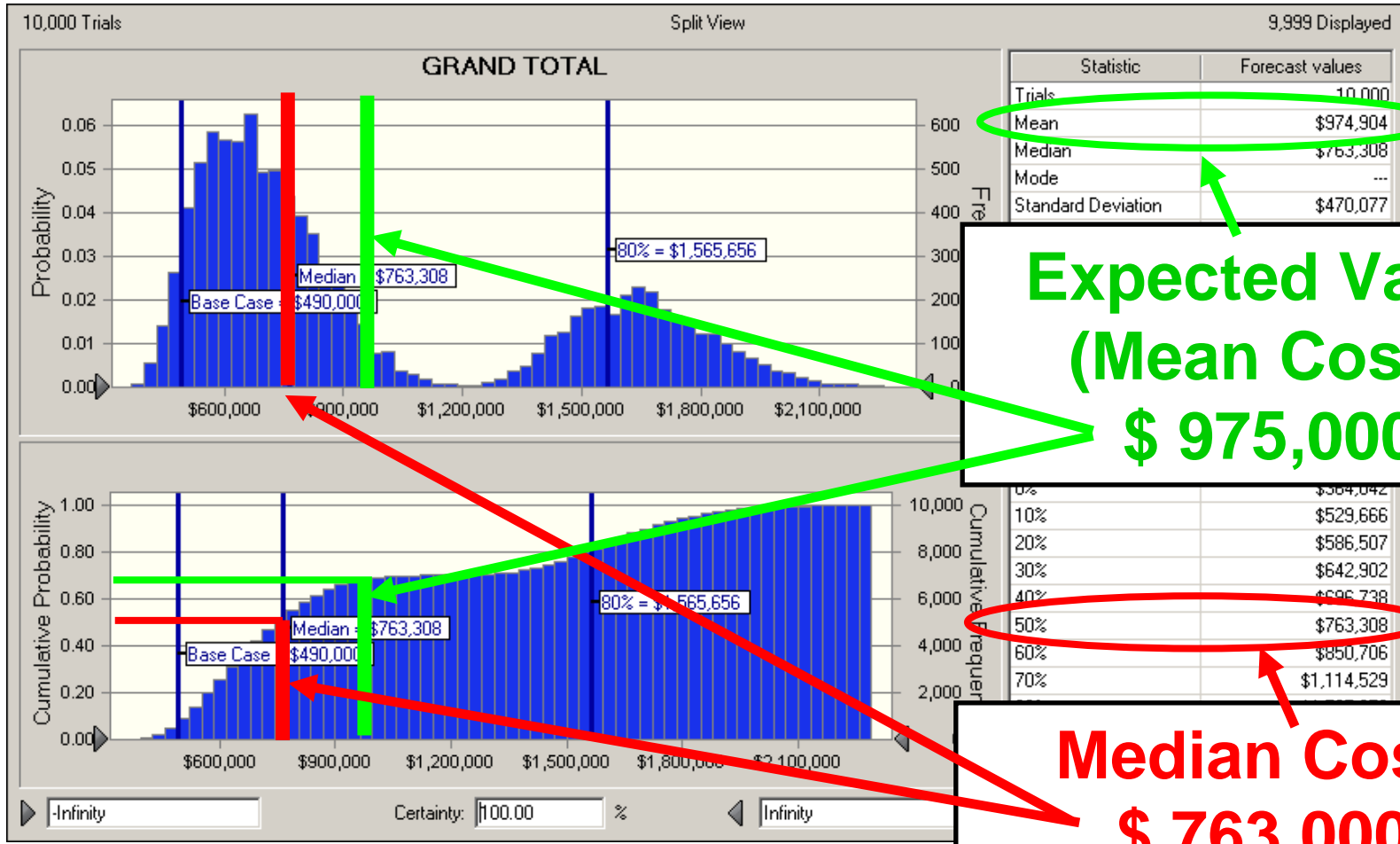
SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS



PCM Applications: Expected Value vs Median



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

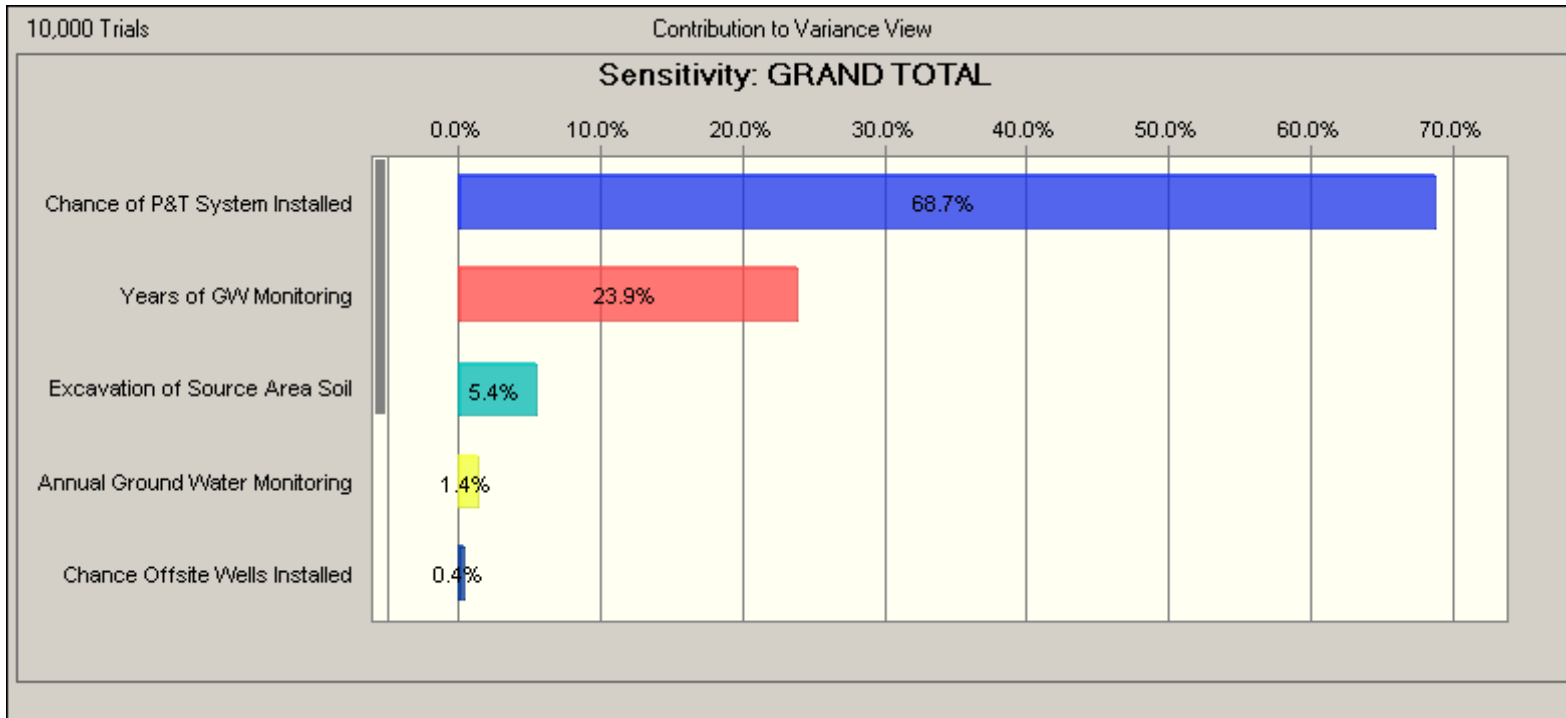


**Expected Value
(Mean Cost):
\$ 975,000**

**Median Cost:
\$ 763,000**

Probabilistic Cost Model Benefits:

