

Evaluating Expected Dredging Costs for Highly Variable Market Conditions

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Market Volatility



- **Historically, dredging/beach costs have been relatively stable and predictable for projects of similar scope.**
- **Recently, costs have been highly variable, with wide ranges.**
 - Limited competition for some projects,
 - Market conditions,
 - Increased distances to offshore sand resources,
 - Contractors accounting for risk in different ways, etc.
- **Wide variations in costs make future cost projections more difficult.**



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Recent Project Example

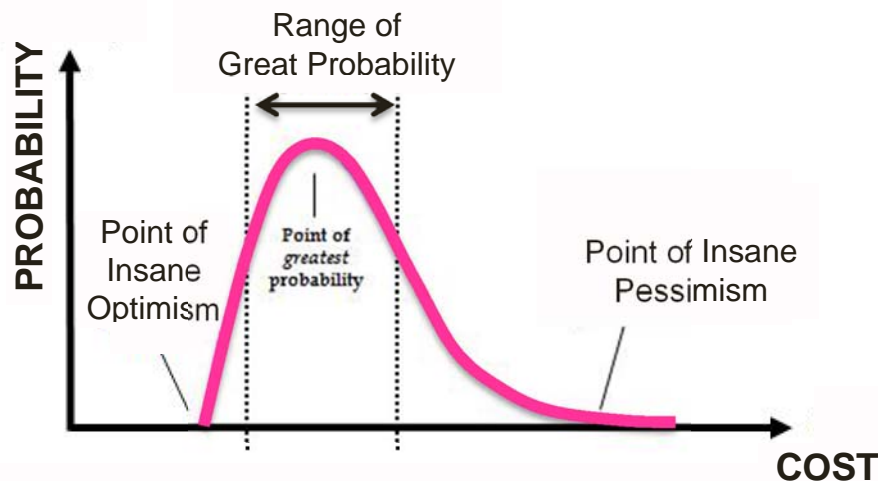
BID ITEM	Quantity	GOVT. EST.		BID #1		BID #2	
		Unit Price	Est. Amount	Unit Price	Est. Amount	Unit Price	Est. Amount
Mob.			\$2,476,000		\$3,435,000		\$4,750,000
Sand	630,000	\$6.30	\$3,969,000	\$6.80	\$4,284,000	\$9.77	\$6,155,100
Tilling	38	\$579	\$22,000	\$295	\$11,200	\$650	\$24,700
Vibration			\$186,700		\$24,800		\$49,500
Turbidity			\$37,000		\$42,300		\$29,000
Endangered Species			\$59,600		\$9,400		\$29,000
TOTAL			\$6,750,200		\$7,806,700		\$11,037,300

Role of the Consulting Engineer

- Project owners require a reasonable level of confidence in cost guidance.
- Consultants use cost history and market conditions to guide project cost analyses.
 - Other corporate models use probability.
 - Goal is to capture market trends by taking a macro approach to pricing.
 - Should begin at the project-planning phase.

Probabilistic Methods are Widely Used to Study Variability and Uncertainty

This is not news:



This *is* news:



- The U.S. Army Corps incorporates risk-based analyses in the development of project cost contingencies.
- Contractors assess risk and uncertainty to establish their expected project cost.

PROBABILISTIC ANALYSIS DOESN'T NEED TO BE DIFFICULT OR EXPENSIVE

- Excel Add-In
- Monte-Carlo Simulator
 - Multiple Probability Distributions
 - Customizable
 - GUI Interface
- Fast and Flexible

Example Product:

“Risk Analyzer”

www.Add-Ins.com/analyzer/

\$49.95



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“Project X”: Beach Renourishment

- Cutter Suction Dredge
- 15,000 feet Max. Pump Distance
- 630,000 cubic yards
- Beach Tilling
- Construction Monitoring:
 - Vibration Control
 - Environmental Protection
 - Turbidity Monitoring, etc.



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Probable Costs to Construct “Project X”

- Mobilization
- Sand Unit Price
- Sand Volume
- Tilling
- Acreage
- Construction Mon.

Study Values

= \$2.8M
= \$6.90/cy
= 630,000 cy
= \$500/ac.
= 40 ac.
= \$500,000

TOTAL

= ~\$7.6M



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Assessing Uncertainty with *Risk Analyzer*

1. Assign variables;
2. Combine variables;
3. Assign range of values;
4. Assign probability distributions;
5. Run Monte-Carlo simulation; and
6. Evaluate output.



