Appendix K:
Cost Evaluations and Risk Assessments

Measurement Converter Table

U.S. to Metric

Length
feet x 0.305 = meters
miles x 1.6 = kilometers

Volume
cubic feet x 0.03 = cubic meters
gallons x 3.8 = liters

Area
square miles x 2.6 = square kilometers

Mass
pounds x 0.45 = kilograms

Metric to U.S.

Length
meter x 3.28 = feet
kilometers x 0.6 = miles

Volume
cubic meters x 35.3 = cubic feet
liters x 0.26 = gallons

Area
square kilometers x 0.4 = square miles

Mass
kilograms x 2.2 = pounds

Appendix K: Table of Contents

APPENDIX K:

Cost Evaluations and Risk Assessment

Methods

Cost Determinations

Costs have been estimated for the four potential alternatives that require additional investment over a 10-year implementation schedule. Costs are based on the best available information, through research and through discussions with project collaborators. These estimations are a means of comparing the costs between the proposed levels of implementation, as well as visualizing the amount of effort needed to support decisionmaking related to groundwater and other physical systems within the Great Lakes basin.

Task costs can be composed of any combinations of the following:

a. extrapolations of unit costs for equipment purchases, installation, operations and maintenance;
b. extrapolations of unit costs for product development;
c. costs for research investigations;
d. cost for field sampling and analysis;
e. program development and administration costs; and,
f. computer system hardware/software and operations costs.

Extrapolation of unit costs for equipment purchases, installation, operations and maintenance are frequently the most reliable cost estimates, since they are based upon reliable experiential information. The best example of these types of cost bases is for Task 3: Groundwater Observation Wells and Task 9: Streamgauging Network.

Extrapolation of unit costs for product development also is highly reliable, since they too are based upon reliable experiential information in most cases. The best examples of these types of cost determinations would be Task 1: Digital Soil Surveys, Task 2: Geological Mapping and Task 52: Medium Resolution Land Cover Mapping. Many other tasks within the integrated biohydrological information system would be predicated on becoming operational systems with specific products being developed and produced over time. As such, these tasks would lead to better estimates after initial implementation.

Costs for research investigations are typically derived from similar studies conducted by collaborating federal agencies and/or academic institutions. These costs can be more uncertain since research investigations can lead to findings that require additional investment prior to completion. A substantial number of the tasks outlined for the biohydrological information system fall primarily under this category.

Costs for field sampling and analysis are again typically derived from similar investigations conducted by federal agencies and/or academic institutions. These costs are typically less uncertain than research investigations, in that they can be scoped with greater definition in advance of implementation. Several tasks within the integrated biohydrological information system would have copious workload under this category, such as Task 1:Digital Soil Surveys, Task 4: Infiltration Rates, Task 21: Circulation Modeling, Task 25: Diversion Accounting and several of the tasks related to monitoring and modeling of cumulative water withdrawal impacts on habitats.

Costs for program development and administration are derived from similar programmatic operations conducted within the region. These costs can be more uncertain since the operational mandate of these programs might endure substantial change as they become implemented. Primary examples of these types of costs would be the entire task within Appendix F: *Water Withdrawal Use Data and Information.*

Costs for computer system hardware/software and operations costs are estimated based upon current experiences for designing, implementing and operating large distributed information system. Cost efficiencies over time would be expected due to technological advances but additional unforeseen applications might arise to offset these benefits. Hence, tasks within this category have larger uncertainties.

In general, the proposed costs for each task outlined under each report Appendix consider other costs outlined in other appendices to avoid double accounting. Each implementation alternative is designed to avoid redundancies and provide cost efficiencies whenever possible. The cost estimates for each implementation alternative reflect anticipated economies of scale, whenever applicable.

Cost Uncertainties

Costs that are proposed under each task for each alternative are evaluated based upon the inherent uncertainties as they are currently known. The proposed costs are presented for each task and against each alternative in the report appendices.

Within this Appendix a range of likely costs are presented, between lowest possible and highest possible. The proposed cost for a particular task and alternative may not necessarily equate to the median of the highest/lowest estimates, since not all tasks are normally distributed. A measure of statistical distribution is chosen to reflect the nature of the confidence available for these estimates.

The lowest, proposed and highest cost estimates are used, along with an appropriate statistical distribution, in a Monte Carlo simulation of 10,000 possible occurrences to determine an expected cost for each task for each alternative. The expected costs for each task for each of the four alternatives are detailed in the following pages of this Appendix and summarized in Table 1 of the Main Report.

Relative Value of Tasks

In order to conduct standard USACE risk assessment procedures, each task needs to have an ordinal ranking assigned to it, representing the degree of benefits that would be attained at a given investment level. If quantitative measures are not possible this evaluation needs to be made on qualitative measures, which is subjective. The matrix of Relative Values for the 59 tasks is included at the end of this Appendix.

The assignment of a relative value for a particular task is made considering the importance of this task in meeting the objective of the biohydrological information system. That is to develop an information system that can be used to monitor hydrologic and biologic changes that have occurred in the past as a consequence of cumulative water withdrawals and to predict anticipated consequences of future cumulative water withdrawals. With this in mind, it is clear that knowledge of the extent and quality of groundwater resources is extremely critical, along with monitoring of streamflow characteristics. These tasks have substantially more weight than other more narrow tasks. Physical process modeling (open lakes and interconnecting waterway hydrodynamic modeling and groundwater prediction models), ecological prediction modeling and information integration tasks also have very high relative weights.

The relative values for a particular task are applied to each implementation alternative to provide a measure of the degree of completion that would be accomplished. For example, under Task 1: Digital Soil Surveys, the Minimum Investment and Selective Implementation alternative are assigned a relative weight of 0 of the 10 possible points for this task, since no investments would be made under these scenarios and, hence, no products would be developed. Under the Selective Implementation alternative, this task is assigned a 5.0 (or 50% of all possible points), since nearly half of all the needed soil surveys for the U.S. Great Lakes – St. Lawrence River system would be in digital form. Under the Enhanced Implementation alternative this value is 7.0 for anticipation of about 70% completion for this task. Finally, under the Full Implementation alternative, the value is 10.0 or 100% completion.

These relative values can also be used as a surrogate for assessing the relative benefit of one implementation alternative against any other in total when all 59 component tasks are summed. This summation indicates that the No Change (Without Project) alternative is a minus 11%, the Minimum Investment is 18%, the Selective Implementation is 38%, the Enhanced Implementation is 61% and the Full Implementation alternative is 100% in meeting the objectives of the biohydrological information system.

Cost Effectiveness and Incremental Analysis

The expected costs derived from the Monte Carlo simulation are used with the relative value measure for each task to determine whether one alternative is more cost effective than another. This Cost Effectiveness test is completed for all 59 tasks and reported in this Appendix.

An Incremental Analysis is then completed to compare the per-unit cost of each prospective level of each task. Units of output were represented by an ordinal ranking of the relative

values discussed above. The incremental cost is then determined based on the expected cost obtained in the Monte Carlo simulation and reported in this Appendix.

Task 1 – Digital Soil Surveys

Implementation Alternatives and Cost Details

Task: *The Natural Resources Conservation Service (NRCS) needs to complete all soil survey maps within and immediately adjacent to the Great Lakes-St. Lawrence River basin in a consistent manner and encode them in digital form.*

Without Plan Strategy – Digitizing of existing soil surveys under the Soil Survey Geographic (SSURGO) program is expected to be completed for the entire country in 2008, dependent upon continued level funding for the effort ($12.5 M per year).

Minimum Investment Strategy – No additional investment is considered under this alternative as it assumes continued funding for the NRCS through 2007 to complete its digitization of existing soil surveys. The continuation of level funding ($12.5 M per year) must be guaranteed through 2007 for the Natural Resources Conservation Service (NRCS) to complete its digitization of existing soil surveys. 84 counties are left to digitize.

Selective Implementation Strategy – Provide funding to the NRCS to fully fund the creation of soil surveys for the 12 remaining unsurveyed counties and revisions to 3 obsolete county surveys within the Great Lakes-St. Lawrence River basin at a cost of $38 M over a compressed 3-year schedule. This alternative assumes continued level funding for the NRCS to complete digitization of existing soil surveys. In addition, the continuation of level funding ($12.5 M per year) must be guaranteed through 2007 for the NRCS to complete its digitization of existing soil surveys. The prospective range in unit costs per acre for surveying, mapping and digitizing soils ($2-4/acre; $3 proposed) and revisions of older surveys ($1-3/acre).

Enhanced Implementation Strategy – Provide funding to the NRCS to fully fund the creation of soil surveys for the 12 remaining unsurveyed counties and revisions to 8 obsolete county surveys within the Great Lakes-St. Lawrence River basin at a cost of $53 M over a compressed 3-year schedule. This alternative assumes continued level funding for the NRCS to complete digitization of existing soil surveys. In addition, the continuation of level funding ($12.5 M per year) must be guaranteed through 2007 for the NRCS to complete its digitization of existing soil surveys. The prospective range in unit costs per acre for surveying, mapping and digitizing soils ($2-4/acre; $3 proposed) and revisions of older surveys ($1-3/acre).

Full Implementation Strategy – Provide funding to the NRCS to fully fund the creation of soil surveys for the 12 remaining unsurveyed counties and revisions to 16 county obsolete surveys within the Great Lakes-St. Lawrence River basin at a cost of $80 M over 3 years. This alternative assumes continued level funding for the NRCS to complete digitization of

existing soil surveys. The prospective range in unit costs per acre for surveying, mapping and digitizing soils ($2-4/acre; $3 proposed) and revisions of older surveys ($1-3/acre).

Range of Costs

Table K-1: Task 1 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Proposed	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$26.000	$39.000	$51.000	$34.000	$50.000	$68.000	$54.000	$78.000	$108.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional federal funding is anticipated for the Minimum Investment alternative for this task, other than continuation of existing commitments. The prospective range in costs of the Selective, Enhanced and Full Implementation alternatives reflect variability in unit costs per acre for surveying, mapping and digitizing soils ($2-4/acre; $3 proposed) and revisions of older surveys ($1-3/acre).

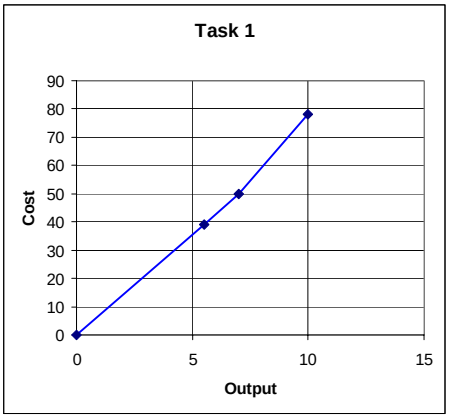
Relative Task Value

Table K-2: Task 1 Relative Task Value

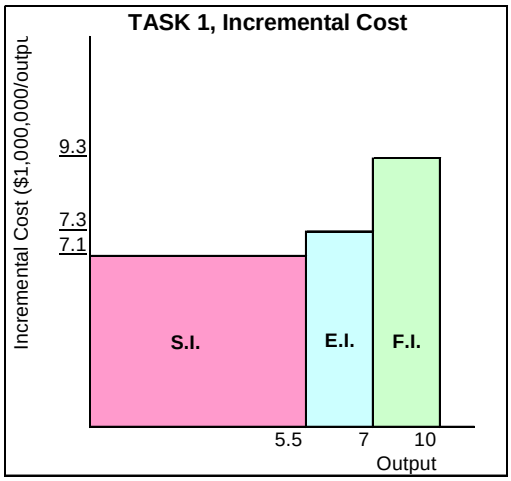
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	5.5	7.0	10.0

Remarks: Information on soil characteristics in digital map form is essential for all surface and groundwater models. The program is currently incomplete for the region. Substantial benefit is realized by all comprehensive implementation alternatives.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $7.1 M for every one unit increase in output.
Enhanced – Increase in cost is $7.3 M for every one unit increase in output
Full – Increase in cost is $9.3 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 2 – Three-Dimensional Geological Mapping

Implementation Alternatives and Cost Details

Task: *High resolution, digital, three-dimensional geologic maps need to be produced by the USGS and collaborating state agencies to define the aquifer systems in the Great Lakes - St. Lawrence River region.*

Without Plan Strategy – Maintain current funding commitment to the USGS Central Great Lakes Geologic Mapping Coalition ($500 K per year) for the continuation of pilot projects in the four participating states of Indiana, Illinois, Ohio, and Michigan. Continue current federal funding allocations for federal/state cost-share support for the STATEMAP component of the USGS National Cooperative Geologic Mapping Program at a cost of $7.6 M per year.

Minimum Investment Strategy - No additional investment considered.

Selective Implementation Strategy – Provide funding to the USGS Central Great Lakes Geologic Mapping Coalition and STATEMAP Program to complete the mapping of approximately 500 quads (or about 20 percent) of priority sites at a cost of $120 M over 10 years. This level of funding would allow for the completion of additional discrete projects throughout the basin. Costs are based upon estimated unit costs of $250,000 per quadrangle.

Enhanced Implementation Strategy – Expand focus of the USGS Central Great Lakes Geologic Mapping Coalition to include all 8 Great Lakes states. Provide funding to the Coalition and STATEMAP Program at a level of $320 M over the next 10 years to conduct geological mapping and related studies of approximately 1300 quads (or about 60 percent) of priority sites across the Great Lakes-St. Lawrence River basin. Costs are based upon estimated unit costs of $250,000 per quadrangle.

Full Implementation Strategy – Expand focus of the USGS Central Great Lakes Geologic Mapping Coalition to include all 8 Great Lakes states. Provide funding to the Coalition and STATEMAP Program to work jointly in completing all geologic mapping for all remaining quads (approximately 2200) within or adjacent to the Great Lakes-St. Lawrence River basin at a cost of $560 M over next 10 years. Funding levels beyond these specified amounts would be impractical due to personnel limitations. However, additional funding may be required beyond the scope of 10 years to complete the recommended task. Costs are based upon estimated unit costs of $250,000 per quadrangle.**

Footnotes

** Funding levels beyond these specified amounts would be impractical due to personnel limitations. However, additional funding may be required beyond the scope of 10 years to complete the recommended task.

Range of Costs

Table K-3: Task 2 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$75.000	$120.000	$160.000	$160.000	$270.000	$350.000	$220.000	$440.000	$600.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Federal funding for the Minimum Investment for this task is not proposed. The prospective range of costs of the Selective, Enhanced and Full Implementation alternatives are based upon estimated unit costs of $250,000 per quadrangle with greater uncertainty on the lower end of the range reflecting potential economies of scale.

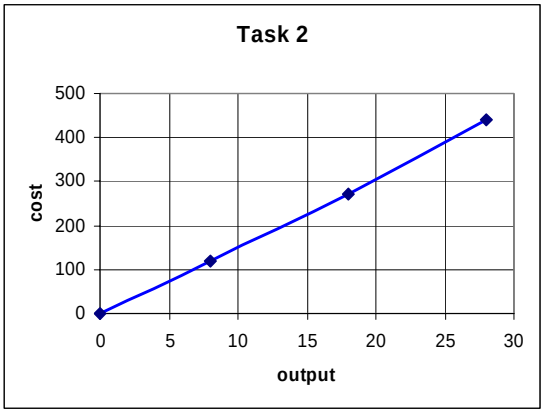
Relative Task Value

Table K-4 Task 2 Relative Task Value

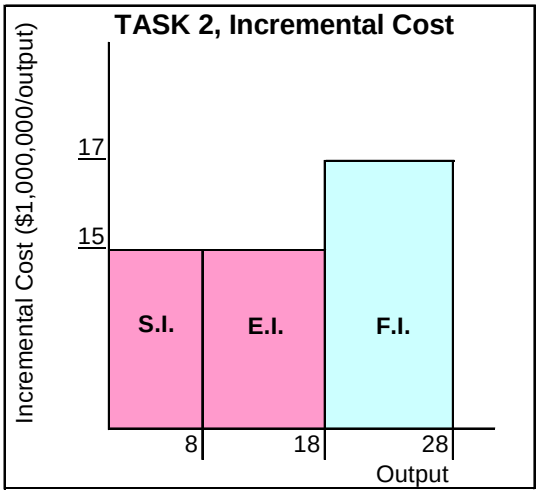
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	0.0	0.0	8.0	18.0	28.0

Remarks: Mapping of groundwater aquifers across the region is essential to determining sustainable yield estimates. Full coverage of the system is realized by all comprehensive implementation alternatives, with greater geologic detail being provided as more funds are dedicated and, hence, reduced uncertainties.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $15 M for every one unit increase in output.
Enhanced – Increase in cost is $15 M for every one unit increase in output
Full – Increase in cost is $17 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 3 – Groundwater Observation Wells

Implementation Alternatives and Cost Details

Task: *The USGS needs to develop, maintain and expand the network of groundwater observation wells within and immediately adjacent to the Great Lake - St. Lawrence River basin.*

Without Plan Strategy – A non-systematic network currently exists with a variety of funding sources and objectives, resulting in unequal concentrations of groundwater wells within the U.S. Great Lakes groundwater basin. The number of wells within the current network will likely decrease due to constraints associated with maintenance funding.

Minimum Investment Strategy – Provide additional funding to the USGS to maintain the existing network of groundwater wells within the U.S. Great Lakes groundwater basin. This additional funding should be used to replace cost-share funding arrangements on existing wells that are vulnerable to current and future cost-share funding reductions. Full federal funding is required to protect the continuity of the wells and long-term data collection at a cost of $750 K over 5 years, and operation and maintenance costs thereafter. This cost is an estimate based on $3200 per well to maintain and restore.

Selective Implementation Strategy – Provide funding to the USGS to restore and maintain 100 underutilized groundwater observation wells throughout the U.S. Great Lakes groundwater basin at a cost of $3.2 M over 10 years, and operation and maintenance costs thereafter. This cost is based on restoring and maintaining one well at $3200. This task will cover about 1 well per watershed.

Enhanced Implementation Strategy – Provide funding to the USGS to restore and maintain 300 underutilized groundwater observation wells throughout the U.S. Great Lakes groundwater basin at a cost of $10 M over 10 years, and operation and maintenance costs thereafter. This cost is based on restoring and maintaining one well at $3200. This task will cover about 3 well per watershed.

Full Implementation – Strategy Provide funding to the USGS to restore and maintain 400 underutilized groundwater observation wells and install and maintain 175 new wells where needed at a cost of $20M over 10 years, and operation and maintenance costs thereafter. This cost is based on restoring and maintaining one well at $3200 and new well installation at $10,000 per well. This task will cover about 5 wells per watershed.

Range of Costs

Table K-5: Task 3 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.750	$0.750	$0.750	$2.900	$3.200	$3.500	$9.000	$10.000	$11.000	$17.000	$20.000	$23.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: There is no range of costs for the Minimum Investment alternative since this covers a fixed additional federal funding level needed to maintain the viability of the existing network. The Selective, Enhanced and Full Implementation alternatives reflect increasing program development. The prospective range of cost for these three scenarios is normally distributed.

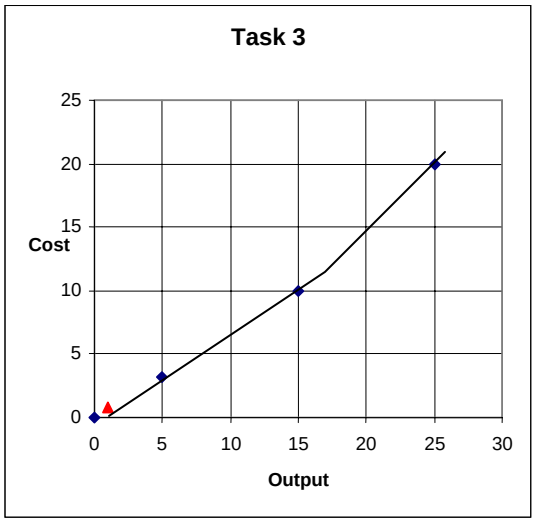
Relative Task Value

Table K-6: Task 3 Relative Task Value

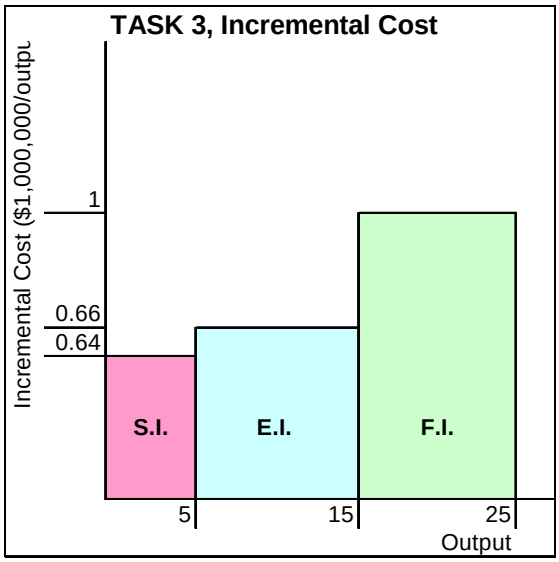
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
25.0	-10.0	1.0	5.0	15.0	25.0

Remarks: Maintenance of existing groundwater monitoring wells is critical to establish trends over time. Without new funding, the existing network will likely decrease in extent and coverage. Significant monitoring of the rates of groundwater recharge or depletion will not be attained until funding levels reach the Enhanced Implementation alternative.

Cost Effectiveness



Incremental Analysis



Conclusion: Minimum Investment alternative is shown to be less cost effective as a result of the Cost Effectiveness test. The Minimum Investment alternative calls for modest funding to maintain the current functionality of the groundwater monitoring network. If none of the other comprehensive alternatives are implemented, this task is justified at the lowest funding level.

Incremental Analysis:
Minimum – Increase in cost is $0.75 M for every one unit increase in output.
Selective – Increase in cost is $0.6 M for every one unit increase in output.
Enhanced – Increase in cost is $0.68 M for every one unit increase in output
Full – Increase in cost is $1 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 4 – Groundwater Infiltration Rates

Implementation Alternatives and Cost Details

Task: *The USGS needs to define the infiltration, recharge and drainage characteristics of the Great Lakes-St. Lawrence River basin that affect water supplies within the region.*

Without Plan Strategy – Estimates of impervious surfaces are coarse and lack consistency. Infiltration, recharge and drainage characteristics may exist in some key areas, but are not comprehensive.

Minimum Investment Strategy – The USGS would conduct a pilot study on infiltration and recharge rates for all land cover types in at least one high priority watershed within Great Lakes-St. Lawrence River basin at a cost of $1 M over 3 years. The proposed level of additional federal funding to conduct this basic research is estimated to be $250,000 in the first year of implementation, $350,000 in the second year and $400,000 in the third year. The estimates are based upon similar complex basin-wide studies.

Selective Implementation Strategy – The USGS would conduct a pilot study for all land cover types in at least one high priority watershed within Great Lakes-St. Lawrence River basin at a cost of $1 M over 3 years. The proposed level of additional federal funding to conduct this basic research is estimated to be $250,000 in the first year of implementation, $350,000 in the second year and $400,000 in the third year. The estimates are based upon similar complex basin-wide studies.

Enhanced Implementation Strategy – The USGS would conduct studies for all land cover types in at least one high priority watersheds in each Great Lakes state at a cost of $2M over 3 years. The proposed level of additional federal funding to conduct this basic research is estimated to be $500,000 in the first year of implementation, $750,000 in the second year and $750,000 in the third year. The estimates are based upon similar complex basin-wide studies.

Full Implementation Strategy – The USGS would develop a comprehensive, detailed model of infiltration rates for all land cover types for all U.S. watersheds at a cost of $5 M over 5 years. The proposed level of additional federal funding to conduct this basic research is estimated to be $1,000,000 per year for each of five years. This estimate is extrapolated from the estimates provided under the Selective and Enhanced Implementation alternatives.

Range of Costs

Table K-7: Task 4 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.750	$1.060	$1.500	$0.750	$1.060	$1.500	$1.500	$2.000	$2.500	$4.000	$5.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment and Selective Implementation alternatives are identical reflecting a minimum level of basic research. The prospective range of costs for all four alternatives is normally distributed.

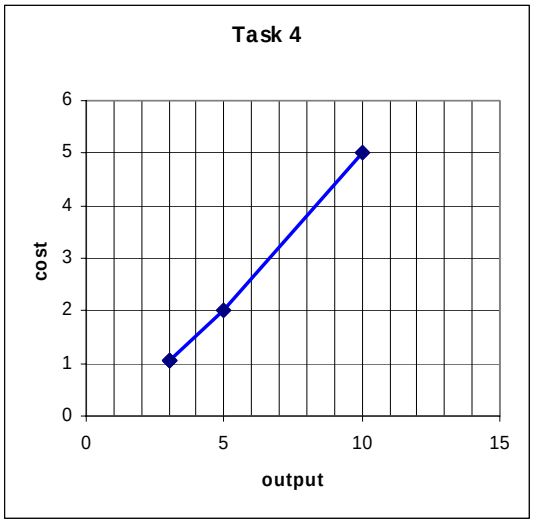
Relative Task Value

Table K-8: Task 4 Relative Task Value

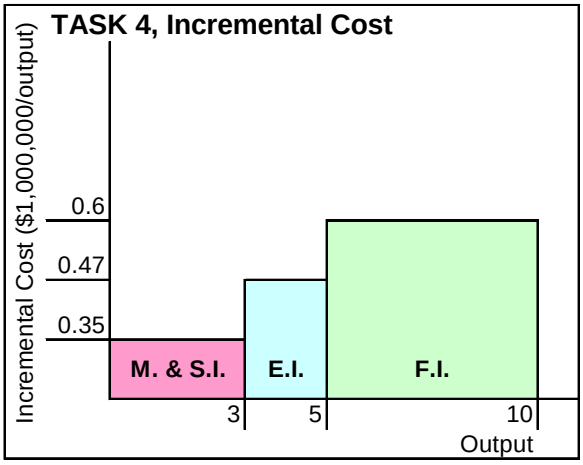
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	3.0	3.0	5.0	10.0

Remarks: Minimum benefits are attained at the Minimum Investment and Selective Implementation alternatives for basic research. Significant returns are realized as funding is increased thereafter to monitor infiltration rates.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.35 M for every one unit increase in output.
Selective – Increase in cost is $0.35 M for every one unit increase in output.
Enhanced – Increase in cost is $0.47 M for every one unit increase in output
Full – Increase in cost is $0.6 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 5 – Groundwater Extraction Rates

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional and state agencies, needs to conduct focused research aimed at improving accounting of groundwater extraction rates from the Great Lakes-St. Lawrence River basin.*

Without Plan Strategy – Groundwater withdrawals are estimated or calculated based upon pumping capacity and/or estimation techniques for selected water use sectors. Accounting is inconsistent from state to state. Future approaches are not likely to change without significant collaboration.

Minimum Investment Strategy – This alternative calls for an increase in funding to the USGS to advance the National Water Use Information Program (NWUIP) and continue federal/state cost-share support for program at a cost of $2 M over 10 years, and continue thereafter. The focus of the program would be expanded to emphasize groundwater, especially the need to increase accuracy and consistency of groundwater withdrawal data and increasing the ability to meter, measure, or improve calculation methods. According to USGS NWUIP staff, the NWUIP is under funded to extent that producing its 5-year national water use program was in question. These proposed activities require sustained funding of at least $200,000 per year over 10 years. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Selective Implementation Strategy – Increase funding for the USGS NWUIP and continue federal/state cost-share support for program at a cost of $5 M over 10 years, and continue thereafter. Expand focus of the program to emphasize groundwater, especially the need to increase accuracy and consistency of groundwater withdrawal data and increasing the ability to meter, measure, or improve calculation methods. These proposed activities require sustained funding of at least $500,000 per year over 10 years. As well observations expand collection, reporting, verification and storage, groundwater use data becomes increasingly a larger task. Estimates are passed on discussions from the NWUIP staff and state data collection and reporting staff.

Enhanced Implementation Strategy – Increase funding for the USGS NWUIP and continue federal/state cost-share support for the program. Establish or expand state programmatic authority to require direct measurement of groundwater withdrawals for all categories of use. Ensure adequate funding to carry out the program at the state and national levels. Costs are estimated at $10 M over 10 years, and continue thereafter. These proposed activities require sustained funding of at least $1,000,000 per year over 10 years. As well observations expand collection, reporting, verification and storage, groundwater use data becomes increasingly a larger task. Estimates are passed on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – Require states to implement direct measurements of groundwater withdrawals for all categories of use. Federal funding to support this mandate

could be as high as $50 M over 10 years, and continue thereafter. The proposed activity requires sustained funding of at least $5,000,000 per year over 10 years. As well observations expand collection, reporting, verification and storage, groundwater use data becomes increasingly a larger task, Estimates are passed on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-9: Task 5 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$1.600	$2.000	$2.400	$4.000	$5.000	$6.000	$8.000	$10.000	$12.000	$40.000	$50.000	$60.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The prospective range of costs for each of the four alternatives is normally distributed with consistent confidence levels.

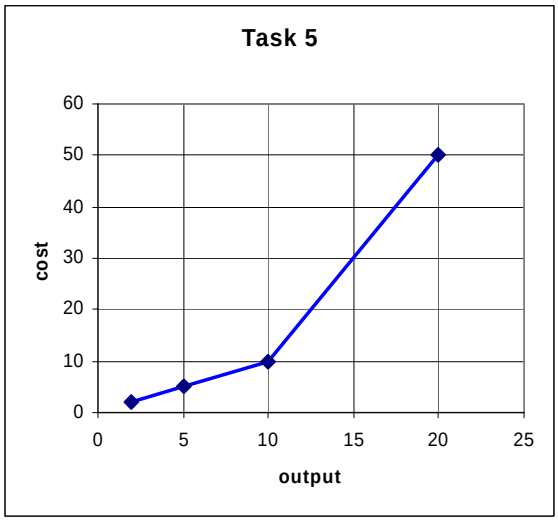
Relative Task Value

Table K-10: Task 5 Relative Task Value

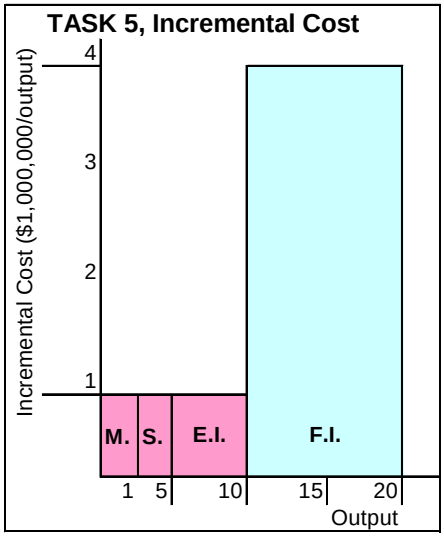
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	2.0	5.0	10.0	20.0

Remarks: Incremental returns would be realized as a linear function of investment in monitoring groundwater extraction rates.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $1 M for every one unit increase in output.
Selective – Increase in cost is $1 M for every one unit increase in output.
Enhanced – Increase in cost is $1 M for every one unit increase in output

Full – Increase in cost is $4 M for every one unit increase in output.

