2020

NORTH Dakota | Water Commission

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North Dakota Guidance for Life Cycle Cost Analysis of Water Supply Projects

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INTRODUCTION AND OVERVIEW

1.1 BACKGROUND - ND LEGISLATION AND STATUTES

The 65th (2017) Legislative Assembly passed House Bill 1020 – the North Dakota State Water Commission's budget bill. Section 21 of the bill provided for a new section of North Dakota Century Code (NDCC), Chapter 61-03. Specifically, NDCC 61-03-21.4 requires:

> The State Engineer shall develop an economic analysis process for water conveyance projects and flood-related projects expected to cost more than one million dollars, and a life cycle analysis process for municipal water supply projects. When the State Water Commission is considering whether to fund a water conveyance project, flood-related project, or water supply project, the State Engineer shall review the economic analysis or life cycle analysis, and inform the State Water Commission of the findings from the analysis and review.

The 65th Legislative Assembly also passed HB 1374, providing a definition for "life cycle analysis" in NDCC 61-02-02.

> **LIFE CYCLE ANALYSIS**
>
> means the summation of all costs associated with the anticipated useful life of a project, including project development, land, construction, operation, maintenance, and disposal or decommissioning.

Project sponsors of water supply projects are required to submit a Life Cycle Cost Analysis (LCCA) for projects requesting cost-share. Sponsors are required to use the current LCCA electronic model available for download from the State Water Commission website. The steps outlined in the Appendix provide a detailed description of the data required and how to use the fillable electronic LCCA model for water supply projects and evaluation of alternative projects.

1.2 PURPOSE

To meet the statutory requirements of NDCC 61-03-21.4, this document, the North Dakota Guidance for Life Cycle Cost Analysis of Water Supply Projects, has been developed to:

- Explain the Life Cycle Cost Analysis (LCCA) concept;
- Outline the basic elements of what is included in an LCCA;
- Provide an overview of why LCCA is conducted, how it's used, and the benefits it provides; and
- Provide a process for conducting LCCA - from a North Dakota perspective.

1.3 WHAT IS LCCA?

Life Cycle Cost Analysis (LCCA) is an analytical method that can assist in selecting the most cost-effective water supply alternative that can achieve the desired long-term service life and meet the needs of a community. LCCA enables a community or project sponsor to compare the total costs,

over time, of multiple alternatives, each of which may be appropriate for implementation. Under a simpler scenario, if a single alternative is selected, LCCA can be used to better understand the timing of total costs associated with that project – from its beginning stages, to the end of its useful life. LCCA considers general guidelines and best practices for application and follows basic economic principles to encourage uniformity and achieve useful results.

LCCA, in lieu of only calculating initial capital construction costs, is essential in evaluating all of the long-term implications of different strategies to achieving an extended service life, but which have different levels and timing of cost requirements. Generally speaking, key elements in the LCCA include initial costs and all relevant future costs associated with required inspection, maintenance, repair, rehabilitation, and possible component replacement, including associated demolition, disposal, and user costs.

IMPORTANT NOTE

It is important to note that the lowest life cycle cost option may not necessarily be implemented when other considerations such as risk, budget constraints, and political and environmental concerns are taken into account. LCCA provides critical information to the overall decision-making process, but not the final answer.

BASIC ELEMENTS OF LCCA

North Dakota Life Cycle Cost Analyses for water supply projects should include:		
Element	Description	Example
CAPITAL COST	Construction costs to put the asset into initial service.	Construction costs may be obtained from historical records, current bids, and engineering judgment.
ANNUAL OPERATIONS AND MAINTENANCE COSTS (O&M)	These costs include those for preventive maintenance activities that are planned to extend the life of the asset.	Day-to-day routine maintenance intended to address safety, and operational concerns.
PERIODIC REPAIR, REHABILITATION, AND REPLACEMENT COSTS	These costs include those for preventive activities that are also planned to extend the life of the asset but require more extensive action such as rehabilitation or replacement of equipment and infrastructure.	Pumping equipment may have a useful life of 10 years before needing more extensive servicing (rehabilitation) and eventually replacement. If using a 30-year period of analysis, the LCCA should include repair, rehabilitation, and replacement costs for pumping equipment at years 10, 20, and 30 (or other intervals as appropriate for a specific system).
SALVAGE VALUE	The final cost is the value of the infrastructure and equipment at the end of the life cycle. This may be considered end-of-life costs.	If a distribution pipeline with an expected useful life of 50 years was installed in the first year of the study period (30 years), the salvage value would be approximately 40% (=(50-30)/50) of its initial cost. Salvage value may be positive (in the case where the component/system has value) or negative (in the case where demolition costs are incurred).

Care should be taken to avoid double counting. All of this information is compiled to calculate a total present value cost (PVC), which is the summation as shown below:

FORMULA

PVC = PV FACTOR (CAP) + PV FACTOR (O&M) + PC FACTOR (RRR) +/- PV FACTOR (SV)

Where:

PVC	present value of costs
CAP	up-front capital costs
O&M	annual operations & maintenance costs
RRR	time-specific repair, rehab, & replacement costs
SV	salvage value (may be either + or -)

1.4 WHY USE LCCA?

It is important to note that the lowest life cycle cost option may not necessarily be selected for implementation when other considerations are taken into account. LCCA provides critical economic information to the overall decision-making process, but it is not the sole decision-making criterion.

Decisions related to implementation of a water supply project should generally require that more than one reasonable alternative be considered. Many factors may contribute to a community's decision to select a particular option, such as risk, budget constraints, and political and environmental concern. And, although initial project costs may dominate this decision, it is only part of the story.

Selection of an alternative will commit a community to future expenditures for operation, maintenance, and rehabilitation actions over the life of a project. The LCCA framework provides the means to include initial construction costs, as well as all future expenditures associated with a project. Finally, LCCA provides a measure of transparency through documentation of the LCCA process, which then provides the project sponsor with the ability to demonstrate the best use of the public's funds in selecting a project. LCCA also highlights future expenses that need to be included in future infrastructure budgets for rehabilitation, repair, and replacement accounts.

1.5 KEY CONCEPTS FOR LCCA

LCCA incorporates several key economic concepts, such as discounting and present value, constant vs. real dollars, and financial vs. economic analysis. A clear understanding of these concepts is crucial to gaining local decision makers' acceptance of LCCA results.

DISCOUNTING AND PRESENT VALUE - An inherent problem in any evaluation or decision analysis is the difficulty of making value comparisons among projects that are not measured in common units. For example, dollars spent today are not equal to dollars projected to be spent in 50 years. To account for this, all future costs are converted to present value costs through a process known as discounting, which shows what a dollar received in 50 years, for example, is worth today. Discounting is accomplished using a discount rate selected to represent the time value of money. For the ND LCCA guidance, the recommended rate is the annual discount rate published in US Army Corps of Engineers Economic Guidance Memorandum (EGM) Federal Discount Rate, table: Water Supply Interest Rates[1]. The EGM is updated annually so current federal rates should be used. For 2017, the federally approved discount rate was 2.875%. Higher discount rates benefit projects with more costs incurred in the future, while the lower discount rates benefit projects with more up-front costs[2]. If the timing of costs is similar between projects, the discount rate has little effect on the economic analysis.

Life cycle costs are converted to present value using the following calculation:

In an LCCA FRAMEWORK where costs occur over the life of the project, total present value costs are obtained by summing the present value of each annual cost.

For example, consider a project with costs occurring over 4 years. With a discount rate of 2.875%, the table below shows the calculation of present value in each year. The total present value cost is $11,395 or the sum of the present value costs in the last row of Table 1 over all four years.

FORMULA

$$PV = \frac{FV}{(1+r)^n}$$

Where: PV present value of the cost or benefit
FV the future value of the cost or benefit
r the discount rate
n the current time period in years

TABLE 1

YEAR	1	2	3	4
Cost	$5,000	$5,000	$1,000	$1,000
Discount Rate (2017)	2.875	2.875	2.875	2.875
Present Value Calculation	$PV = \frac{\$5000}{(1.02875)^1}$	$PV = \frac{\$5000}{(1.02875)^2}$	$PV = \frac{\$1000}{(1.02875)^3}$	$PV = \frac{\$1000}{(1.02875)^4}$
Present Value Cost	$4,860	$4,724	$918	$893

[1] Economic Guidance Memorandum 18-01, Federal Interest Rates for Corps of Engineers Projects | https://planning.erdc.dren.mil/toolbox/library/EGMs/EGM18-01.pdf

[2] More information on discounting and present value can be found in the CRS Report "Discount Rates in the Economic Evaluation of U.S. Army Corps of Engineers Projects." August 2016. | https://www.everycrsreport.com/reports/R44594.html

ANALYSIS PERIOD

Water supply projects are constructed to provide service for current and future generations. Competing design alternatives may each have a different service life, which is the time period that the asset will remain functional without major repairs. Life-cycle cost analysis (LCCA), however, uses a common period of time to assess cost differences between these alternatives so that the results can be compared against one another in an apples-to-apples basis. This time period is termed the "analysis period."

Allowing analysis periods to vary among design alternatives would result in the comparison of alternatives with different total benefit levels, which is not appropriate under LCCA. The analysis period should demonstrate the total cost differences between the alternatives. Accordingly, the analysis period should be long enough to include the initial construction or major rehabilitation action and at least one subsequent rehabilitation action for each alternative. However, each alternative does not need to have the same number of maintenance or rehabilitation activities during the analysis period.

**Please note, this guidance document provides a process for conducting life cycle cost analysis of water supply projects as required by statute. Financial analysis is a separate and independent process that is outside the scope of what is required within this guidance.*

FINANCIAL VS. LIFE CYCLE COST ANALYSIS - It should also be noted that economic and financial analyses are not the same. The objective of economic analysis and LCCA is to determine the least costly alternative. The objective of financial analysis is to determine financial feasibility (that is, whether someone is willing to pay for a project and has the capability to raise the necessary funds). The key differences between economic analysis and financial analysis are as follows:

LIFE CYCLE COST ANALYSIS

- Although LCCA can be evaluated from many different perspectives (individuals, communities, etc.), the State Water Commission is conducting these analyses from a statewide perspective.
- All project costs, capital and annual operation costs, are estimated in uninflated dollars.
- Costs are adjusted to show expected differences in their relative economic value over time.
- Economic discount rate is applied to account for time value of project costs produced by the project.
- Project inputs are valued at their economic opportunity cost.
- Financing costs are not included.

FINANCIAL ANALYSIS

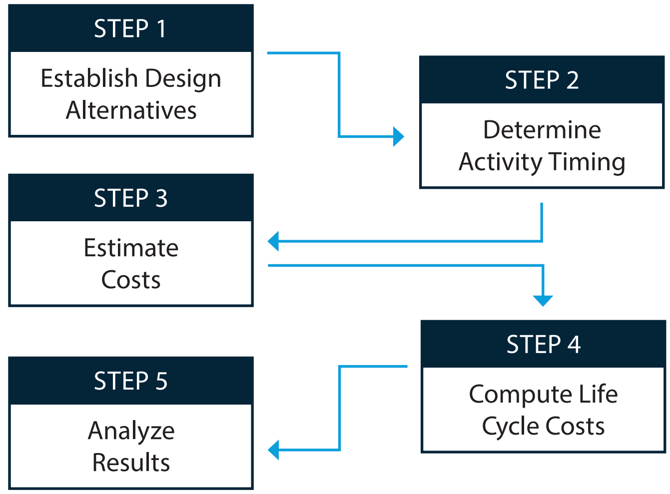
- Evaluation is from the perspective of parties expected to pay their allocated costs.
- Evaluation period is the bond repayment period (for example, 20 years).
- Project costs are expected monetary outlays to implement and operate the project.
- Project income and capital and annual operation costs are estimated in inflated dollars. This bond interest rate includes both inflation and income to the lender and is therefore a representation of the cost of financing and not the opportunity cost of the project.
- Expected interest rate of bonds sold to finance the project is used as the time value of project costs.
- Project inputs are valued at their purchase cost.
- Bond sale and service costs are included.

FIVE STEP COMPLETION

Completion of these five steps in LCCA can be accomplished through the use of LCCA worksheets, which take the user step-by-step through the analysis. The worksheets are available via the Water Commission's website at www.swc.nd.gov, under the "Project Development" tab.

1.6 PROCESS TO CONDUCT LCCA

LCCA involves five steps, ordered so that the analysis builds upon information gathered in prior steps. The analyst should review the worksheets presented in the Appendix to become familiar with the specific inputs needed in each step of LCCA.



1. ESTABLISH DESIGN ALTERNATIVES - This starts with fully articulating the problem statement, and identifying strategies to address the key objectives to resolving the problem. Next, identifying tactical approaches to implement each strategic alternative. Then a reasonable subset of potential design alternatives with criteria for inclusion and exclusion are narrowed for more detailed comparison. This step involves establishing the elements of initial design and identifying the associated activities that will be required throughout its service life for maintenance, rehabilitation, or element replacement within a system or subsystem, for each alternative being considered. An alternative is another way of accomplishing an objective, not simply a modification of one alternative.

2. DETERMINE ACTIVITY TIMING - The timing of associated activities tied to each alternative throughout the period of comparison must be determined. Estimating when certain activities must be performed is important in making valid comparisons between/among alternatives. This process might involve identifying required maintenance on a yearly basis, or levels of potential rehabilitation due to expected wear after a specified period of time, or when individual components or elements such as valves or bearings may have to be replaced. Project specific data are important in establishing when various levels of maintenance, rehabilitation, or replacement may be required. In the absence of retrievable timing data, expert opinion can be used.

3. ESTIMATE COSTS - This step involves estimating the initial construction cost associated with each alternative and the costs associated with future operations, maintenance, rehabilitation, and replacement activities. Costs are computed on the basis of current cost data.

4. COMPUTE LIFE CYCLE COSTS - This step involves computing PVC for each alternative.

5. ANALYZE RESULTS - This step involves comparing the present value of all costs throughout a life-cycle across alternatives and determining the most cost-effective solution (the one with the lowest PVC).

APPENDIX: LIFE CYCLE COST ANALYSIS WORKSHEET FOR EVALUATING WATER SUPPLY PROJECTS

1.7 INTRODUCTION TO LIFE CYCLE COST ANALYSIS WORKSHEET FOR EVALUATING WATER SUPPLY PROJECTS

THE LIFE CYCLE COST ANALYSIS WORKSHEET is an MS Excel Spreadsheet-based worksheet designed to allow project analysts to carry-out a simplified and straightforward LCCA for up to four (4) water supply alternatives. The LCCA worksheet is available for download via the Water Commission's website at WWW.SWC.ND.GOV under the "Project Development" tab. For practical purposes and ease of use, users should be focused on data entry within worksheets '1-Inputs' and '2-Detailed Costs,' with results found in worksheets '3- Results Summary,' and '4-LCCA.'

The worksheets are structured as follows:

TITLE PAGE – The first page, which opens with the model, shows the version date. NOTE The most current version must be used at the time of submission.

HOW TO – This worksheet provides the user information on each of the worksheets, where data can be entered, notes, and other updated guidance.

"1 – INPUTS" - This is the primary data entry worksheet where users provide brief descriptions of the alternatives being considered (up to 4), as well as, information on annual O&M and length of project construction. The SWC requires a "Do Nothing" and regionalization alternatives be included or verification as to why they are not considered.

"2 – DETAILED COSTS" - This is the secondary data entry worksheet where users enter itemized costs by specific major categories. The worksheet will assign a standard useful life based on the category selected. Users may override this function and provide a useful life if professional judgment warrants doing so on Tab #7 - Cost Category List.

"3 – RESULTS SUMMARY" – This worksheet serves as the summary for all outputs created in the model. For the given inputs, the Results Summary provides an overview of capital costs; annual O&M; repair, rehabilitation, and replacement costs; and salvage value. Under the Results Summary, the user will find costs for each category, and alternative.

"4 – LCCA" – This worksheet is where the user can review the present value calculations for up to 4 alternatives. Contact staff if you require more than 4 alternatives.

"5 – LCCA WORKSHEET" - This worksheet is a background calculation. In this sheet, the life cycle costs are computed for each alternative.

"6 – ANALYSIS YEARS" - This worksheet is a background calculation. In this sheet, costs for rehabilitation cycles and salvage values are estimated.

"7 – COST CATEGORY LIST" – This worksheet contains lists for functional cost categories and associated useful life of categories. Users can add categories as needed on this page. Source, or justification for changes and additions should be briefly explained.

ENTERING DATA

The user should be prepared to provide project descriptions, detailed timeline and construction costs, assign construction costs to cost categories, provide the expected duration of construction, and an estimate of annual operations and maintenance.

In the data entry worksheets, "1 – Inputs" and "2 – Detailed Costs," cells (intersections of rows and columns) are color coded for ease of use.

Yellow cells show calculations or are references to other worksheets.

Orange Cells are cells requiring the user to enter project specific data.

STEP 1: PROCEED TO "1 - INPUTS" WORKSHEET TO BEGIN DATA ENTRY.

In the data entry worksheet "1 – Inputs," the necessary inputs for each alternative are outlined in the table below.

DATA INPUT	UNITS	NOTES
BASE YEAR FOR THE LCCA MODEL PERIOD OF ANALYSIS	Year	This year will be the first year of the analysis and typically is set as the year in which the analysis is being conducted.
NAME OF ALTERNATIVE	Not Applicable	Enter a name that is relevant and differentiates each alternative. Limit the name to 40 characters.
DESCRIPTION OF ALTERNATIVE	Not Applicable	Provide one or more sentences that succinctly describes the alternative and differentiates each alternative from the others. Include major activities or features of each alternative.
YEARS OF CONSTRUCTION	Years	This should be based on anticipated project schedules.
ANNUAL OPERATIONS AND MAINTENANCE	Dollars	This is an estimate of the expected annual O&M for the alternative.

STEP 2: ENTER THE BASE YEAR FOR THE LCCA MODEL PERIOD OF ANALYSIS.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Input	Units	Input Value	Definition of Term	Reference
Base Year for LCCA Model Period of Analysis	Year	**2018**	Beginning of analysis period	HDR
Analysis Duration	Years	50		
End Year for LCCA Model Period of Analysis	Year	2068	Ending year of analysis period	Assumes 50 years of operations
Discount Factor	%	2.875%	Discount factor used for present value calculations	Discounting is the process of determining the present value of a payment or a stream of payments that is to be received in the future. Given the time value of money, a dollar is worth more today than it would be worth tomorrow. Source EGM 18-01 - https://planning.erdc.dren.mil/toolbox/library.cfm?Option=Start
Total Volume of Water Provided by the Project	1000's/Day		Thousands of Gallons Per Day	

Name of Alternative	**Alternative 1**
Description of Alternative	**Description of Alternative 1**

STEP 3: ENTER THE TOTAL CAPACITY OF THE PROJECT IN THOUSANDS OF GALLONS PER DAY.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Input	Units	Input Value	Definition of Term	Reference
Base Year for LCCA Model Period of Analysis	Year	2018	Beginning of analysis period	HDR
Analysis Duration	Years	50		
End Year for LCCA Model Period of Analysis	Year	2068	Ending year of analysis period	Assumes 50 years of operations
Discount Factor	%	2.875%	Discount factor used for present value calculations	Discounting is the process of determining the present value of a payment or a stream of payments that is to be received in the future. Given the time value of money, a dollar is worth more today than it would be worth tomorrow. Source EGM 18-01 - https://planning.erdc.dren.mil/toolbox/library.cfm?Option=Start
Total Volume of Water Provided by the Project	1000's/Day	**100.00**	Thousands of Gallons Per Day	

Name of Alternative	**Alternative 1**
Description of Alternative	**Description of Alternative 1**

STEP 4: DEFINE THE FIRST ALTERNATIVE – (SEE STEPS 4A-4C).

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Name of Alternative	Alternative 1			
Description of Alternative	Description of Alternative 1			

Capital Investment		Units	Alternative 1	Notes
Construction	Total Construction	$	$575,000	
	Years of Construction	Years	3	
Annual O&M	Annual O&M	$	$150,000	

STEP 4A: PROVIDE A NAME FOR THE ALTERNATIVE AND DESCRIPTION OF THE ALTERNATIVE.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Name of Alternative	Alternative 1
Description of Alternative	Description of Alternative 1

Capital Investment		Units	Alternative 1	Notes
Construction	Total Construction	$	$575,000	
	Years of Construction	Years	3	
Annual O&M	Annual O&M	$	$150,000	

STEP 4B: PROVIDE THE EXPECTED DURATION OF CONSTRUCTION FOR THE ALTERNATIVES.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Name of Alternative	Alternative 1
Description of Alternative	Description of Alternative 1

Capital Investment		Units	Alternative 1	Notes
Construction	Total Construction	$	$575,000	
	Years of Construction	Years	3	
Annual O&M	Annual O&M	$	$150,000	

STEP 4C: PROVIDE AN ESTIMATE OF THE EXPECTED ANNUAL O&M FOR THE ALTERNATIVE.

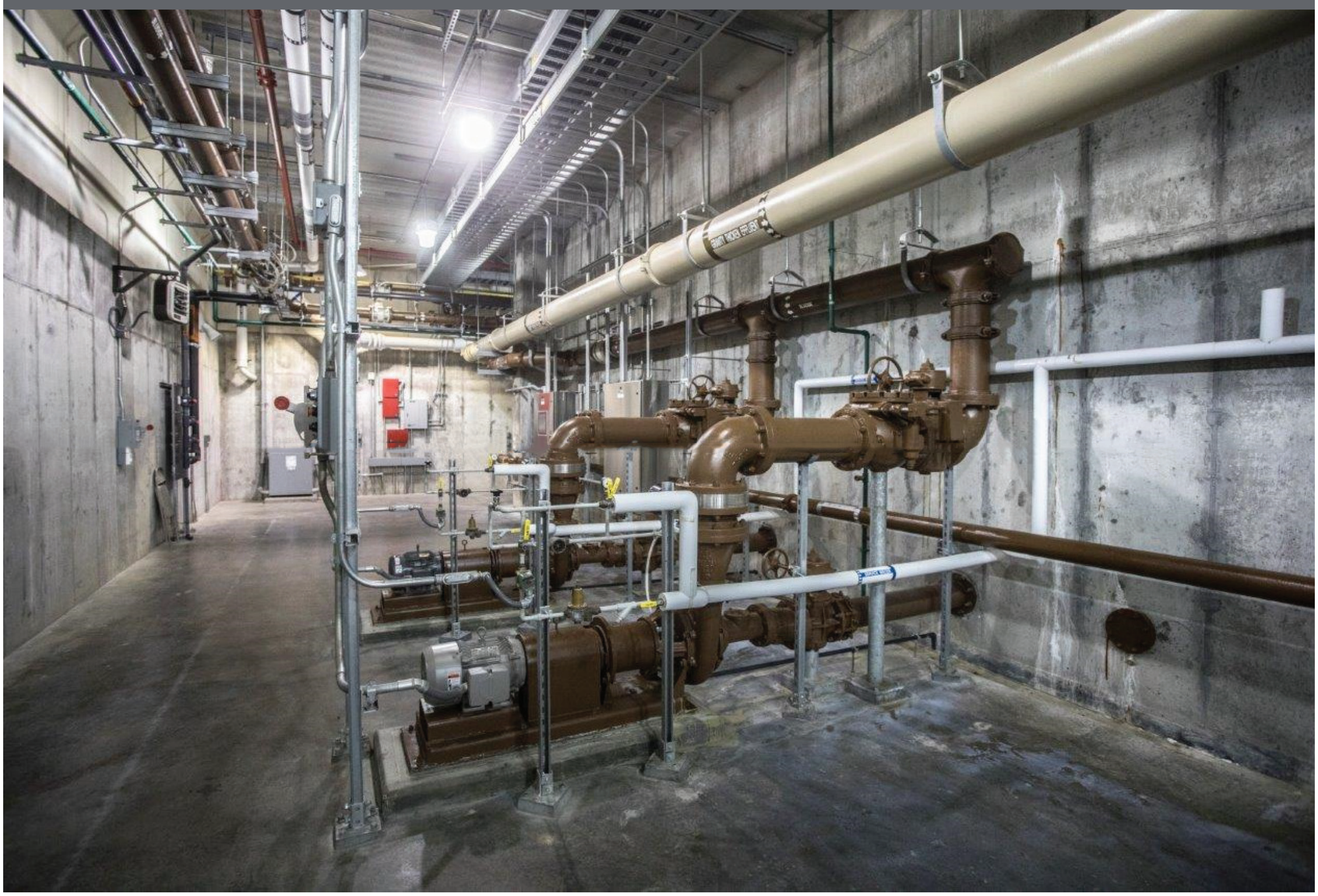
Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Name of Alternative	Alternative 1
Description of Alternative	Description of Alternative 1

Capital Investment		Units	Alternative 1	Notes
Construction	Total Construction	$	$575,000	
	Years of Construction	Years	3	
Annual O&M	Annual O&M	$	$150,000	

NOTE: REPAIR, REPLACEMENT, AND REHABILITATION COSTS ARE COVERED ELSEWHERE.

STEP 5, 6, & 7: REPEAT STEP 4 FOR UP TO THREE ADDITIONAL ALTERNATIVES.



STEP 8: PROCEED TO THE "**2 - DETAILED COSTS**" WORKSHEET FOR EACH ALTERNATIVE.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Alternative 1

Total Cost: $6,374,000

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
					Category	Useful Life	

IN THE DATA ENTRY WORKSHEET
"2 - Detailed Costs," users will enter itemized detailed project construction costs data in columns A through H.

DESCRIPTION (COLUMN A)
Users provide a description for each project element with an itemized alternative cost.

QUANTITY (COLUMN B)
Users provide a quantity for the cost item.

UNITS (COLUMN C)
Users define the units associated with the cost item. For example, linear feet (LF).

UNIT COST (COLUMN D)
Users provide the unit cost for each cost item.

COST (COLUMN E)
Calculated (and rounded) based on previous quantity and unit cost entries.

COST CATEGORY (COLUMN F)
Users assign the costs to a predefined functional cost category.
Cost categories are predefined in the model in tab "7 - Cost Category List".

USEFUL LIFE (COLUMN G)
The worksheet will automatically assign the itemized cost a useful life based on the selected cost category.
Users may override this function and provide a useful life if professional judgment warrants doing so.
However, the user is required to note justification for the change.

NOTES (COLUMN H)
Users can provide annotations describing any unique elements about the cost item or specific assumptions if necessary.

STEP 8A: ENTER "DESCRIPTIONS" OF THE DETAILED COST BREAKDOWN IN COLUMN A.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Alternative 1

Total Cost: $6,374,000

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
Watermain	1	-			Category	Useful Life	
North Loop	1	-			Category	Useful Life	
Connection	1	-			Category	Useful Life	
Town Water Storage	1	-			Category	Useful Life	
Town Water Tower	1	-			Category	Useful Life	
		-			Category	Useful Life	

STEP 8B: ENTER THE "QUANTITY", "UNITS", AND "UNIT COST" FOR EACH PROJECT.

Orange cells are for entering project specific data

Yellow cells reference data from other worksheets

Alternative 1

Total Cost **$6,374,000**

NOTE: When entering cost data, the total cost calculation will update automatically

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
Groundwater Wells	3	-	$150,000	$450,000	Groundwater Wells	20	
Filtration	1	-	$100,000	$100,000	Water Treatment	20	
Chlorination System	1	-	$25,000	$25,000	Water Treatment	20	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	

STEP 8C: ASSIGN A PREDEFINED FUNCTIONAL "COST CATEGORY" IN COLUMN F.

Orange cells are for entering project specific data

Yellow cells reference data from other worksheets

Alternative 1

Total Cost **$6,374,000**

Clicking on the cell will activate the drop-down

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
Groundwater Wells	3	-	$150,000	$450,000	Groundwater Wells	20	
Filtration	1	-	$100,000	$100,000	Water Treatment	20	
Chlorination System	1	-	$25,000	$25,000	Water Treatment	20	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	

Cost Categories are predefined in the model. Clicking on the cell will open a drop down menu with the list of cost categories to select from.

Useful Life (Column G) will automatically assign the itemized cost for a useful life based on the selected cost category.

STEP 8D: REVIEW VALUES IN "USEFUL LIFE" COLUMN G.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Alternative 1

Total Cost **$6,374,000**

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
Groundwater Wells	3	-	$150,000	$450,000	Groundwater Wells	20	
Filtration	1	-	$100,000	$100,000	Water Treatment	20	
Chlorination System	1	-	$25,000	$25,000	Water Treatment	20	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	

These values are automatically assigned based on the selected "Cost Category" from Step 8C. If a different "Useful Life" is expected, a custom value can be entered directly into the cell to override. Justification is required in the "Notes" describing the justification for the change in the "Useful Life".

STEP 8E: PROVIDE ANY "NOTES" DESCRIBING THE UNIQUE PROJECT ELEMENTS.

Orange cells are for entering project specific data	Yellow cells reference data from other worksheets

Alternative 1

Total Cost **$6,374,000**

Description	Quantity	Units	Unit Cost	Cost	Cost Category	Useful Life	Notes
Groundwater Wells	3	-	$150,000	$450,000	Groundwater Wells	20	
Filtration	1	-	$100,000	$100,000	Water Treatment	20	
Chlorination System	1	-	$25,000	$25,000	Water Treatment	20	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	
		-		$0	Category	Useful Life	

"Notes" can be added in Column H to provide any annotation describing unique project elements about the cost item or specific assumptions if necessary.

Users can document any changes to "Useful Life" from the preassigned values.

Notes can also be used to differentiate between detailed costs for two similar alternatives.

STEP 9: REPEAT STEP 8 FOR UP TO THREE ADDITIONAL ALTERNATIVES.

Once all data entry in the "**1 – Inputs**" and "**2 - Detailed Costs**" worksheets are completed, users can proceed to the "**3 – Results Summary**" worksheet to compare PVCs (present values of all costs) of alternatives. You're done! Write it up.

1.8 PRESENTATION AND COMPARISON OF RESULTS

Reviewing the findings is done in the "3 – Results Summary" worksheet. In this worksheet the LCCA is summarized to provide a comparison of PVCs. The data are presented in tabular and graphical format to allow the user to easily distinguish the least cost alternative.

With the life cycle costs computed, the PVCs may be compared across the selected water supply alternatives. The Life Cycle Cost Analysis Worksheet for Evaluating Water Supply Projects provides the user a summary of the findings to make this comparison simple and straightforward. The most basic analysis of a LCCA is to compare the PVCs between/among alternatives and to identify the least cost alternative. If necessary, the LCCA should be updated upon reviewing the findings to adjust or modify for unaccounted for costs prior to selecting a finalized alternative.

RESULTS SUMMARY

Users are presented with a summary of the Present Value of Capital Costs, Annual O&M, Repair, Rehab, and Replacement Costs, and Salvage Value for each alternative. Comparing the cost breakdown will demonstrate how projects differ over their entire life cycle.

The best economic option is simply the alternative with the lowest life cycle cost or net present value, all other things equal.

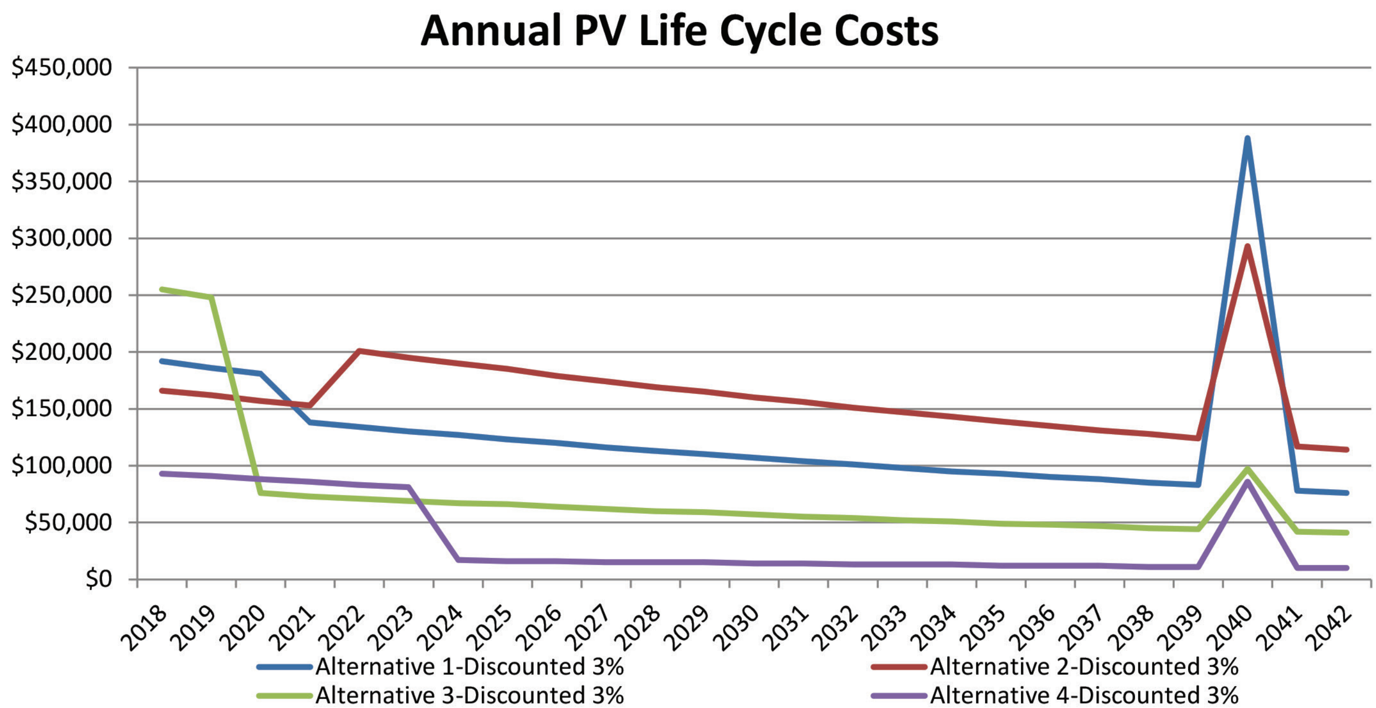
Scenario Analysis - Present Value Life Cycle Cost Summary

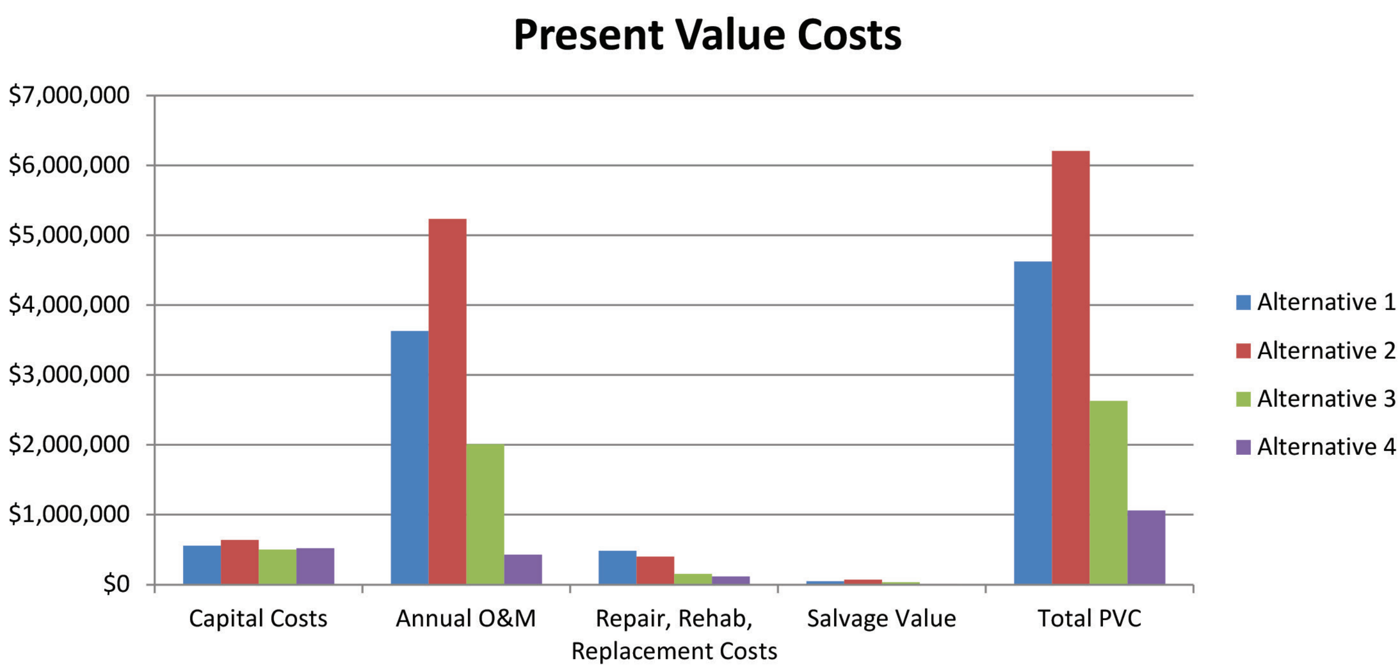
Cost Summary

Present Value	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Capital Costs	$6,374,000	$648,000	$639,000	$630,000
Annual O&M	$172,000	$8,098,000	$460,000	$573,000
Repair, Rehab, Replacement Costs	$2,723,000	$87,000	$84,000	$87,000
Salvage Value	$2,314,000	$186,000	$186,000	$186,000
Total PVC	**$6,955,000**	**$8,647,000**	**$997,000**	**$1,104,000**

GRAPHICAL RESULTS: ANNUAL PV LIFE CYCLE COSTS CHARTS

A chart is provided showing the stream of life cycle costs over the analysis period.





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