1) Assign and 2) Combine Variables

- Mobilization / Demobilization
- Sand Unit Price
- Sand Volume
- Tilling
- Acreage
- Construction Management
- **TOTAL**

**VARIABLES
CONTAINING
UNCERTAINTY**



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3) Value Ranges and 4) Probability Distributions

Risk Analyzer

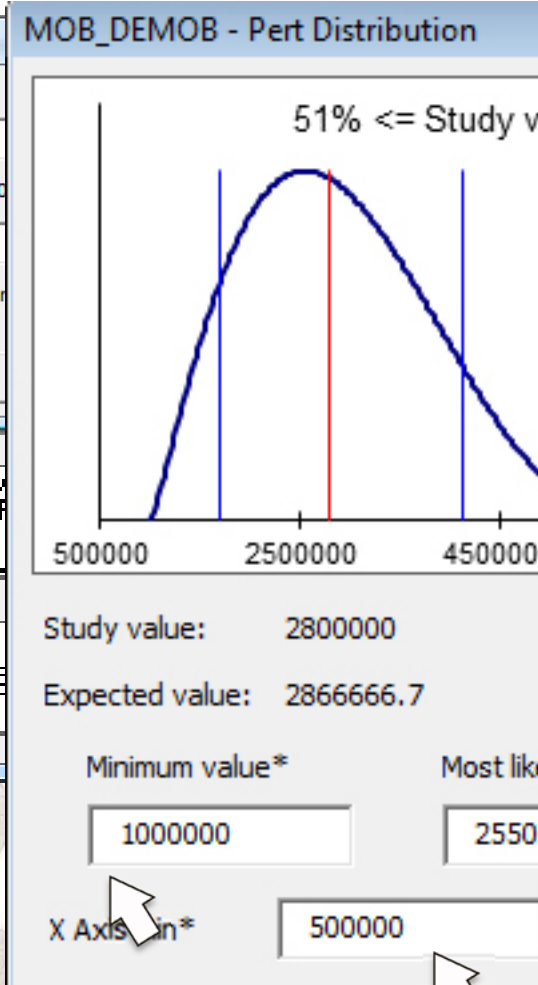
MOB_DEMOB

Minimum possible value:

Study value: 2800000

Maximum possible value:

Thousand separators and % signs can be used when you enter values.



Risk Analyzer

Premises, Simulations, and Reports | Other Features

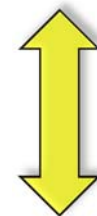
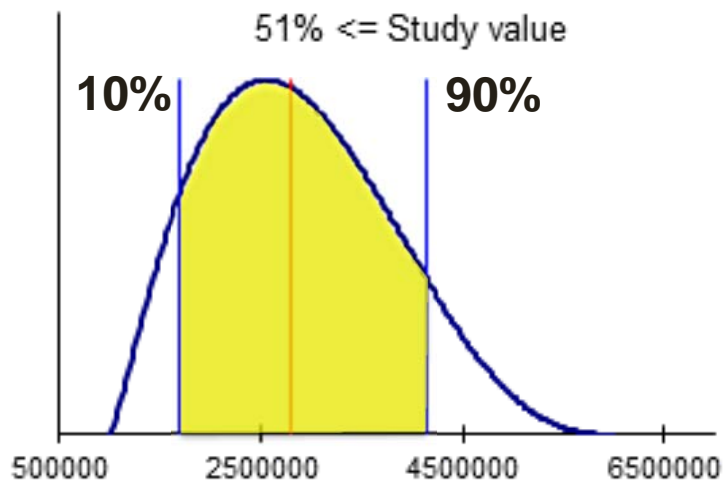
- ☐ Create a risk premises and reports workbook
 - ☐ Add or remove input or output range names
 - ☐ Specify title rows and columns for multi-cell output range names
- ☒ Define or change probability distributions
 - ☐ Create input probability distribution reports
 - ☐ Create output sensitivity reports and tornado / fishbone charts
- ☐ Run simulations / create output reports
 - ☐ Create or update output reports & histograms
 - ☐ Consolidate output results into tables
 - ☐ Graph consolidated results (create funnel chart)

Probability Function (Variable 1)

Mobilization / Demobilization

Study File Value	Min Allowed Value	10/90	Expected Value	90/10	Max Allowed Value
\$2,800,000	\$1,000,000	\$1,695,891	\$2,866,667	\$4,129,722	\$6,000,000

Pert distribution



10% < \$1.7M

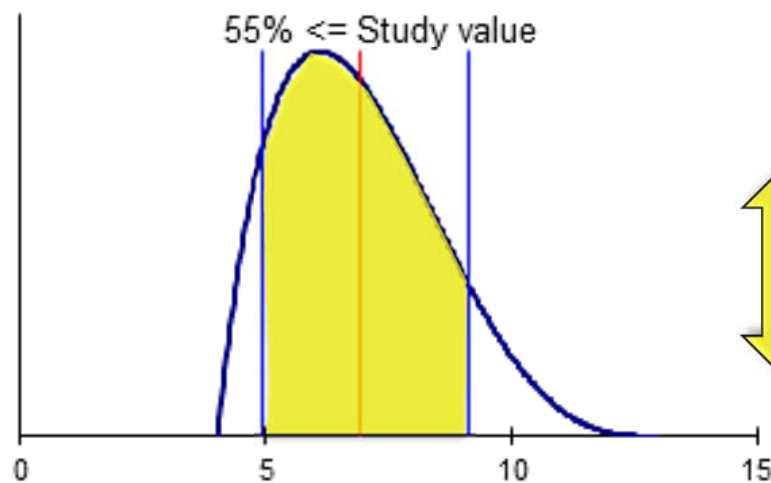
90% < \$4.1M

Probability Function (Variable 2)

Sand Unit Price

Study File Value	Min Allowed Value	10/90	Expected Value	90/10	Max Allowed Value
\$6.90	\$4.00	\$4.92	\$6.90	\$9.12	\$13.00

Pert distribution

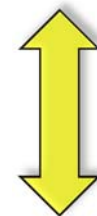
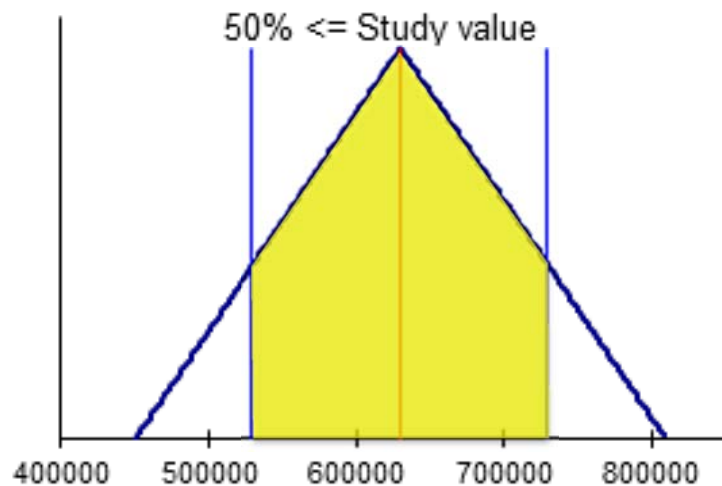


Probability Function (Variable 3)

Sand Volume

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
630,000	450,000	529,779	630,000	630,000	728,781	810,000

Triangular distribution



10% < 530,000 cy

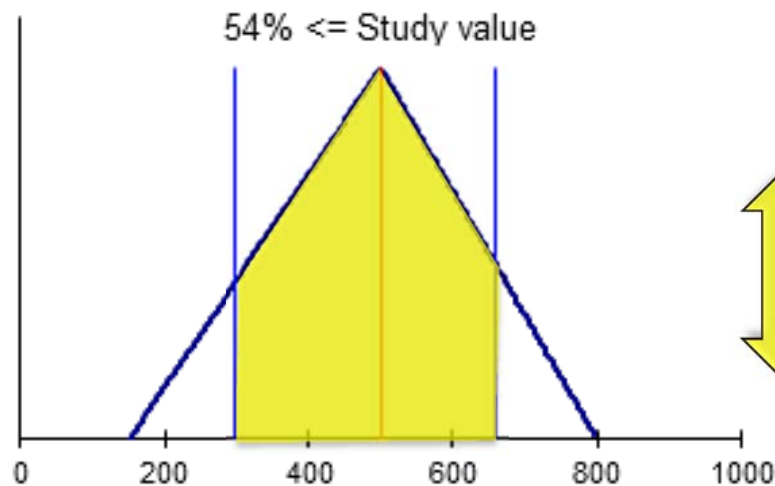
90% < 730,000 cy

Probability Function (Variable 4)

Tilling

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
\$500	\$150	\$300	\$500	\$483	\$659	\$800

Triangular distribution



10% < \$300/ac.

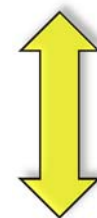
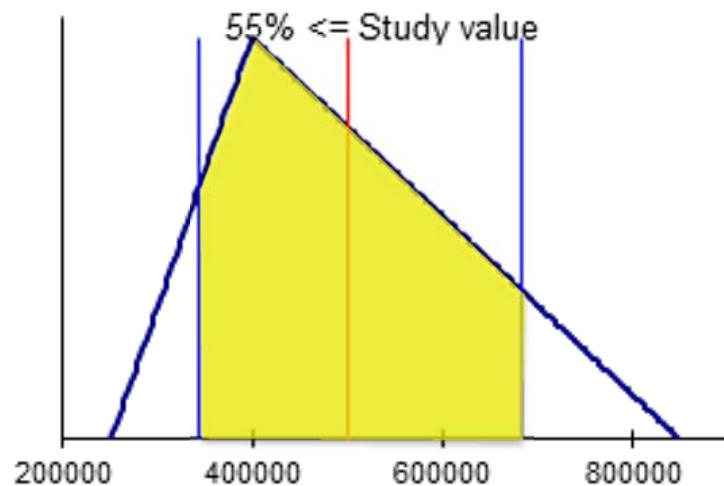
90% < \$660/ac

Probability Function (Variable 5)

Construction Mon.

Study File Value	Min Allowed Value	10/90	Peak Value	Expected Value	90/10	Max Allowed Value
\$500,000	\$250,000	\$343,674	\$400,000	\$500,002	\$684,481	\$850,000