The Full Implementation alternative reflects substantial costs for implementing mandatory monitoring of groundwater extraction that may have significant reticence for societal acceptance.

Task 6 – Groundwater Consumptive Uses

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional and state agencies, needs to conduct focused research on improving consumptive use estimates of Great Lakes - St. Lawrence River groundwater resources.*

Without Plan Strategy – Without significant new collaboration, coefficients will need to be used to estimate consumption; these estimates will continue to be inconsistent and unreliable.

Minimum Investment Strategy – Under this alternative, the USGS would assess consumptive use data needs, compile available sources of consumptive use data, and assess quality of that data at a cost of $100 K for 1 year. This cost is based on the costs of similar basic research studies.

Selective Implementation Strategy – Under this alternative, the USGS would assess consumptive use data needs, compile available sources of consumptive use data, and assess quality of that data at a cost of $100 K for 1 year. This cost is based on the costs of similar basic research studies.

Enhanced Implementation Strategy – Under this alternative, the USGS in cooperation with appropriate regional and state agencies would develop estimates of consumptive groundwater use by categories specific to the Great Lakes by conducting pilot studies that directly measure groundwater consumptive use for selective use categories or facility types at a cost of $500 K over 2 years. This cost is based on the costs of similar basic research studies.

Full Implementation Strategy – Under this alternative, Congress would require the Great Lakes states to implement direct measurements of groundwater consumptive uses and would provide pass-through funding to establish and maintain necessary infrastructure. Federal funding to support this mandate could be as high as $10 M over 10 years, and continue thereafter. . Typically, consumptive use is calculated, not measured. This task may not be technically or politically feasible therefore the cost is a best estimate.

Range of Costs

Table K-11: Task 6 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.100	$0.100	$0.100	$0.100	$0.100	$0.100	$0.500	$0.500	$0.500	$5.000	$20.000	$50.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The prospective range of costs for the Minimum Investment and Selective and Enhanced Implementation alternatives are zero, reflecting fixed levels of basic research. The prospective range of costs for the Full Implementation alternative reflects low confidence in the upper bounds of implementation (if politically acceptable).

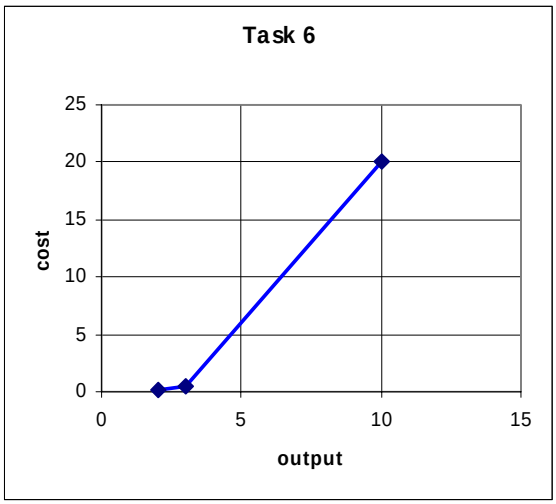
Relative Task Value

Table K-12: Task 6 Relative Task Value

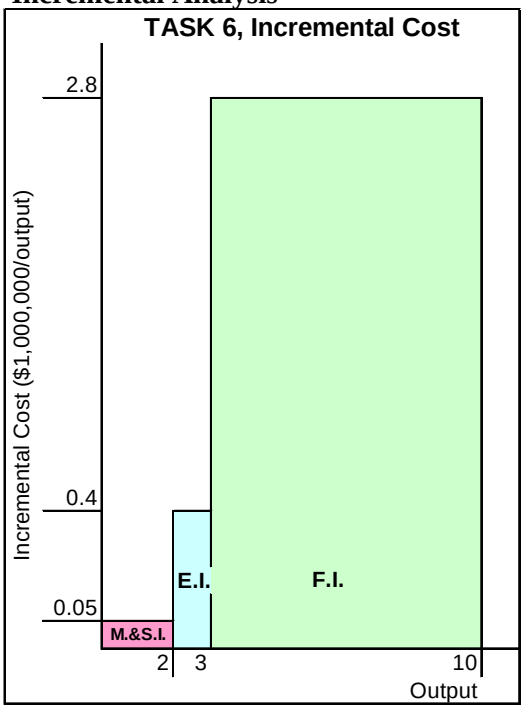
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	2.0	2.0	3.0	10.0

Remarks: Water taken from groundwater reserves that is not somehow recharged needs to be sufficiently accounted for. Uncertainties associated with this factor will adversely affect groundwater modeling. Basic research at the lower investment levels provides important returns on investment, but maximum return is only realized at the Full Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.05 M for every one unit increase in output.
Selective – Increase in cost is $0.05 M for every one unit increase in output.
Enhanced – Increase in cost is $0.4 M for every one unit increase in output
Full – Increase in cost is $2.8 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 7 – Groundwater Modeling

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional agencies and academic institutions, needs to develop comprehensive modeling procedures that can be used to assess impacts of groundwater withdrawals within and adjacent to the Great Lakes - St. Lawrence River basin.*

Without Plan Strategy – Some modeling will be developed for individual watersheds or subwatersheds by various entities based upon need. These efforts will continue to be inconsistent.

Minimum Investment Strategy – Under this alternative, the USGS would develop a prototype groundwater model for at least one or more pilot watersheds at a cost of $500 K over 2 years. This cost is based on the costs of similar basic research studies.

Selective Implementation Strategy – Under this alternative, the USGS would develop a prototype groundwater model for at least one or more pilot watersheds at a cost of $500 K over 2 years. This cost is based on the costs of similar basic research studies.

Enhanced Implementation Strategy – Contingent upon substantial information availability based upon completion of prior tasks, the USGS in cooperation with regional entities would complete comprehensive groundwater models for up to 20 pilot U.S. Great Lakes watersheds at a cost of $10 M over 10 years. This cost is based on the costs of similar basic research studies.

Full Implementation Strategy – Contingent upon substantial information availability based upon completion of prior tasks, the USGS in cooperation with regional entities would complete comprehensive groundwater models for all U.S. Great Lakes watersheds at a cost of $35 M over 10 years. There are 109 major watersheds within the U.S. side of the Great Lakes-St. Lawrence River basin. The cost of developing a groundwater model is estimated at $330,000 per watershed.

Range of Costs

Table K-13: Task 7 Range of Costs

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.400	$0.500	$0.600	$0.400	$0.500	$0.600	$0.800	$10.000	$12.000	$28.000	$35.000	$42.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment and Selective Implementation alternatives are identical reflecting a level of basic research. The prospective range of costs for each of the four alternatives is normally distributed with consistent confidence levels.

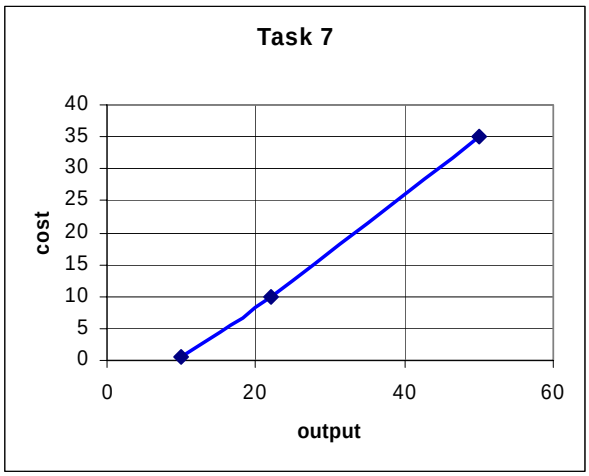
Relative Task Value:

Table K-14: Task 7 Relative Task Value (in millions of dollars)

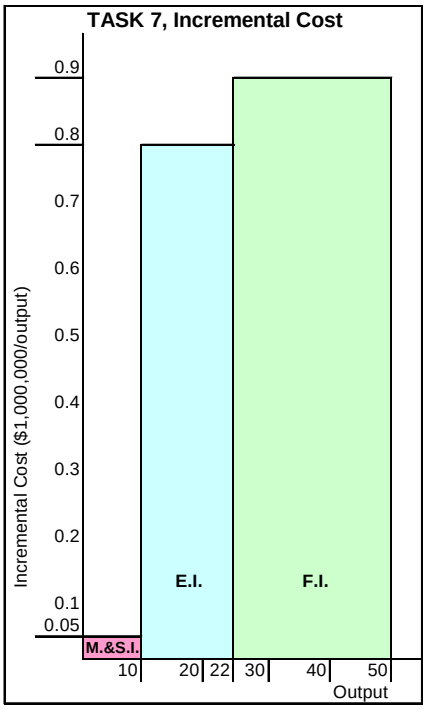
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
50.0	0.0	10.0	10.0	22.0	50.0

Remarks: Water taken from groundwater reserves that is not somehow recharged needs to be sufficiently accounted for. Uncertainties associated with this factor will adversely affect groundwater modeling. Basic research at the lower investment levels provides important returns on investment, but maximum return is only realized at the Full Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.05 M for every one unit increase in output.
Selective – Increase in cost is $0.05 M for every one unit increase in output.
Enhanced – Increase in cost is $0.8 M for every one unit increase in output
Full – Increase in cost is $0.9 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 8 – Anthropogenic Changes

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with state natural heritage programs, needs to conduct research to define the natural stream dynamics of all U.S. tributary watersheds within the Great Lakes – St. Lawrence River system and identify the salient flow characteristics affected by anthropogenic changes.*

Without Plan Strategy – Incomplete, inconsistent and spatially sporadic research is currently available. Minimal state resources are available to continue regional investigations.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – The USGS would work with all Great Lakes states natural heritage and historic programs to digitize distribution maps of biological and cultural resources in riverine areas. Subsidies would go towards research on tier 1 priority* tributaries at a cost of $1M over 5 years.

Enhanced Implementation Strategy – The USGS would work with all Great Lakes states natural heritage and historic programs to digitize distribution maps of biological and cultural resources in riverine areas. Subsidies would go towards research on tier 1 and tier 2 priority tributaries at a cost of $3M over 5 years.

Full Implementation Strategy – The USGS would work with all Great Lakes states natural heritage and historic programs to digitize distribution maps of biological and cultural resources in riverine areas. Subsidies would go towards research on all major tributaries at a cost of $5M over 5 years.

Footnotes

A process to identified priority tributaries may involve input from state and local agencies. Tributaries identified as most critical are tier I. Tier 2 and 3 correspond to tributaries in decreasing priority

Range of Costs

Table K-15: Task 8 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.800	$1.000	$1.200	$2.400	$3.000	$3.600	$4.000	$5.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No Minimum Investment is proposed. This is initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

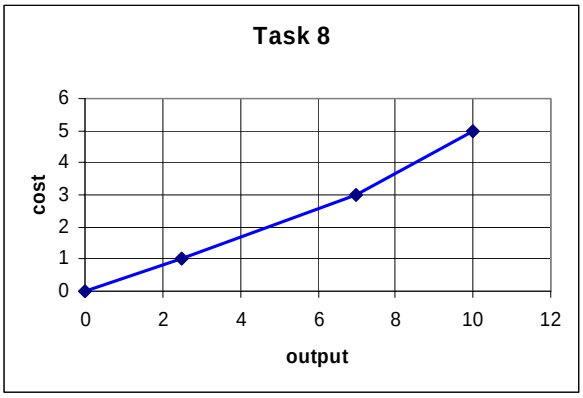
Relative Task Value

Table K-16: Task 8 Relative Task Value

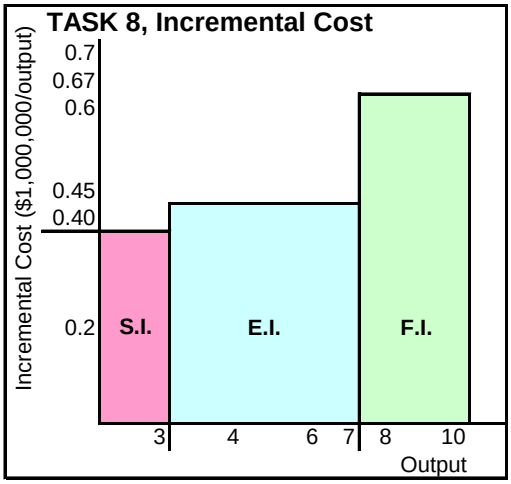
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	2.5	7.0	10.0

Remarks: Advancement in knowledge of natural stream dynamics under any of the comprehensive implementation scenarios will provide significant benefits to implementation of the Annex improvement standard.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.4 M for every one unit increase in output.
Enhanced – Increase in cost is $0.44 M for every one unit increase in output
Full – Increase in cost is $0.67 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 9 – Streamgauging Network

Implementation Alternatives and Cost Details

Task: *The USGS needs to maintain, expand and upgrade the stream gauging network in the U.S. portion of the Great Lakes - St. Lawrence River basin. Under this task the USGS needs to conduct appropriate network analysis to identify headwater areas where additional stream gauging is warranted to meet water resource management needs. In addition, the USGS needs to identify and expand streamflow gauges at the tributary river mouths employing state-of-the-art instrumentation.*

Without Plan Strategy – 372 stream gauging stations (long and short-term operating gauges) are currently in operation in the U.S. portion of the basin. Short-term gauges will discontinue in 3 to 5 years. The network of long-term gauges may continue to deteriorate due to lack of federal financial support (as well as funding partners).

Minimum Investment Strategy – Increase federal funds for gauging stations under the National Streamflow Information Program (NSIP) to reverse the loss of gauges to the network in the U.S. portion of the Great Lakes-St. Lawrence River basin. Where funding partners drop for long-term gauges (with a 5 year or more period of record) the USGS would pick up at the cost of $11,500 per gauge per year for maintaining the gauges and collecting and disseminating data. Increase federal funds from 35 percent to 50 percent of total support of the current network costing $5.25M over 10 years.

Selective Implementation Strategy – Increase federal funds for gauging stations under the National Streamflow Information Program (NSIP) to reverse the loss of gauges to the network in the U.S. portion of the Great Lakes-St. Lawrence River basin. Additionally, expand the network in priority watersheds by adding approximately 25 more gauges, with particular emphasis on headwater areas. Where practical, install acoustic flow meters at key downstream gauging stations to enhance watershed outflow monitoring. Where funding partners drop for long-term gauges (with a 5 year or more period of record) the USGS would pick up at the cost of $11,500 per gauge per year for maintaining the gauges and collecting and disseminating data. Increase federal funds from 35 percent to 50 percent of total support of the current network and additional gauging costing $20M over 10 years.

Enhanced Implementation Strategy – Increase gauging network to cover at least 75 percent the area in the U.S. portion of the Great Lakes-St. Lawrence River basin maintaining the existing network and by adding approximately 90 more gauges to the current 372 gauges, with particular emphasis on headwater areas. Where practical, install acoustic flow meters at key downstream gauging stations to enhance watershed outflow monitoring. Includes increased federal funding for operation and maintenance of existing gauging stations and 100 percent federal funding for installation, operation and maintenance of all new gauges at a total costs of $35M over 10 years.

Full Implementation Strategy - Gauge 100 percent of the U.S. basin area by adding about 250 new gauges to the network, with particular emphasis on headwater areas. Install acoustic flow meters at all downstream gauging stations of major tributaries to enhance outflow monitoring. Increase the federal cost share for operation and maintenance of existing gauging stations and 100 percent federal funding for installation, operation and maintenance of all new gauges at a total costs of $60M over ten years. (Note that the $20M to maintain current network is in this figure)

Footnote

20 gauges in the U.S. network are short term gauges and will be disconnected in 3 to 5 years. Additionally, at least 9 U.S. gauges have been discontinued since 2000.

Range of Costs

Table K-17: Task 9 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$5.000	$5.250	$5.500	$18.000	$20.000	$22.000	$30.000	$35.000	$40.000	$50.000	$60.000	$70.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: A high level of confidence exists for the range of prospective costs for this task under the Minimum Investment alternative. Confidence in the range of prospective costs increases as the implementation alternatives go from Selective to Enhanced and onto Full. The range of prospective costs for all alternatives is normally distributed.

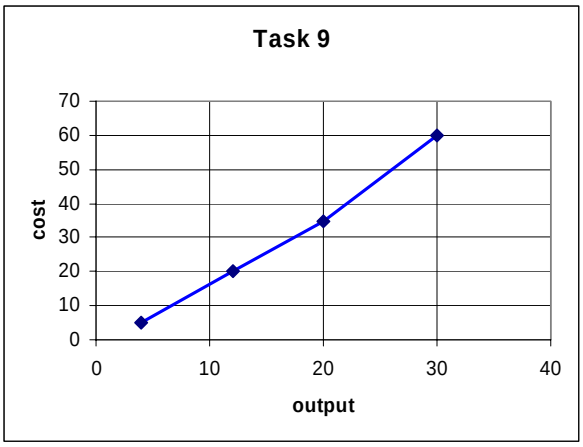
Relative Task Value

Table K-18: Task 9 Relative Task Value

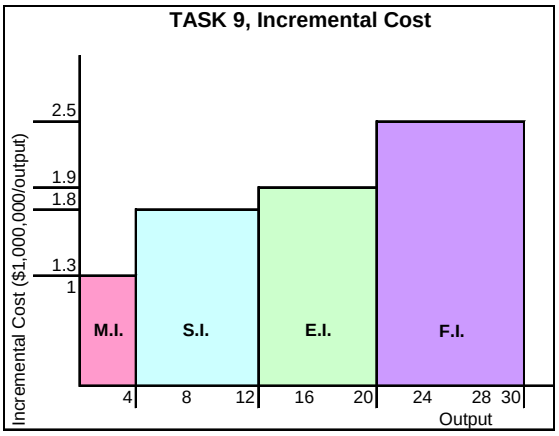
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	-15.0	4.0	12.0	20.0	30.0

Remarks: Continued maintenance of the existing stream gauging network is critical to the decisionmaking process. The existing network has been reduced due to cost pressures over the last two decades. Substantial additional benefits would be attained at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $1.3 M for every one unit increase in output.
Selective – Increase in cost is $1.84 M for every one unit increase in output
Enhanced – Increase in cost is $1.88 M for every one unit increase in output
Full – Increase in cost is $2.5 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as result of this analysis.

Task 10 – Abiotic Stream Sampling

Implementation Alternatives and Cost Details

Task: *The USGS needs to upgrade and maintain adequate instrumentation to monitor abiotic streamflow characteristics at key stream gauging locations.*

Without Plan Strategy – Maintain existing sampling instrumentation where deployed.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Add instrumentation for water temperature, dissolved oxygen, conductivity, etc. at all existing U.S. stream gauging stations on tier I priority tributaries* by adding sensors to 50 gauges at $6 M over ten years. Additional gauging and instrumentation to be 100 percent federally funded. The estimated cost for operate abiotic sensors range from $12 K to $14 K per site per year.

Enhanced Implementation Strategy – Add instrumentation for water temperature, dissolved oxygen, conductivity, etc. for all tier I and tier II priority tributaries by adding sensors to about 200 gauges at $24 M over ten years. Additional gauging and instrumentation

to be 100 percent federally funded. The estimated cost for operate abiotic sensors range from $12 K to $14 K per site per year.

Full Implementation Strategy – Add instrumentation for water temperature, dissolved oxygen, conductivity, etc. for all existing gauges by adding sensors to 520 gauges at $60 M over ten years. Additional gauging and instrumentation would be 100 percent federally. The estimated cost for operate abiotic sensors range from $12 K to $14 K per site per year.

Footnotes

A process to identified priority tributaries may involve input from state and local agencies. Tributaries identified as most critical are tier I. Tier 2 and 3 correspond to tributaries in decreasing priority.

Range of Costs

Table K-19: Task 10 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$5.500	$6.000	$6.500	$22.000	$24.000	$26.000	$55.000	$60.000	$65.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. Confidence in the range of prospective costs increases as the implementation alternatives go from Selective to Enhanced and to Full. The range of prospective costs for all alternatives is normally distributed.

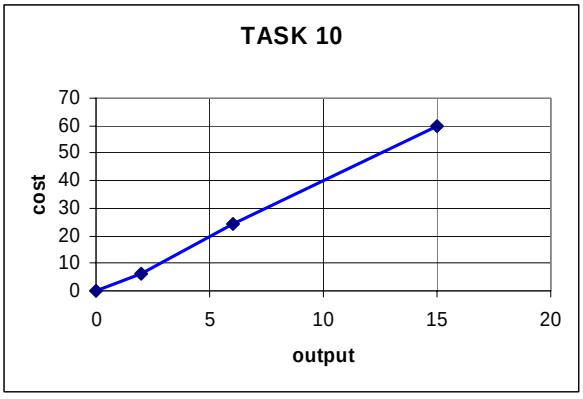
Relative Task Value

Table K-20: Task 10 Relative Task Value

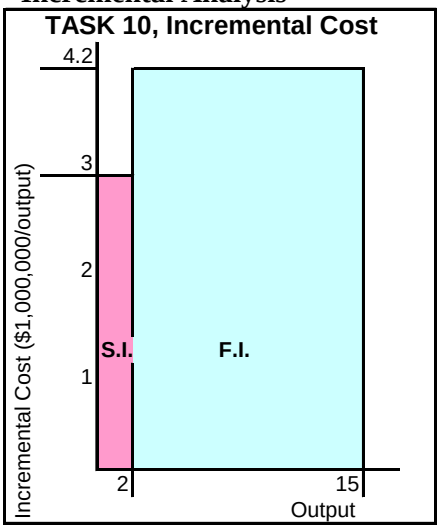
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
15.0	0.0	0.0	2.0	6.0	15.0

Remarks: Significant improvement in understanding of water chemistry and other critical stream parameters would be derived at all funding levels. Maximum reduction of uncertainties about withdrawal impacts would only being realized at the Full Implementation level, however.

Cost Effectiveness



Incremental Analysis



Conclusion: Enhanced Implementation may be less cost effectiveness than the other alternatives, but not significant enough to eliminate this alternative entirely.

Incremental Analysis:
Selective – Increase in cost is $3 M for every one unit increase in output
Enhanced – Increase in cost is $4.5 M for every one unit increase in output
Full – Increase in cost is $4.15 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 11– Instream Withdrawals

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with Great Lakes Commission and state authorities, needs to develop procedures to improve accounting of instream withdrawals.*

Without Plan Strategy – Surface withdrawals are estimated or calculated based upon pumping capacity and/or estimation techniques for selected water use sectors. Accounting is inconsistent from state to state. Future approaches are not likely to change without significant collaboration.

Minimum Investment Strategy – Increase funding to the USGS to work collaboratively with the Great Lakes Commission and state authorities to improve estimates of surface water withdrawals in the National Water Use Information Program (NWUIP) under existing federal/state cost-share formulas a cost of $1 M over 10 years. This task would focus on providing consistent estimates for five years.

Selective Implementation Strategy – Increase funding to the USGS to work collaboratively with the Great Lakes Commission and state authorities to calculate estimates of surface water withdrawals under the NWUIP with an increased federal cost-share at a cost of $5 M over 10 years, and continued thereafter. This task would focus on providing consistent estimates every two years.

Enhanced Implementation Strategy – Increase funding for the NWUIP and increase the federal cost-share support for the program. Establish or expand state programmatic authority to require direct measurement of surface withdrawals for all categories of use. Ensure adequate funding to carry out program at state and national level with annual updates. Costs are estimated at $10 M over 10 years, and continued thereafter.

Full Implementation Strategy – Require states to implement direct measurements of surface water withdrawals for all categories of use updated annually. Federal funding to support this mandate could be as high as $50 M over 10 years, and continued thereafter.

Range of Costs

Table K-21: Task 11 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.750	$1.000	$1.250	$4.000	$5.000	$6.000	$8.000	$10.000	$12.000	$40.000	$50.000	$60.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Confidence in the range of prospective costs decreases as the alternatives go from Minimum Investment to Full Implementation. The range of prospective costs for all alternatives is normally distributed.

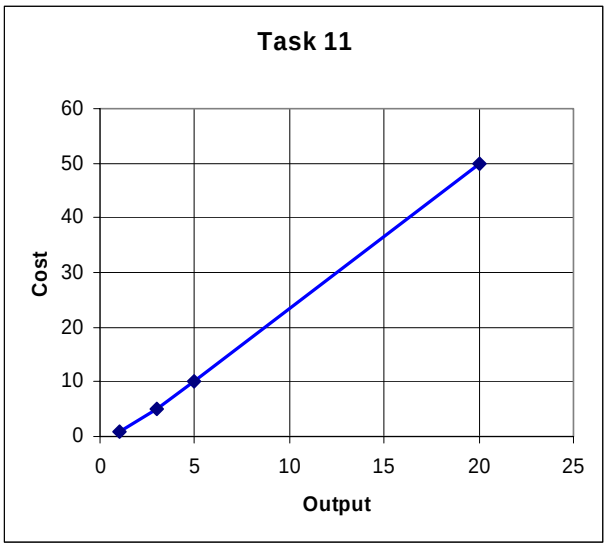
Relative Task Value

Table K-22: Task 11 Relative Task Value

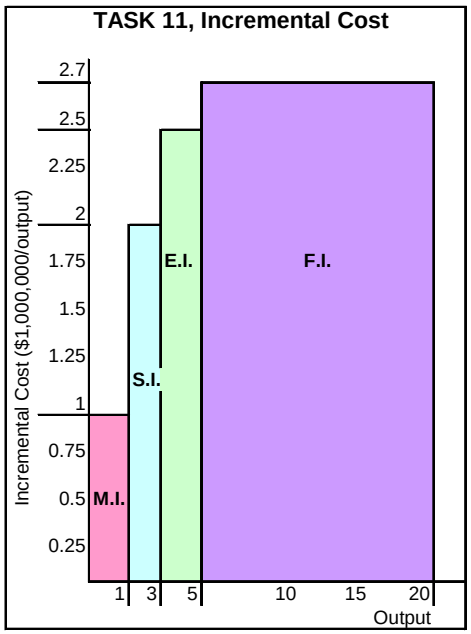
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	1.0	3.0	5.0	20.0

Remarks: Knowledge of the magnitude, duration and cumulative effect of instream withdrawals is of critical importance to implementing watershed modeling.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $1 M for every one unit increase in output.
Selective – Increase in cost is $2 M for every one unit increase in output.
Enhanced – Increase in cost is $2.5 M for every one unit increase in output.
Full – Increase in cost is $2.67 M for every one unit increase in output.

The Minimum Investment alternative differs from the other alternatives in that most reporting is reliant on current collection methods while the others include improved or enhanced collection.

No alternatives are excluded as a result of the Incremental Analysis.

Task 12– Instream Consumptive Uses

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with the Great Lakes Commission and state authorities, needs to develop and improve consumptive use estimates from instream withdrawals for application in watershed modeling.*

Without Plan Strategy – Without significant new collaboration, consumptive use coefficients will need to be used to estimate consumption; estimates will continue to be inconsistent and unreliable.

Minimum Investment Strategy – Assess consumptive use data needs, compile available sources of consumptive use data, and assess quality of that data at a cost of $100 K for 1 year. This estimate is based on similar programmatic funding efforts. Cost estimates are based on similar programs.

Selective Implementation Strategy – Assess consumptive use data needs, compile available sources of consumptive use data, and assess quality of that data at a cost of $100 K for 1 year. Cost estimates are based on similar programs.

Enhanced Implementation Strategy – Develop estimates of consumptive surface water use by categories specific to the Great Lakes by conducting pilot studies that directly measure surface water consumptive use for selective use categories or facility types at a cost of $500 K over 2 years. Cost estimates are based on similar programs.

Full Implementation Strategy – Require states to implement direct measurements of surface water consumptive uses. Federal funding to support this mandate could be as high as $10 M over 10 years, and continued thereafter. This estimate is based on similar programmatic funding efforts.

Range of Costs

Table K-23: Task 12 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.100	$0.100	$0.100	$0.100	$0.100	$0.100	$0.400	$0.500	$0.600	$8.000	$10.000	$12.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment and Selective Implementation alternatives are identical reflecting a level of basic research. The prospective range of costs for the Enhanced and Full Implementation alternatives are normally distributed with consistent confidence levels.

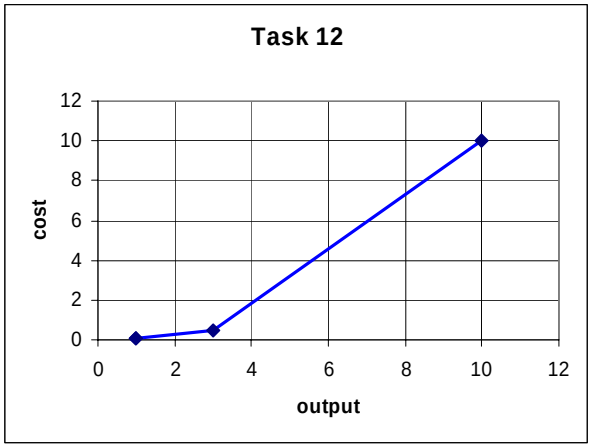
Relative Task Value

Table K-24: Task 12 Relative Task Value

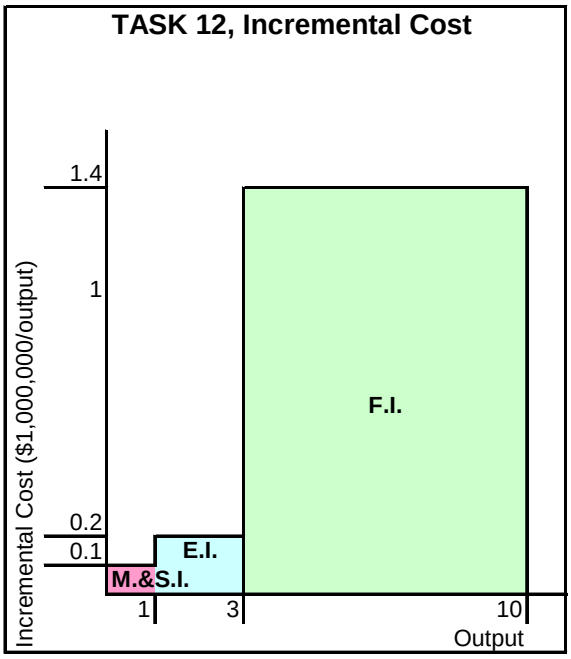
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	1.0	1.0	3.0	10.0

Remarks: Water taken via instream withdrawal that is not returned and insufficiently accounted for can adversely affect the water balance within a watershed. Substantial benefit is derived for even modest funding under the Minimum Investment and Selective Implementation alternatives.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.01 M for every one unit increase in output.
Selective – Increase in cost is $0.01 M for every one unit increase in output.
Enhanced – Increase in cost is $0.2 M for every one unit increase in output.
Full – Increase in cost is $1.36 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 13 – Gauged Watershed Modeling

Implementation Alternatives and Cost Details

Task: The U.S. Army Corps of Engineers, in conjunction with other federal agencies, regional, state and academic institutions, needs to develop, test and operationally implement simulation and predictive flow models for gauged watersheds within the U.S. Great Lakes – St. Lawrence River basin.

Without Plan – Models exist for some tributary streams albeit not comprehensive and inconsistent.

Minimum Investment – Provide authority to the U.S. Army Corps of Engineers and funding authorization to develop a prototype model for one tier 1 priority* tributaries at a cost of $200 K over 1-year.

Selective Implementation – Provide authority to the U.S. Army Corps of Engineers and funding authorization to model a minimum of 30 tier 1 priority tributaries at a cost of $4.5 M over 5-year.

Enhanced Implementation – Provide authority to the U.S. Army Corps of Engineers and funding authorization to model at least 70 tier 1 and tier 2 priority tributaries at a cost of $7.5 M over 5-years.

Full Implementation – Provide authority to the U.S. Army Corps of Engineers and funding authorization to model all gauged 109 U.S. tributary watersheds at a cost of $9.0 M over 7-years. This option assumes that all watersheds are fully gauged.

Footnote*
A process to identified priority tributaries may involve input from state and local agencies. Tributaries identified as most critical are tier 1. Tier 2 and 3 correspond to tributaries in decreasing priority.

Range of Costs

Table K-25: Task 13 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.200	$0.200	$3.750	$4.500	$5.250	$6.000	$7.500	$9.000	$7.500	$9.000	$10.500

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment and Selective Implementation alternatives are identical reflecting a level of basic research. The prospective range of costs for each of the four alternatives is normally distributed with consistent confidence levels.

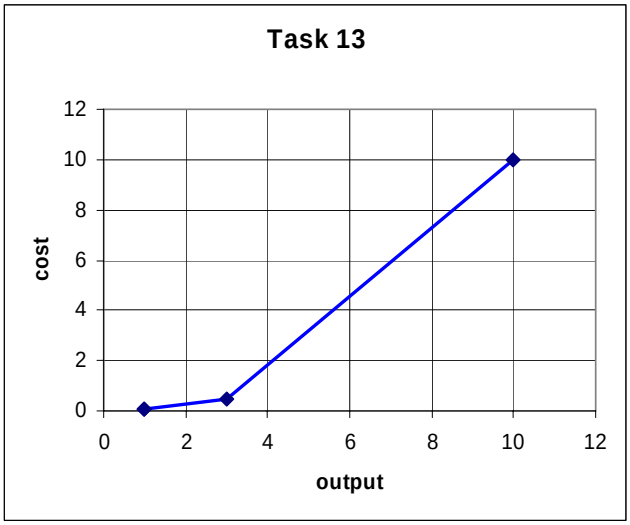
Relative Task Value

Table K-26: Task 13 Relative Task Value

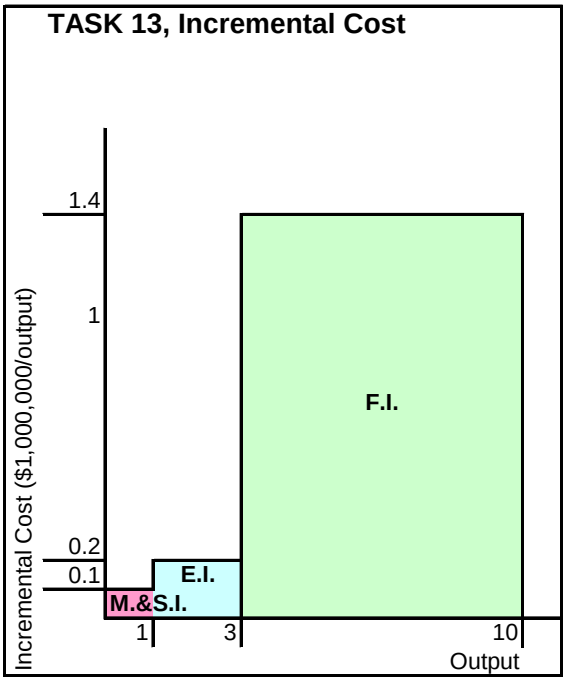
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	0.0	1.0	10.0	20.0	30.0

Remarks: Detailed modeling of gauged watersheds, based upon state-of-the-science techniques and additional data streamflow data, is essential for determining the sustainable yield from the hydrologic system. All comprehensive implementation scenarios provide significant benefits.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.1 M for every one unit increase in output.
Selective – Increase in cost is $0.1 M for every one unit increase in output.
Enhanced – Increase in cost is $0.2 M for every one unit increase in output.
Full – Increase in cost is $1.36 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 14 – Ungauged Watershed Modeling

Implementation Alternatives and Cost Details

Task: The USACE, in conjunction with other U.S. federal agencies and regional, state and academic institutions needs to develop watershed estimation tools to assess water withdrawal impacts on ungauged watersheds.

Without Plan Strategy – Inconsistent methods of streamflow estimations for ungauged areas will continue.

Minimum Investment Strategy – Develop a robust method estimating streamflow in ungauged areas as proposed in the Northeast-Midwest Institute proposal for water resource and management needs at a cost of $400 K over 2 years. Cost estimates are based on similar studies.

Selective Implementation Strategy – Develop a robust method estimating streamflow in ungauged areas as proposed in the Northeast-Midwest Institute proposal for water resource and management needs at a cost of $400 K over 2 years. Cost estimates are based on similar studies.

Enhanced Implementation Strategy – Develop a robust method estimating streamflow in ungauged areas as proposed in the Northeast-Midwest Institute proposal for water resource and management at a cost of $400 K over 2 years. Cost estimates are based on similar studies. Cost estimates are based on similar studies.

Full Implementation Strategy – Develop a robust method estimating streamflow in ungauged areas as proposed in the Northeast-Midwest Institute proposal for water resource and management at a cost of $500 K over 2 years, with additional emphasis on incorporating updated land use/cover mapping. Cost estimates are based on similar studies.

Range of Costs

Table K-27: Task 14 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.350	$0.400	$0.450	$0.350	$0.400	$0.450	$0.350	$0.400	$0.450	$0.450	$0.500	$0.550

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment, Selective and Enhanced Implementation alternatives are identical reflecting a level of basic research with modest uncertainty. The range of prospective costs for the Full Implementation alternative is higher reflecting a larger scope.

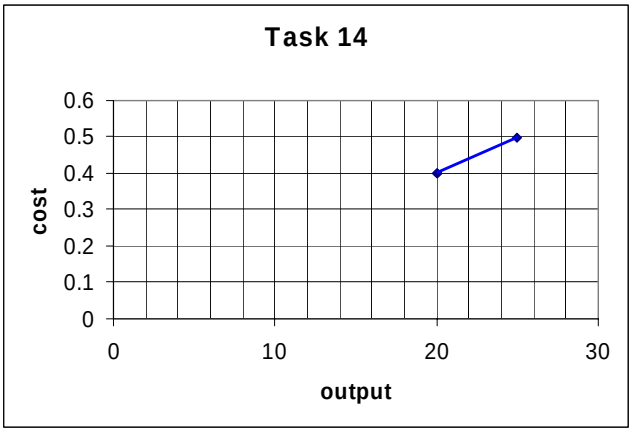
Relative Task Value

Table K-28: Task 14 Relative Task Value

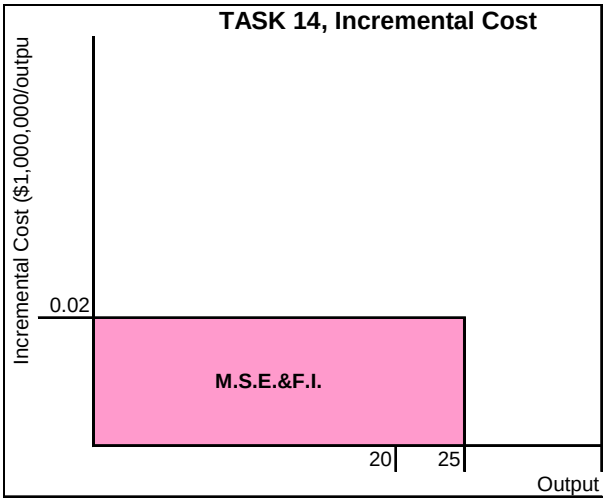
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
25.0	0.0	20.0	20.0	20.0	25.0

Remarks: With nearly half of the tributary watersheds being ungauged, the minimum investment called for under all alternatives for basic research is significant. The basic research is needed, since extensive gauging is likely unattainable.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.02 M for every one unit increase in output.
Selective – Increase in cost is $0.02 M for every one unit increase in output.
Enhanced – Increase in cost is $0.02 M for every one unit increase in output.
Full – Increase in cost is $0.02 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 15 – Net Basin Supply Estimation

Implementation Alternatives and Cost Details

Task: *The U.S. Army Corps of Engineers (USACE), in conjunction with other U.S. federal agencies, Canadian authorities and academic institutions, needs to improve the accuracy and detail in Great Lakes water balance models and needs to monitor changes in net basin supply for each of the Great Lakes on a monthly basis.*

Without Plan Strategy– Net basin supply is modeled by the National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory (NOAA-GLERL), by the USACE and by Canadian authorities. Modeling disagreements are common, without clear definition of the applicability of one modeling process over another for support of Great Lakes Charter Annex needs. The NOAA-GLERL modeling package is the basis of the Coordinated Great Lakes Regulation and Routing Model, a collaborative effort of U.S. and Canadian federal agencies. This model, however, does not provide suitable temporal or spatial detail to monitor cumulative withdrawals through the system. Without major scientific advancements to various modeling components, this situation will remain unchanged.

Minimum Investment Strategy – The activities to be conducted herein will focus on improving the accuracy of the NOAA-GLERL modeling package to address overlake precipitation and evaporation observations from satellite data and other ancillary inputs. The cost to implement these studies is estimated at $4.0 M over ten years. Estimated cost is based on similar studies

Selective Implementation Strategy – The activities to be conducted and their costs are addressed in the subordinate implementation options for this task.

Enhanced Implementation Strategy – The activities to be conducted and their costs are addressed in the subordinate implementation options for this task.

Full Implementation Strategy – The activities to be conducted and their costs are addressed in the subordinate implementation options for this task.

Range of Costs

Table K-29: Task 15 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Epected	Highest
$3.000	$4.000	$5.000	$-	$-	$-	$-	$-	$-	$-	$-	$-

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The Minimum Investment alternative reflects a combination of all activities identified under Tasks 16-25, based only upon existing data, systems and networks. The range of prospective

costs under this alternative is normally distributed. The three Implementation alternatives are not considered under this combined research task.

Relative Task Value

Table K-30: Task 15 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	-5.0	10.0	0.0	0.0	0.0

Remarks: This is a task only factored into the Minimum Investment alternative. It lumps research on expanding current understandings of uncertainties for all hydrologic factors affecting water supplies limited to existing data and systems. Without additional funding for this task (or its subordinate components), the uncertainties of net basin supplies will increase.

Cost Effectiveness and Incremental Analysis

Conclusion: The Minimum Investment alternative is the only choice. No comparison is possible.

Task 16 – Overlake Precipitation

Implementation Alternatives and Cost Details

Task: *The National Oceanic and Atmospheric Administration (NOAA), in cooperation with other federal agencies and regional academic institutions, needs to develop an operational program to measure over-lake precipitation using land-based weather radar and ancillary satellite observations to reduce the level of uncertainty in water balance models.*

Without Plan Strategy – Currently over-lake precipitation is estimated as a function of over-land precipitation. This approach is debatable and a major source of uncertainty in water balance computations.

Minimum Investment Strategy – Included under Task 15, Minimum Investment.

Selective Implementation Strategy – Provide authorization and funding to NOAA's National Weather Service to develop procedures to estimate daily totals for over-lake precipitation using land-based radar systems and satellite observations for all of the Great Lakes at a cost of $2.0 M over 4 years. Cost estimates are based on similar programs.

Enhanced Implementation Strategy – Provide authorization and funding to NOAA's National Weather Service to develop procedures for estimating daily totals for overlake precipitation using land-based radar systems and satellite observations for all of the Great Lakes and implement this program as an operational product at a cost of $6.0 M over 10 years. Cost estimates are based on similar programs.

Full Implementation Strategy – Provide authorization and funding to NOAA's National Weather Service to develop procedures for estimating daily totals for overlake precipitation

using land-based radar systems and satellite observations for all of the Great Lakes and implement this program as an operational product at a cost of $6.0 M over 10 years. Cost estimates are based on similar programs.

Range of Costs

Table K-31: Task 16 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.000	$2.500	$5.000	$2.500	$6.000	$10.000	$2.500	$6.000	$10.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The confidence in the range of prospective costs is low for all three Implementation alternatives given the possibility that these observations can be achieved without substantial additional instrumentation. Conversely, the level of research required to generate operational products could be substantially higher than estimated under the recommended level.

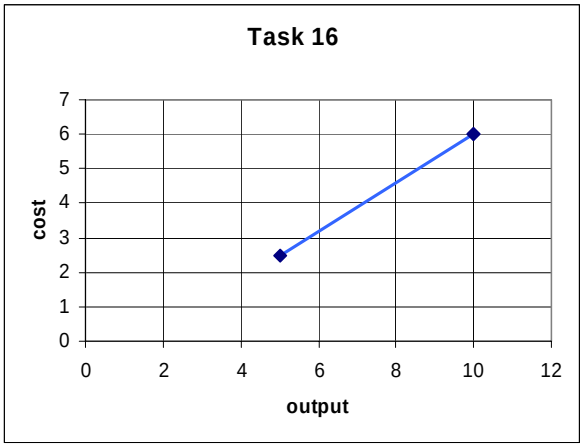
Relative Task Value

Table K-32: Task 16 Relative Task Value

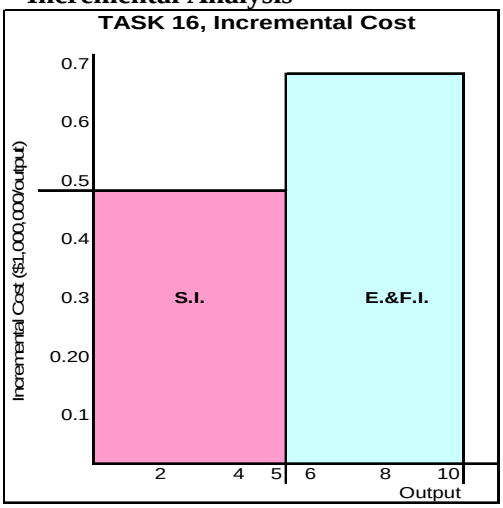
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	5.0	10.0	10.0

Remarks: Improvements in uncertainties for overlake precipitation would be significantly improved at the Selective Implementation level with full functionality gained at the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.5 M for every one unit increase in output.
Enhanced – Increase in cost is $0.7 M for every one unit increase in output.
Full – Increase in cost is $0.7 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 17 – Overlake Evaporation

Implementation Alternatives and Cost Details

Task: *The NOAA, in cooperation with other U.S. federal agencies, Canadian authorities and academic institutions, needs to generate improved daily estimates of lake evaporation conditions by applying satellite, airborne and in-situ observations.*

Without Plan Strategy – Currently lake evaporation is computed as a coarse estimate. During winter months estimates are generally unreliable. This approach is a major source of uncertainty in water balance computations, which will continue at current funding levels.

Minimum Investment Strategy – Included under Task 15, Minimum Investment.

Selective Implementation Strategy – Provide authorization and funding to NOAA to initiate studies to refine and calibrate current evaporation estimation models and reduce uncertainties in water balance computations. The cost to implement these studies is estimated at $1.5 M over two years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Provide authorization and funding to NOAA to initiate studies to refine and calibrate current evaporation estimation models and reduce uncertainties in water balance computations. The cost to implement these studies is estimated at $1.5 M over two years. Estimated cost is based on similar studies

Full Implementation Strategy – Provide authorization and funding to NOAA to initiate studies to refine and calibrate current evaporation estimation models and reduce uncertainties in water balance computations. The cost to implement these studies is estimated at $1.5 M over two years. Estimated cost is based on similar studies

Range of Costs

Table K-33: Task 17 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.200	$1.500	$1.800	$1.200	$1.500	$1.800	$1.200	$1.500	$1.800

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. This task would be initiation of a new program under the three implementation alternatives with full functionality achieved at the Selective Implementation level. The range of prospective costs for all implementation alternatives is normally distributed.

Relative Task Value

Table K-34: Task 17 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	10.0	10.0	10.0

Remarks: Improvements in uncertainties for overlake evaporation would be significantly improved at the Selective Implementation level with full functionality gained at the Enhanced Implementation level.

Cost Effectiveness and Incremental Analysis

Conclusion: Minimum Investment is $0. The remaining alternatives are the same. No comparison is possible.

Task 18 – Overlake Hydrometeorology

Implementation Alternatives and Cost Details

Task: *The NOAA needs to improve monitoring of over-lake hydrologic and meteorological parameters (barometric pressure, wind direction and speed, wave energy, relative humidity, dew point, solar radiation, air and lake surface temperatures and precipitation by upgrading and expanding the Great Lakes buoy and fixed station network to meet the data and information needs of the Great Lakes Charter Annex.*

Without Plan Strategy – Existing buoy network provides minimum coverage to support marine forecasting objectives but do not provide adequate coverage for coastal habitat modeling.

Minimum Investment Strategy – Included under Task 15, Minimum Investment.

Selective Implementation Strategy – Expand the Great Lakes buoy network by adding 1 buoy or C-MAN stations in Lake Erie to collect observations of barometric pressure, wind direction and speed, wave energy, relative humidity, dew point, solar radiation, air and lake temperatures and precipitation, if possible, at a cost of $500 K over ten years and commensurate funding per annum thereafter. Installation a buoy or C-MAN station is estimated to be $90 K. The annual operational cost for a buoy station is $35 K and for a C-MAN station is $25 K.

Enhanced Implementation Strategy – Expand the Great Lakes buoy network by adding at least 4 buoys or C-MAN stations at critical locations on lakes Michigan, Huron, St. Clair, and Erie to collect observations of barometric pressure, wind direction and speed, wave energy, relative humidity, dew point, solar radiation, air and lake temperatures and precipitation, if possible, at a cost of $2 M over ten years and commensurate funding per annum thereafter. Installation a buoy or C-MAN station is estimated to be $90 K. The annual operational cost for a buoy station is $35 K and for a C-MAN station is $25 K.

Full Implementation Strategy – Expand the Great Lakes buoy network by adding 14 buoys or C-MAN stations at critical locations on each of the lakes including Lake St. Clair to collect observations of barometric pressure, wind direction and speed, wave energy, relative humidity, dew point, solar radiation, air and lake temperatures and precipitation, if possible, at a cost of $10 M over ten years and commensurate funding per annum thereafter.

Installation a buoy or C-MAN station is estimated to be $90 K. The annual operational cost for a buoy station is $35 K and for a C-MAN station is $25 K.

Range of Costs

Table K-35: Task 18 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.400	$0.500	$1.000	$1.500	$2.500	$4.000	$8.000	$11.000	$15.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The confidence in the range of prospective costs for each implementation alternative is high on the low end since instrumentation costs are well known but operational costs could be more extensive on the higher end. The alternatives increase in costs as a function of increased scope.

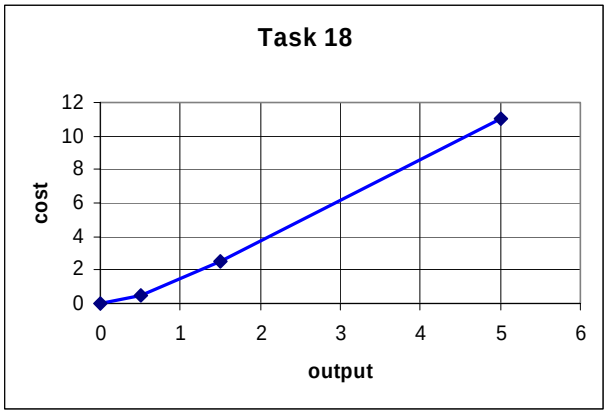
Relative Task Value

Table K-36: Task 18 Relative Task Value

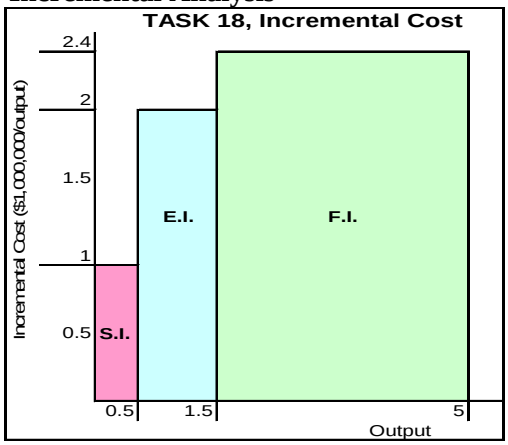
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	-1.0	0.0	0.5	1.5	5.0

Remarks: Without additional funding, attrition of existing open lake monitoring systems will occur. Improvements in uncertainties for overlake hydrometeorology would be significantly met only at the Full Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $1 M for every one unit increase in output.
Enhanced – Increase in cost is $2 M for every one unit increase in output.
Full – Increase in cost is $2.4 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 19 – Ice Cover Modeling

Implementation Alternatives and Cost Details

Task: *The NOAA, in conjunction with other U.S. federal agencies, needs to improve the spatial resolution of ice cover mapping over the Great Lakes. The USACE needs to lead U.S. federal research efforts into short- and long-term ice cover effects on nearshore habitats.*

Without Plan Strategy – Current studies on ice cover over the Great Lakes-St. Lawrence River basin will continue to focus on its linkage with global climate at NOAA's Great Lakes Environmental Research Laboratory. Sporadic studies on the effects of ice cover on nearshore habitats may be conducted at academic institutions, but comprehensive assessments will remain lacking.

Minimum Investment Strategy – Included under Task 15, Minimum Investment.

Selective Implementation Strategy – Provide authorization and funding to NOAA to conduct preliminary studies on the effects of ice cover on nearshore habitats at a cost of $1.5 M over two years. The estimated cost is based on the similar studies.

Enhanced Implementation Strategy – Provide authorization and funding to NOAA to conduct studies with comprehensive field investigations on the effects of ice cover on nearshore habitats at a cost of $3.5 M over five years. The estimated cost is based on the similar studies.

Full Implementation Strategy – Provide authorization and funding to NOAA to conduct studies with comprehensive field investigations on the effects of ice cover on nearshore habitats and generate predictive models to evaluate ice effects on nearshore habitats under variable hydrologic and climatologic scenarios at a cost of $5.5 M over ten years. The estimated cost is based on the similar studies.

Range of Costs

Table K-37: Task 19 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.000	$1.500	$2.000	$2.500	$3.500	$4.500	$4.500	$5.500	$6.500

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

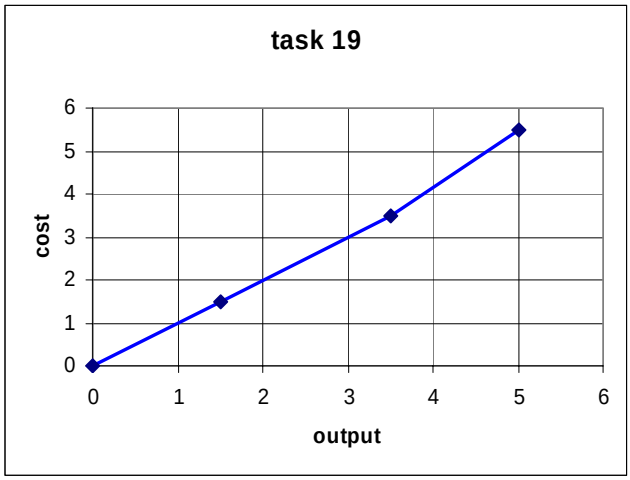
Relative Task Value

Table K-38: Task 19 Relative Task Value

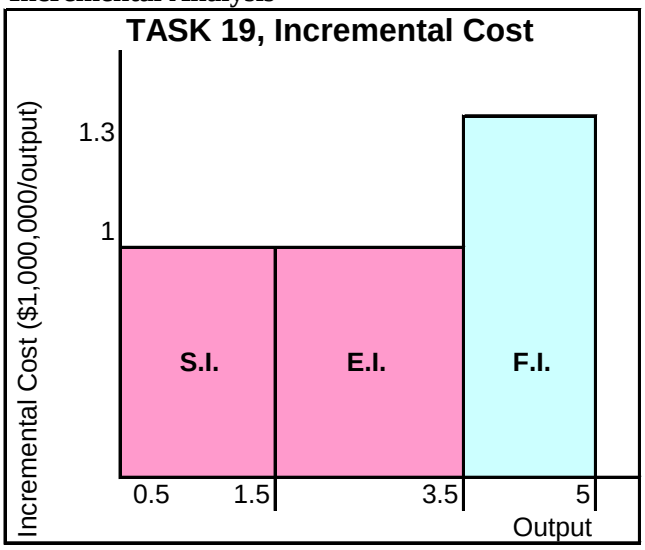
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	-1.0	0.0	1.5	3.5	5.0

Remarks: Without additional funding, attrition of existing resources focused on ice cover monitoring will occur. Additional funding under each of the comprehensive implementation alternatives would promote improved understanding of ice dynamics within the system.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $1 M for every one unit increase in output.
Enhanced – Increase in cost is $1 M for every one unit increase in output.
Full – Increase in cost is $1.3 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 20 – Wave Energy

Implementation Alternatives and Cost Details

Task: *The USACE, in cooperation with other U.S. federal agencies, needs to improve monitoring of wave conditions in the nearshore environment and update wave hindcast models for each of the Great Lakes and Lake St. Clair.*

Without Plan Strategy – Wave climate models are updated for Lake Ontario alone. Without additional funding, prior investigations in nearshore wave dynamics will not be

updated for lakes Superior, Michigan, Huron, and Erie. Without additional funding these data sets will become outdated.

Minimum Investment Strategy – Included under Task 5, Minimum Investment.

Selective Implementation Strategy – Direct the U.S. Army Corps of Engineers to update all wave hindcasts for lakes Superior, Michigan, Huron, St. Clair and Erie. The cost is estimated at $1.5 M over two years. This estimate is based on similar modeling efforts.

Enhanced Implementation Strategy – Direct the U.S. Army Corps of Engineers the authority and funding to update all wave hindcasts for lakes Superior, Michigan, Huron, St. Clair and Erie and to develop a monitoring strategy to keep this information up-to-date. The cost is estimated at $2.5 M over three years. This estimate is based on similar modeling efforts.

Full Implementation Strategy – Direct the U.S. Army Corps of Engineers to update all wave hindcasts for all Great Lakes and Lake St. Clair and to update this information on an annual basis. The cost is estimated at $3.5 M over four years. This estimate is based on similar modeling efforts.

Range of Costs

Table K-39: Task 20 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.200	$1.500	$1.800	$2.000	$2.500	$3.000	$3.000	$3.500	$4.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

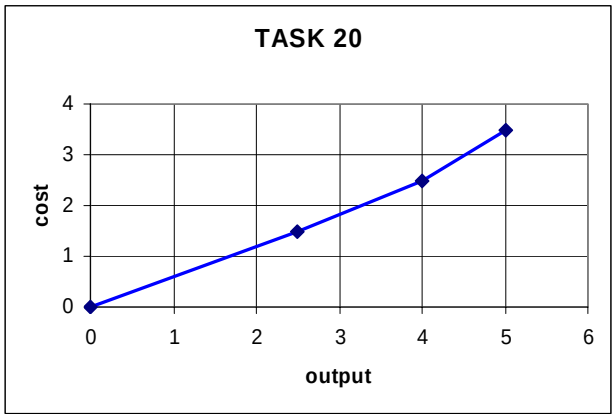
Relative Task Value

Table K-40: Task 20 Relative Task Value

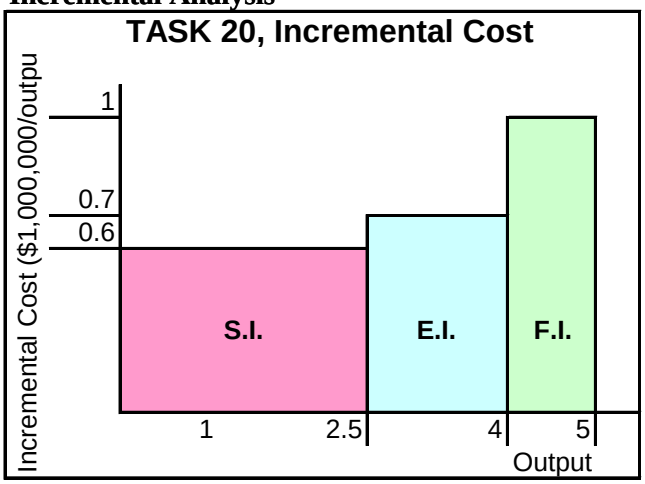
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	-1.0	0.0	2.5	2.0	5.0

Remarks: Without additional funding, wave information will become outdated and irrelevant. Additional funding under each of the comprehensive implementation alternatives would promote improved understanding of wave dynamics affecting coastal habitats within the system.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.6 M for every one unit increase in output.
Enhanced – Increase in cost is $0.67 M for every one unit increase in output.
Full – Increase in cost is $1 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 21 – Open Lake Circulation Modeling

Implementation Alternatives and Cost Details

Task: *The USACE, in conjunction with the NOAA and regional academic institutions, needs to implement high resolution hydrodynamic modeling for each of the Great Lakes and their embayments on a continuous operational basis.*

Without Plan Strategy – Circulation modeling of the Great Lakes is coarse and not continuous; these models have limited utility in monitoring cumulative water withdrawal impacts on nearshore habitats. Satellite monitoring of surface temperatures and upwelling events is sporadic. Future data collection and modeling will likely be conducted piecemeal.

Minimum Investment Strategy – Develop operational continuous circulation models for all Great Lakes (except their embayments) and input satellite and in-situ observations wherever appropriate at a cost of $1.5 M over three years. The estimated cost is based on similar studies.

Selective Implementation Strategy – Develop operational continuous circulation models for all Great Lakes (except their embayments) and input satellite and in-situ observations

wherever appropriate at a cost of $1.5 M over three years. The estimated cost is based on similar studies.

Enhanced Implementation Strategy – Implement continuous circulation models for all Great Lakes including embayments with regular input of satellite and in-situ observations at a cost of $2.5 M over five-years. The estimated cost is based on similar studies.

Full Implementation Strategy – Improve satellite monitoring for near-real time input to continuous circulation models and develop and operate continuous circulation models for all Great Lakes including embayments at a cost of $3.5 M over ten years. The estimated cost is based on similar studies.

Range of Costs

Table K-41: Task 21 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$1.000	$1.500	$2.000	$1.000	$1.500	$2.000	$3.000	$3.500	$4.000	$3.000	$3.500	$4.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative are normally distributed, with increase costs reflecting increased scope until full functionality is achieved at the Enhanced Implementation level.

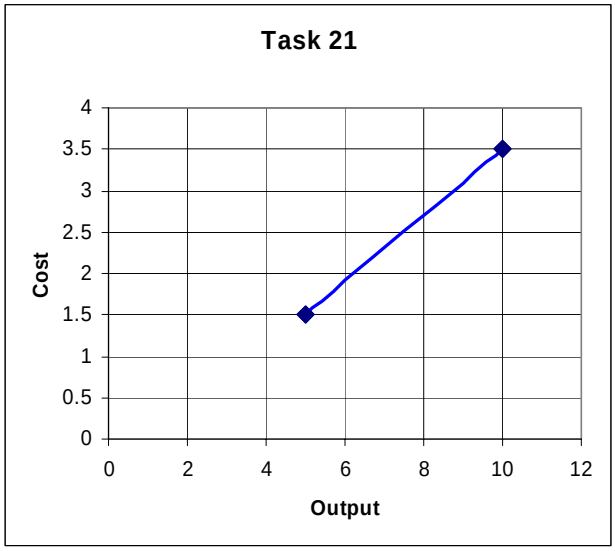
Relative Task Value

Table K-42: Task 21 Relative Task Value

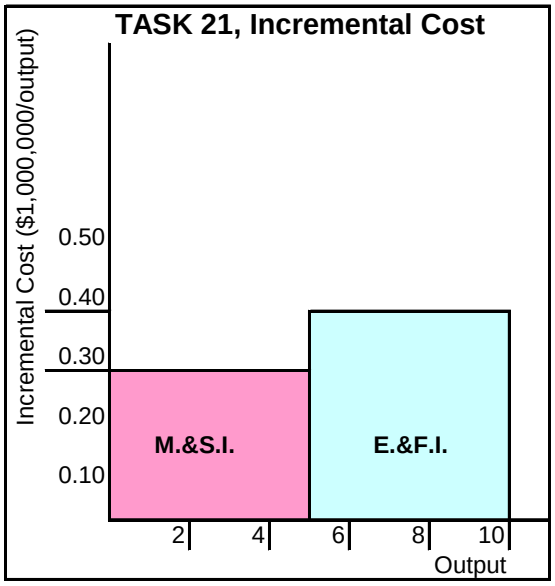
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	5.0	5.5	10.0	10.0

Remarks: Significant improvement in understanding of open lake circulation patterns would be derived at all funding levels with maximum return being realized at the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.3 M for every one unit increase in output.
Selective – Increase in cost is $0.3 M for every one unit increase in output.
Enhanced – Increase in cost is $0.4 M for every one unit increase in output.
Full – Increase in cost is $0.4 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 22 – Nearshore Abiotic Conditions

Implementation Alternatives and Cost Details

Task: *The NOAA, in cooperation with regional academic institutions, needs to improve monitoring of abiotic parameters in the nearshore environment and off-shore by upgrading and expanding instrumentation on buoys and fixed stations and applying satellite remote sensing to provide input to nearshore habitat modeling. These parameters include surface water temperature, pH, salinity, dissolved oxygen and conductivity.*

Without Plan Strategy – The current information base for these parameters is sporadic in spatial and temporal coverage. This situation will remain under existing funding limitations.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Deploy instrumentation to collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges. Collect the same abiotic observations at all buoy and CMAN stations. Costs are estimated at $2 M over ten years. These are based on estimates from the NDBC staff.

Enhanced Implementation Strategy – Deploy instrumentation to collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges. Contingent upon expansion of the buoy network by 10 buoys, collect the same abiotic observations at all buoy and CMAN stations. Costs are estimated at $8 M over ten years. These are based on estimates from the NDBC staff.

Full Implementation Strategy – Deploy instrumentation to collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges. Contingent upon expansion of the buoy network by 15 buoys, collect the same abiotic observations at all buoy and CMAN stations. Costs are estimated at $18 M over ten years. These are based on estimates from the NDBC staff.

Range of Costs

Table K-43: Task 22 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.500	$2.000	$2.500	$6.000	$8.000	$10.000	$15.000	$18.000	$21.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

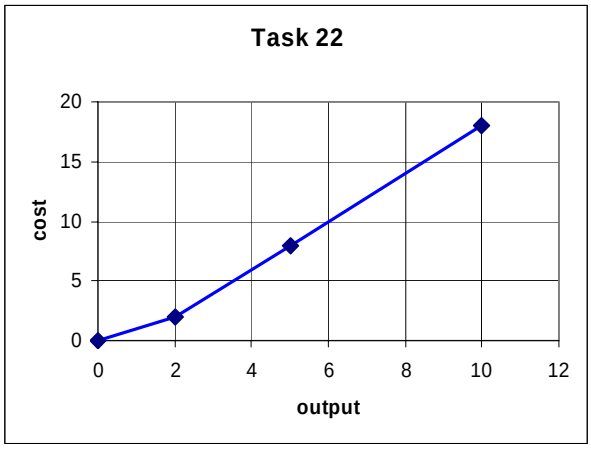
Relative Task Value

Table K-44: Task 22 Relative Task Value

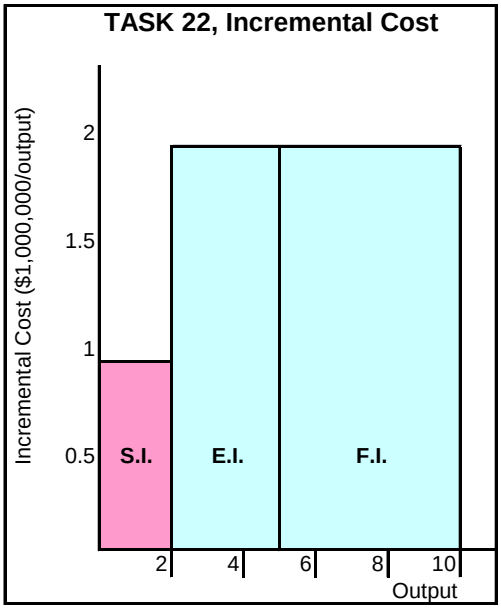
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	2.0	5.0	10.0

Remarks: Significant improvement in understanding of nearshore chemistry and other parameters would be derived at all funding levels with maximum return only being realized at the Full Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $1 M for every one unit increase in output.
Enhanced – Increase in cost is $2 M for every one unit increase in output.
Full – Increase in cost is $2 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 23 – Interconnecting Waterways Hydrodynamics

Implementation Alternatives and Cost Details

Task: *The USACE, in conjunction with the NOAA, the U.S. Geological Survey (USGS) and Canadian authorities and in cooperation with regional academic institutions, needs to implement continuous modeling of water levels, outflows, and hydrodynamics in the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Currently water levels are adequately measured in all of the interconnecting waterways, Lake St. Clair and the St. Lawrence River. In-place flow meters have been deployed in the Detroit and St. Clair Rivers for research studies. One research buoy has been deployed in Lake St. Clair but is not a permanent fixture. Circulation modeling is based upon hydrodynamic models currently under initial development. Operational utilization is hampered by lack of funding and low priority. Estimated cost is based on similar programs.

Minimum Investment Strategy – Implement one in-place flow meter for continuous operation in each of the St. Clair and Detroit rivers. Maintain the existing buoy in Lake St. Clair. Develop and implement continuous hydrodynamic models for the St. Clair – Detroit River systems. The costs to implement and maintain these components are estimated at $3 M over 10-years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Implement a minimum of one in-place flow meter for continuous operation on each of the interconnecting waterways and the St. Lawrence River. Maintain the existing buoy in Lake St. Clair. Develop and implement continuous hydrodynamic models for each of the Great Lakes interconnecting waterways and Lake St. Clair. The costs to implement and maintain these components are estimated to be $16 M over 10-years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Install and operate a minimum of one in-place flow meters in each of the interconnecting waterways and the St. Lawrence River. Maintain the existing buoy in Lake St. Clair. All existing connecting channel and St. Lawrence River gauges would be upgraded to permanent structures and automated to provide instantaneous data interrogation. Develop and implement continuous hydrodynamic models for each of the Great Lakes interconnecting waterways and Lake St. Clair. The total costs to implement and maintain these components are estimated to be $20 M over 10-years. Estimated cost is based on similar programs.

Full Implementation Strategy – All existing connecting channel and St. Lawrence River gauges would be upgraded to permanent structures and automated to provide instantaneous data interrogation. Install and operate a minimum of two in-place flow meters in each of the interconnecting waterways and St. Lawrence River. Maintain the existing buoy network and add one off-shore buoy on each Great Lake and Lake St. Clair. Develop and implement continuous hydrodynamic models for each of the Great Lakes interconnecting waterways and Lake St. Clair. The total costs to implement and maintain these components are estimated to be $23.5 M over 10-years. Estimated cost is based on similar programs.

Range of Costs

Table K-45: Task 23 Range of Costs (in millions of dollars)

Minimum Investment			**Selective Implementation**			**Enhanced Implementation**			**Full Implementation**		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$2.500	$3.000	$3.500	$12.000	$16.000	$20.000	$15.000	$20.000	$25.000	$18.000	$23.000	$29.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

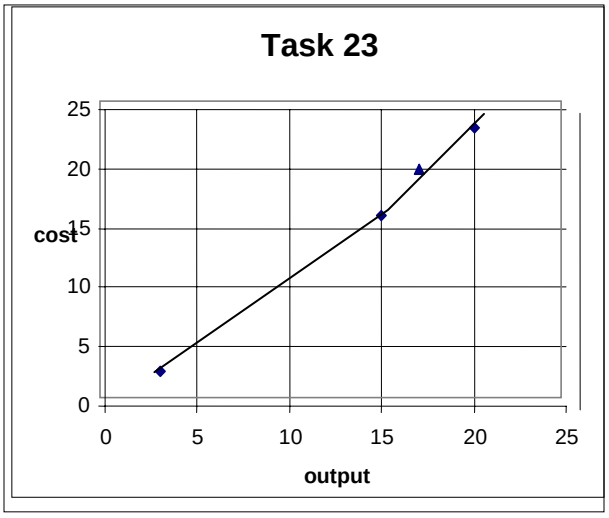
Relative Task Value

Table K-46: Task 23 Relative Task Value

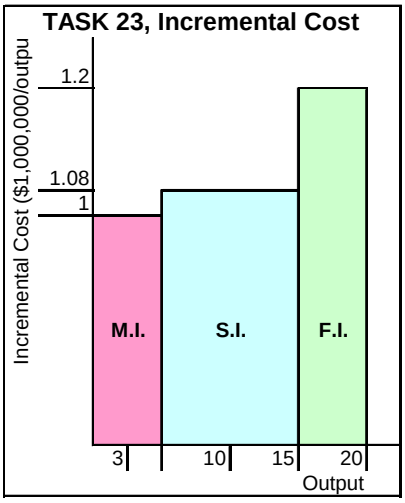
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	3.0	15.0	17.0	20.0

Remarks: Improved understanding of the effects of cumulative water withdrawals on the sustainability of habitats in the highly prolific interconnecting waterways would be incrementally attained as funding levels increase for each of the comprehensive Implementation alternatives.

Cost Effectiveness



Incremental Analysis



Conclusion: Enhanced Alternative is deemed to be less cost effective. Due to the criticality of implementing this task under this alternative, it should not be eliminated solely by this test.

Incremental Analysis:
Minimum – Increase in cost is $1 M for every one unit increase in output.
Selective – Increase in cost is $1.1 M for every one unit increase in output.
Enhanced – Increase in cost is $2 M for every one unit increase in output.
Full – Increase in cost is $1.2 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 24 – Interconnecting Waterways Abiotic Conditions

Implementation Alternatives and Cost Details

Task: *The NOAA, in conjunction with other U.S. federal agencies and hydropower authorities, needs to upgrade instrumentation at water level gauging stations to better monitor abiotic conditions in the habitats of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Current information base on abiotic parameters in the interconnecting waterways, Lake St. Clair and the St. Lawrence River is sporadic and incomplete. This situation is not likely to change with existing funding and on-going programs.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges in the St. Clair – Lake St. Clair – Detroit River system and at the one buoy in Lake St. Clair. The total cost for this activity is estimated at $3.5 M over 10-years and commensurate funding per annum thereafter. Estimated Costs are based on similar programs.

Enhanced Implementation Strategy – Collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges in the St. Marys River and in the St. Clair – Lake St. Clair – Detroit River system, including all buoys in Lake St. Clair. The total cost for this activity is estimated at $6 M over 10-years and commensurate funding per annum thereafter. Estimated costs are based on similar programs.

Full Implementation Strategy – Collect abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all water level gauges in the Great Lakes interconnecting waterways and the St. Lawrence River and at buoys in Lake St. Clair. The total cost for this activity is estimated to be $12 M over 10-years with commensurate funding per annum thereafter. Estimated costs are based on similar programs.

Range of Costs

Table K-47: Task 24 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$2.500	$3.500	$4.500	$4.500	$6.000	$7.500	$10.000	$12.000	$14.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

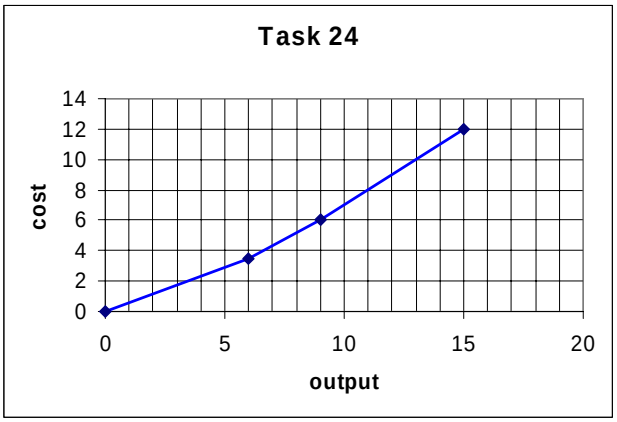
Relative Task Value

Table K-48: Task 24 Relative Task Value

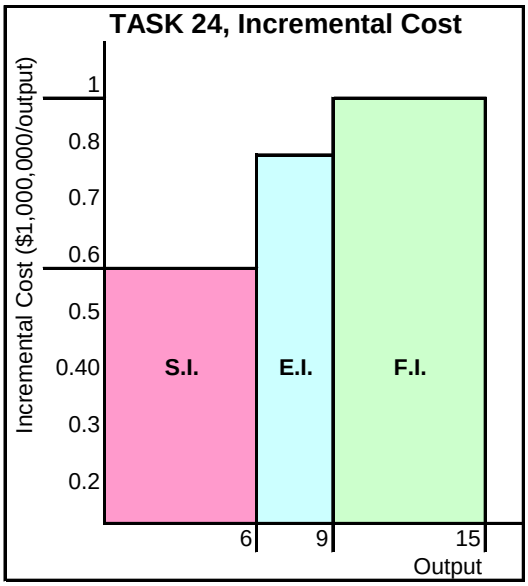
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
15.0	0.0	0.0	6.0	9.0	15.0

Remarks: Significant improvement in understanding of water chemistry and other abiotic parameters would be derived at all funding levels with maximum return only being realized at the Full Implementation alternative.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.6 M for every one unit increase in output.
Enhanced – Increase in cost is $0.8 M for every one unit increase in output.
Full – Increase in cost is $1 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 25 – Diversion Accounting

Implementation Alternatives and Cost Details

Task: *The USACE needs to be provided authorities to work with other U.S. federal agencies, Canadian authorities and state, provincial and municipal entities to improve monitoring, modeling and accounting of all inflows and outflows into, between, and out of the Great Lakes drainage basins by employing state-of-the-science measuring techniques, numerical modeling approaches and automated observing systems.*

Without Plan Strategy – Currently inflows and outflows through the major Great Lakes diversions have been determined along with confidence levels in estimation techniques. The uncertainty associated with these estimates is very large, dwarfing any single prospective water withdrawal, and in some cases, most minor withdrawals when considered collectively. The current level of monitoring is likely to continue under on-going programs and funding, but little improvement in accuracy; timeliness or thoroughness can be expected. Significant shortfalls exist in assuring accuracies of minor diversions throughout the system and

monitoring them on an acceptable periodicity. These problems will not be addressed within existing resource allocations.

Minimum Investment Strategy – The total cost for this activity is estimated at $1.5 M over 3-years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Conduct comprehensive assessments of the uncertainties of outflow accounting procedures for the Lake Michigan Diversion at Chicago and generate detailed plans for improving the accuracy and timeliness for reporting. The total cost for this activity is estimated at $1.5 M over 3-years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Conduct comprehensive assessments of the uncertainties of outflow accounting procedures for the Lake Michigan Diversion at Chicago and for the New York Barge Canal system and implement plans for improving the accuracy and timeliness of annual reporting. The total cost for this activity is estimated at $6 M over 10-years and commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Full Implementation Strategy – Conduct comprehensive assessments of the uncertainties of outflow accounting procedures for all major and minor diversions systems in the U.S., with particular emphasis on the Lake Michigan Diversion at Chicago and for the New York Barge Canal system, and implement plans for improving the accuracy and timeliness of annual reports. The total cost for this activity is estimated to be $12 M over 10-years with commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Range of Costs

Table K-49: Task 25 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$1.000	$1.500	$2.000	$2.000	$3.000	$4.000	$4.000	$6.000	$8.000	$9.000	$12.000	$15.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: No additional funding was considered under the Minimum Investment alternative. The range of prospective costs for each implementation alternative is normally distributed, with increase costs reflecting increased scope.

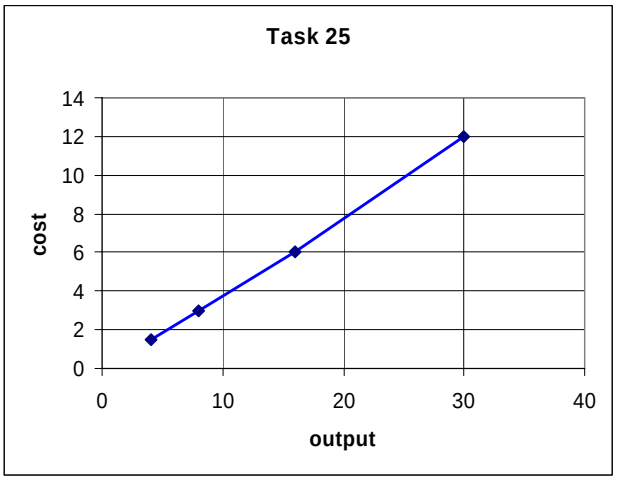
Relative Task Value

Table K-50: Task 25 Relative Task Value

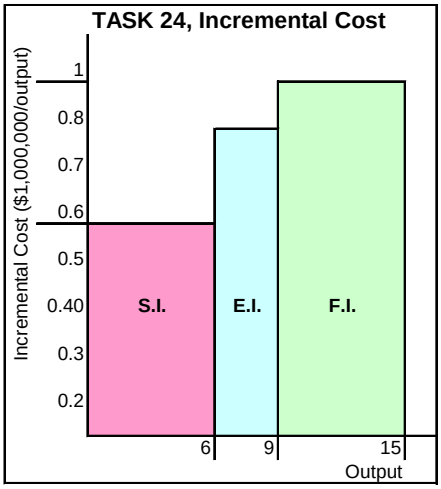
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	-10.0	4.0	8.0	16.0	30.0

Remarks: Improvements in diversion accounting would be attained incrementally and uniformly as funding is increased. Comprehensive understanding of all the influences of all minor diversions into, out of and between the Great Lakes surface watersheds would only be attained by the Full Implementation alternative.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.375 M for every one unit increase in output.
Selective – Increase in cost is $0.375 M for every one unit increase in output.
Enhanced – Increase in cost is $0.375M for every one unit increase in output.
Full – Increase in cost is $.4 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 26 – NWUIP Improvements

Implementation Alternatives and Cost Details

Task: *The USGS needs to strengthen the National Water Use Information Program (NWUIP) and integrate this program with other related federal programs to support implementation of the Great Lakes Charter Annex.*

Without Plan Strategy – The USGS NWUIP will continue to receive limited federal funding.** Inconsistent information on water withdrawals and uses will continue due to differing levels of cooperation by states, inside and outside of the Great Lakes region. Incomplete, non-uniform and unreliable information will continue to be the norm, compromising science-based water resources management decisions to implement Great Lakes Charter Annex.

Minimum Investment Strategy – Change existing authorities to increase the federal funding to ensure effective operation of NWUIP in each USGS state district in the Great Lakes basin. Additionally, this will ensure consistent and uniform water withdrawal and use information within the region. The cost for this action is estimated to be $1 M over ten years.

Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Selective Implementation Strategy – Change existing authorities to increase the federal funding by 250% to ensure effective operation of NWUIP in each USGS state district in the Great Lakes basin. Additionally, this will ensure consistent and uniform water withdrawal and use information within the region. The cost for this action is estimated to be $16 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Enhanced Implementation Strategy – Change existing authorities to increase federal funding by 375% to ensure participation of all Great Lakes states in the NWUIP. Also, provide pass-through funding to the Great Lakes Commission to coordinate and expand state program infrastructure and facilitate linkages with other federal programs including the North American Water Quality Assessment (NAWQA) program, the Gap Analysis Program (GAP). These actions would coincide with increased withdrawal monitoring and improved estimation under related tasks. The estimated cost for this program is $32 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – Change existing authorities to increase federal funding by 500% to ensure participation of all Great Lakes states in the NWUIP. Also, provide pass-through funding to the Great Lakes Commission to fund state program infrastructure and facilitate linkages with other federal programs, including the North American Water Quality Assessment (NAWQA) program and the Gap Analysis Program (GAP). These actions would coincide with increased withdrawal monitoring and improved estimation under related tasks. The estimated cost for this program is $60 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-51: Task 26 Range of Costs (in millions of dollars)

Minimum Investment			**Selective Implementation**			**Enhanced Implementation**			**Full Implementation**		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.800	$1.500	$2.000	$12.000	$16.000	$20.000	$24.000	$32.000	$40.000	$45.000	$60.000	$75.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Estimates for enhancing existing program with substantial expansion to Great Lakes interests. Range of prospective costs is normally distributed, except for Minimum Investment alternative where minimum and proposed are identical to insure basic program functionality.

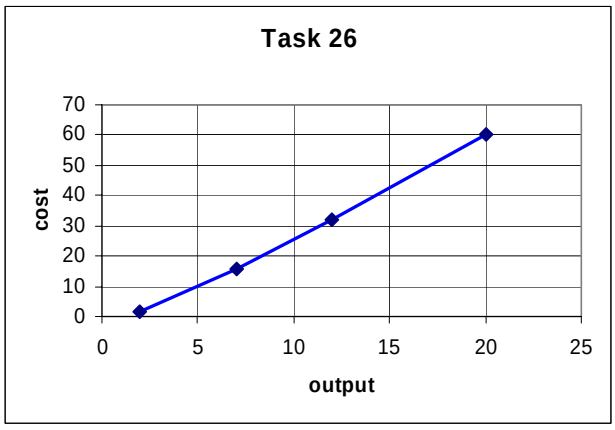
Relative Task Value

Table K-52: Task 26 Relative Task Value

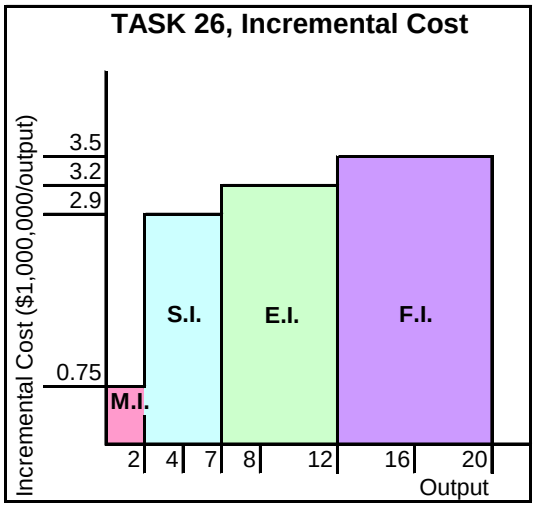
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	-10.0	2.0	7.0	12.0	20.0

Remarks: Improvements to the National Water Use Information Program emphasizing Great Lakes uses would clarify the relationship between sustainable water resources and demand. Without new funding, prior water use inventories will not be updated. Return would be realized at all levels, with substantial benefit being realized at the Enhanced level and above.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.75 M for every one unit increase in output.
Selective – Increase in cost is $2.9 M for every one unit increase in output.
Enhanced – Increase in cost is $0.32M for every one unit increase in output.
Full – Increase in cost is $3.5 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 27 – Water Withdrawal Reporting

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional interests, needs to implement periodic reporting of water withdrawals and use for the Great Lakes-St. Lawrence River basin.*

Without Plan – Without additional funding, periodic updates of regional water uses will not occur.

Minimum Investment – Provide authority to the USGS to work in partnership with the Great Lakes Commission in support of annual reporting of water withdrawal and use within the Great Lakes basin, with pass-through funding to the Great Lakes states to build requisite infrastructure. The estimate cost for this program is $2 M over 10 years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Selective Implementation – Provide authority to the USGS to work in partnership with the Great Lakes Commission in support of annual reporting of water withdrawal and use within the Great Lakes basin, with pass-through funding to the Great Lakes states to build requisite infrastructure. The estimate cost for this program is $5 M over 10 years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Enhanced Implementation – Provide authority to the USGS to work in partnership with the Great Lakes Commission in support of annual reporting of water withdrawal and use within the Great Lakes basin, with pass-through funding to the Great Lakes states to build requisite infrastructure. The estimate cost for this program is $10 M over ten years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation – Provide authority to the USGS to work in partnership with the Great Lakes Commission in support of annual reporting of water withdrawal and use within the Great Lakes basin, with pass-through funding to the Great Lakes states to build requisite infrastructure. The estimate cost for this program is $10 M ** over ten years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Footnotes
** The reason why the costs of partial and full implementation option are the same is as follows; if investment in quality data is high, the costs of reporting may go down.

Range of Costs

Table K-53: Task 27 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$2.000	$2.000	$3.000	$5.000	$6.000	$8.000	$10.000	$11.000	$12.000	$10.000	$11.000	$12.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Estimates to establish a permanent program. Minimum and proposed costs are identical since they reflect high confidence in needs of basic program functionality. The difference between Enhanced and Full Implementation alternatives are non-existent due to economies in scale.

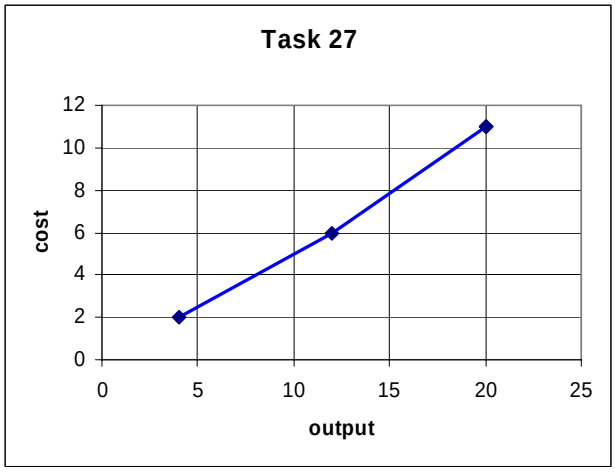
Relative Task Value

Table K-54: Task 27 Relative Task Value

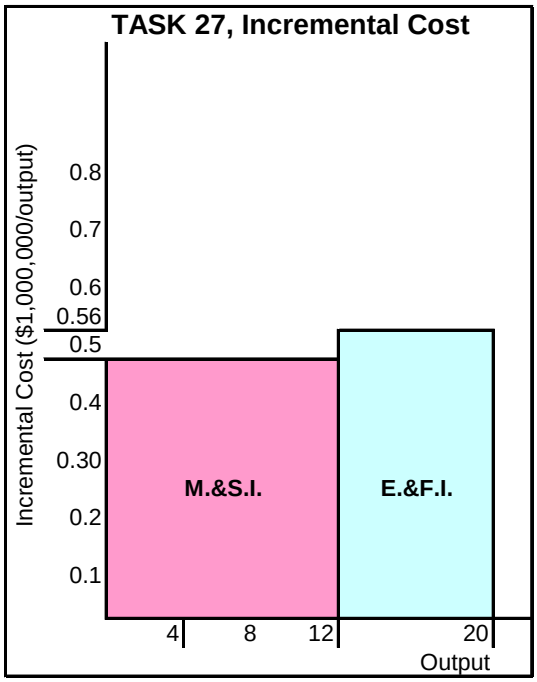
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	-5.0	4.0	12.0	20.0	20.0

Remarks: Substantial return on investment would be realized at the Selective Implementation level with full functionality occurring at the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.48 M for every one unit increase in output.
Selective – Increase in cost is $0.48 M for every one unit increase in output.
Enhanced – Increase in cost is $0.625M for every one unit increase in output.

Full – Increase in cost is $0.625 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 28 – Water Use Uncertainties

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional, state and provincial authorities, needs to define and implement metadata standards to improve knowledge of inherent uncertainties in water use and withdrawal data for the Great Lakes – St. Lawrence River basin.*

Without Plan Strategy – Documentation of water use data and information will continue to be highly variable from state to state resulting in inconsistencies and a lack of scientific rigor. The resulting poor quality data will contribute to indefensible water withdrawal decisions under Great Lakes Charter Annex.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Develop metadata standards for water use and withdrawal data for all water use categories and all Great Lakes states at a cost of $500 K over two years. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Enhanced Implementation Strategy – Provide authority to the USGS to require state compliancy to federal metadata standards for water withdrawal and use data at a 50-50 cost-share with the states to implement this program at the estimated federal cost of $2 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – Provide authority to the USGS to require state compliancy to federal metadata standards for water withdrawal and use data. This authority would be 100% federal funded, with pass-through to the states. The estimated cost for this program would be $4 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-55: Task 28 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.500	$0.500	$0.800	$1.500	$2.000	$2.500	$3.000	$4.000	$5.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Initiation of new program considered only for system implementation alternatives. Range of prospective costs is normally distributed.

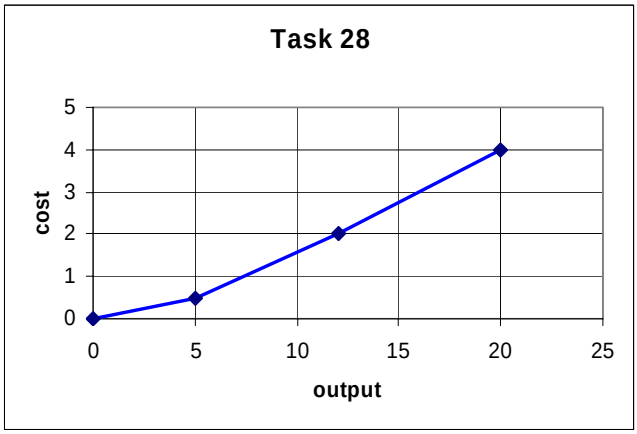
Relative Task Value

Table K-56: Task 28 Relative Task Value

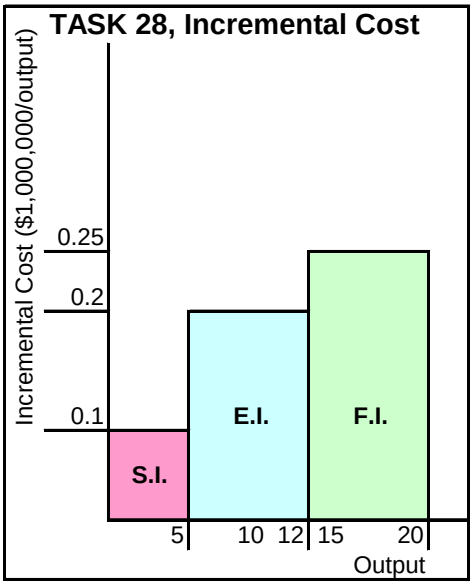
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	-5.0	0.0	5.0	12.0	20.0

Remarks: Definition of uncertainties of water uses is of critical importance to withdrawal permitting. Substantial benefit will be attained at all levels of comprehensive implementation.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.1 M for every one unit increase in output.
Enhanced – Increase in cost is $0.214 M for every one unit increase in output.
Full – Increase in cost is $0.25 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 29 – Water Use Estimations

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional, state and provincial authorities needs to improve estimation techniques of water withdrawal and use for surface and groundwater whenever direct measurements are unavailable to support Great Lakes Annex decisionmaking.*

Without Plan Strategy – The quality of water use data will continue to be low especially for those categories that rely on estimation rather than direct measurement. The reliability of estimated data will show little improvement as estimation techniques are varied and untested, with no single approach identified and recommended to implement the Great Lakes Charter Annex.

Minimum Investment Strategy – Undertake a systematic comparison of water use estimation methods in the Great Lakes states for all categories of use where estimation is currently utilized. The USGS would need to develop a manual of procedures including the definition of statistical sampling approaches to improve the reliability of estimation techniques. The estimated cost for this program is $1 M over two years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Provide authority to the USGS to implement periodic estimations of water withdrawal for the livestock, irrigation, self-supplied domestic and other use categories, and withdrawals not directly measured for electric power facilities, public water supplies, and industrial uses below the state registration level of 100,000 gal/day. This program would require pass-through funding to the Great Lakes states. The estimated cost for this program is $4 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Partial Implementation Strategy – Provide authority to the USGS to implement periodic estimations of water withdrawal for the livestock, irrigation, self-supplied domestic and other use categories, and withdrawals not directly measured for electric power facilities, public water supplies, and industrial uses below the state registration level of 100,000 gal/day. This program would require pass-through funding to the Great Lakes states. The estimated cost for this program is $10 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – The full implementation option considers that all withdrawals above the state registration level of 100,000 gal/day would be measured directly. Development of appropriate estimation techniques and annual reporting would still be needed for cumulative withdrawals below the state registration level. This program would be 100% federally funded with pass through to the Great Lakes states at a cost of $20 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-57: Task 29 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$1.000	$1.000	$2.000	$4.000	$5.000	$6.000	$8.000	$10.000	$12.000	$16.000	$20.000	$24.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Initiation of new program considered for all alternatives. Minimum and proposed costs are identical for the Minimum Investment and Selective Implementation alternatives since they reflect high confidence in needs of minimum program functionality. Range of prospective costs is normally distributed for the Enhanced and Full Implementation alternatives.

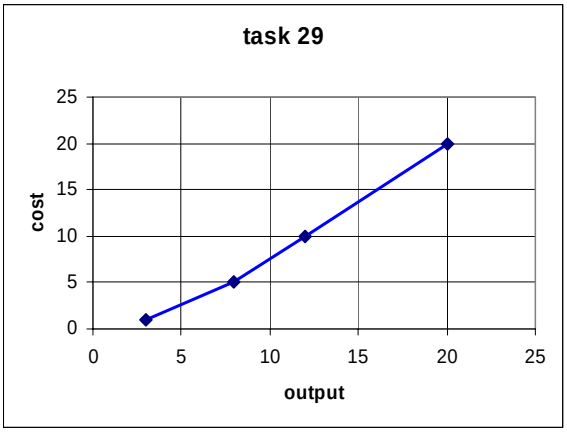
Relative Task Value

Table K-58: Task 29 Relative Task Value

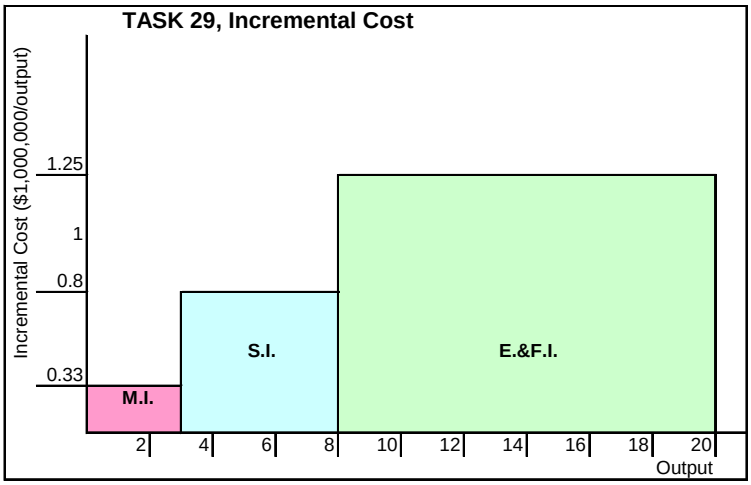
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	-5.0	3.0	8.8	12.0	20.0

Remarks: Improvements in estimating water uses when direct measures are unavailable is very important for assessing demand trends and impacts on water resources. Substantial benefits are attained at all levels of comprehensive implementation.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.33 M for every one unit increase in output.
Selective – Increase in cost is $0.8 M for every one unit increase in output.
Enhanced – Increase in cost is $1.25 M for every one unit increase in output.
Full – Increase in cost is $1.25 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 30 – Water Use Direct Measurements

Implementation Alternatives and Cost Details

Task: *The USGS needs to work collaboratively with regional, state and provincial authorities to implement direct measurements of water withdrawal and use, wherever technically feasible and implementable, to support decisionmaking under the Great Lakes Charter Annex.*

Without Plan Strategy– Currently water withdrawal and use data are at least partially measured for the public water supply, thermal-electric, thermal-nuclear, hydroelectric power, and industrial categories. Without additional authority and funding, improvements in direct measurements of these categories will not occur.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation – Require that all facilities in the public water supply and power generating facilities to measure and report withdrawals from surface and groundwater above the state registration level of 100,000 gal/day. This program would require pass-through funding to the Great Lakes states to develop infrastructure to implement this program. The estimated cost for this program is $10 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Enhanced Implementation Strategy – Require that all facilities in the public water supply, thermal-electric, thermal-nuclear, hydroelectric power, and industrial categories to measure and report withdrawals from surface and groundwater above the state registration level of 100,000 gal/day. This program would require pass-through funding to the Great Lakes states to develop infrastructure to implement this program. The estimated cost for this program is $24 M over ten years, with commensurate per annum funding thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – Require all facilities to implement direct measurements of surface and groundwater withdrawals for all categories of use above the state registration level of 100,000 gal/per day. Establish a federal program to assist the states in requiring full measurements of withdrawals at a cost of $150 M over 10 years, and continued thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-59: Task 30 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$8.000	$12.000	$16.000	$16.000	$24.000	$32.000	$50.000	$62.000	$80.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Initiation of new program considered for only system implementation alternatives. Range of prospective costs is normally distributed for the Selective and Enhanced Implementation alternatives. The minimum and proposed costs for Full Implementation reflect high confidence in program needs for basic functionality (if this alternative is even practical).

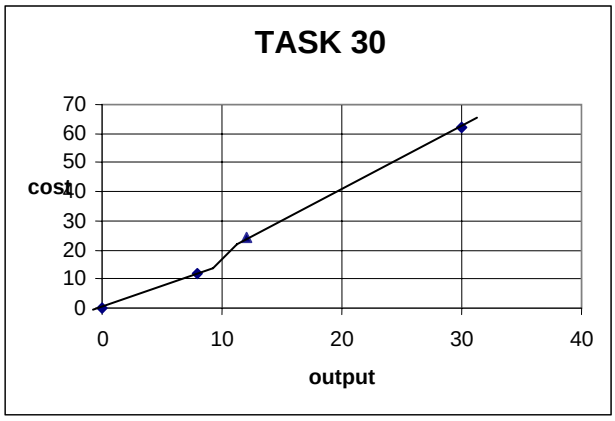
Relative Task Value

Table K-60: Task 30 Relative Task Value

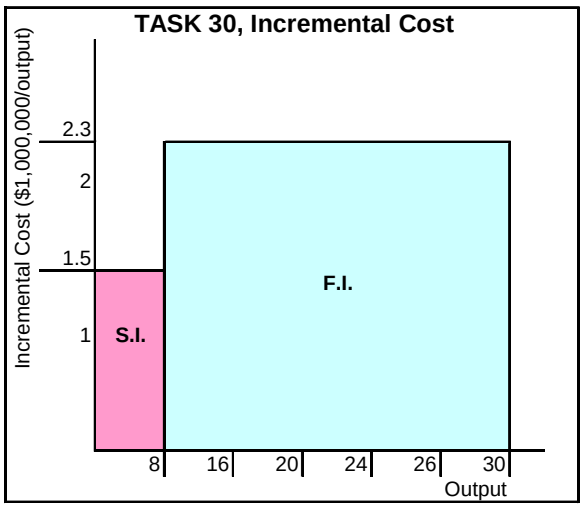
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	-5.0	0.0	8.0	12.0	30.0

Remarks: Direct measurements of water withdrawals are preferred whenever and wherever technical possible and financially practical. Substantial benefits are attained at all levels of comprehensive implementation.

Cost Effectiveness



Incremental Analysis



Conclusion: The Enhanced Alternative is less cost effective than the other alternatives. Due to its critical nature in the integrated system, however, it should not be excluded for this task.

Incremental Analysis:
Selective – Increase in cost is $1.5 M for every one unit increase in output.
Enhanced – Increase in cost is $3 M for every one unit increase in output.
Full – Increase in cost is $2.1 M for every one unit increase in output.

Task 31 – Consumptive Use Estimations

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with regional, state and provincial authorities needs to develop a systematic method for estimating consumptive use for those water use categories where direct measurements are not possible.*

Without Plan Strategy – Without significant additional funding, research and collaboration, current consumptive use coefficients will continue to be used to estimate consumption. Consumptive use estimates will continue to be inconsistent and unreliable.

Minimum Investment Strategy – Develop systematic methods to estimate consumptive use by water use category for both surface and groundwater. Conduct pilot studies that directly measure consumptive use for both surface and groundwater for selective water use categories or facility types at a cost of $500 K over 2 years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Develop systematic methods to estimate consumptive use by water use category for both surface and groundwater. Conduct pilot studies that directly measure consumptive use for both surface and groundwater for selective water use categories or facility types at a cost of $500 K over 2 years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Require all facilities within the power generating, public water supply and industrial categories to directly measure consumptive uses from both surface and groundwater. Apply systematic methods to estimate consumptive use for those categories where consumptive use measurements are not possible. Federal funding to support this mandate is estimated to be $20 M over 10 years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Full Implementation Strategy – Require all facilities for all categories of use to directly measure consumptive uses for both surface and groundwater. Apply systematic methods to estimate consumptive use for those categories where consumptive use measurements are not possible. Federal funding to support this mandate could be as high as $50 M over 10 years, with commensurate funding per annum thereafter. Estimates are based on discussions from the NWUIP staff and state data collection and reporting staff.

Range of Costs

Table K-61: Task 31 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.500	$0.500	$0.500	$0.500	$0.500	$0.500	$16.000	$23.000	$32.000	$40.000	$58.000	$80.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Initiation of new program for all alternatives. There is no range of costs for the Minimum Investment and Selective Implementation alternatives since they reflect an uniform level of research.

Decreasing confidence exists about the range of costs for the Enhanced and Full Implementation alternatives reflecting the complexity of information types involved.

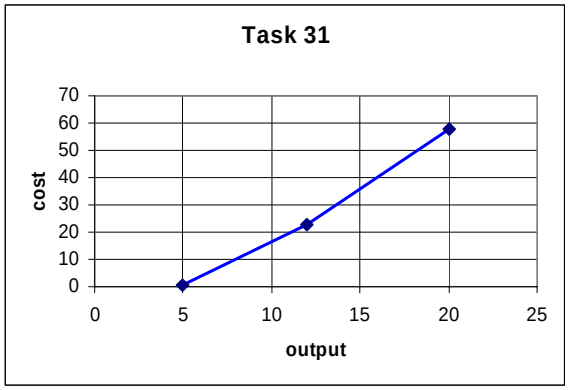
Relative Task Value

Table K-62: Task 31 Relative Task Value

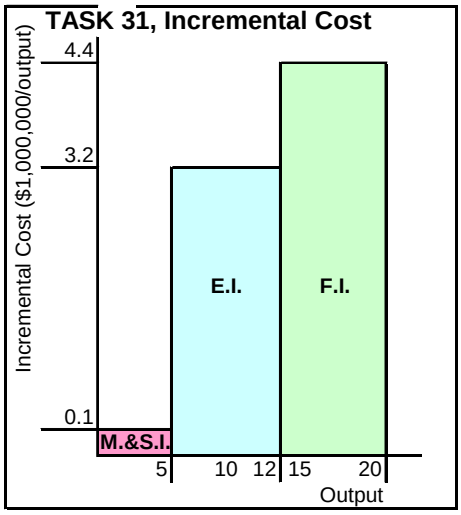
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	-5.0	5.0	5.0	12.0	20.0

Remarks: Estimations of water not returned to a system are of critical importance to understanding the water budget. At the Minimum Investment and Selective Implementation levels, funding covers only basic research with nominal additional data. Substantial benefits are only attained at higher funding levels.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.1 M for every one unit increase in output.
Selective – Increase in cost is $0.1 M for every one unit increase in output.
Enhanced – Increase in cost is $4.47 M for every one unit increase in output.
Full – Increase in cost is $3.47 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 32 – Demand Forecasting

Implementation Alternatives and Cost Details

Task: *The USGS needs to coordinate development of consistent demand forecasts of water withdrawals and uses for all USGS major watersheds in the Great Lakes-St. Lawrence River basin at the state and local levels, including integration current and projected land use information.*

Without Plan Strategy – Demand forecasting will occur sporadically with no coordination among or between jurisdictions. This will negatively impact implementation of the Great Lakes Charter Annex due to the paucity of data. With little or no financial and programmatic support at the state level, demand forecasting tools will not be developed.

Minimum Investment Strategy – Develop a consistent and uniform methodology for demand forecasting of water withdrawals and uses for all USGS major watersheds and establish a uniform schedule for conducting demand forecasts. The estimated cost for this program is $200 K over two years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Develop a consistent and uniform methodology for demand forecasting of water withdrawals and uses for all USGS major watersheds and establish a uniform schedule for conducting demand forecasts. Conduct one pilot demand forecast for one USGS major watershed in the Great Lakes Basin. The estimated cost for this program is $1.5 M over two years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Develop a consistent and uniform methodology for demand forecasting of water withdrawals and uses for all USGS major watersheds and establish a uniform schedule for conducting demand forecasts. Conduct a pilot demand forecast for one USGS major watershed in each of the Great Lakes states. Estimated cost of this program is $12 M over three years. Estimated cost is based on similar studies.

Full Implementation Strategy – Conduct demand forecasts for all 109 USGS major watersheds in the U.S. Great Lakes basin on a coordinated schedule at a cost of $150 M over 5 years, with updates occurring every decade thereafter. Estimated cost is based on similar studies.

Range of Costs

Table K-63: Task 32 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.300	$0.400	$1.000	$1.500	$2.000	$8.000	$12.000	$16.000	$110.000	$150.000	$190.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: Initiation of new program for all alternatives. Under the Minimum Investment alternative the minimum and proposed costs are identical since they reflect a minimum level for research. Range of prospective costs is normally distributed for all alternatives.

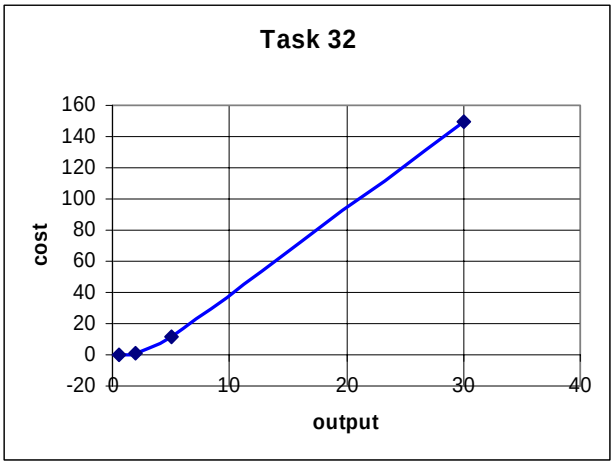
Relative Task Value

Table K-64: Task 32 Relative Task Value

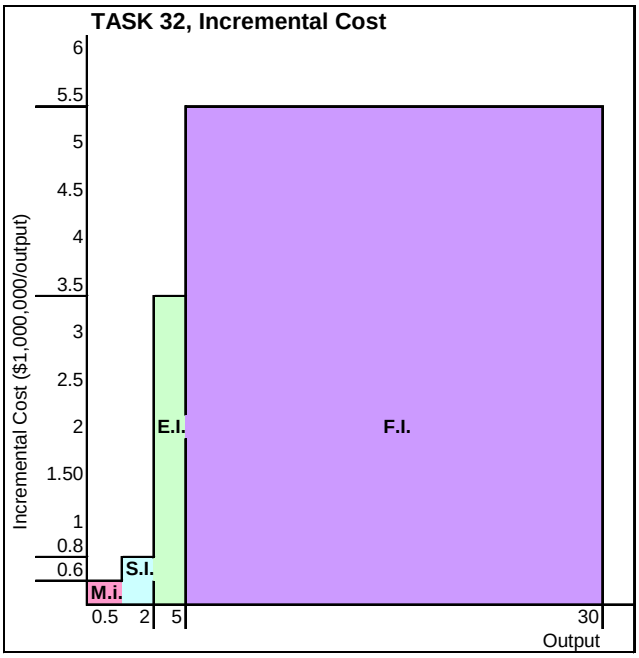
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	-5.0	0.5	2.0	5.0	30.0

Remarks: Demand forecasts for future water uses are expensive and intensive. Significant return is realized at the Enhanced Implementation level for forecasting high priority watersheds with potential spin-offs of extrapolating results to adjacent or similar watersheds.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.3 M for every one unit increase in output.
Selective – Increase in cost is $0.41 M for every one unit increase in output.
Enhanced – Increase in cost is $0.7 M for every one unit increase in output.
Full – Increase in cost is $13.8 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 33 – Interconnecting Waterways Hydrologic Impacts

Implementation Alternatives and Cost Details

Task: *The U.S. Geological Survey (USGS) in cooperation with other U.S. federal agencies, Canadian federal and provincial interests, and other governmental and non-governmental institutions, needs to develop detailed models of habitat impacts in the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River as a consequence of cumulative water withdrawals.*

Without Plan Strategy – Currently water levels are adequately measured in all of the interconnecting waterways, Lake St. Clair and the St. Lawrence River. In-place flow meters have been deployed in the Detroit and St. Clair Rivers for research studies. One research buoy has been deployed in Lake St. Clair but is not a permanent fixture. Circulation modeling is based upon hydrodynamic models currently under initial development. Operational utilization is hampered by lack of funding and low priority.

Minimum Investment Strategy – Develop and implement a prototype habitat impact model for the Detroit and St. Clair rivers and Lake St. Clair, which fully utilizes existing hydrodynamic modeling, improved flow monitoring, water level gauging and buoy observations at a cost of $500 K over two years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Implement and maintain a continuous habitat impact models for each of the Great Lakes interconnecting waterways, the St. Lawrence River and Lake St. Clair which rely upon imbedded hydrodynamic models and upgraded flow monitoring, water level gauging and buoy observations at a cost of $10 M over 10 years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Implement and maintain a continuous habitat impact models for each of the Great Lakes interconnecting waterways, the St. Lawrence River and Lake St. Clair which rely upon imbedded hydrodynamic models and upgraded flow monitoring, water level gauging and buoy observations at a cost of $10 M over 10 years. Estimated cost is based on similar studies.

Full Implementation Strategy – Implement and maintain a continuous habitat impact models for each of the Great Lakes interconnecting waterways, the St. Lawrence River and Lake St. Clair which rely upon imbedded hydrodynamic models and upgraded flow monitoring, water level gauging and buoy observations at a cost of $10 M over 10 years. Estimated cost is based on similar studies.

Footnotes
Refer to Appendix D on the hydrology and meteorology of the open lake for tasks on the expansion of the water level gauge and buoy networks.

Range of Costs

Table K-65: Task 33 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.400	$0.500	$0.600	$8.000	$10.000	$12.000	$8.000	$10.000	$12.000	$8.000	$10.000	$12.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an expansion of existing program activities for all alternatives. Complete functionality is achieved at the Selective Implementation level; hence, the range of prospective costs for the other implementation alternatives is identical. The range of prospective costs for all alternatives is normally distributed.

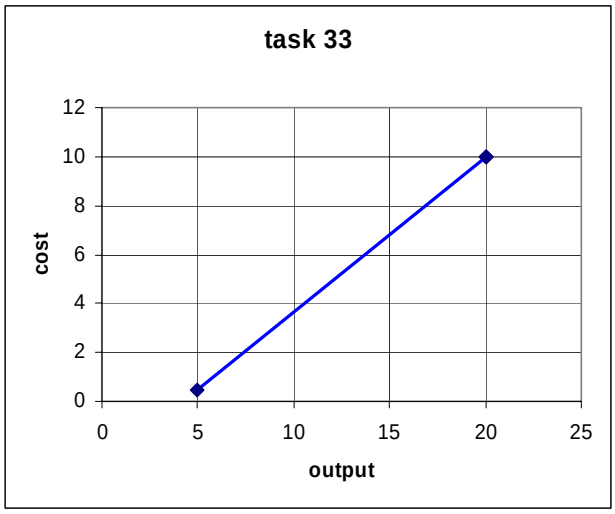
Relative Task Value

Table K-66: Task 33 Relative Task Value

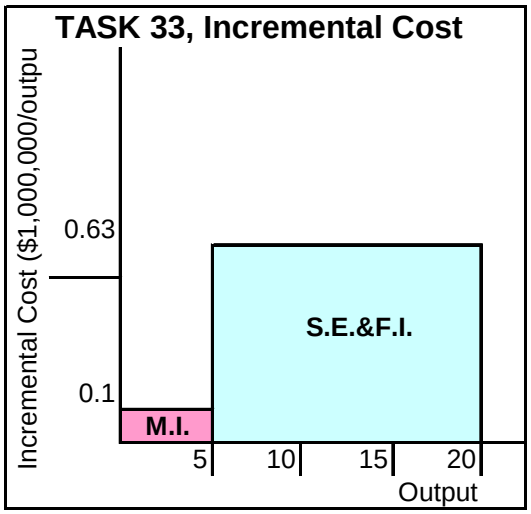
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	5.0	20.0	20.0	20.0

Remarks: Modeling of changes in the hydraulic characteristics and the habitats of the Interconnecting Waterways caused by cumulative water withdrawals is of critical importance. These waterways are the most productive regions of the system. Complete functionality can be achieved at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.5 M for every one unit increase in output.
Selective – Increase in cost is $0.475 M for every one unit increase in output.
Enhanced – Increase in cost is $0.475 M for every one unit increase in output.
Full – Increase in cost is $0.475 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 34 – Interconnecting Waterways Land Use Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE, state and provincial authorities and regional academic institutions, needs to develop standard modeling procedures to evaluate the impacts of land use modifications on habitats of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Land use and cover maps are complete albeit inconsistent and dated and do not provide information on temporal changes. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Conduct land use impact assessments on habitats adjacent to all U.S. Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River utilizing new comprehensive land use and cover mapping at a cost of $2 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Conduct land use impact assessments on habitats adjacent to all U.S. Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River utilizing new comprehensive land use and cover mapping at a cost of $2 M over two years. Estimated cost is based on similar programs.

Full Implementation Strategy – Conduct land use impact assessments on habitats adjacent to all U.S. Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River utilizing new comprehensive land use and cover mapping at a cost of $2 M over two years. Estimated cost is based on similar programs.

Range of Costs

Table K-67: Task 34 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.500	$2.000	$2.500	$1.500	$2.000	$2.500	$1.500	$2.000	$2.500

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: The studies required are met at the Selective Implementation level. The range of prospective costs for all implementation alternatives is normally distributed.

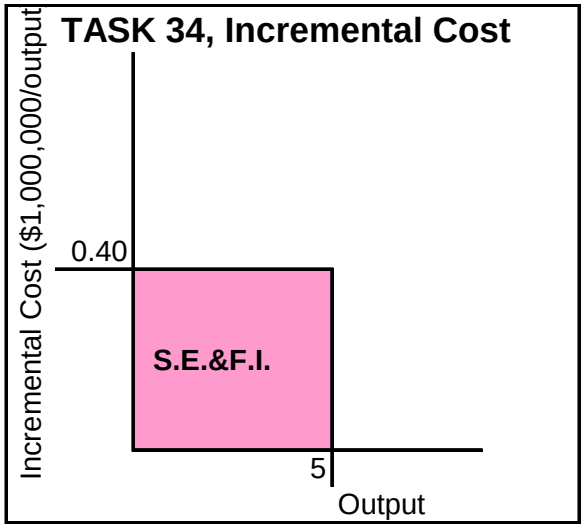
Relative Task Value

Table K-68: Task 34 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	0.0	5.0	5.0	5.0

Remarks: Discriminating effects of cumulative water withdrawals versus adjacent land use changes is needed to assess consequences of withdrawal permitting. This task is completed at the Selective Implementation level.

Cost Effectiveness and Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.4 M for every one unit increase in output.
Enhanced – Increase in cost is $0.4 M for every one unit increase in output.
Full – Increase in cost is $0.4 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 35 – Interconnecting Waterways Sedimentation Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE, state and provincial authorities and regional academic institutions, needs to develop standard modeling procedures to determine effects of sedimentation on habitats of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Sediment transport models exist at very few locations and are dated. Future work will likely be site specific.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Conduct studies on the ecological impacts of sedimentation in the deltas of the Detroit and St. Clair Rivers costing $1 M over three years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Conduct studies on the ecological impacts of sedimentation in the St. Marys, St. Clair and Detroit Rivers and Lake St. Clair costing $10 M over ten years.

Full Implementation Strategy – Conduct studies on the ecological impacts of sedimentation in all of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River costing $15 M over ten years. Estimated cost is based on similar studies.

Range of Costs

Table K-69: Task 35 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.750	$1.000	$1.250	$8.000	$10.000	$12.000	$12.500	$15.000	$17.500

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This activity is an initiation of a new study at the Selective Implementation alternative and expansion to other areas for the Enhanced and Full Implementation alternatives. The range of prospective costs for all implementation alternatives is normally distributed.

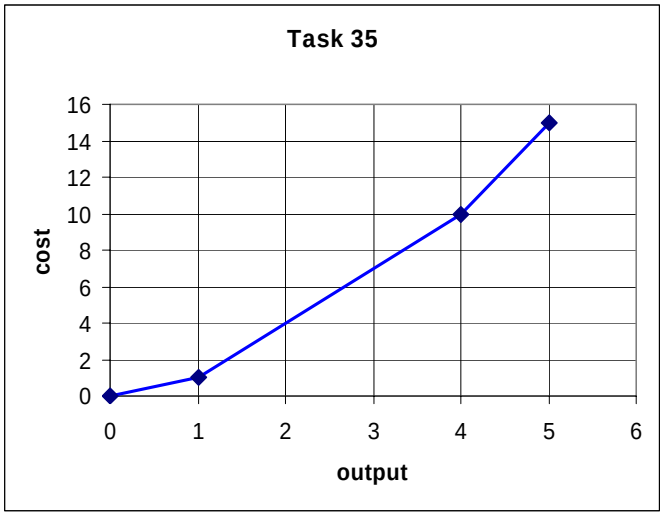
Relative Task Value

Table K-70: Task 35 Relative Task Value

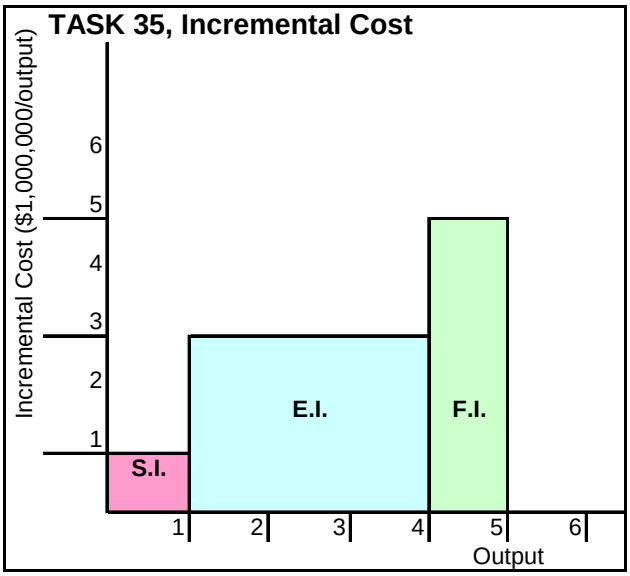
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	0.0	0.5	3.0	5.0

Remarks: Discriminating effects of cumulative water withdrawals on sedimentation rates are needed to assess consequences of withdrawal permitting. This task is completed at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $1 M for every one unit increase in output.
Enhanced – Increase in cost is $3 M for every one unit increase in output.
Full – Increase in cost is $5 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 36 – Interconnecting Waterways Geomorphic Classification

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE, state and provincial authorities and regional academic institutions, needs to classify habitats of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River by hydrologic and geomorphologic.*

Without Plan Strategy – Habitats are not universally classified for each of the interconnecting waterways Lake St. Clair and the St. Lawrence River for geomorphology and hydrology.

Minimum Investment Strategy – Classify habitat by hydrology and geomorphology for of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River at a cost of $250 K over two years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Classify habitat by hydrology and geomorphology for of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River at a cost of $250 K over two years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Classify habitat by hydrology and geomorphology for of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River at a cost of $250 K over two years. Estimated cost is based on similar studies.

Full Implementation Strategy – Classify habitat by hydrology and geomorphology for of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River at a cost of $250 K over two years. Estimated cost is based on similar studies.

Range of Costs

Table K-71: Task 36 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.250	$0.300	$0.200	$0.250	$0.300	$0.200	$0.250	$0.300	$0.200	$0.250	$0.300

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This activity is an initiation of a new study at the Selective Implementation alternative and expansion to other areas for the Enhanced and Full Implementation alternatives. The range of prospective costs for all implementation alternatives is normally distributed.

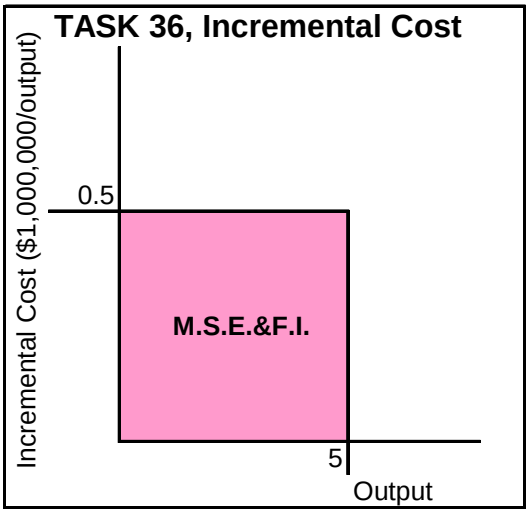
Relative Task Value

Table K-72: Task 36 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	5.0	5.0	5.0	5.0

Remarks: Discriminating effects of cumulative water withdrawals on sedimentation rates is needed to assess consequences of withdrawal permitting. This task is completed at the Selective Implementation level.

Cost Effectiveness and Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.05 M for every one unit increase in output.
Selective – Increase in cost is $0.05 M for every one unit increase in output.
Enhanced – Increase in cost is $0.05 M for every one unit increase in output.
Full – Increase in cost is $0.05 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 37 – Interconnecting Waterways Abiotic Changes

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE, state and provincial authorities and regional academic institutions, needs to develop standard modeling procedures for evaluating abiotic changes in habitats of the Great Lakes interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Current information base is sporadic and incomplete. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Develop and implement standard modeling procedures for evaluating abiotic changes in the Detroit River, St. Clair River and Lake St. Clair, utilizing upgraded collection at water level gauging stations and buoys, at a cost of $1.5 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Develop and implement standard modeling procedures for evaluating abiotic changes in the Great Lakes interconnecting waterways, the St. Lawrence River and Lake St. Clair, utilizing upgraded collection at water level gauging stations and buoys, at a cost of $3 M over three years. Estimated cost is based on similar programs.

Full Implementation Strategy - Develop and implement standard modeling procedures for evaluating abiotic changes in the Great Lakes interconnecting waterways, the St. Lawrence River and Lake St. Clair, utilizing upgraded collection at water level gauging stations and buoys, at a cost of $3 M over three years. Estimated cost is based on similar programs.

Range of Costs

Table K-73: Task 37 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.000	$1.500	$2.000	$2.500	$4.000	$6.000	$2.500	$4.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

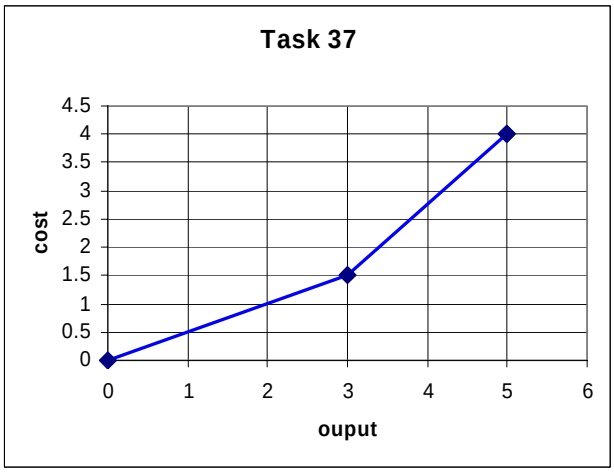
Relative Task Value

Table K-74: Task 37 Relative Task Value

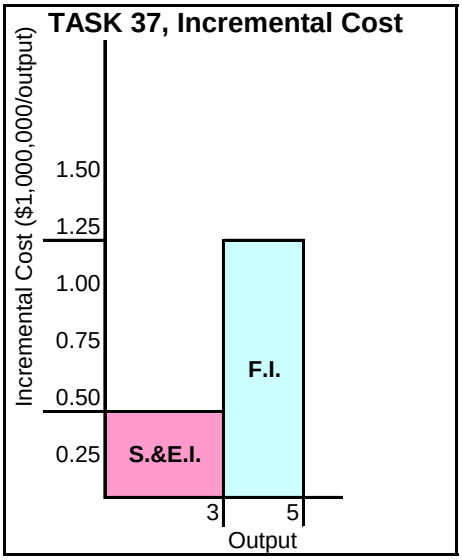
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	0.0	3.0	5.0	5.0

Remarks: Monitoring water chemistry and related parameters in the interconnecting waterways is an important component of monitoring impacts of cumulative water withdrawals. Substantial return is provided at the Selective Implementation level with incremental return above.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.5 M for every one unit increase in output.
Enhanced – Increase in cost is $0.5 M for every one unit increase in output.
Full – Increase in cost is $1.05 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 38 – Nearshore Hydrology Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the NOAA and the USACE, and in cooperation with state agencies and regional academic institutions, needs to develop and implement standard modeling tools for evaluating the hydrologic impacts of cumulative water withdrawals on nearshore habitats in the Great Lakes, their embayments, their interconnecting waterways, Lake St. Clair and the St. Lawrence River.*

Without Plan Strategy – Currently most shorelines have adequate water level gauging; embayments may be lacking. Existing buoy network provides adequate coverage for marine forecasting but not for habitat modeling. Satellite monitoring of surface temperatures and upwelling events is sporadic. Circulation modeling is coarse and not continuous. Future data collection and modeling will likely be conducted piecemeal.

Minimum Investment Strategy – Contingent upon expansion of the buoy network and improvements in satellite observations, implement an operational hydrodynamic model for Lake Michigan, excluding its embayments, with the capacity to monitor changes in nearshore circulation patterns, at a cost of $500 K over two years.

Selective Implementation Strategy – Contingent upon expansion of the buoy network and improvements in satellite observations, develop operational continuous hydrodynamic models for all of the Great Lakes excluding embayments to monitor changes in nearshore circulation at a cost of $2.2 M over 10 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon expansion of the buoy network and improvements in satellite observations, develop operational continuous hydrodynamic models for all of the Great Lakes including embayments to monitor changes in nearshore circulation at a cost of $3.2 M over 10 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon expansion of the buoy network and improvements in satellite observations, develop operational continuous hydrodynamic models for all of the Great Lakes including embayments to monitor changes in nearshore circulation costing $3.2 M over 10 years. Estimated cost is based on similar programs.

Footnotes

Refer to Appendix D on the hydrology and meteorology of the open lake for tasks on the expansion of the water level gauge and buoy networks.

Range of Costs

Table K-75: Task 38 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.400	$0.500	$0.600	$1.400	$2.200	$3.000	$2.000	$3.200	$4.400	$2.000	$3.200	$4.400

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

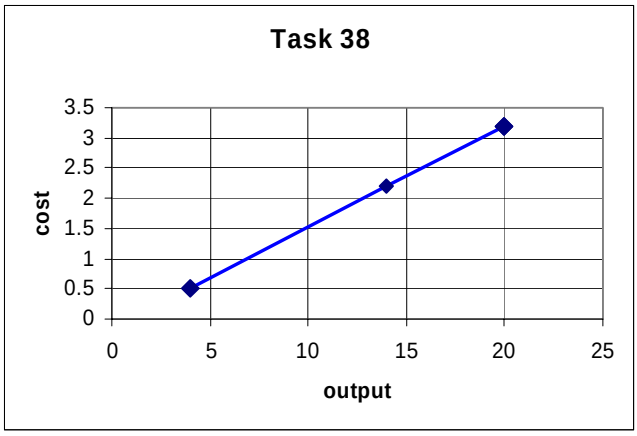
Relative Task Value

Table K-76: Task 38 Relative Task Value

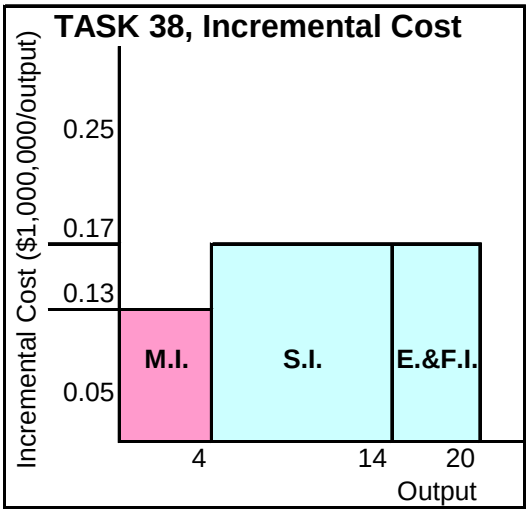
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	4.0	14.0	20.0	20.0

Remarks: Modeling of changes in the nearshore water level and circulation affected by cumulative water withdrawals is critical important. Coastal wetlands are highly productive systems. Substantial benefit is achieved at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.1 M for every one unit increase in output.
Selective – Increase in cost is $0.17 M for every one unit increase in output.
Enhanced – Increase in cost is $0.2 M for every one unit increase in output.
Full – Increase in cost is $0.2 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 39 – Nearshore Land Use Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for repetitive evaluations of the impacts of land use modifications on nearshore habitats.*

Without Plan Strategy – Mapping is complete albeit inconsistent and dated and does not provide information on temporal changes. Situation is likely not to change.

Minimum Investment Strategy – Contingent upon acquiring new detailed land use and cover mapping, conduct pilot habitat impact studies on Lake Michigan shorelines excluding embayments costing $200 K over one year. Estimated cost is based on similar programs.

Selective Implementation Strategy – Contingent upon acquiring new detailed land use and cover mapping, conduct habitat impact studies on all U.S. Great Lakes' shorelines excluding embayments costing $2 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon acquiring new detailed land use and cover mapping, conduct habitat impact studies on all U.S. Great Lakes' shorelines including embayments costing $6 M over four years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon acquiring new detailed land use and cover mapping, conduct habitat impact studies on all U.S. Great Lakes shorelines including embayments costing $6 M over four years. Estimated cost is based on similar programs.

Range of Costs

Table K-77: Task 39 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.200	$0.200	$1.500	$2.000	$2.500	$4.500	$6.000	$7.500	$4.500	$6.000	$7.500

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a study under the Minimum Investment alternative. This funding level is required to meet basic research requirements. The implementation alternatives become broader in scope from the Selective to Enhanced levels when full functionality is achieved. The range of prospective costs for all alternatives is normally distributed.

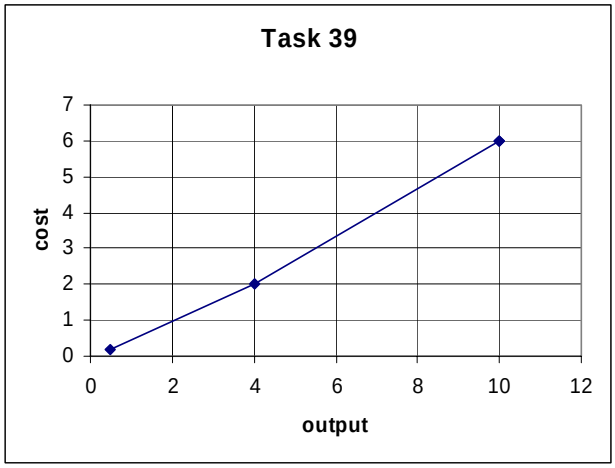
Relative Task Value

Table K-78: Task 39 Relative Task Value

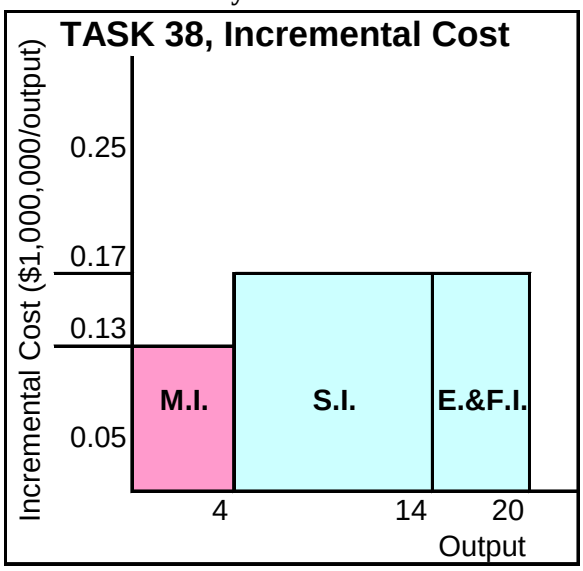
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.5	4.0	10.0	10.0

Remarks: Discriminating effects of cumulative water withdrawals versus adjacent land use changes is needed to assess consequences of cumulative withdrawals. This task is completed at the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.2 M for every one unit increase in output.
Selective – Increase in cost is $0.45 M for every one unit increase in output.
Enhanced – Increase in cost is $0.8 M for every one unit increase in output.
Full – Increase in cost is $0.8 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 40 – Nearshore Sedimentation Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for determining effects of sedimentation changes on nearshore habitat.*

Without Plan Strategy – Sediment transport modeling exists at few site specific locations. Future work will expand to regional modeling, but still will not be comprehensive.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Develop a prototype sediment transport studies over pilot regional areas on Lakes Erie and Ontario costing $2 M over three years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Conduct sediment transport studies over all Great Lakes shorelines excluding embayments costing $10 M over five years. Estimated cost is based on similar studies.

Full Implementation Strategy – Conduct sediment transport studies over all Great Lakes shorelines including embayments costing $20 M over five years. Estimated cost is based on similar studies.

Range of Costs

Table K-79: Task 40 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.500	$2.000	$2.500	$8.000	$10.000	$12.000	$15.000	$20.000	$25.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

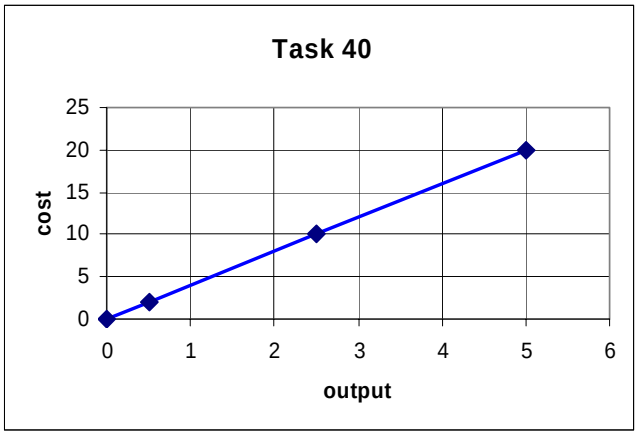
Relative Task Value

Table K-80: Task 40 Relative Task Value

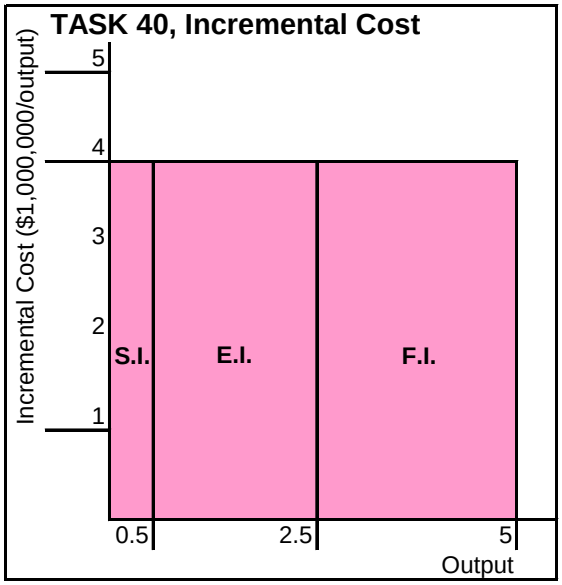
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	0.0	0.5	2.5	5.0

Remarks: Discriminating effects of cumulative water withdrawals on sediment transport in the coastal zone is needed to assess consequences of withdrawal permitting. This task provides incremental benefits as funding increases.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $4 M for every one unit increase in output.
Enhanced – Increase in cost is $4 M for every one unit increase in output.
Full – Increase in cost is $4 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 41 – Nearshore Geomorphic Classification

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to classify nearshore habitats by their hydrologic and geomorphic characteristics.*

Without Plan Strategy – The U.S. Great Lakes' shorelines have been geomorphically classified for erosion modeling applications. However, nearshore habitat classification by hydrology and geomorphology does not exist; and no development is anticipated under existing programs and funding.

Minimum Investment Strategy – Classify habitat by hydrology and geomorphology for all U.S. Great Lakes excluding embayments at a cost of $250 K over two years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Classify habitat by hydrology and geomorphology for all U.S. Great Lakes excluding embayments at a cost of $250 K over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Classify habitat by hydrology and geomorphology for all U.S. Great Lakes including embayments at a cost of $600 K over three years. Estimated cost is based on similar programs.

Full Implementation Strategy – Classify habitat by hydrology and geomorphology for all U.S. Great Lakes including embayments at a cost of $600 K over three years. Estimated cost is based on similar programs.

Range of Costs

Table K-81: Task 41 Range of Costs (in millions of dollars)

Minimum Investment			**Selective Implementation**			**Enhanced Implementation**			**Full Implementation**		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.250	$0.300	$0.200	$2.500	$0.300	$0.450	$0.800	$0.750	$0.450	$0.600	$0.750

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of basic studies under all alternatives, with the Minimum Investment and Selective Implementation alternatives being equal and a broader scope being identical for the Selective and Enhanced Implementation alternatives. The range of prospective costs for all alternatives is normally distributed.

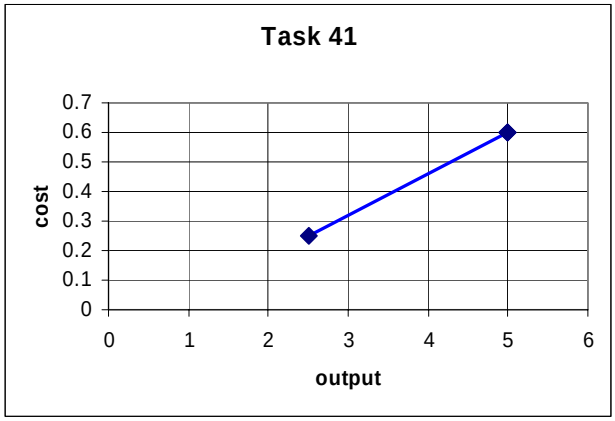
Relative Task Value

Table K-82: Task 41 Relative Task Value

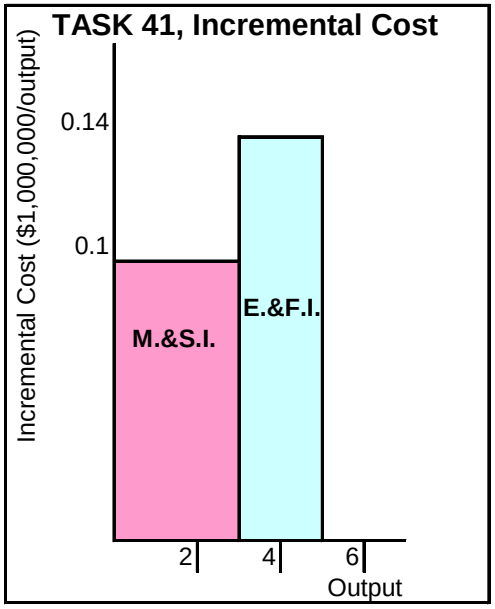
Relative Value	**No Change**	**Minimum Investment**	**Selective Implementation**	**Enhanced Implementation**	**Full Implementation**
5.0	0.0	2.5	2.5	5.0	5.0

Remarks: Defining the geomorphic characteristic of the coastal zone is an essential task of modeling these systems. This task is partially addressed at the Minimum Investment and Selective Implementation levels and fully completed above the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.125 M for every one unit increase in output.
Selective – Increase in cost is $0.125 M for every one unit increase in output.
Enhanced – Increase in cost is $0.117 M for every one unit increase in output.
Full – Increase in cost is $0.117 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 42 – Nearshore Abiotic Changes

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for periodically evaluating abiotic changes in nearshore habitats.*

Without Plan Strategy – Current information base is sporadic and incomplete. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Contingent upon the collection of abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges and the expansion and upgrades to the buoy network, conduct pilot studies on abiotic

conditions at selected nearshore locations in the U.S. at cost of $1.5 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon the collection of abiotic parameters including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing water level gauges and the expansion and upgrades to the buoy network, conduct pilot studies on abiotic conditions at selected nearshore locations in the U.S. at cost of $1.5 M over two years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon expansion of water level and open lake buoy networks, develop and maintain continual monitoring of abiotic conditions in all U.S. nearshore habitats at a cost of $ 3 M over ten years. Estimated cost is based on similar programs.

Footnotes

Refer to Appendix D on the hydrology and meteorology of the open lake for tasks on the expansion of the water level gauge and buoy networks.

Range of Costs

Table K-83: Task 42 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.250	$1.500	$1.750	$1.250	$1.500	$1.750	$2.250	$3.000	$3.750

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

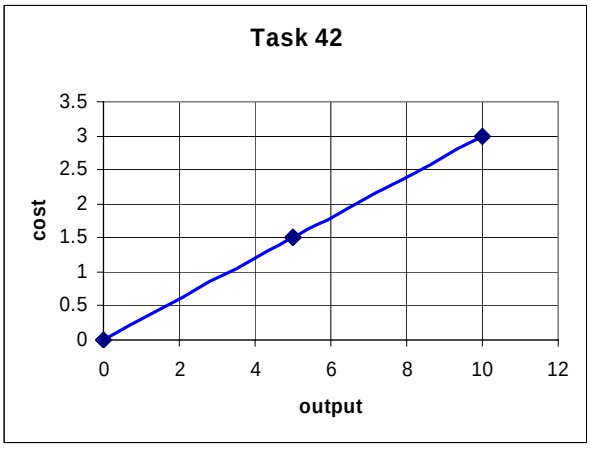
Relative Task Value

Table K-84: Task 42 Relative Task Value

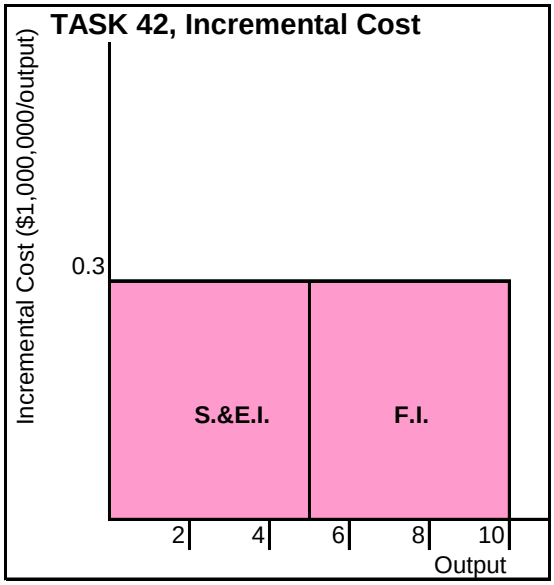
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	5.0	5.0	10.0

Remarks: Monitoring water chemistry and related parameters in the coastal zone is an important component of monitoring impacts of cumulative water withdrawals. Substantial return is provided at the Selective and Enhanced Implementation levels.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.3 M for every one unit increase in output.
Enhanced – Increase in cost is $0.3 M for every one unit increase in output.
Full – Increase in cost is $0.3 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 43 – Lowland Hydrology Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for periodically evaluating water levels and flow impacts on lowland habitats including wetlands inland lakes, streams, rivers and river mouths.*

Without Plan Strategy – Currently 60 percent of the Great Lakes drainage basin is gauged. Without additional gauging, information is not sufficient to evaluate changes in water level and flow regimes for almost all lowland areas.

Minimum Investment Strategy – Conduct pilot studies on monitoring and predicting cumulative water withdrawals on the hydrology of tier 1 priority* tributaries in U.S. lowland habitats at a cost of $1 M over two years. Estimated cost is based on similar studies.

Selective Implementation Strategy – Conduct pilot studies on monitoring and predicting cumulative water withdrawals on the hydrology for selective tier 1 priority* tributaries in U.S. lowland habitats at a cost of $1 M over two years. Estimated cost is based on similar studies.

Enhanced Implementation Strategy – Contingent upon upgrading and expanding the current stream gauging network, develop and implement hydrologic models for all tier 1 priority tributaries at a cost of $3 M over five years. Estimated cost is based on similar studies.

Full Implementation Strategy – Contingent upon upgrading and expanding the stream gauging network to provide comprehensive coverage of all the U.S. watersheds, develop and implement hydrologic models for all tier 1 and tier 2 priority tributaries at a cost of $5 M over five years. Estimated cost is based on similar studies.

Footnotes

A process to identified priority tributaries may involve input from state and local agencies. Tributaries identified as most critical are tier 1. Tier 2 and 3 correspond to tributaries in decreasing priority.

Range of Costs

Table K-85: Task 43 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.800	$1.000	$1.200	$0.800	$1.000	$1.200	$2.500	$3.000	$3.500	$4.000	$5.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

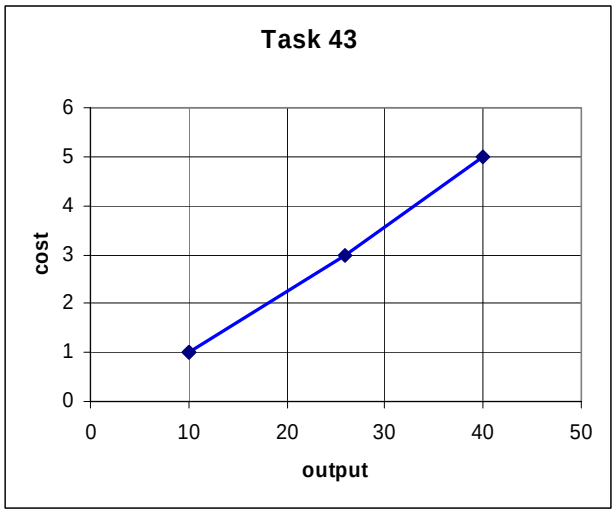
Relative Task Value

Table K-86: Task 43 Relative Task Value

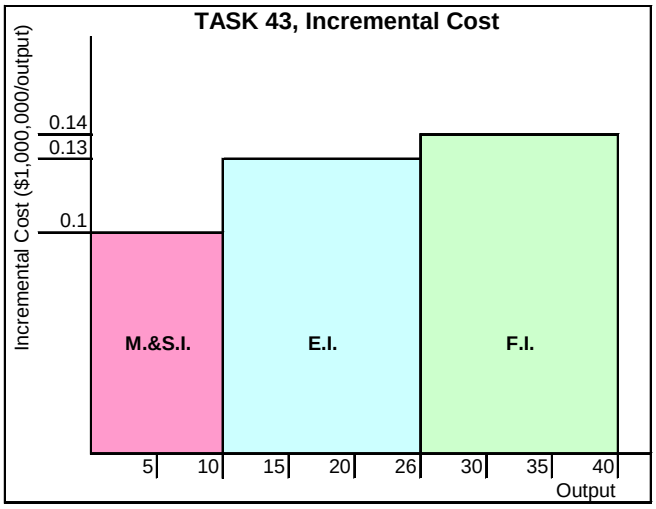
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
40.0	0.0	10.0	10.0	26.0	40.0

Remarks: Cumulative withdrawals are expected to affect the hydrologic response in headwaters of watersheds and adjacent lowlands along tributary streams and rivers. Substantial benefits will be derived at the Enhanced Implementation level and doubled with additional funds.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.1 M for every one unit increase in output.
Selective – Increase in cost is $0.1 M for every one unit increase in output.
Enhanced – Increase in cost is $0.125 M for every one unit increase in output.
Full – Increase in cost is $0.14 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 44 – Lowland Land Use Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for periodically evaluating the effects of land use modifications on lowland habitats including wetlands inland lakes, streams, rivers and river mouths.*

Without Plan Strategy – Land use and cover maps are inconsistent, dated and do not provide information on temporal changes or high definition. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Contingent upon new detailed land use and cover mapping, evaluate past habitat impacts and develop prediction approaches for future changes of pilot areas adjacent to tier 1* priority tributaries in U.S. lowland habitats costing $2 M over 2 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon new detailed land use and cover mapping, evaluate past habitat impacts and develop prediction approaches for future changes for all U.S. lowlands adjacent to tier I priority* tributaries costing $10 M over 5 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon new detailed land use and cover mapping of all inland land masses within the U.S. Great Lakes-St. Lawrence River basin, evaluate past habitat impacts and develop prediction approaches for future changes for all lowland habitats costing $50 M over 10 years. Estimated cost is based on similar programs.

Footnotes*

A process to identified priority tributaries may involve input from state and local agencies. Tributaries identified as most critical are tier I. Tier 2 and 3 correspond to tributaries in decreasing priority

Range of Costs

Table K-87: Task 44 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$1.500	$2.000	$2.500	$8.000	$10.000	$12.000	$40.000	$50.000	$60.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies under the implementation alternatives only. These alternatives become costlier as they increase in scope. The range of prospective costs for all alternatives is normally distributed.

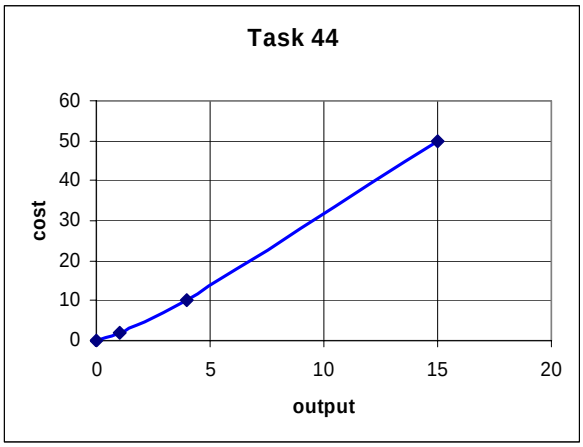
Relative Task Value

Table K-88: Task 44 Relative Task Value

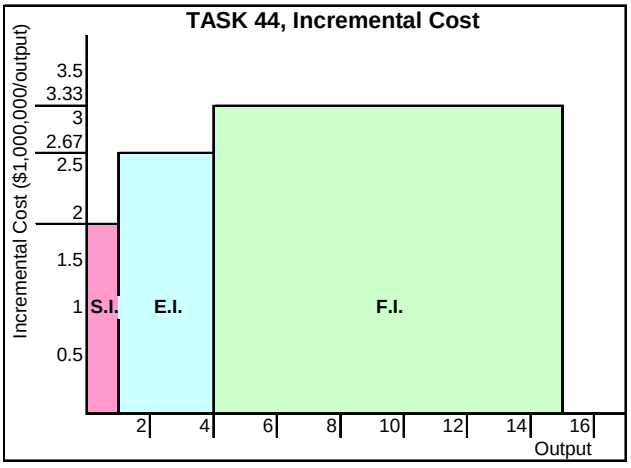
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
15.0	0.0	0.0	1.0	4.0	15.0

Remarks: Discriminating the effects of land use changes and encroachment on the viability of lowland habitat versus cumulative water withdrawals impacts is a critical challenge. This task is completed at the Enhanced Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $2 M for every one unit increase in output.
Enhanced – Increase in cost is $2.67 M for every one unit increase in output.
Full – Increase in cost is $3.64 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 45 – Lowland Sedimentation Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop and implement standard modeling procedures for determining the of sedimentation changes on lowland habitats including wetlands inland lakes, streams, rivers and river mouths.*

Without Plan Strategy – Sediment transport models are completed or in progress for 12-15 tributaries under the 516(e) program of WRDA 1999. Work under this program does not address the full range of tributaries within a watershed. Future work may expand to other eligible watersheds, budget permitting.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Increase funding for the 516(e) program to $25 M over 10 years and focus the attention to modeling all of the tier I priority tributaries identified by the Great Lake states in the 516(e) act. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Increase funding to the 516(e) program to $50 M over 10 years and complete modeling for all of the tier I priority tributaries identified by the Great Lake states in the 516(e) act. Estimated cost is based on similar programs. Estimated cost is based on similar programs.

Full Implementation Strategy – Model all 99 U.S. watersheds, on a prioritized basis, including all segments in a 2-D frame at a cost of $150 M over 10 years. Estimated cost is based on similar programs.

Range of Costs

Table K-89: Task 45 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$20.000	$25.000	$30.000	$40.000	$50.000	$60.000	$120.000	$150.000	$180.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is large and is normally distributed.

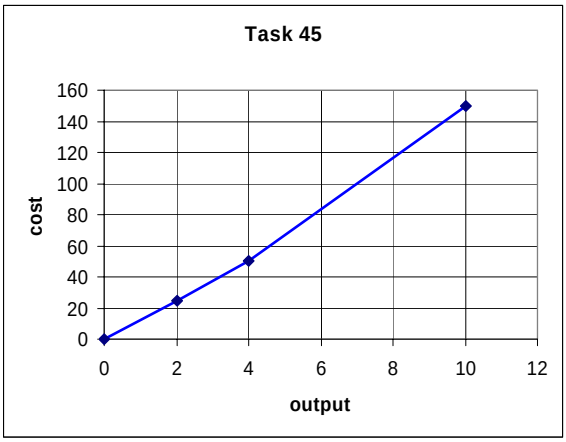
Relative Task Value

Table K-90: Task 45 Relative Task Value

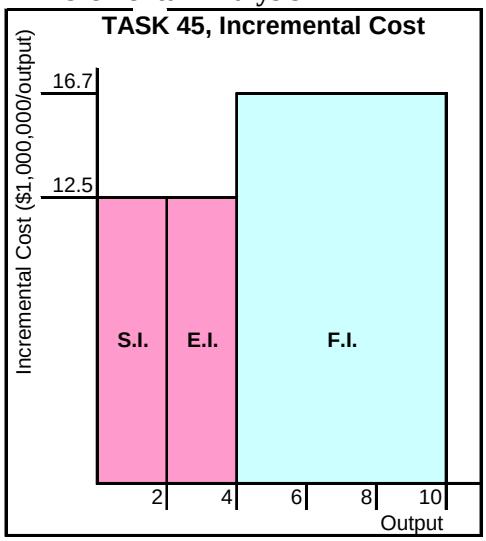
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	2.0	4.0	10.0

Remarks: Discriminating effects of cumulative water withdrawals on sediment loading to tributary streams and rivers is needed. This task provides substantial returns at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $12.5 M for every one unit increase in output.
Enhanced – Increase in cost is $12.5 M for every one unit increase in output.
Full – Increase in cost is $16.67 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 46 – Lowland Geomorphic Classification

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop standard procedures for classifying lowland habitats including wetlands inland lakes, streams, rivers and river mouths by their hydrologic and geomorphologic characteristics.*

Without Plan – Considerable work has been completed or is underway under the National Hydrologic Database (NHD), the National Wetlands Inventory (NWI) and state funded habitat mapping projects to support this requirement. This work, however, is incomplete, outdated or inconsistent, compromising the quality of the analysis. It is likely that these problems will not be resolved.

Minimum Investment Strategy – Update and improve NWI products to acceptable uniform standards and classify lowland habitats by hydrology and geomorphology for the U.S. Great Lakes-St. Lawrence River basin at an estimated cost of $1 M over two years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Increased federal funding is necessary to complete all NHD work at a high spatial resolution and to update and improve NWI products to acceptable uniform standards. Additional work to classify the hydrology and geomorphology is also required. Costs are estimated at $12 M over 10 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Increased federal funding is necessary to complete all NHD work at a high spatial resolution and to update and improve NWI products to acceptable uniform standards. Additional work to classify the hydrology and geomorphology is also required. Costs are estimated at $12 M over 10 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Increased federal funding is necessary to complete all NHD work at a high spatial resolution and to update and improve NWI products to acceptable uniform standards. Additional work to classify the hydrology and geomorphology is also required. Costs are estimated at $12 M over 10 years. Estimated cost is based on similar programs.

Range of Costs

Table K-91: Task 46 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.800	$1.000	$1.200	$10.000	$12.000	$14.000	$10.000	$12.000	$14.000	$10.000	$12.000	$14.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies which expand as implementation alternatives become broader in scope. The range of prospective costs for all alternatives is normally distributed.

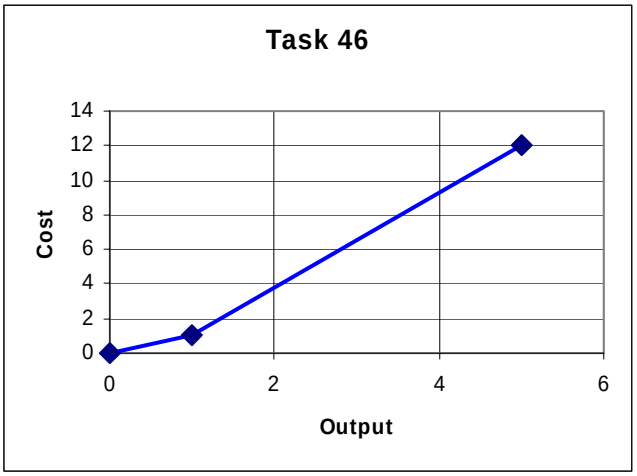
Relative Task Value

Table K-92: Task 46 Relative Task Value

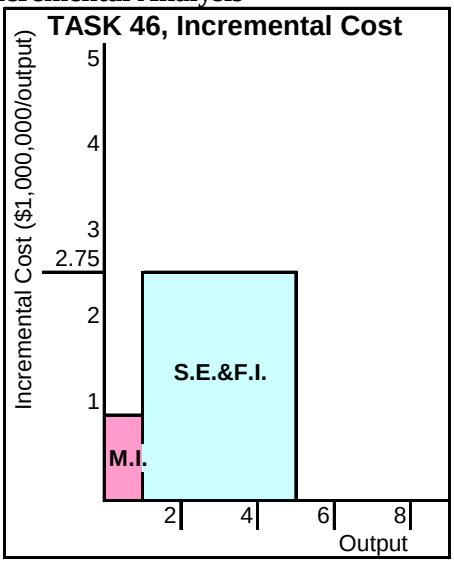
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	1.0	5.0	5.0	5.0

Remarks: Defining the geomorphic characteristic of tributary streams and rivers is essential to modeling these systems. This task is essentially completed at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $1 M for every one unit increase in output.
Selective – Increase in cost is $2.75 M for every one unit increase in output.
Enhanced – Increase in cost is $2.75 M for every one unit increase in output.
Full – Increase in cost is $2.75M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 47 – Lowland Abiotic Changes

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop standard modeling procedures for periodically evaluating hydrologic changes on uplands habitats.*

Without Plan Strategy – Current information base is sporadic and incomplete. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Develop and implement standard monitoring and modeling procedures for periodically evaluating changes in abiotic conditions including temperature, salinity, conductivity, dissolved oxygen, etc. at all existing U.S. stream gauging stations on tier I priority tributaries at a cost of $6 M over 10 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon expansion of water level network to cover the majority of the U.S. Great Lakes watersheds and upgrading of these stations to include abiotic sensors, develop and implement standard monitoring and modeling procedures for evaluating abiotic changes for all tier I and tier II priority tributaries at a cost of $13 M over years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon expansion of the water level network to directly measure streamflow for all U.S. Great Lakes watersheds and the addition of abiotic sensors to all stations, develop and implement periodic monitoring of abiotic changes for all tributaries at a cost of $20 M over years. Estimated cost is based on similar programs.

Range of Costs

Table K-93: Task 47 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$5.000	$6.000	$7.000	$10.000	$13.000	$16.000	$15.000	$20.000	$25.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies only under the three implementation alternatives which expand as these alternatives increase in scope. The range of prospective costs for all alternatives is normally distributed.

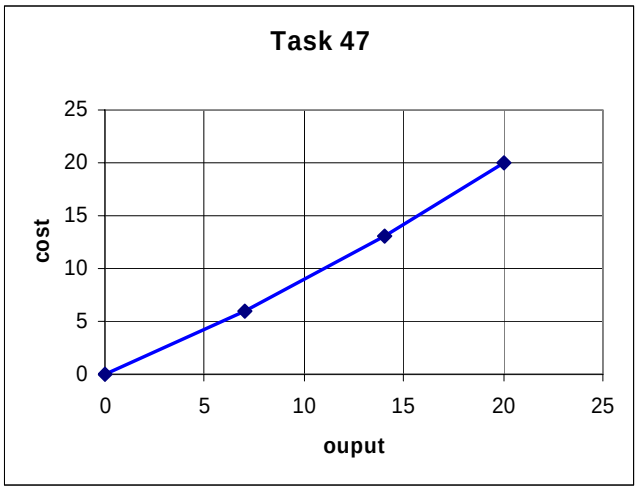
Relative Task Value

Table K-94: Task 47 Relative Task Value

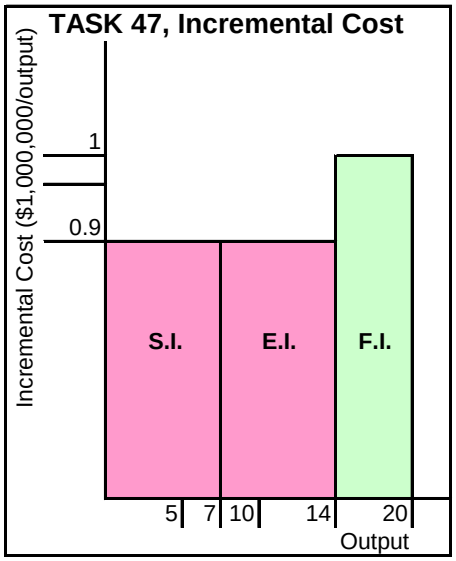
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	0.0	7.0	14.0	20.0

Remarks: Cumulative withdrawals impacts on tributary stream and river chemistry and nutrient and pollution loads are of substantial interest. Substantial benefits will be derived at the Selective Implementation level with incremental increased returns as funding is increased.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.86 M for every one unit increase in output.
Enhanced – Increase in cost is $0.86 M for every one unit increase in output.
Full – Increase in cost is $1M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 48 – Upland Habitat Hydrology

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop standard modeling procedures for periodically evaluating ground water withdrawal impacts on upland habitats.*

Without Plan Strategy – Currently there is no information available on ground water withdrawal impacts on upland habitats. Future condition is likely not to change.

Minimum Investment Strategy – Contingent upon completing the classification of upland habitat by geomorphology, conduct pilot ground water withdrawal impact studies on representative habitats costing $500 K over two years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology, conduct pilot ground water withdrawal impact studies on representative habitats costing $500 K over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology and contingent upon new detailed land use and cover mapping, conduct pilot ground water withdrawal impact studies on representative habitats costing $500 K over two years.

Full Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology and contingent upon new detailed land use and cover mapping, generate prediction tools on habitat impacts from ground water withdrawals for all upland areas within the U.S. Great Lakes-St. Lawrence River basin costing $2.5 M over three years. Estimated cost is based on similar programs.

Range of Costs

Table K-95: Task 48 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.400	$0.500	$0.600	$0.400	$0.500	$0.600	$0.400	$0.500	$0.600	$2.000	$2.500	$3.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a specific study under the Minimum Investment, Selective Implementation and Enhanced Implementation levels, hence their costs are identical. The Full Implementation alternative includes a substantial increase in scope. The range of prospective costs for all alternatives is normally distributed.

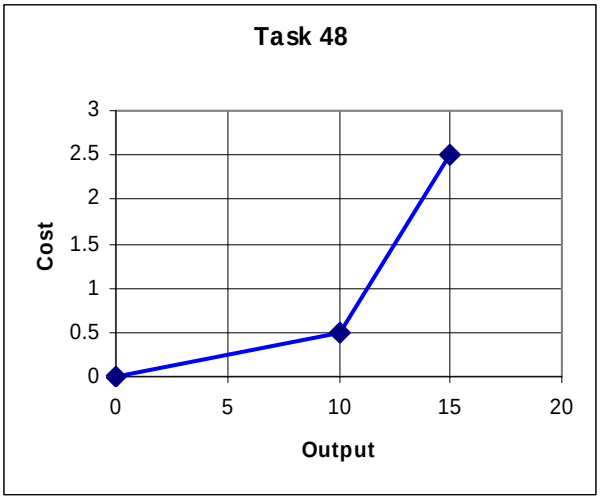
Relative Task Value

Table K-96: Task 48 Relative Task Value

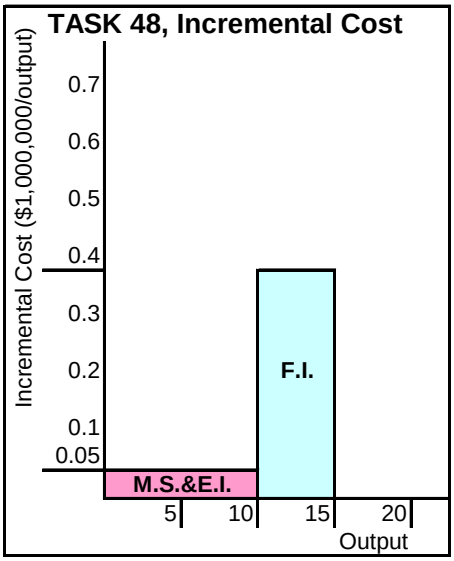
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
15.0	10.0	10.0	10.0	10.0	15.0

Remarks: Cumulative withdrawals are expected to affect hydrologic responses of uplands dependant on groundwater supply, particularly perched wetlands. Uncertainties are expected to remain high even with substantial additional investment due to the complexity of factors and local circumstances.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.05 M for every one unit increase in output.
Selective – Increase in cost is $0.05 M for every one unit increase in output.
Enhanced – Increase in cost is $0.05 M for every one unit increase in output.
Full – Increase in cost is $0.4 M for every one unit increase in output.

The Full Implementation alternative is significantly more extensive than all other alternatives which can justify the differences in this assessment.

Task 49 – Upland Land Use Impacts

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to develop standard modeling procedures for periodically evaluating the effects of land use modifications on upland habitats.*

Without Plan Strategy – Land use and cover maps are inconsistent, dated and do not provide information on temporal changes or high definition. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology and contingent upon new detailed land use and cover mapping, conduct land use encroachment studies on representative habitats within the U.S. Great Lakes - St. Lawrence River basin costing $1 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology and contingent upon new detailed land use and cover mapping, conduct land use encroachment studies on representative habitats within the U.S. Great Lakes - St. Lawrence River basin costing $1 M over two years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon completing the classification of upland habitat by geomorphology and contingent upon new detailed land use and cover mapping, conduct land use encroachment studies on all upland habitats within the U.S. Great Lakes - St. Lawrence River basin costing $3 M over three years. Estimated cost is based on similar programs.

Range of Costs

Table K-97: Task 49 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.800	$1.000	$1.200	$0.800	$1.000	$1.200	$2.500	$3.000	$3.500

Remarks: This is an initiation of a specific study under the Minimum Investment, Selective Implementation and Enhanced Implementation levels, hence their costs are identical. The Full Implementation alternative includes a substantial increase in scope. The range of prospective costs for all alternatives is normally distributed.

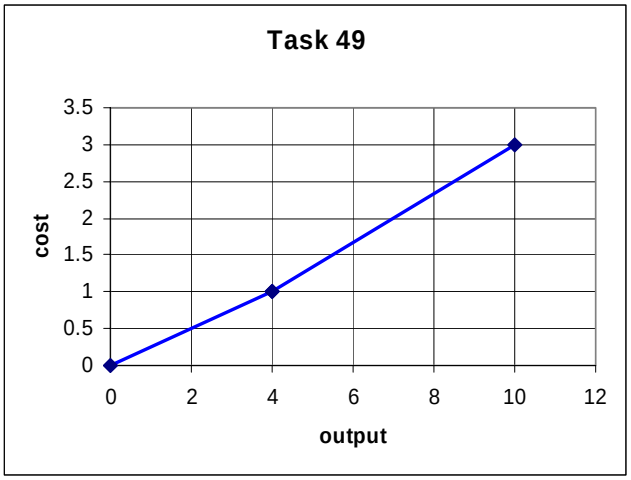
Relative Task Value

Table K-98: Task 49 Relative Task Value

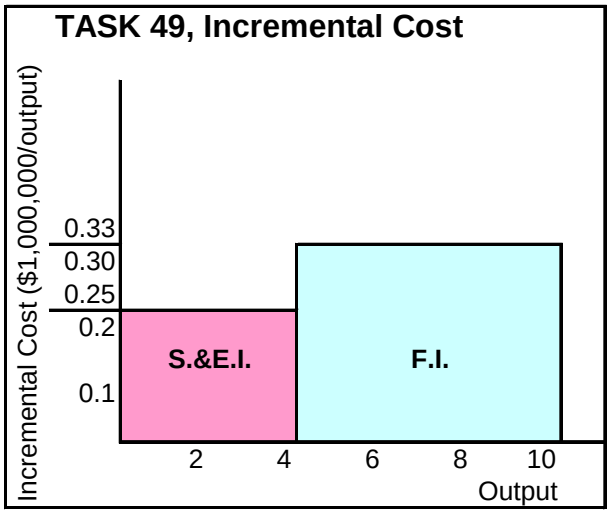
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	0.0	4.0	4.0	10.0

Remarks: Discriminating the effects of land use changes and encroachment on the viability of upland habitat versus cumulative water withdrawals impacts is a difficult challenge. This task is substantially addressed at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.25 M for every one unit increase in output.
Enhanced – Increase in cost is $0.25 M for every one unit increase in output.
Full – Increase in cost is $0.33 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 50 – Upland Geomorphic Classification

Implementation Alternatives and Cost Details

Task: *The USGS, in cooperation with other U.S. federal agencies, state agencies and regional academic institutions, needs to comprehensively classify upland habitats by their geomorphologic characteristics.*

Without Plan Strategy – Considerable work has been completed by the NRCS to map soils in high detail and by the USGS to map stratigraphy in coarser detail. Much of the NRCS soil maps still need to be digitized. Situation is likely to improve albeit slowly. However, upland habitats have not been classified by geomorphology for use in a decision support framework and this work is unfunded.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Using existing digital soils and stratigraphy information, classify habitats by geomorphology for all areas where these data are available within the U.S. Great Lakes - St. Lawrence River basin at a cost of $250 K over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon digital soils and stratigraphy information being fully completed, classify habitats by geomorphology for all areas within the U.S. Great Lakes - St. Lawrence River basin at a cost of $500 K over two years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon digital soils and stratigraphy information being fully completed, classify habitats by geomorphology for all areas within the U.S. Great Lakes - St. Lawrence River basin at a cost of $500 K over two years. Estimated cost is based on similar programs.

Range of Costs

Table K-99: Task 50 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.200	$0.250	$0.300	$0.400	$0.500	$0.600	$0.400	$0.500	$0.600

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies under the three implementation alternatives only with full functionality being achieved at the Enhanced Implementation level. The range of prospective costs for all alternatives is normally distributed.

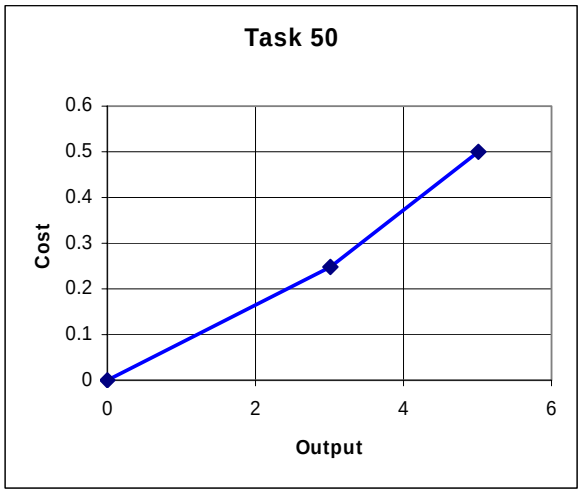
Relative Task Value

Table K-100: Task 50 Relative Task Value

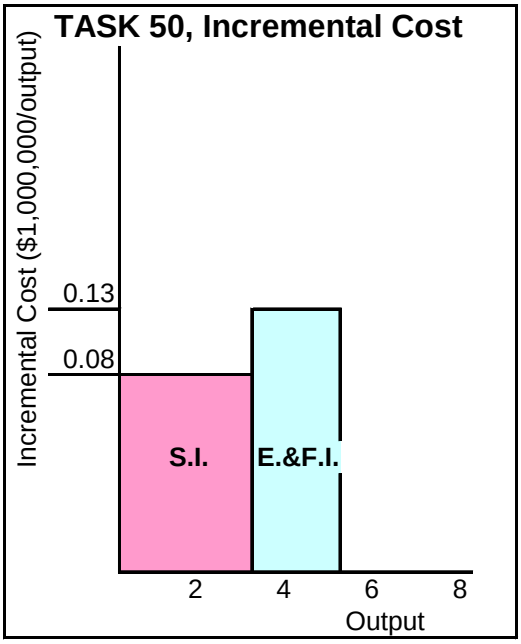
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
5.0	0.0	0.0	3.0	5.0	5.0

Remarks: Defining the geomorphic characteristic of upland areas is important to modeling these areas. This task is substantially met at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.083 M for every one unit increase in output.
Enhanced – Increase in cost is $0.125 M for every one unit increase in output.
Full – Increase in cost is $0.125 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 51 – Climate Change Impacts on Upland Habitat

Implementation Alternatives and Cost Details

Task: *The USGS, in collaboration with NOAA and other U.S. federal agencies, and in cooperation with state, regional and academic institutions, needs to develop standard modeling procedures for monitoring upland habitat responses to climatic changes.*

Without Plan Strategy – Current information base is sporadic and incomplete. Situation is likely not to change.

Minimum Investment Strategy – No additional investment considered.

Selective Implementation Strategy – Contingent upon completing the geomorphic classification of upland habitats, develop prototype predictive models on upland habitat response to climate change costing $1 M over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Contingent upon completing the geomorphic classification of upland habitats, develop prototype predictive models on upland habitat response to climate change costing $1 M over two years. Estimated cost is based on similar programs.

Full Implementation Strategy – Contingent upon classifying upland habitats by their geomorphic characteristics, develop and apply predictive models for all upland habitats within the system in response to climate change costing $3 M over three years. Estimated cost is based on similar programs.

Range of Costs

Table K-101: Task 51 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$-	$-	$-	$0.800	$1.000	$1.200	$0.800	$1.000	$1.200	$2.000	$3.000	$4.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of specific studies under the three implementation alternatives with identical commitments under the Selective and Enhanced alternatives. The Full Implementation alternative includes a substantial increase in scope. The range of prospective costs for all alternatives is normally distributed.

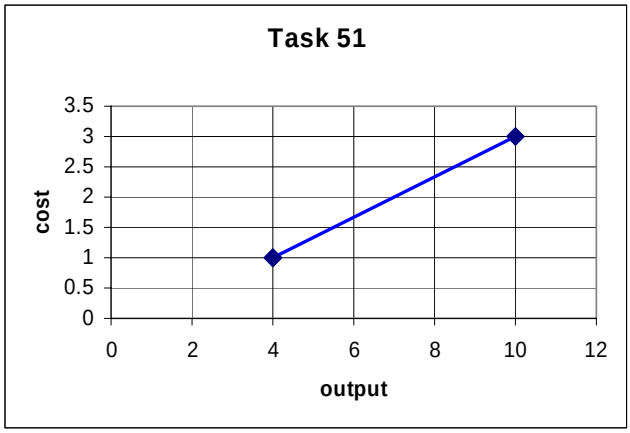
Relative Task Value

Table K-102: Task 51 Relative Task Value

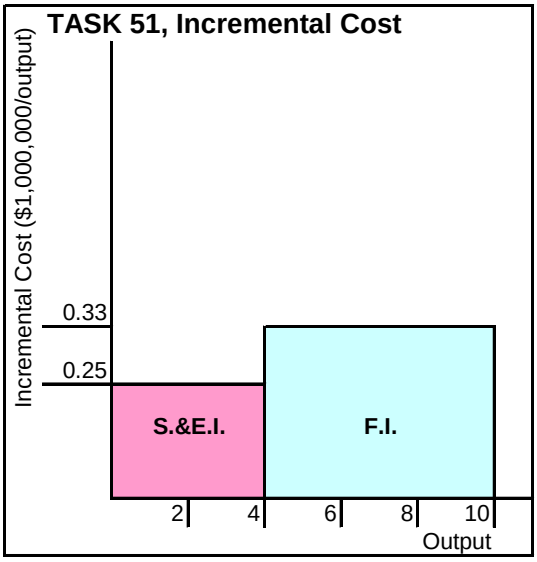
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0-	0.0	0.0	4.0	4.0	10.0

Remarks: Climatic changes are expected to be manifested more distinctly on upland habitats. Assessing the role of cumulative withdrawals during periods of significant climate change will be an important challenge. Returns on this monitoring would be significant at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Selective – Increase in cost is $0.33 M for every one unit increase in output.
Enhanced – Increase in cost is $0.33 M for every one unit increase in output.
Full – Increase in cost is $0.29 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 52 – Medium Resolution Land Cover Mapping

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the NOAA and the USACE and in cooperation with state agencies, need to produce comprehensive and consistent land cover datasets for the entire Great Lakes - St. Lawrence River basin on a five-year repeat cycle.*

Without Plan – Various agencies will continue to work together within the Multi-Resolution Land Characteristics consortium which produced the 1992 National Land Cover Dataset (NLCD) and has begun work on a version based on 2000-era data. Completion time will depend on funding from partners and may range from three to seven or more years. No formal repetition cycle is planned. The utility of data that is more than 10-years old is suspect. Current programmatic investments indicate that there will be few predictions of land cover characteristics to support critical water resource management decisionmaking.

Minimum Investment Strategy – Provide additional funding to NOAA to acquire and process 2005 satellite imagery for the Great Lakes-St. Lawrence River region as part of a change analysis cycle under the Coastal Change Analysis Program (C-CAP) at a cost of $300 K over two years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide additional funding to NOAA to acquire and process 2005 satellite imagery for the Great Lakes-St. Lawrence River region as part of a change analysis cycle under the Coastal Change Analysis Program (C-CAP) at a cost of $300 K over two years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide additional funding to NOAA to acquire and process 2005 satellite imagery for the Great Lakes-St. Lawrence River region as part of a change analysis cycle under the Coastal Change Analysis Program (C-CAP). In addition, cross-reference classification categories from NOAA C-CAP and USGS NLCD 1992 to allow change analysis for the period over which a national land cover dataset exists and processing has been carried out. The estimated cost for this activity is $500 K over 2 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Coordinate NOAA's C-CAP efforts and the efforts of the Multi-Resolution Land Characteristics Consortium to institutionalize and streamline the efforts of all agencies involved in those processes. Establish a program to acquire and process new imagery every 3- years, releasing new land cover datasets within 6-months of data acquisition. The estimated cost for this activity is $1.5 M over 10 years, with commensurate funding annual funding thereafter to insure that the 5-year repeat cycle is maintained. Estimated cost is based on similar programs.

Range of Costs

Table K-103: Task 52 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.300	$0.300	$0.300	$0.300	$0.300	$0.300	$0.500	$0.500	$0.500	$1.250	$1.500	$1.750

Remarks: Work conducted under this task is an extension of activities already conducted. There is no range of prospective costs for the Minimum Investment and the Selective and Enhanced Implementation alternatives since they reflect minimum program functionality. The prospective range of costs for the Full Implementation alternative is normally distributed.

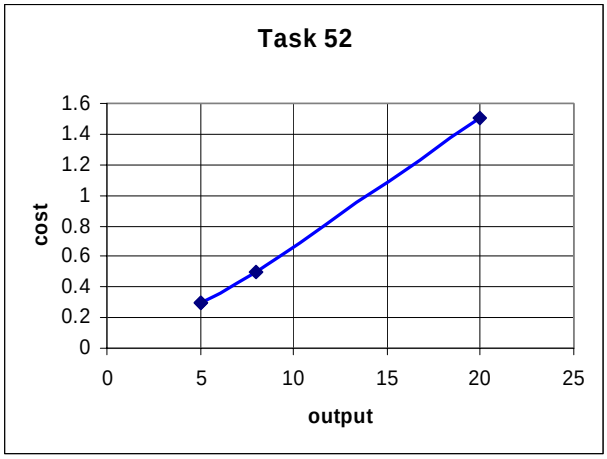
Relative Task Value

Table K-104: Task 53 Relative Task Value

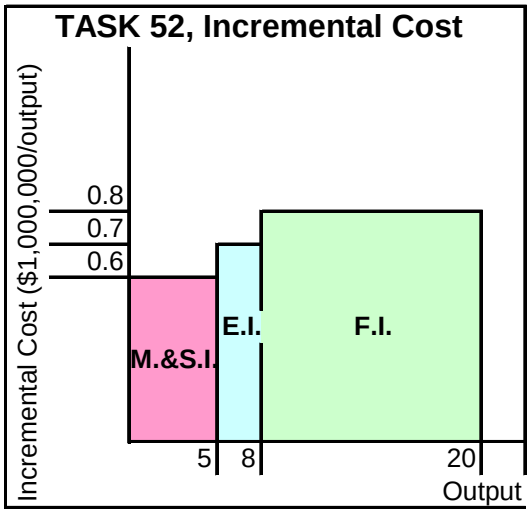
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	5.0	5.0	8.0	20.0

Remarks: Mapping of regional land cover characteristics is an important input to hydrologic and habitat models. This task would not provide substantial benefits unless funding was provided at the Full Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.06 M for every one unit increase in output.
Selective – Increase in cost is $0.06 M for every one unit increase in output.
Enhanced – Increase in cost is $0.07 M for every one unit increase in output.
Full – Increase in cost is $0.83 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 53 – High Resolution Land Cover Mapping

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE and in cooperation with state agencies, need to produce high-resolution land cover data within the Great Lakes - St. Lawrence River basin to support detailed assessments of specific water withdrawal proposals.*

Without Plan Strategy – Local communities, especially urban areas, will gradually acquire high-resolution data products for use in land use planning and other efforts. There will be poor spatial completeness and little or no temporal match between adjacent political units. The data may or may not be processed for classification into land cover categories.

Minimum Investment Strategy – Provide funding to the USGS to acquire high-resolution satellite imagery and create a high-resolution land cover dataset for priority rapidly changing areas within the Great Lakes - St. Lawrence River basin. Existing lower resolution data sets and census information would be used to determine these priority areas. The estimated cost of this activity would be $500 K over 3 years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide funding to the USGS to acquire high-resolution satellite imagery and create a high-resolution land cover dataset for rapidly changing areas within the Great Lakes - St. Lawrence River basin. Existing lower resolution data sets and census information would be used to determine priority areas. The estimated cost of this activity would be $3 M over 10 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide funding to the USGS to acquire high-resolution satellite imagery and create a high-resolution land cover dataset for all urban areas and major transportation arteries across the Great Lakes - St. Lawrence River region and update this mapping every 5-years. Existing land cover datasets can be used to determine priority areas. The cost for this activity is estimated at $4.5 M over 10-years with commensurate annual funding thereafter. Estimated cost is based on similar programs.

Full Implementation Strategy – Provide funding to the USGS to acquire high-resolution satellite imagery and create a high-resolution land cover dataset for all areas within the Great Lakes - St. Lawrence River region and update this mapping every 3-years. Estimated cost is based on similar programs.

Range of Costs

Table K-105: Task 53 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.450	$0.600	$0.750	$2.500	$3.000	$3.500	$4.000	$4.500	$5.000	$5.000	$7.000	$10.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a new program under all alternatives. The range of prospective costs for the Minimum Investment alternative is not normally distributed, since there is a greater uncertainty at the higher end about mapping needs for area of rapid change. The range of prospective costs for the Selective and Enhanced Implementation alternatives are normally distributed. The range of prospective costs for the Full Implementation alternative reflects greater uncertainty on the high end caused by unforeseen program complexity.

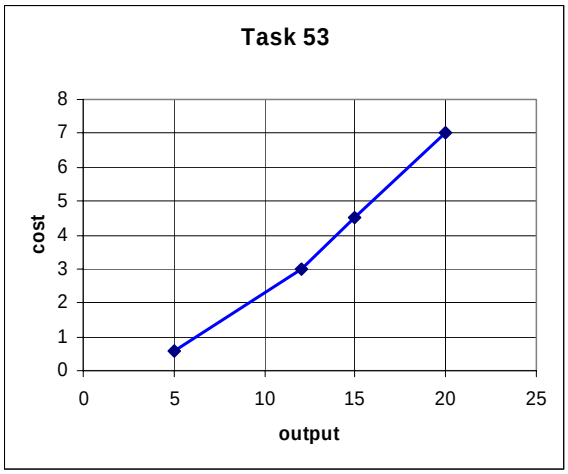
Relative Task Value

Table K-106: Task 53 Relative Task Value

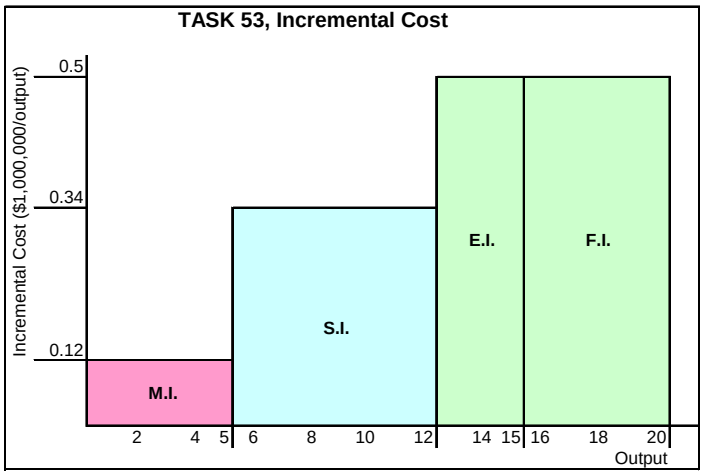
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	0.0	5.0	12.0	15.0	20.0

Remarks: Detailed mapping of land cover characteristics is critically important in modeling habitat and hydrologic response of watersheds. Substantial benefits are derived at the Selective Implementation level with incremental increases as funding rises

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.25 M for every one unit increase in output.
Selective – Increase in cost is $0.34 M for every one unit increase in output.
Enhanced – Increase in cost is $0.5 M for every one unit increase in output.
Full – Increase in cost is $0.5 M for every one unit increase in output.

Increasing incremental costs reflect increasing project complexity. No alternative is excluded as a result of this analysis.

Task 54 – Land Cover Change

Implementation Alternatives and Cost Details

Task: *The USGS, in conjunction with the USACE and in cooperation with state agencies, need to produce land cover change evaluations from available data and 30-year land use projections for the entire the Great Lakes – St. Lawrence River basin to refine ecological impact assessments and anticipated future demands on water resources.*

Without Plan Strategy – Various agencies will likely develop land cover change mapping products. These products, however, will not be complete, be inconsistent over varying analysis periods, with varying classification strategies and varying spatial scales. Comprehensive and comparable products for the region will be lacking. Emphasis on future land cover projections will also not likely be addressed, and if so, will likely be incomplete in geographic scope, inconsistent in spatial scale, and temporal detail and based upon differing classification methods.

Minimum Investment Strategy – Provide funding to the USGS to develop data standards and consistent analysis procedures for land cover change and future projections specific to the needs of water resource decisionmaking for the Great Lakes – St. Lawrence River system. At a minimum, the National Land Cover Dataset would be used to assess changes over the last 10-12 years. The cost for this activity is estimated at $200 K over 2 years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide funding to the USGS to develop data standards and consistent analysis procedures for land cover change and future projections specific to the needs of water resource decisionmaking for the Great Lakes – St. Lawrence River system At a minimum, the National Land Cover Dataset would be used to assess changes over the last 10-12 years. The cost for this activity is estimated at $200 K over 2 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide funding to the USGS to develop data standards and consistent analysis procedures for land cover change and future projections specific to the needs of water resource decisionmaking for the Great Lakes – St. Lawrence River system. Information from the National Land Cover Dataset would be used to assess changes over the last 10-12 years and other ancillary and higher-resolution data sources. The cost for this activity is estimated at $300 K over 2 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Provide funding to the USGS to develop data standards and consistent analysis procedures for land cover change and future projections specific to the needs of water resource decisionmaking for the Great Lakes – St. Lawrence River system. Information from the National Land Cover Dataset would be used to assess changes over the last 10-12 years and other ancillary and higher-resolution data sources. The cost for this activity is estimated at $1.5 M over 10 years and commensurate annual funding thereafter. Estimated cost is based on similar programs.

Range of Costs

Table K-107: Task 54 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.200	$0.200	$0.200	$0.200	$0.200	$0.200	$0.300	$0.300	$0.300	$1.250	$1.600	$2.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a new program under all alternatives and would be conducted concurrent with Tasks 52 and 53. There is no range of prospective costs for the Minimum Investment and the Selective and Enhanced Implementation alternatives since they reflect minimum program functionality. The range of prospective costs for the Full Implementation alternative reflects greater uncertainty on the high end caused by unforeseen program complexity.

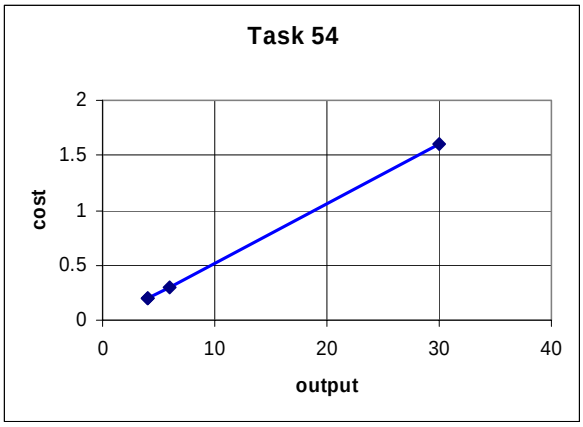
Relative Task Value

Table K-108: Task 54 Relative Task Value

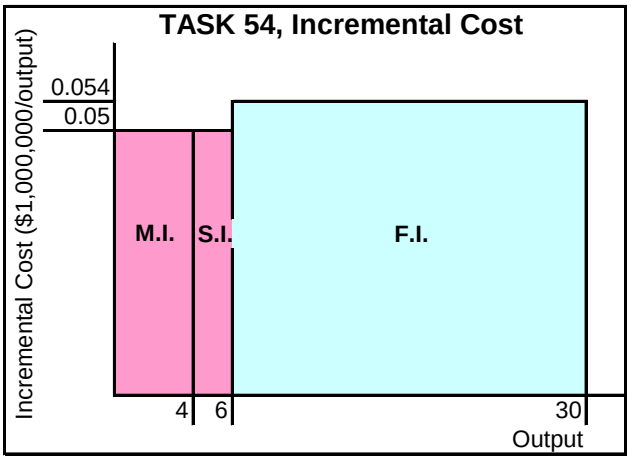
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
30.0	0.0	4.0	4.0	6.0	30.0

Remarks: Understanding land cover changes as a function of demographic patterns is needed to understand its impact on habitat changes versus cumulative water withdrawals. Returns are modest until substantial funding is provided under the Full Implementation alternative.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.05 M for every one unit increase in output.
Selective – Increase in cost is $0.05 M for every one unit increase in output.
Enhanced – Increase in cost is $0.054 M for every one unit increase in output.
Full – Increase in cost is $0.054 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 55 – Information Clearinghouse Node

Implementation Alternatives and Cost Details

Task: *The USACE, in conjunction with the USGS, and in cooperation with other U.S. federal agencies, state entities and Canadian interests, needs to ensure that all federal biohydrological data for the Great Lakes – St. Lawrence River is served on registered NSDI clearinghouse nodes.*

Without Plan Strategy – Biohydrological data will remain fragmented across the different federal agencies. Institutional agency "fiefdoms" will persist, compromising science-based water resources management decisions across the basin.

Minimum Investment Strategy – Provide funding to the USACE to work in partnership with the Great Lakes Commission to insure integration of existing biohydrological data across the Great Lakes – St. Lawrence River system and posting of associated metadata to registered NSDI clearinghouse nodes. The estimated cost for this effort is $600K over the next 3-years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide funding to the USACE to work in partnership with the Great Lakes Commission to insure integration of existing biohydrological data across the Great Lakes – St. Lawrence River system and posting of associated metadata to registered NSDI clearinghouse nodes. The estimated cost for this effort is $600K over the next 3-years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide funding to the USACE to work in partnership with the Great Lakes Commission to insure integration of existing biohydrological data across the Great Lakes – St. Lawrence River system and posting of associated metadata to registered NSDI clearinghouse nodes. The estimated cost for this effort is $600K over the next 3-years. Estimated cost is based on similar programs.

Full Implementation Strategy – Provide funding to the USACE to work in partnership with the Great Lakes Commission to insure integration of existing biohydrological data across the Great Lakes – St. Lawrence River system and posting of associated metadata to registered NSDI clearinghouse nodes. The estimated cost for this effort is $600K over the next 3-years. Estimated cost is based on similar programs.

Range of Costs

Table K-109: Task 55 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.600	$0.700	$0.800	$0.600	$0.700	$0.800	$0.600	$0.700	$0.800	$0.600	$0.700	$0.800

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a new program under all alternatives. This component of an integrated decision support system would be accomplished at the Minimum Investment alternative, hence the Selective, Enhanced and Full Implementation alternatives are identical. The minimum and

proposed costs are also identical since they reflect high confidence in meeting basic program functionality.

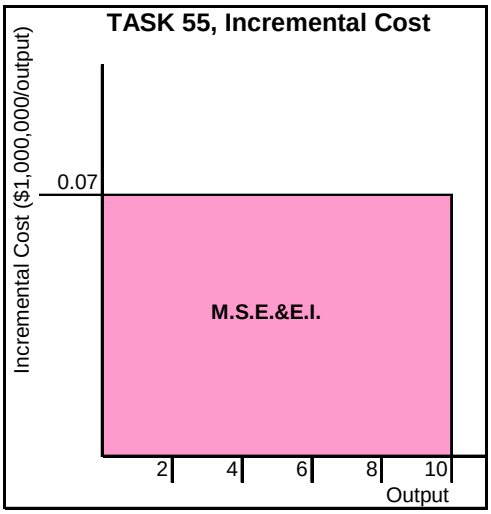
Relative Task Value

Table K-120: Task 55 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	10.0	10.0	10.0	10.0

Remarks: Ready access to well documented data is critical for timely withdrawal permitting. This task provides maximum benefits at the lowest funding level.

Cost Effectiveness and Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.07 M for every one unit increase in output.
Selective – Increase in cost is $0.07 M for every one unit increase in output.
Enhanced – Increase in cost is $0. 0.07 M for every one unit increase in output.
Full – Increase in cost is $0.07 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 56 – Metadata Standards

Implementation Alternatives and Cost Details

Task: *The USACE, in conjunction with the USGS, and in cooperation with other U.S. federal agencies, state entities and Canadian interests, needs to develop metadata standards to handle all hydrologic, meteorologic, ecological and water quality data needed for Great Lakes – St. Lawrence River water resource decision support.*

Without Plan Strategy – Inconsistent, incomplete, non-uniform and unreliable information will continue to be the norm. Current FGDC endorsed standards do not cover all of the datasets required to make informed management decisions in the Great Lakes-St. Lawrence River system.

Minimum Investment Strategy – Increase funding for the USGS to support the FGDC to expand metadata standards development program emphasizing hydrologic and meteorologic data models and definition of their accuracies and consistencies for model input at a cost of $500K over 2- years. Estimated cost is based on similar programs.

Selective Implementation Strategy – Increase funding for the USGS to support the FGDC to expand metadata standards development program emphasizing hydrologic and meteorologic data models and definition of their accuracies and consistencies for model input at a cost of $2M over 5 years. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Increase funding for the USGS to support the FGDC to expand metadata standards development program emphasizing hydrologic, meteorologic and biologic data models and definition of their accuracies and consistencies for model input at a cost of $4M over 5 years. Estimated cost is based on similar programs.

Full Implementation Strategy – Increase funding for the USGS to support the FGDC to expand metadata standards development program emphasizing hydrologic, meteorologic and biologic data models and all other relevant model inputs and outputs and definition of their accuracies and consistencies for model input at a cost of $6M over 5 years. Estimated cost is based on similar programs.

Range of Costs

Table K-121: Task 56 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.500	$0.500	$0.500	$1.500	$2.000	$2.500	$3.000	$4.000	$5.000	$5.000	$6.000	$7.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is a new program initiation under all alternatives. There is no range of costs for the Minimum Investment alternative since if reflects a basic level of research. The range of prospective costs for all system implementation alternatives is normally distributed.

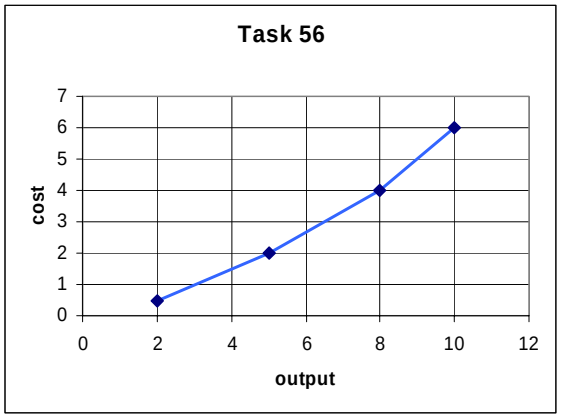
Relative Task Value

Table K-122: Task 56 Relative Task Value

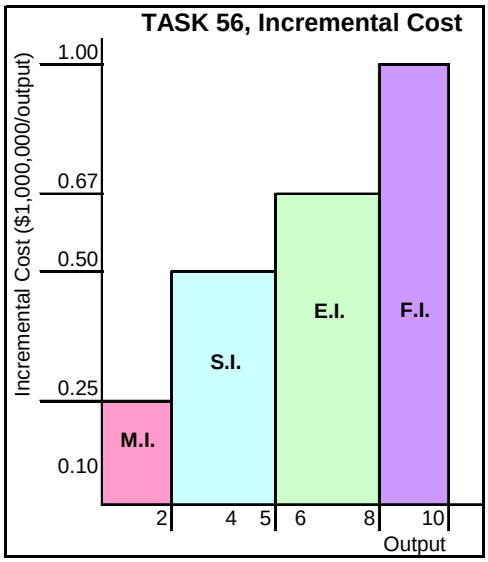
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	2.0	5.0	8.0	10.0

Remarks: Self documented datasets provide legal defensibility for withdrawal decisions. This task provides increasing incremental benefits above the Minimum Investment alternative.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.
Incremental Analysis:
Minimum – Increase in cost is $0.25 M for every one unit increase in output.
Selective – Increase in cost is $0.75 M for every one unit increase in output.
Enhanced – Increase in cost is $0.5 M for every one unit increase in output.
Full – Increase in cost is $1 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 57 – Metadata Listings

Implementation Alternatives and Cost Details

Task: *The USACE, in conjunction with the USGS, needs to ensure that all U.S. federal biohydrological data that is collected and stored for the Great Lakes –St. Lawrence River to have metadata created and posted on a NSDI registered clearinghouse node.*

Without Plan Strategy – Under Executive Order 12906, each federal agency is directed to document all geospatial data it collects, produces and distributes. Minimal funding has been set aside for metadata development for historic data. Implementation of the Executive Order has been spotty at best over the region. Inconsistent, incomplete, non-uniform and unreliable information will continue to be the norm.

Minimum Investment Strategy – Provide funding to the USACE to work in partnership with the other U.S. federal agencies to become compliant with all of the provisions of Executive Order 12906. The estimated cost for this effort is $600 K over a ten-year period. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide funding to the USACE to work in partnership with the other U.S. federal agencies to become compliant with all of the provisions of Executive Order 12906. The estimated cost for this effort is $600 K over a ten-year period. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide funding to the USACE to work in partnership with the other U.S. federal agencies to become compliant with all of the provisions of Executive Order 12906. The estimated cost for this effort is $600 K over a ten-year period. Estimated cost is based on similar programs.

Full Implementation Strategy – Provide funding to the USACE to work in partnership with the other U.S. federal agencies to become compliant with all of the provisions of Executive Order 12906. The estimated cost for this effort is $600 K over a ten-year period. Estimated cost is based on similar programs.

Range of Costs

Table K-123: Task 57 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.600	$0.700	$0.800	$0.600	$0.700	$0.800	$0.600	$0.700	$0.800	$0.600	$0.700	$0.800

Remarks: This is an initiation of a new program under all alternatives. This task would be accomplished under the Minimum Investment alternative, hence all other alternatives are identical. The minimum and proposed costs are also identical since they reflect high confidence in meeting basic functionality.

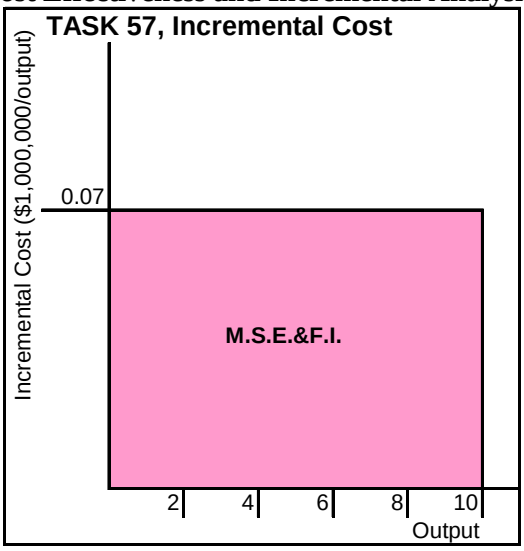
Relative Task Value

Table K-124: Task 57 Relative Task Value

Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
10.0	0.0	10.0	10.0	10.0	10.0

Remarks: Ready access to well documented data is critical for timely withdrawal permitting. This task provides maximum benefits at the lowest funding level.

Cost Effectiveness and Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.07 M for every one unit increase in output.
Selective – Increase in cost is $0.07 M for every one unit increase in output.
Enhanced – Increase in cost is $0.07 M for every one unit increase in output.
Full – Increase in cost is $0.07 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 58 – Regional Data Exchange

Implementation Alternatives and Cost Details

Task: *The USACE needs to lead U.S. federal interagency coordination for promoting regional data exchange agreements covering all required Great Lakes – St. Lawrence River biohydrological data.*

Without Plan Strategy – Current information base is sporadic and incomplete. Situation is likely not to change.

Minimum Investment Strategy – Provide funding to the USACE to coordinate with federal, state and provincial agencies in the U.S. and Canada to develop a data exchange agreement and implement the necessary data exchange mechanisms for sharing and accessing data. The estimated cost for this program is $1 M over ten years, with commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Selective Implementation Strategy – Provide funding to the USACE coordinate with federal, regional, state and provincial agencies in the U.S. and Canada to develop a data exchange agreement and implement the necessary data exchange mechanisms for sharing and accessing data. This will require pass-through funding to the Great Lakes states to build requisite infrastructure. The estimated cost for this program is $5 M over ten years, with commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Enhanced Implementation Strategy – Provide funding to the USACE coordinate with federal, regional, state and provincial agencies in the U.S. and Canada to develop a data exchange agreement and implement the necessary data exchange mechanisms for sharing and accessing data. This will require pass-through funding to the Great Lakes states to build requisite infrastructure. The estimated cost for this program is $5 M over ten years, with commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Full Implementation Strategy – Provide funding to the USACE coordinate with federal, regional, state and provincial agencies in the U.S. and Canada to develop a data exchange agreement and implement the necessary data exchange mechanisms for sharing and accessing data. This will require pass-through funding to the Great Lakes states to build requisite infrastructure. The estimated cost for this program is $5 M over ten years, with commensurate funding per annum thereafter. Estimated cost is based on similar programs.

Range of Costs

Table K-125: Task 58 Range of Costs (in millions of dollars)

Minimum Investment			**Selective Implementation**			**Enhanced Implementation**			**Full Implementation**		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$0.800	$1.000	$1.200	$4.000	$5.000	$6.000	$4.000	$5.000	$6.000	$4.000	$5.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a new program under all alternatives. The Minimum Investment reflects basic coordination only, with no infrastructure development at the state level. Full functionality is accomplished at the Selective Implementation alternative, hence the Enhanced and Full Implementation alternatives are identical. The range of prospective costs for all alternatives is normally distributed.

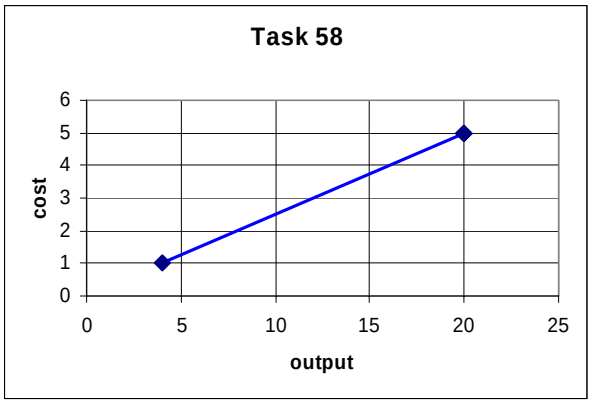
Relative Task Value

Table K-126: Task 58 Relative Task Value

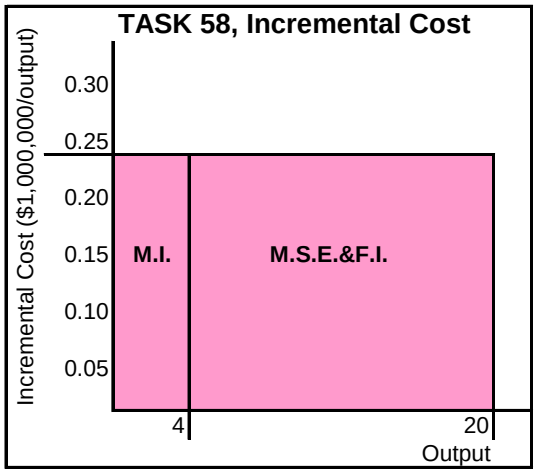
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
20.0	-5.0	4.0	20.0	20.0	20.0

Remarks: Information sharing between multiple jurisdictions over any Great Lakes basin is needed to insure operability of Annex decisionmaking. This task provides maximum benefits at the Selective Implementation level.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.25 M for every one unit increase in output.
Selective – Increase in cost is $0.25 M for every one unit increase in output.
Enhanced – Increase in cost is $0.25 M for every one unit increase in output.
Full – Increase in cost is $0.25 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.

Task 59 – Model Integration

Implementation Alternatives and Cost Details

Task: *The USACE, in cooperation with other U.S. federal agencies, state entities, Canadian interests, and regional academic institutions needs to develop procedures for maintaining and promoting linkages between computer models needed to support implementation of the Great Lakes Charter Annex.*

Without Plan Strategy – Projecting likely impacts of potential water withdrawals will continue to be compromised due to inconsistencies between model inputs and outputs.

Limited model integration will proceed out of necessity, but not in a systemic approach. Holistic analysis will continue to be difficult and not be cost effective.

Minimum Investment Strategy – Develop a prototype integrated and holistic model that can illustrate all the cause-effect relationships that exist between potential water withdrawals and biological impacts and apply it for one high priority Great Lakes watershed at a cost of $1.5 M over two years.

Selective Implementation Strategy – Develop a prototype integrated and holistic model that can illustrate all the cause-effect relationships that exist between potential water withdrawals and biological impacts and apply it for one high priority Great Lakes watershed at a cost of $1.5 M over two years.

Enhanced Implementation Strategy – Develop and implement a prototype integrated and holistic model framework. Models would be developed and applied to individual watersheds or subwatersheds based upon priority need. The cost of this effort is estimated at $3 million over the next five-years.

Full Implementation Strategy – Develop and implement an integrated and holistic model framework for each U.S. Great Lakes – St. Lawrence watershed. The cost of this effort is estimated at $5 million over the next five-years.

Range of Costs

Table K-127: Task 59 Range of Costs (in millions of dollars)

Minimum Investment			Selective Implementation			Enhanced Implementation			Full Implementation		
Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest	Lowest	Expected	Highest
$1.200	$1.500	$1.800	$1.200	$1.500	$1.800	$2.400	$3.000	$3.600	$4.000	$5.000	$6.000

[Expected costs are derived from proposed costs outlined in each appendix using standard risk assessment methods.]

Remarks: This is an initiation of a new program for all alternatives. The range of prospective costs is normally distributed for all alternatives. The Minimum Investment and Selective Implementation alternatives are identical reflecting conceptual model integration for one Great Lakes basin. The Enhanced Implementation alternative reflects development for two Great Lakes basins, while the Full Implementation alternative includes model integration for all Great Lakes basins and corresponding economies of scale.

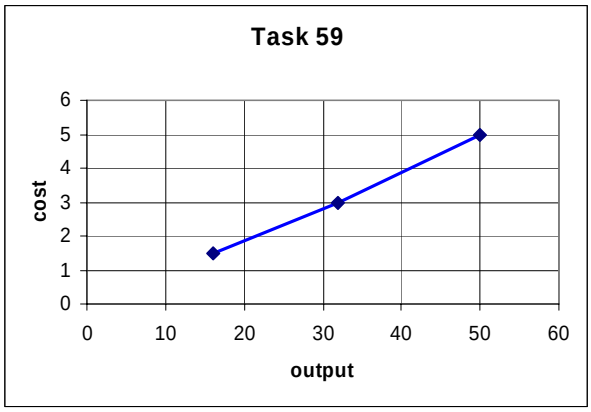
Relative Task Value

Table K-128: Task 59 Relative Task Value

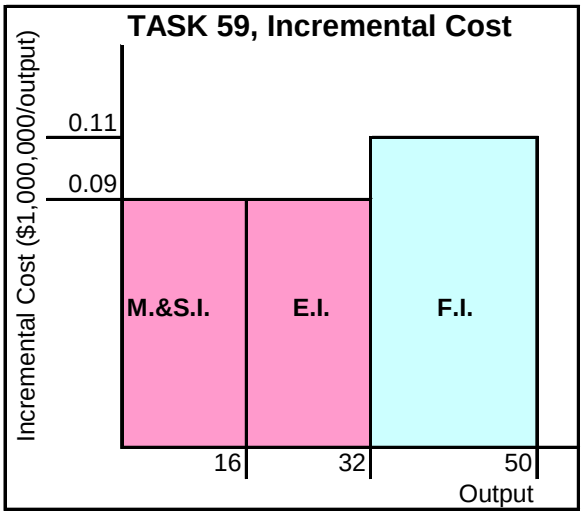
Relative Value	No Change	Minimum Investment	Selective Implementation	Enhanced Implementation	Full Implementation
50.0	-20.0	16.0	16.0	20.0	50.0

Remarks: Integration of decision support components, particularly hydrologic and habitat modeling is the highest priority task. Substantial returns occur at the Minimum Investment and Selective Implementation levels with increasing benefits as funding rise.

Cost Effectiveness



Incremental Analysis



Conclusion: No alternative is excluded as a result of the cost effectiveness test.

Incremental Analysis:
Minimum – Increase in cost is $0.09 M for every one unit increase in output.
Selective – Increase in cost is $0.09 M for every one unit increase in output.
Enhanced – Increase in cost is $0.09 M for every one unit increase in output.
Full – Increase in cost is $0.11 M for every one unit increase in output.

No alternative is excluded as a result of the Incremental Analysis.