Sensitivity Analysis



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

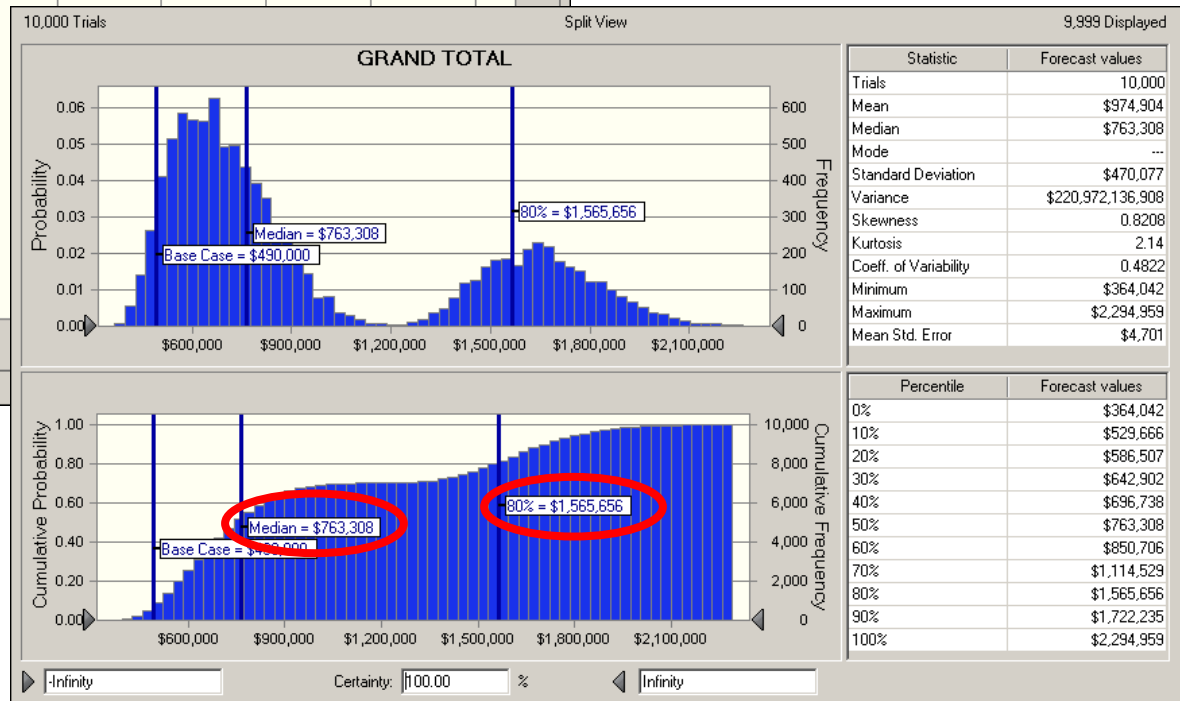
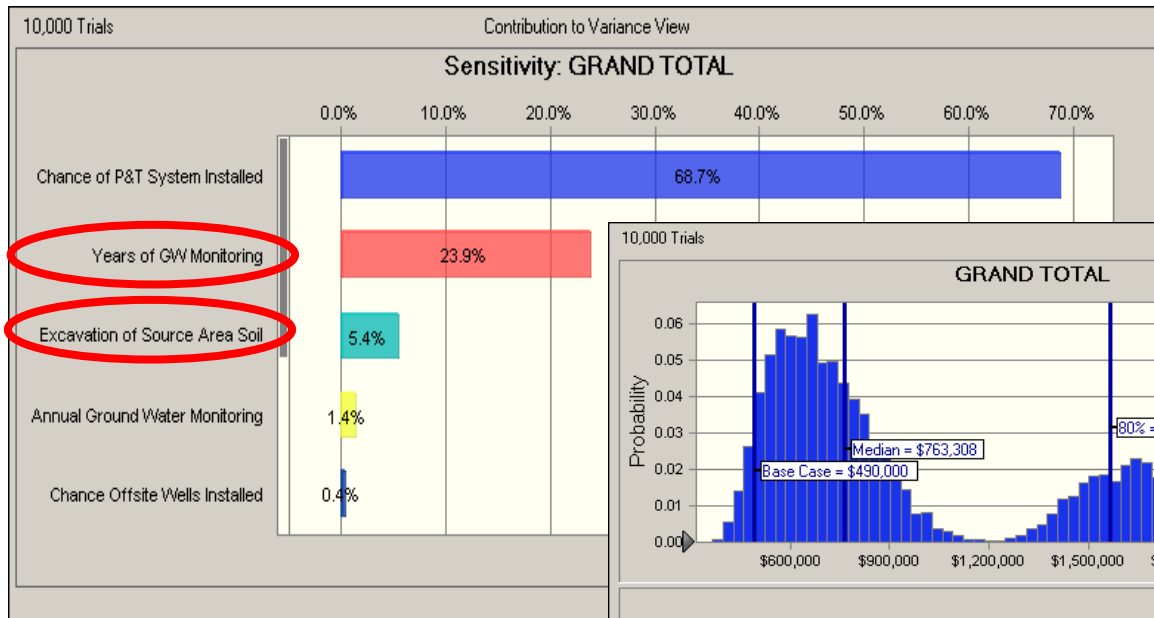
Sensitivity Analysis: Identifies the assumptions that contribute most to the variation in cost.