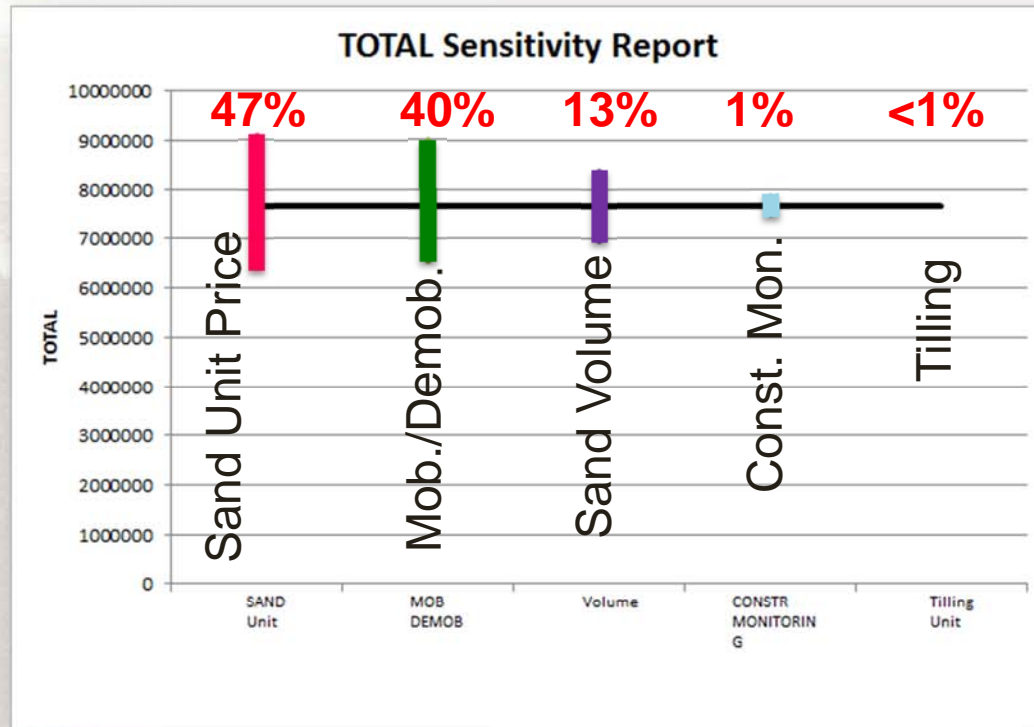
Triangular distribution



10% < \$340,000

90% < \$680,000

Sensitivity Report

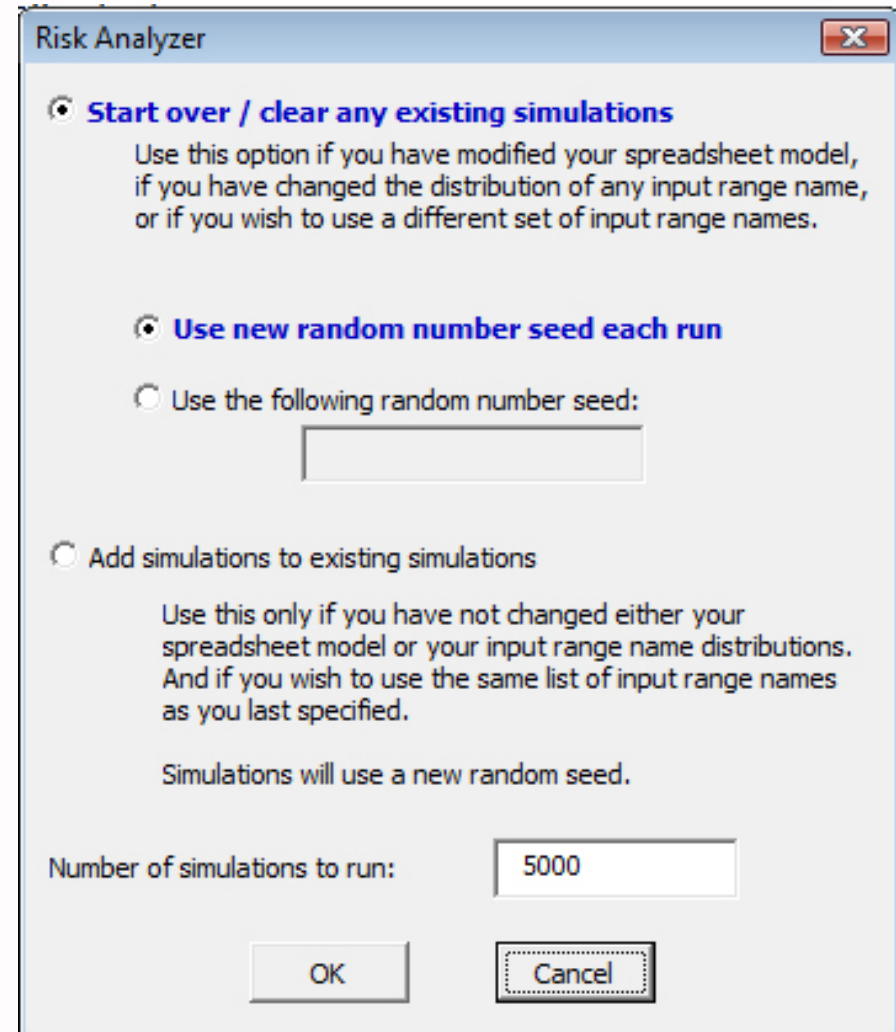


The horizontal line represents the study case. A vertical line represents the output range between an input's 10% likely and 90% likely values. Inputs with long vertical lines have the most effect on the output cells.

TOTAL sensitivity to:	10/90	Study	90/10	Variance	
				Amount	Cumulative
Sand Unit Price	6,421,851	7,667,000	9,067,618	47%	47%
Mob./Demob.	6,562,891	7,667,000	8,996,722	40%	87%
Sand Volume	6,975,472	7,667,000	8,348,592	13%	99%
Const. Monitoring	7,510,674	7,667,000	7,851,481	1%	100%
Tilling Unit Price	7,658,981	7,667,000	7,673,362	0%	100%

5) Run Monte-Carlo Simulation

- A. Select number of simulations.
- B. Select variables to include as input & output.
- C. Run Simulation.



The image shows a 'Risk Analyzer' dialog box with a title bar and a close button. It contains three radio button options. The first option, 'Start over / clear any existing simulations', is selected and includes a descriptive paragraph. The second option, 'Use new random number seed each run', is also selected and includes a text input field. The third option, 'Add simulations to existing simulations', is unselected and includes a descriptive paragraph and a note about using a new random seed. At the bottom, there is a label 'Number of simulations to run:' followed by a text input field containing the value '5000'. Below this are 'OK' and 'Cancel' buttons.

Risk Analyzer

☒ **Start over / clear any existing simulations**
Use this option if you have modified your spreadsheet model, if you have changed the distribution of any input range name, or if you wish to use a different set of input range names.

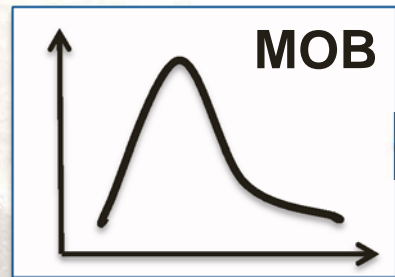
☒ **Use new random number seed each run**
☐ Use the following random number seed:

☐ **Add simulations to existing simulations**
Use this only if you have not changed either your spreadsheet model or your input range name distributions. And if you wish to use the same list of input range names as you last specified.

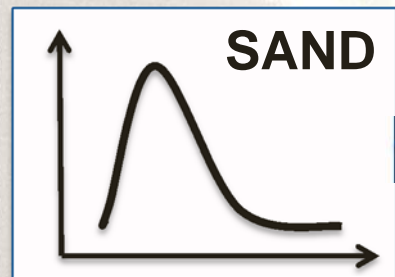
Simulations will use a new random seed.

Number of simulations to run:

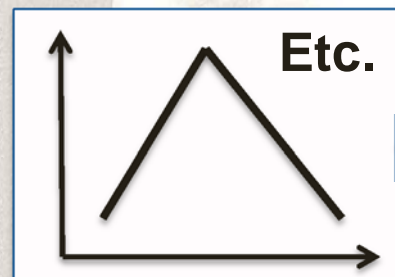
Monte-Carlo Simulation



Model 1

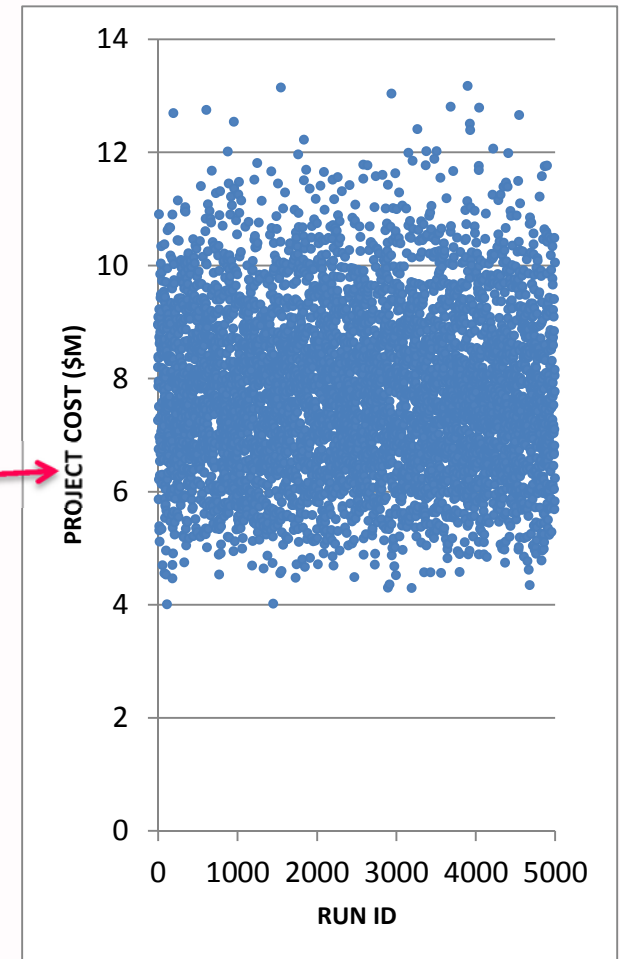


Model 2



Model 3

Output Data



Input Data
Distributions

Simulations

Results after
5,000 runs

6) Output

TOTAL Results

Minimum result	\$4,005,324
Maximum result	\$13,172,321
Expected value	\$7,729,394
Std Deviation	\$1,469,926

\$7,667,000 Study value

50.8% of results are equal or lower

49.2% of results are equal or greater

Out of 5000 simulations
5000 had numeric values.
0 had error values.

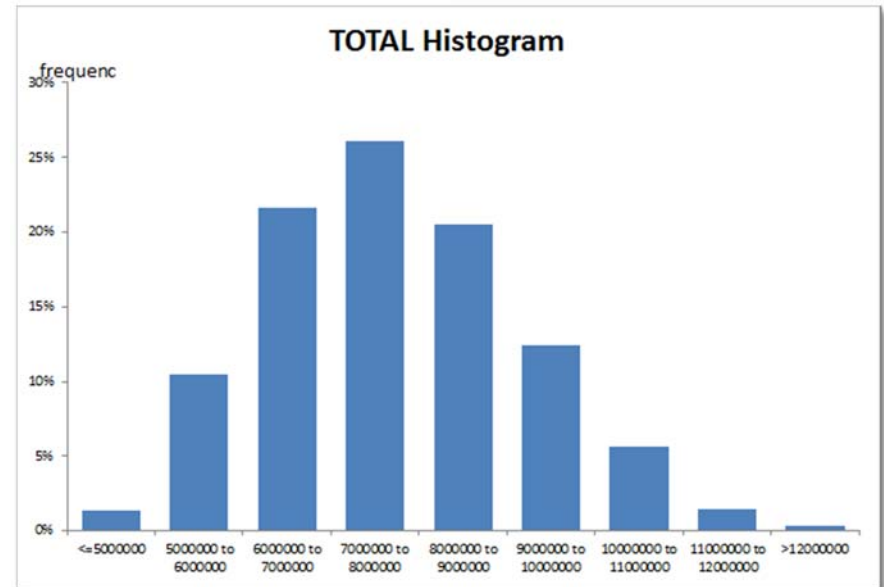
Of those with numeric values:

5% <=	\$5,478,438
10% <=	\$5,887,403
15% <=	\$6,160,818
20% <=	\$6,429,166
25% <=	\$6,649,449
30% <=	\$6,847,088
35% <=	\$7,063,554
40% <=	\$7,252,459
45% <=	\$7,442,526
50% <=	\$7,632,781
55% <=	\$7,830,838
60% <=	\$8,015,045
65% <=	\$8,226,169
70% <=	\$8,467,876
75% <=	\$8,692,286
80% <=	\$8,984,447
85% <=	\$9,322,581
90% <=	\$9,721,374
95% <=	\$10,292,018
100% <=	\$13,172,321

If TOTAL is: **\$7,667,000**
(Chg to do what ifs)

50.8% of results are equal or lower

49.2% of results are greater



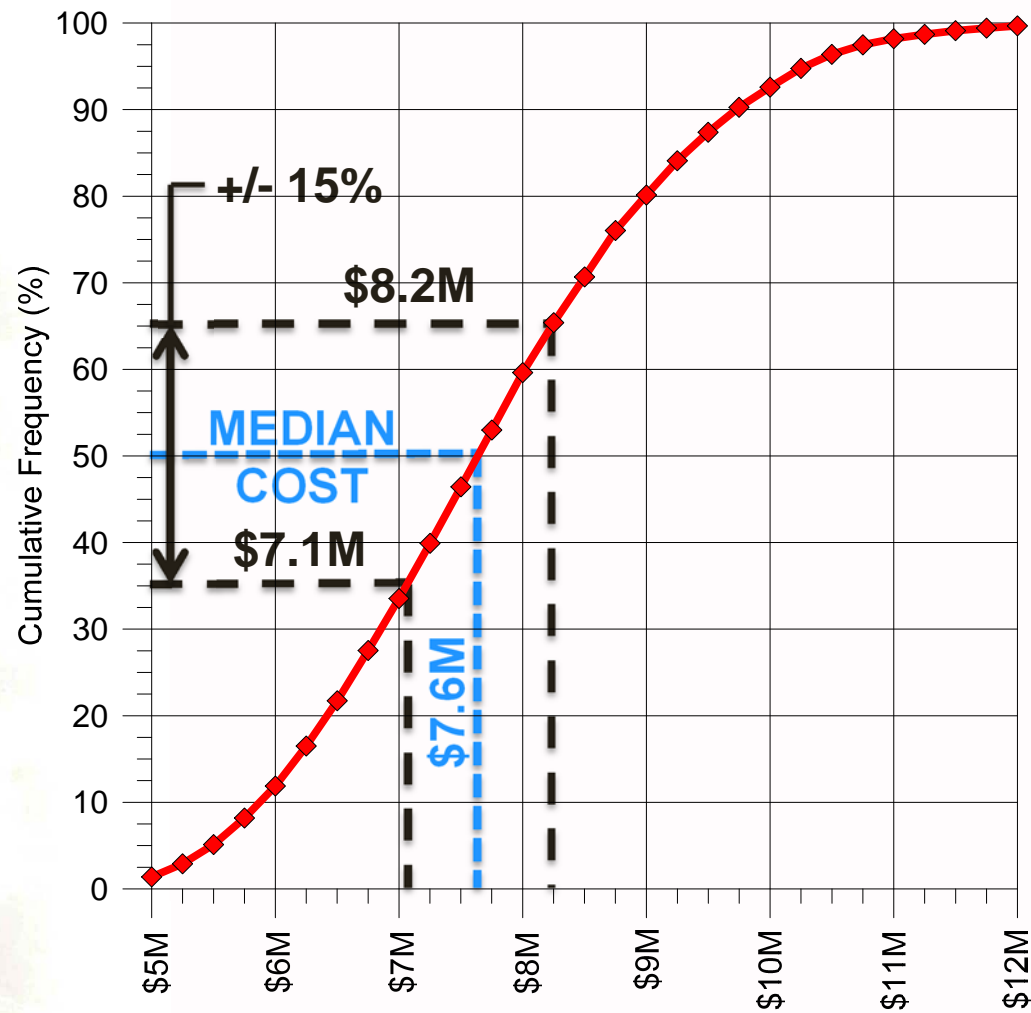
6) Output

50% Prob. price is less than \$7.6M

80% Prob. price is less than \$9M

5% <=	\$5,478,438
10% <=	\$5,887,403
15% <=	\$6,160,818
20% <=	\$6,429,166
25% <=	\$6,649,449
30% <=	\$6,847,088
35% <=	\$7,063,554
40% <=	\$7,252,459
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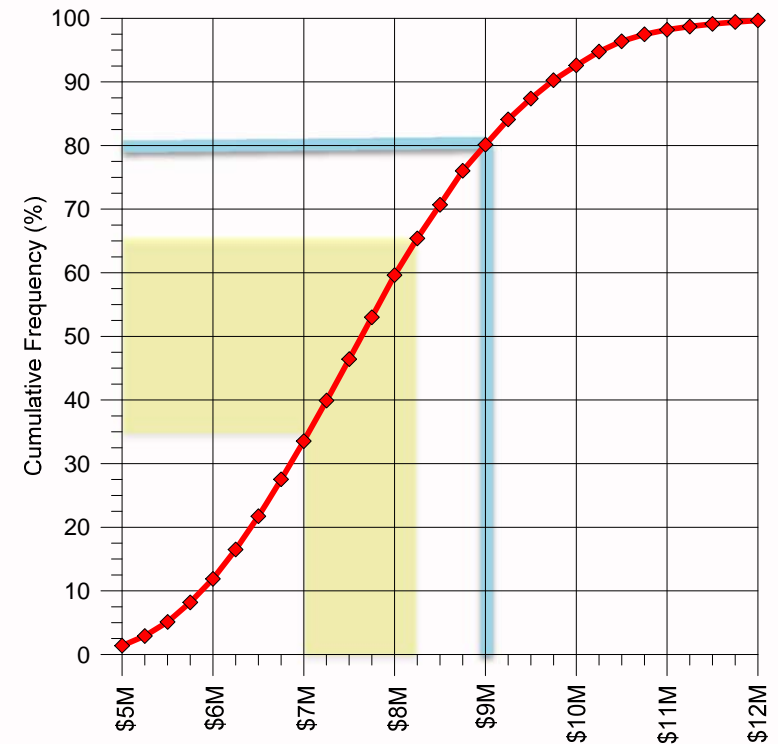
6) Output



Presenting Model Results

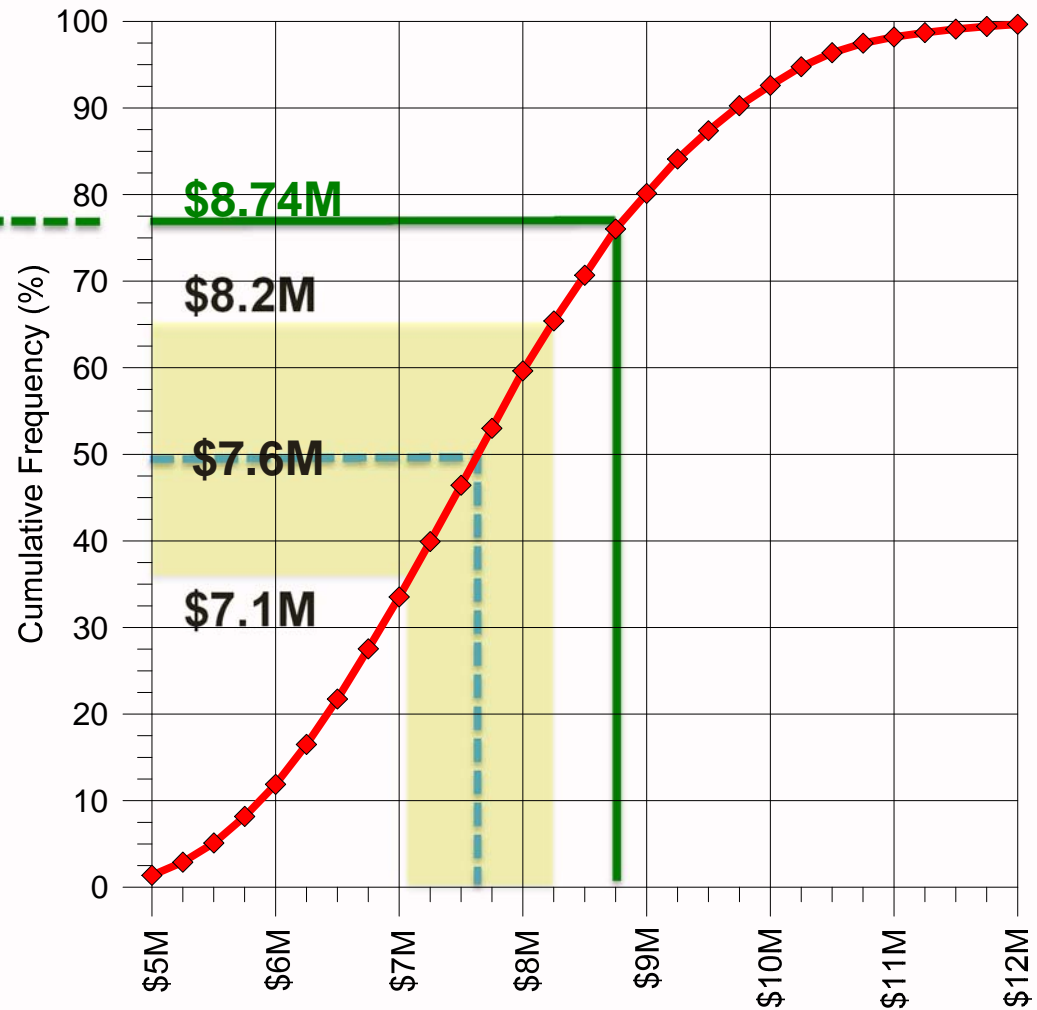
“Project ‘X’ is anticipated to cost between \$7.1M and \$8.2M.”

“There is a 20% probability that project costs will exceed \$9M.”

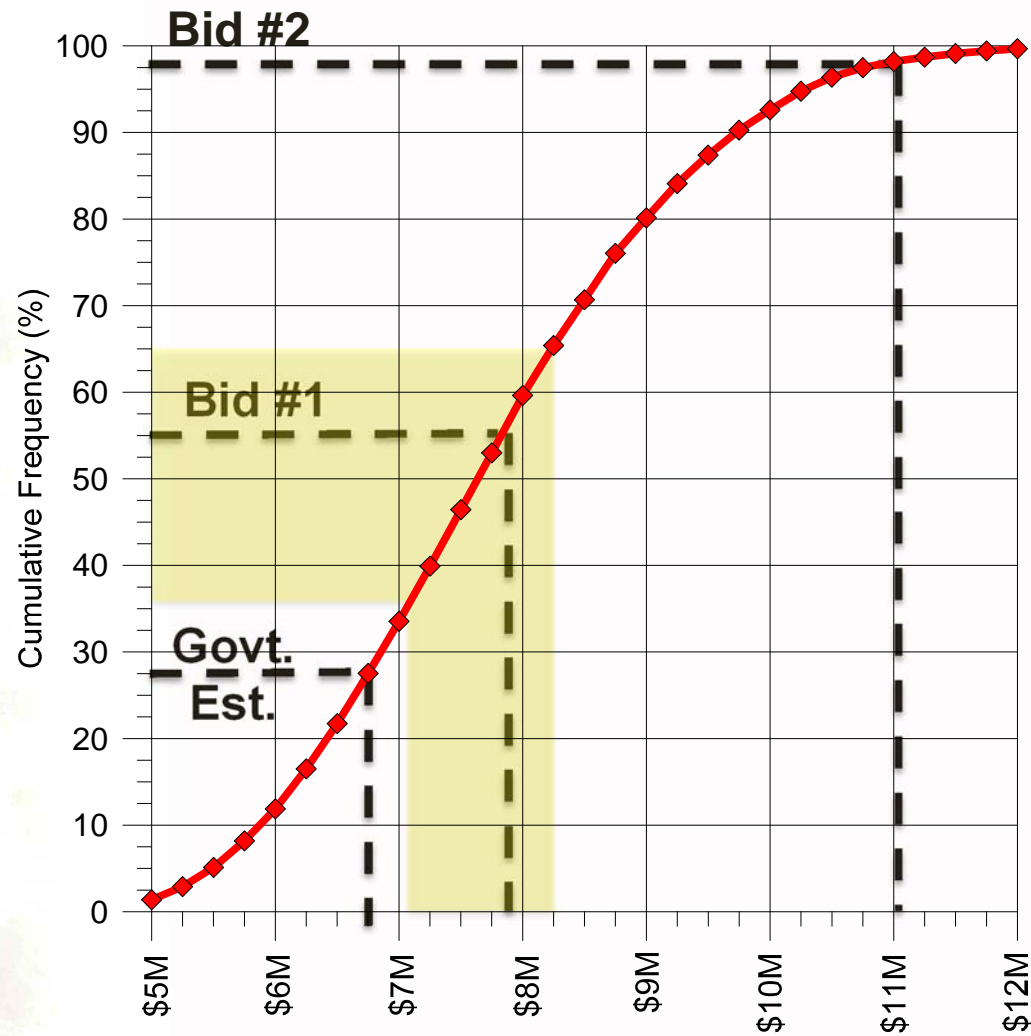


Study Value Plus 15% Contingency

Original Engineers Estimate
X 115% = \$8.74M
(77% Prob.)



Bid Results, Project X



Incorporating probability to develop contingencies based on market conditions increases the overall utility of a cost estimate and can be accomplished quickly and easily.



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