Cost/Benefit Analysis of the Proposed Newark Reservoir

May 19, 2002

Gerald Kauffman

UAPP 827-010 Program and Project Analysis

Dr. Paul Solano

Cost/Benefit Analysis of the Proposed Newark Reservoir
May 19, 2002

Objective of Paper

The objective of this paper is to conduct an *in media res* (during the course of a project) cost/benefit analysis (CBA) of the proposed Newark Reservoir. Three alternatives will be evaluated: (A) no reservoir, preserve land for city park, (B) no reservoir, land developed for 200 homes, and (C) 317 mg reservoir, preserve land for city park. The project standing will be the City of Newark with 28,000 residents. The discount rate over a 30-year assumed project life would be 3 percent. The CBA will be conducted using the basic equation: Net Present Value (NPV) = Present Value Benefits (B) minus Present Value Costs (C) or NPV = B – C.

Project Definition

As insurance against drought, the City of Newark, Delaware proposes to build a 317 million-gallon reservoir approximately a mile north of the city downtown. Over a 60-day drought - planning period, the reservoir will provide up to 5 mgd of supplemental water should stream flows in the White Clay Creek (the normal water source) decline to drought flow levels. Groundbreaking for the reservoir was in early May 2002. Construction will begin in June 2002 with project completion and fill up scheduled for fall 2003.

Presently the site is a 109 acre abandoned farm. If the reservoir were not built, the owner was prepared to sell the land to develop 200 homes. The reservoir will include a city park with hiking, bird watching, and other passive recreation activities. The city will fill the reservoir by pumping water through a pipeline about a mile from the White Clay Creek to a head house near the reservoir dam.

The actual cost for the reservoir is $8 million for land acquisition as paid to the seller and $10 million for construction of the reservoir and pump station as bid by the low bid contractor. Estimated operation and maintenance costs are $1.5 million annually for pump station electricity, treatment costs, and reservoir clean out and pump upkeep.

Cost/Benefit Analysis

We will evaluate the cost effectiveness of the proposed Newark Reservoir utilizing the basic steps of a cost/benefit analysis:

1. Specify alternatives.
2. Decide project standing.
3. Catalogue impacts, select indicators, and monetize and attach dollar values.
4. Predict impacts over life of project.
5. Discount benefits and costs to obtain present values.
6. Compute NPV of each alternative.
7. Make recommendation based on the NPV of each alternative.

1. Specify alternatives

Three alternatives will be evaluated for the 109-acre Koelig Farm property:

(A) No reservoir, preserve land for city park.
(B) No reservoir, land developed for 200 homes
(C) 317 mg reservoir preserves land for city park.

Alternative A: The farm would be sold to the city to preserve the site as open space for a city park, which would have environmental and recreational benefits. The city would not have a new reserve supply of water and during drought would be required to buy water from a private water utility for $4.00 per 1000 gallons. Appraisals from ongoing land condemnation proceedings indicate the land cost of the unimproved site for open space park purposes is $6 million. The park land would be removed from city tax rolls.

Alternative B: The land would be sold to a housing developer who would erect 200 homes as recently approved by New Castle County Council. There would be no recreational and environmental benefits. The city would not have a reserve supply of water and during drought would be required to buy water from private water utility for $4.00 per 1000 gallons. Land appraisals from the land condemnation proceedings indicate the land cost of an improved site permitted for homes with water and sewer available is $10 million. The site would be added to the city tax rolls with property taxes accruing from 200 new dwellings.

Alternative C: The land was sold to the city in 2001 for the construction of a 317-mg reservoir and surrounding city park. There would be recreational and environmental benefits from the new park with hiking trails, habitat, and birding. The city would have a new reserve supply of water during drought and would not be required to buy water from a private water utility when stream flows in the White Clay Creek decline during drought. Instead the City could sell the water to its customers for $ 3.00 per 1000 gallons. Land appraisals from the condemnation proceedings indicate the land acquisition costs for the reservoir was $8 million. The reservoir and parkland would be removed from the city tax rolls.