PCM Applications: Model Outputs



SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

PCM Results for Example Problem



Assumptions Causing the Most Variance:

1. Chance of P&T System Installed
2. Years of Ground Monitoring
3. Excavation of Source Area Soil

Probabilistic Cost Model Benefits: Focus on most important factors



A Tool to Assess What Really Matters

The results of a probabilistic cost model lets you see what factors are *quantitatively* effecting the range of costs. Allowing you to focus your investigations and research in areas that will better refine the cost estimate.

Tons of Soil Requiring Excavation

#2

~~Years of Operation~~

~~Number of Monitoring Wells~~

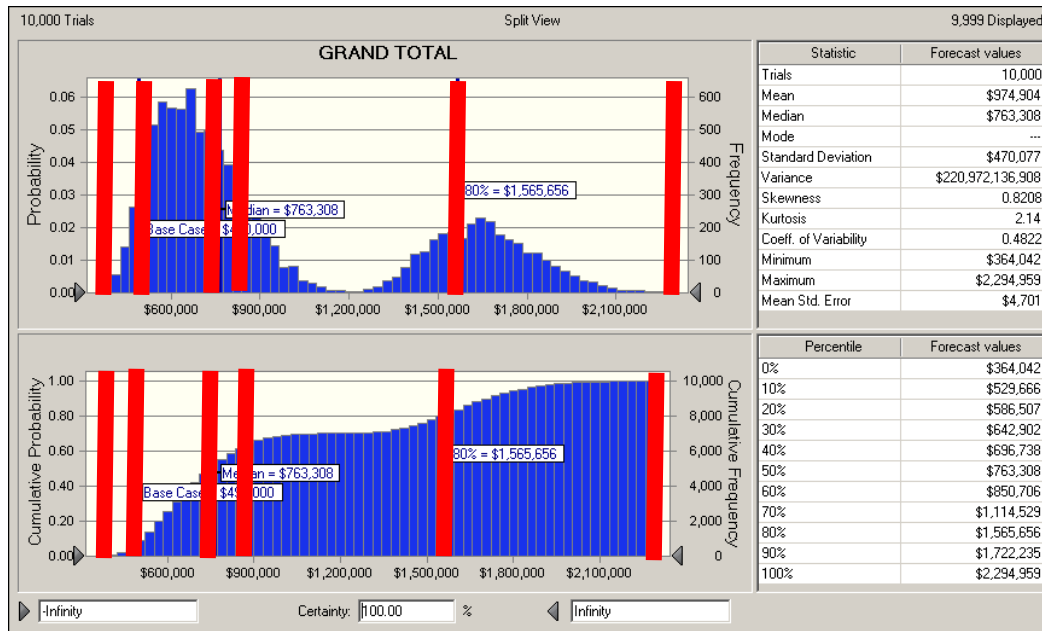
#1

Years of Monitoring

~~Pump & Treat vs. Chemical Oxidation~~

~~Cost of Analytical~~

PCM Results: What Value Do You Use?



- **Comfort Level: Uncertainty & Risk**
- **Business Decision**
- **Purpose of the Model**

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

\$ 490,000 Base Case or Original MLV?

Range of \$ 365K to \$ 2.3M?

\$ 860,000 Weighted Average Result?

\$ 1.6M 80th Percentile?

\$ 763,000 PCM P50 Median?



Probabilistic Cost Models: Applications



- **Litigation, Settlement & Mediation**
- **Environmental Reserve Setting**
- **Risk Transfer Transactions**
- **Remedial Approach Decision Making**

Probabilistic Cost Models: Litigation, Settlement & Mediation



Approach Used:

- Evaluate the potential environmental costs to closure
- Account for all **foreseeable** scenarios

Results Given:

- Expected value (mean of the probability weighted average)
- Or, a selected probability value (e.g., P50, P80, P90, etc)

Benefits of Using PCMs for Litigation, Settlement & Mediation:

- Provides a clear, visual representation of the damages
- Accounts for variation and uncertainty
- Identifies which assumptions contribute most to the variation

Probabilistic Cost Models: Environmental Reserve Setting



Approach Used:

- Evaluate the reasonable and foreseeable environmental costs to closure given the **known** conditions at the site
 - This includes all costs to the company – legal support, internal employees time & resources

Results Given:

- Base Case derived from Most Likely input values
