Appendix A

Example Displays of Project Engineering and Economic Performance Results from Risk-based Analysis

Table A-1: Expected Value and Probabilistic Values of EAD and EAD Reduced

Plan	Expected Annual Damage ($'000)			Probability EAD Reduced Exceeds Indicated Amount ($'000)				
	Without Plan	With Plan	Damage Reduced	0.95	0.75	0.50	0.25	0.05
20 foot levee	575.0	220.0	355.0	290.0	325.0	350.0	380.0	450.0
25 foot levee	575.0	75.0	500.0	370.0	435.0	490.0	550.0	690.0
30 foot levee	575.0	0.0	575.0	410.0	495.0	560.0	630.0	815.0
Channel	575.0	200.0	375.0	300.0	325.0	360.0	400.0	600.0
Detention Basin	575.0	250.0	325.0	200.0	260.0	300.0	330.0	450.0
Relocation	575.0	300.0	275.0	150.0	200.0	260.0	300.0	450.0

Table A-2: Expected Value and Probabilistis Values of Net Benefits

Plan	Expected Annual NED Benefit and NED Cost ($'000)			Probability Net Benefit Exceeds Indicated Amount ($'000)				
	Benefits	Cost	Net Benefits	0.95	0.75	0.50	0.25	0.05
20 foot levee	355.0	300.0	55.0	(25.0)	20.0	53.0	88.0	148.0
25 foot levee	500.0	400.0	100.0	(40.0)	35.0	91.0	152.0	280.0
30 foot levee	575.0	550.0	25.0	(155.0)	(60.0)	12.0	88.0	261.0
Channel	375.0	300.0	75.0	(30.0)	15.0	70.0	120.0	205.0
Detention Basin	325.0	275.0	50.0	(20.0)	18.0	50.0	75.0	150.0
Relocation	275.0	475.0	(200.0)	(300.0)	(250.0)	(210.0)	(170.0)	50.0

Table A-3: Expected Value and Probabilistic Values of Benefit/Cost Ratios

Plan	Expected Benefit/Cost Ratio	Probability B/C > 1	Probability Benefit/Cost Ratio Exceeds Indicated Amount				
			0.95	0.75	0.50	0.25	0.05
20 foot levee	1.19	0.86	0.92	1.07	1.18	1.30	1.52
25 foot levee	1.25	0.89	0.90	1.09	1.23	1.40	1.70
30 foot levee	1.05	0.57	0.72	0.90	1.02	1.16	1.47
Channel	1.25	0.84	0.90	1.05	1.22	1.39	1.65
Detention Basin	1.18	0.82	0.93	1.06	1.16	1.25	1.50
Relocation	0.58	0.00	0.37	0.47	0.56	0.62	0.89

Table A-4: Annual Performance and Equivalent Long-term Risk

Plan	Annual Performance (Expected Annual Probability of Design Being Exceeded)	Equivalent Long-term Risk (Probability of Exceedance Over the Indicated Time Period)		
		10 Years	20 Years	50 Years
W/O Project	0.250	0.944	0.997	1.000
20 foot Levee	0.020	0.183	0.332	0.636
25 foot Levee	0.010	0.096	0.182	0.395
30 foot Levee	0.001	0.010	0.020	0.049
Channel	0.025	0.224	0.397	0.718
Detention Basin	0.030	0.263	0.456	0.782
Relocation	0.100	0.651	0.878	0.995

Table A-5: Alternative Display of Annual Performance and Equivalent Long-term Risk

Plan	Annual Performance (Expected Annual Probability of Design Not Being Exceeded)	Equivalent Long-Term Risk (Chances of Design Being Exceeded Over the Indicated Time Period)		
		10 Years	20 Years	50 Years
W/O Project	0.750	1 in 1.1	1 in 1.0	1 in 1.0
20 foot Levee	0.980	1 in 5.5	1 in 3.0	1 in 1.6
25 foot Levee	0.990	1 in 10.5	1 in 5.5	1 in 2.5
30 foot Levee	0.999	1 in 100.5	1 in 50.5	1 in 20.5
Channel	0.975	1 in 4.5	1 in 2.5	1 in 1.4
Detention Basin	0.970	1 in 3.8	1 in 2.2	1 in 1.3
Relocation	0.900	1 in 1.5	1 in 1.1	1 in 1.0

Table A-6: Conditional Probability of Design Non-exceedance

Plan	Conditional Probability of Design Containing Indicated Event					
	10 %	4 %	2 %	1 %	.4 %	.2 %
20 foot Levee	0.990	0.920	0.450	0.100	0.015	0.000
25 foot Levee	0.999	0.990	0.900	0.440	0.075	0.010
30 foot Levee	~1.000	~1.000	0.999	0.985	0.870	0.600
Channel	0.800	0.600	0.350	0.050	0.000	0.000
Detention Basin	0.700	0.550	0.250	0.025	0.000	0.000
Relocation	0.500	0.100	0.015	0.000	0.000	0.000

Table A-7: Probabilistic Values for Population at Risk

Plan	Annual Probability that Population At Risk Equals or Exceeds Indicated Amount with Project				
	0.250	0.100	0.020	0.010	0.001
Without Project	500	1000	2000	2500	5000
20 foot levee	0	0	2000	2500	5000
25 foot levee	0	0	2000	2500	5000
30 foot levee	0	0	0	0	15000
Channel	0	0	500	2000	5000
Detention Basin	0	0	500	2500	5000
Relocation	0	500	1500	2000	4500

Table A-8: Residual Risk Comparison

Plan	Annual Performance (Expected Annual Probability of Design Being Exceeded)
W/O Project	0.250
20 foot Levee	0.020
25 foot Levee	0.010
30 foot Levee	0.001
Channel	0.025
Detention Basin	0.030
Relocation	0.100
Comparable Property	
Fire Damage	0.0010
Wind Damage	0.0050
Earthquake	0.0010

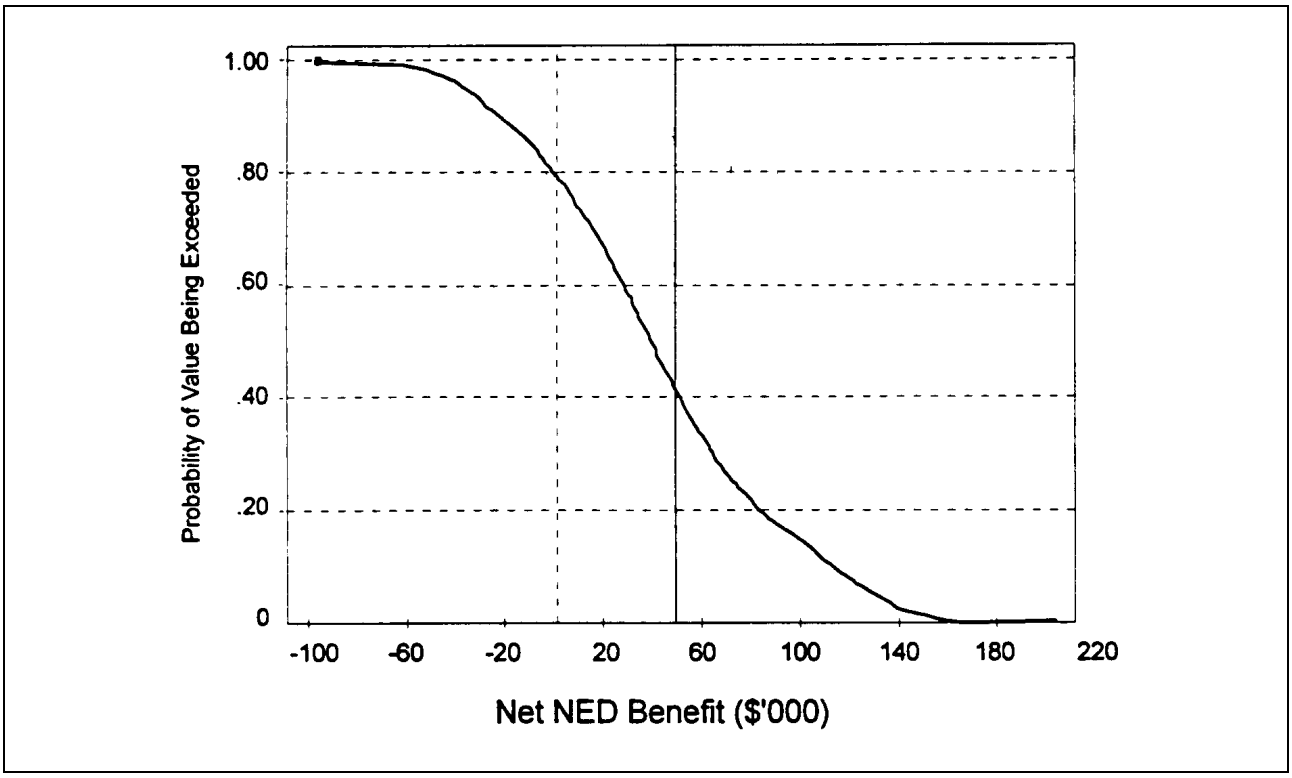

Figure A-1: Cumulative Distribution Function of Net Benefit for 20' Levee

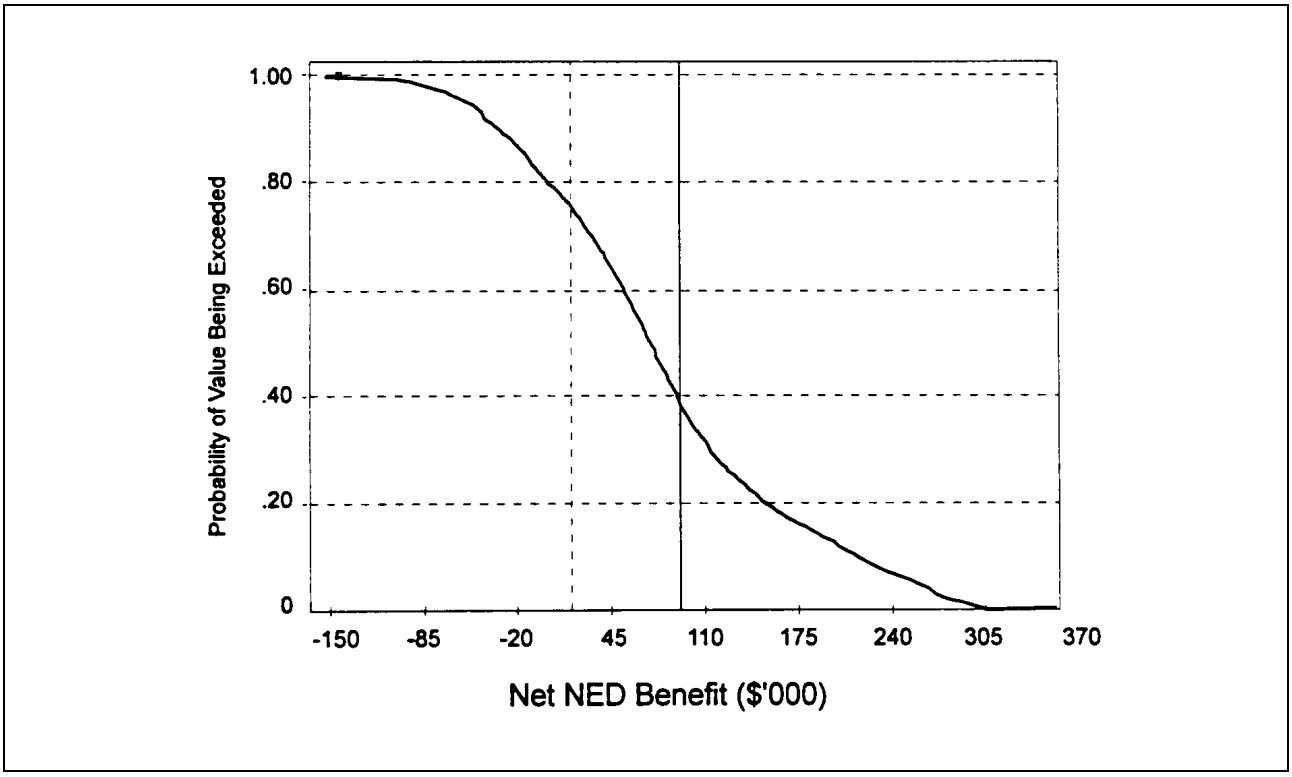

Figure A-2: Cumulative Distribution Function of Net Benefit for 25' Levee

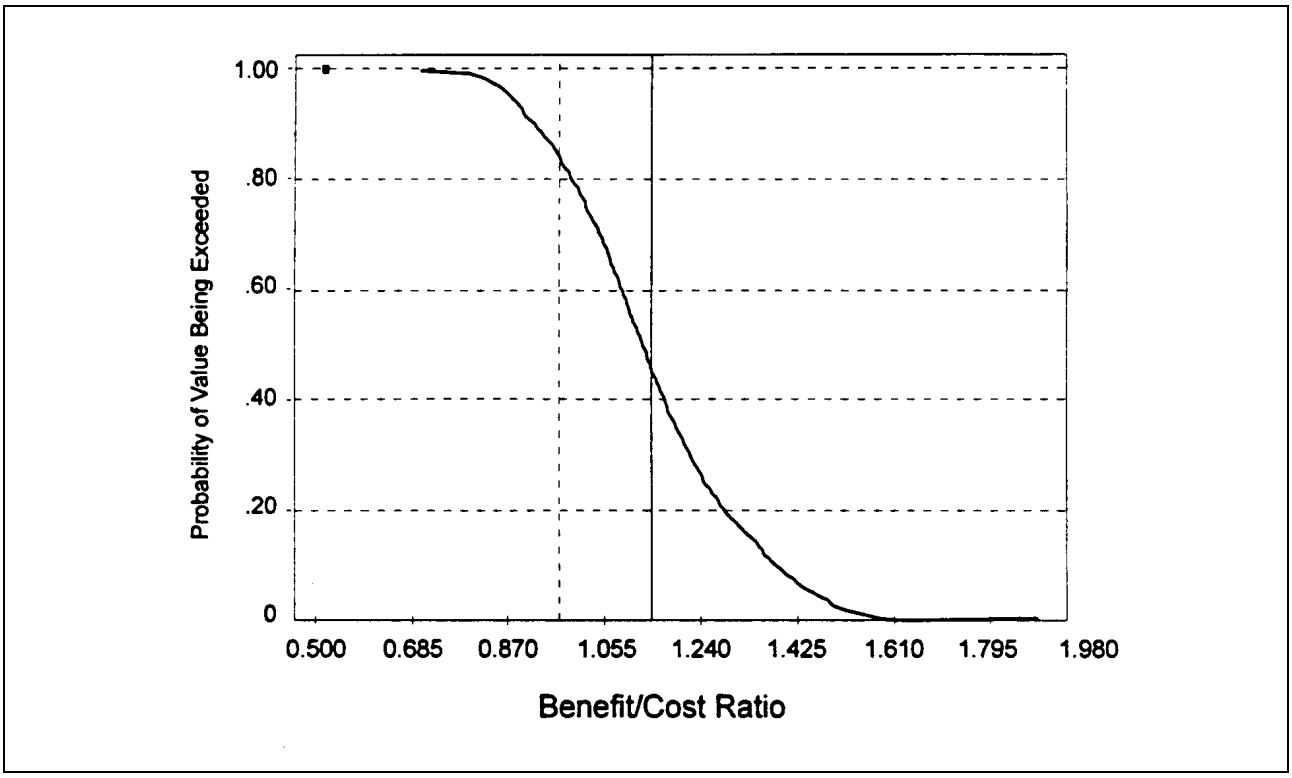

Figure A-3: Cumulative Distribution Function of Benefit/Cost Ratio for 20' Levee

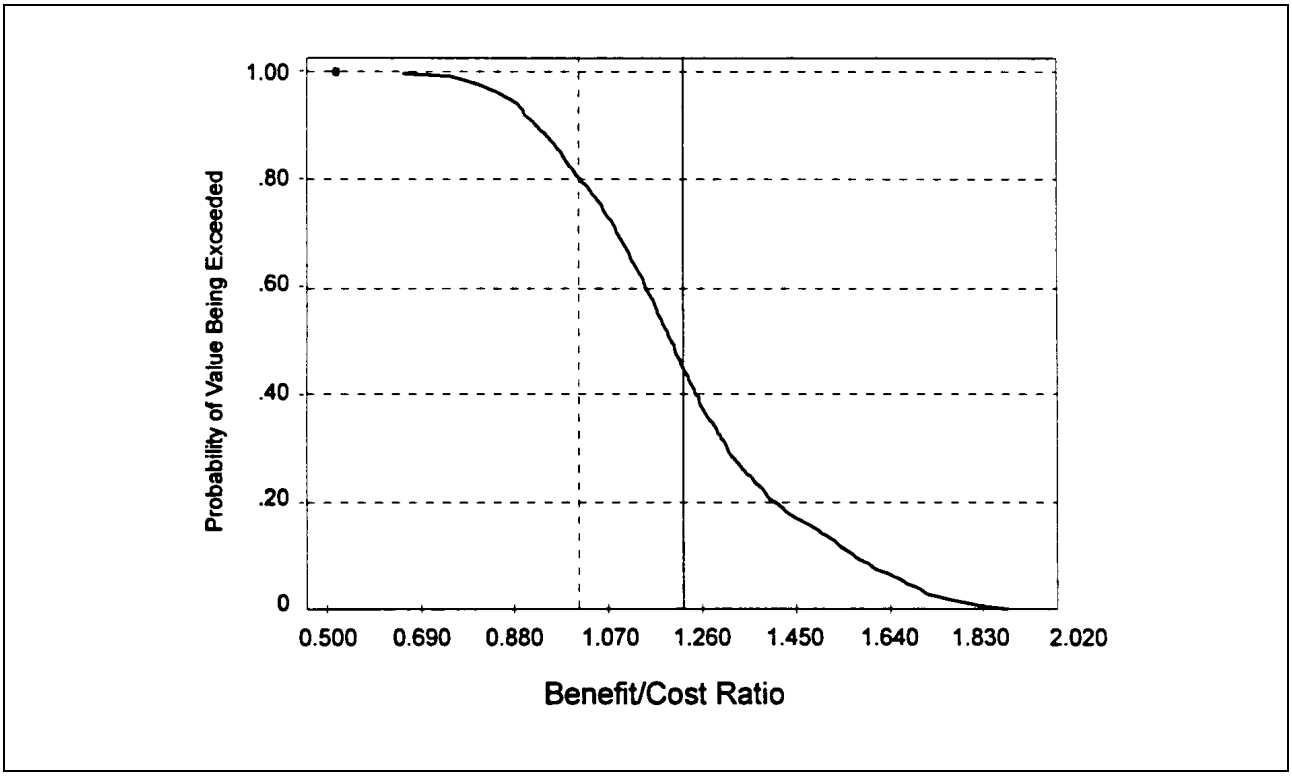

Figure A-4: Cumulative Distribution Function for Benefit/Cost Ratio for 25' Levee

Should the levees protecting My City south of the Your River be threatened, residents could attempt to move to nearby higher ground. The depth of flooding in the protected neighborhoods in this area would generally not exceed that at the river's edge although a few areas would experience flooding of more than 10 feet. New Town, on the other hand, is ringed by levees so that residents trying to leave the area would have to find their way across the main highway system to areas of higher ground. Moreover, because New Town is in a depression, a third of the area would flood to depths over 10 feet. Some areas would flood to as much as 35 feet. Because of the lengthy duration of flooding and the lack of natural drainage from this areas, flood water would likely remain in New Town for 2 weeks or more. With the proposed levee, New Town is subject to a 1 in 100 chance of being flooded in any year but a 1 in 2.5 chance in 50 years. Therefore, the probability of a catastrophic event within the lifetime of most residents is nearly the same as flipping a fair coin and getting heads.

SOURCE: Adapted from: National Research Council. 1995. Flood Risk Management and the American River Basin: An Evaluation. Washington, DC: National Academy Press.

Figure A-5: Example Scenario