2. Decide project standing.

Next we decide for whom the benefits and costs should be counted. In this case the city funded most of the reservoir and the park. City residents will use the reservoir. Therefore, the project standing will be the 28,000 residents of the City of Newark.

3. Catalogue impacts, select indicators, and monetize values to all impacts.

In this step we associate dollar values to the benefits and costs of the alternatives.

Benefits: Water supply benefits include the willingness to pay by the city voters through referenda to raise property taxes and increase water rates to pay for the reservoir. In 2001, the voters approved by a 3 to 1 margin to raise property taxes approximately $30 per home annually to pay for the reservoir or $280,000 annually for the 9,333 properties in the city. Also

in 2001, the voters approved by referendum to raise water rates from $100 per year for 60,000 gallons used annually to $200 per year, an increase of $100 per year or $933,300 per year for the city.

A third water supply benefit is that the city would not have to buy water at $4.00 per 1000 gallons from a private water utility during drought. Based on stream gage records, during drought the White Clay Creek can reliably provide sufficient water for the 3 mgd treatment plant 84 percent of the time or 305 days per year. The other 16 percent or 60 days in a year the city must buy water at $4.00 per 1000 gallons from another water utility. To provide 3 mgd over 60 days, the city must pay (3 mgd) ($4.00/1000 gal) (1000) (60 days) = $720,000 per year. If the reservoir is not built, this cost not paid is accrued on the "cost" side of the ledger.

Environmental benefits accrue from preserving the land for a park habitat and releasing water to improve the fish habitat in White Clay Creek. The plug in value for habitat preservation is $10 per person per day or $365,000 per year assuming 100 visitors to the park per day. The plug in for improving the White Clay Creek to cold-water fishing through reservoir releases is $30 per year per household or $150,000 annually assuming 5000 trout anglers per year.

Recreational benefits accrue from the preservation of the property as a city park. The plug in values for hiking are $43 per day per person or $1,600,000 annually for 100 park visitors per day. The plug in values for picnicking are $26 per person per day or $950,000 annually for 100 visitors a day.

The state legislature awarded $3.4 M in funds for the acquisition of the City Park as open space which counts as an additional open space benefit.

Costs: Land appraisals during condemnation hearings indicate the acquisition cost of the 109-acre site is $6 million for Alternative A - no reservoir but park, $10 million for Alternative B - no reservoir but 200 homes, and $8 million which was actually paid for Alternative C - build the reservoir and city park.

Construction costs according to engineering contract bids submitted to the City of Newark are $1.0 million for a new park only and $10 million for a new reservoir and new city park.

Maintenance costs of a new park only are $50,000 per year. Estimated maintenance cost of a new reservoir pump station, water treatment, pump electricity and sediment removal are $1.5 million per year.

If the reservoir is not built the city must buy water for $720,000 per year from a private water purveyor for a 60-day period.

If a reservoir is built and new homes are not constructed, then the city loses property tax from 200 homes at $1,000 per property or 200,000 per year which is a cost for Alternatives A and C but a benefit for Alternative B.

4. Predict impacts over life of project.

The fourth task is to predict impacts over the life of the project which is this case will be n = 30 years. Land acquisition and construction costs accrue in year 1 of the project. Maintenance costs and benefits accrue annually over 30 years.

5. Discount benefits and costs to obtain present values.

Since the project occurs over 30 years we next aggregate the benefits and costs that occur in different years to obtain their present values. The discount rate will be 3 percent since the reservoir is funded by municipal, low interest bonds. The U.S. Panel on Cost Effectiveness recommends a 3 percent discount rate for U.S. municipalities. Table 1 calculates the present values of benefits and costs that occur in different years for a discount rate of i = 3 percent with the discount annuity factor.

Table 1
Discount Annuity Factor Convert to Present Value CBA Newark Reservoir

Year	Discount Annuity Factor I = 3%	Water Rates Incr WTP Benefit	Prprty Tax Increase Benefit	Water not Bought Benefit	Land Habitat Benefit	Fish Habitat Benefit	Hiking Benefit	Picnicking Benefit	New Park Maintenance Cost	New Reservoir Maintenance Cost	Lose of Prperty Tax Cost
0	1	933,000	280,000	720,000	365,000	150,000	1,600,000	950,000	50,000	1,500,000	200,000
1	1	905,010	271,600	698,400	354,050	145,500	1,552,000	921,500	48,500	1,455,000	194,000
2	1	877,020	263,200	676,800	343,100	141,000	1,504,000	893,000	47,000	1,410,000	188,000
3	1	849,030	254,800	655,200	332,150	136,500	1,456,000	864,500	45,500	1,365,000	182,000
4	1	821,040	246,400	633,600	321,200	132,000	1,408,000	836,000	44,000	1,320,000	176,000
5	1	802,380	240,800	619,200	313,900	129,000	1,376,000	817,000	43,000	1,290,000	172,000
6	1	783,720	235,200	604,800	306,600	126,000	1,344,000	798,000	42,000	1,260,000	168,000
7	1	755,730	226,800	583,200	295,650	121,500	1,296,000	769,500	40,500	1,215,000	162,000
8	1	718,410	215,600	554,400	281,050	115,500	1,232,000	731,500	38,500	1,155,000	154,000
9	1	709,080	212,800	547,200	277,400	114,000	1,216,000	722,000	38,000	1,140,000	152,000
10	1	690,420	207,200	532,800	270,100	111,000	1,184,000	703,000	37,000	1,110,000	148,000
11	1	671,760	201,600	518,400	262,800	108,000	1,152,000	684,000	36,000	1,080,000	144,000
12	1	653,100	196,000	504,000	255,500	105,000	1,120,000	665,000	35,000	1,050,000	140,000
13	1	643,770	193,200	496,800	251,850	103,500	1,104,000	655,500	34,500	1,035,000	138,000
14	1	615,780	184,800	475,200	240,900	99,000	1,056,000	627,000	33,000	990,000	132,000
15	1	597,120	179,200	460,800	233,600	96,000	1,024,000	608,000	32,000	960,000	128,000
16	1	578,460	173,600	446,400	226,300	93,000	992,000	589,000	31,000	930,000	124,000
17	1	559,800	168,000	432,000	219,000	90,000	960,000	570,000	30,000	900,000	120,000
18	1	541,140	162,400	417,600	211,700	87,000	928,000	551,000	29,000	870,000	116,000
19	1	531,810	159,600	410,400	208,050	85,500	912,000	541,500	28,500	855,000	114,000
20	1	522,480	156,800	403,200	204,400	84,000	896,000	532,000	28,000	840,000	112,000
21	1	513,150	154,000	396,000	200,750	82,500	880,000	522,500	27,500	825,000	110,000
22	1	494,490	148,400	381,600	193,450	79,500	848,000	503,500	26,500	795,000	106,000
23	1	466,500	140,000	360,000	182,500	75,000	800,000	475,000	25,000	750,000	100,000
24	0	457,170	137,200	352,800	178,850	73,500	784,000	465,500	24,500	735,000	98,000
25	0	438,510	131,600	338,400	171,550	70,500	752,000	446,500	23,500	705,000	94,000
26	0	429,180	128,800	331,200	167,900	69,000	736,000	437,000	23,000	690,000	92,000
27	0	419,850	126,000	324,000	164,250	67,500	720,000	427,500	22,500	675,000	90,000
28	0	401,190	120,400	309,600	156,950	64,500	688,000	408,500	21,500	645,000	86,000
29	0	391,860	117,600	302,400	153,300	63,000	672,000	399,000	21,000	630,000	84,000
30	0	382,530	114,800	295,200	149,650	61,500	656,000	389,500	20,500	615,000	82,000
Present Value		**18,221,490**	**5,468,400**	**14,061,600**	**7,128,450**	**2,929,500**	**31,248,000**	**18,553,500**	**976,500**	**29,295,000**	**3,906,000**

6. **Compute Net Present Value (NPV) of each alternative**.

Compute the Net Present Value (NPV) of each alternative as NPV = B – C (Table 2).

Table 2. Net Present Value Over 30 Years at I = 3% CBA Newark Reservoir

	(A) No Reservoir Land for City Park	**(B) No Reservoir Land for 200 Homes**	**(C) 317 MG Reservoir Land for City Park**
Project Benefits ($M)			
Water Supply			
WTP Property Tax	0	0	18.2
WTP Water Rate	0	0	5.5
Environmental			
Fish Habitat	0	0	2.9
Land Habitat	7.1	0	7.1
State Park Funds	3.4	0	3.4
Recreational			
Picnicking	18.5	0	18.5
Hiking	31.2	0	31.2
Property Tax/Avoided Land Cost	0	3.9 + 10	0
Benefits (B)	**60.2**	**13.9 (Prop Tax)**	**86.8**
Project Costs ($M)			
Land Acquisition	6.0	0	8
Construction	1.0	0	10
Maintenance	1.0	0	29.3
Buy Water if no reservoir	14.0	14	0
Loss of Property Tax 200 Homes	3.9	0	3.9
Costs (C)	**25.9**	**14**	**51.2**
Net Present Value (NPV = B-C)	**$34.3 M**	**-$ 0.1 M**	**$ 35.6 M**

7. Make recommendation based on the NPV of each alternative

Public policy makers usually recommend the alternative with the highest net present value since this alternative will cost least over the project lifetime.

Alternative C - Build the reservoir with city park has the highest NPV at $35.6 million since the water supply, recreational, and environmental benefits out-weigh the cost to build and maintain the reservoir over 30 years. The recreational benefits for this alternative are very significant.

Alternative A - No construction of a reservoir but build a park is the next highest NPV at $34.3 million, just less than the build a reservoir alternative. The park accrues significant recreational benefits over the years that outweigh the relatively modest construction cost of a park (as compared to the reservoir) and the cost to buy water from private water utility during drought.

Alternative B - No construction of reservoir and build 200 homes has by far the lowest NPV at -$0.1 million that indicates the project is not cost effective to the residents of Newark. There are hardly any social benefits to the City except for relatively modest property tax income.

Recommendations

This *in media res* cost/benefit analysis of the proposed Newark Reservoir indicates that Alternative C (Build the reservoir) is the most socially beneficial to the standing of Newark from a CBA perspective. This corroborates the decision by Newark City Council to commence construction on this project as per the referenda to raise property taxes and increase water rates that were approved by the voters at 4:1 and 3:1 approval margins, respectively. If for some reason the reservoir is not built in the future, then an advisable alternative would be to buy the farm and build a city park only as this Alternative A (Park only) has appreciable environmental and recreational benefits. If desired, CBA sensitivity analyses could be conducted at interest rates of 5 percent and 7 percent to further verify the cost effectiveness of the proposed Newark Reservoir.

References

Newark Reservoir Files. 2002. Office of the State Water Coordinator, University of Delaware Water Resources Agency

Boardman, A. E. 2001. *Cost - Benefit Analysis Concepts and Practice*. Second Edition. Prentice Hall Publisher.

Walsh, R., et. al. 1992. *Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988.* Water Resources Research, 28. No. 3.

Table 1
Discount Annuity Factor Convert to Present Value CBA Newark Reservoir

Year	Discount Annuity Factor I = 3%	Water Rates Incr WTP Benefit	Prprty Tax Increase Benefit	Water not Bought Benefit	Land Habitat Benefit	Fish Habitat Benefit	Hiking Benefit	Picnicking Benefit	New Park Maintenance Cost	New Reservoir Maintenance Cost	Lose of Prperty Tax Cost
0	1	933,000	280,000	720,000	365,000	150,000	1,600,000	950,000	50,000	1,500,000	200,000
1	1	905,010	271,600	698,400	354,050	145,500	1,552,000	921,500	48,500	1,455,000	194,000
2	1	877,020	263,200	676,800	343,100	141,000	1,504,000	893,000	47,000	1,410,000	188,000
3	1	849,030	254,800	655,200	332,150	136,500	1,456,000	864,500	45,500	1,365,000	182,000
4	1	821,040	246,400	633,600	321,200	132,000	1,408,000	836,000	44,000	1,320,000	176,000
5	1	802,380	240,800	619,200	313,900	129,000	1,376,000	817,000	43,000	1,290,000	172,000
6	1	783,720	235,200	604,800	306,600	126,000	1,344,000	798,000	42,000	1,260,000	168,000
7	1	755,730	226,800	583,200	295,650	121,500	1,296,000	769,500	40,500	1,215,000	162,000
8	1	718,410	215,600	554,400	281,050	115,500	1,232,000	731,500	38,500	1,155,000	154,000
9	1	709,080	212,800	547,200	277,400	114,000	1,216,000	722,000	38,000	1,140,000	152,000
10	1	690,420	207,200	532,800	270,100	111,000	1,184,000	703,000	37,000	1,110,000	148,000
11	1	671,760	201,600	518,400	262,800	108,000	1,152,000	684,000	36,000	1,080,000	144,000
12	1	653,100	196,000	504,000	255,500	105,000	1,120,000	665,000	35,000	1,050,000	140,000
13	1	643,770	193,200	496,800	251,850	103,500	1,104,000	655,500	34,500	1,035,000	138,000
14	1	615,780	184,800	475,200	240,900	99,000	1,056,000	627,000	33,000	990,000	132,000
15	1	597,120	179,200	460,800	233,600	96,000	1,024,000	608,000	32,000	960,000	128,000
16	1	578,460	173,600	446,400	226,300	93,000	992,000	589,000	31,000	930,000	124,000
17	1	559,800	168,000	432,000	219,000	90,000	960,000	570,000	30,000	900,000	120,000
18	1	541,140	162,400	417,600	211,700	87,000	928,000	551,000	29,000	870,000	116,000
19	1	531,810	159,600	410,400	208,050	85,500	912,000	541,500	28,500	855,000	114,000
20	1	522,480	156,800	403,200	204,400	84,000	896,000	532,000	28,000	840,000	112,000
21	1	513,150	154,000	396,000	200,750	82,500	880,000	522,500	27,500	825,000	110,000
22	1	494,490	148,400	381,600	193,450	79,500	848,000	503,500	26,500	795,000	106,000
23	1	466,500	140,000	360,000	182,500	75,000	800,000	475,000	25,000	750,000	100,000
24	0	457,170	137,200	352,800	178,850	73,500	784,000	465,500	24,500	735,000	98,000
25	0	438,510	131,600	338,400	171,550	70,500	752,000	446,500	23,500	705,000	94,000
26	0	429,180	128,800	331,200	167,900	69,000	736,000	437,000	23,000	690,000	92,000
27	0	419,850	126,000	324,000	164,250	67,500	720,000	427,500	22,500	675,000	90,000
28	0	401,190	120,400	309,600	156,950	64,500	688,000	408,500	21,500	645,000	86,000
29	0	391,860	117,600	302,400	153,300	63,000	672,000	399,000	21,000	630,000	84,000
30	0	382,530	114,800	295,200	149,650	61,500	656,000	389,500	20,500	615,000	82,000
Present Value		**18,221,490**	**5,468,400**	**14,061,600**	**7,128,450**	**2,929,500**	**31,248,000**	**18,553,500**	**976,500**	**29,295,000**	**3,906,000**