- Probability value based on accounting practices (e.g., “probable and estimable” using P50, or the median)

Benefits of Using PCMs for Environmental Reserve Setting:

- Provides a clear, well documented method of calculating the reserve’s estimated value
- Accounts for variation and uncertainty in how remediation closure may be obtained

Probabilistic Cost Models: Risk Transfer Transactions



Approach Used:

- Evaluate the potential environmental costs to closure

Results Given:

- Clear understanding of the range of cost risk
- Focus on a P50 (median)
- Insurance underwriters may demand P80 or higher cost value to issue insurance policy for cost-capping purposes

Benefits of Using PCMs for Risk Transfer Transactions:

- Provides a clear, visual representation of the range of costs
- Accounts for variation and uncertainty
- Identifies which assumptions contribute most to the variation

Probabilistic Cost Models: Remedial Approach Decision Making



Approach Used:

- Evaluate the installation and operating costs for various remedial technologies being considered for at a site

Results Given:

- The range of potential costs for each technology that can assist to determine the most cost-effective and appropriate remedial options
- Apply “what-if” scenarios to evaluate various remedial treatment options as well as the sequencing of remediation technologies

Benefits of Using PCMs for Risk Transfer Transactions:

- Provides a clear, visual representation of the range of costs that can be used in project discussions and in reports
- Focus additional work to lower uncertainty and tighten up cost and quantity input ranges of data

Probabilistic Cost Models:

Hierarchy of Approaches for Estimating Costs and Liabilities for Environmental Matters



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From ASTM E 2137-06

Probabilistic Cost Models



- **Provides A Robust Estimate of Future Costs that is Not One Dimensional**
- **Provides Clear, Easy to Understand Results that can be Presented to a Wide Audience**
- **Answers the What-If-Questions and Allows Uncertainty to be Incorporated into the Estimate**
- **A Useful Tool to Estimate Future Environmental Costs for a Variety of Purposes**



Merci !

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS