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FINAL REPORT

on

DEVELOPMENT OF A FRAMEWORK FOR ASSESSING THE
ENVIRONMENTAL, SOCIAL, AND ECONOMIC IMPACT
OF THE CROSS-FLORIDA BARGE CANAL

to

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT

November 26, 1974

by

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INTRODUCTION

This report contains suggestions and alternatives for handling several of the major conceptual problems that must be addressed in the preparation of an adequate environmental impact statement for the Cross-Florida Barge Canal. The ideas presented represent our view of the necessary scope of the most informative and completely responsive environmental impact statement that can be prepared at the present time, assuming no time or money constraints. In many cases these ideas go much beyond current practice; however, they are in the current state of the art and could be used at the discretion of the responsible Federal agency, the U.S. Army Corps of Engineers.

These ideas are put forth with a view of the multiple communicating and reporting requirements to which the Corps may have to respond. These include, in addition to the environmental impact statement itself, a "Section 122" Assessment of Economic, Social, and Environmental Affects of Contemplated Civil Works Projects, as required by Public Law 91-611, planning procedures put forth by the Water Resources Council, and the Florida "Developments of Regional Interest" permitting process, which we understand



does not yet apply to the Barge Canal, but may apply in the future. An impact statement developed along the lines suggested in this report should provide full environmental analysis and data to meet with the full range of possible requirements.

The report is organized into the following main sections:

- Alternatives for Analysis
- Regions for Analysis
- Time Sequence for Analysis
- Suggested Impact Parameters
- Treatment of Impact Uncertainty
- Organizing the Impact Statement for Effective Communication
- Secondary Impact Analysis.
- Models and Methods for Assessing Impacts

ALTERNATIVES FOR ANALYSIS

For a complete treatment of project alternatives, four major classes of alternatives should be considered as follows:

- Alignment Alternatives
- Design Alternatives
- Alternative Solutions (Non-Corps Projects)
- No-Project Alternatives.

The status of each category is discussed below.

Alignment Alternatives

Several alignment alternatives have already been identified. There are three major types. The first is the authorized alignment. The bulk of the data collected to date pertains to this alternative. A second group of alignment alternatives includes possible by-passes of portions of the Oklawaha River. Two of these alternatives (the Eureka to Highway 40, nonriver alignment and the Eureka to Bert Dash Lock nonriver alignment) would exclude the river proper but remain in the flood plain. Two further modifications of these alternatives would place the canal entirely outside the river flood



plain. The Lake George plan, crossing the Ocala National Forest to Lake George, represents a third major type of alignment alternative.

These three types of alignment alternatives should adequately cover possibilities for a canal with the same starting and ending points. For complete coverage of alignment alternatives we would suggest that a fourth category including a plan with differing end points be considered. There is apparently no plan of this type under current investigation, though several have been proposed in the past.

Design Alternatives

Several possible design modifications have been suggested for the Summit Reach. These include

- (1) Additional lock or locks to minimize the depth of cut in the reach
- (2) Paving, channel lining, dental work, and grouting to hold seepage within acceptable limits
- (3) Additional pumping stations at Dunnellon to provide flexible use of the overall system's water supply
- (4) Operational and administrative techniques to minimize the impact of developing the area.

A separate set of design modifications could also be developed to improve flushing action for the Withlacoochee River.

For complete treatment of design alternatives, it might be appropriate to examine a fundamentally different design such as an overhead canal.

Alternative Solutions

For a truly complete impact statement, we strongly recommend the identification and examination of some noncanal alternative. Such an alternative should represent a wholly different method of attaining the objectives sought through the construction of the canal. If, for example, objectives of the canal are defined to include stimulation of the economies near the



two end points of the proposed canal, a different type of Federal assistance program could probably be identified. This alternative would be most effective in the EIS if it is both non-canal and non-Corps of Engineers. An example of such an alternative might be expansion and up-dating of the existing railroad system in the area, including bulk-breakpoints.

No-Project Alternatives

Three major types of no-project alternatives have been identified to date:

- (1) Preserve completed works
- (2) Restore original conditions
- (3) Abandonment.

These should provide adequate coverage unless there are major management options available under preserve completed works. For example, if management for navigation, flood control, or recreation, etc, would entail quite different practices, then perhaps more than one alternative should be considered under this category.

Summary

In summary, it is our judgment that a complete analysis of alternatives may include any or all of those listed in the following outline. Specific alternatives identified to date are shown in parentheses.

A. Alignment Alternatives

1. (Authorized alignment)
2. (1-4 Oklawaha River by-pass alignments)
3. (Lake George alternative)
4. Alternative Canal with different end points

B. Design Alternatives

1. (1-4 modifications in the Summit Reach)
2. (Structural modifications in the Withlacoochee River area)
3. A fundamentally different design alternative

C. Alternative Solutions

1. A non-Corps, non-canal alternative



D. No-Project Alternatives

1. (Preserve completed works)
 - a. Management Plan A
 - b. Management Plan B
 - c. Etc.
2. (Restore original condition)
3. (Abandonment).

In virtually all cases other than the authorized alignment, specific definitions of these alternatives must be developed before an adequate analysis can be conducted for the impact statement.

REGIONS FOR ANALYSIS

Full illumination of project impacts and meaningful interpretation of impact significance require careful specification of the region of analysis. Many environmental impact statements prove deficient because of the failure to identify the region examined. When a region is identified, a single, narrowly defined region is often used, producing justifiable outcries from reviewers who are concerned about impacts outside the bounds of that region.

A better approach may be to identify three types of regions, each appropriate to a different type of impacts. An on-site region or regions should be defined to encompass all direct physical changes produced by the proposed action. On-site regions should be capable of being mapped and may be defined by hydrologic basins or ecological community boundaries, governmental boundaries such as county lines, or arbitrarily (everything within 2 miles of the stream bank, for example). Frequently several subunits of the on-site region can be usefully identified, particularly for dealing with ecological impacts.

A project region should be defined large enough to include the traceable secondary impacts of a project. The boundaries of the project region are necessarily less clearly defined than those of the on-site region contained within it. Appropriate boundaries will be defined as the contiguous



area within which the analyst can trace out secondary, tertiary, and higher order impacts. Generally the impacts of significance at the project region level are social-economic impacts, though secondary ecological or physical-chemical changes may occasionally be significant as well.

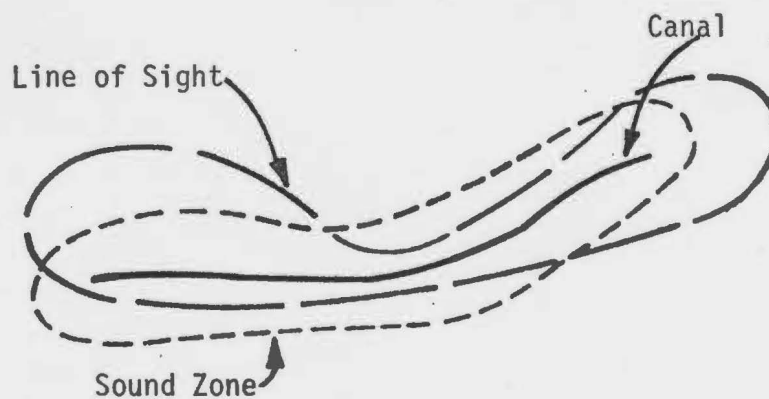
Beyond the on-site and project regions lies the out-region or regions. This is the level at which national or interstate issues come into play. These issues may include shifts in economic activities from a non-contiguous region to the project region, concern for irrevocable uses of scarce resources, and concerns for the fate of unique areas of national significance.

As the above typology indicates, it is generally not useful to attempt to straight-jacket all types of impacts into a single region of analysis. Similarly, it is not necessary to maintain consistent regions across all impact categories. For example, the appropriate on-site region for ecological variables will frequently have different boundaries than the on-site region for economic impact variables. It is helpful, however, to use the same regional boundaries for as many of the alternatives as possible. On-site, or project regions can, thus, be defined broadly enough to encompass several slightly different alignment or design alternatives. Alternatives that differ in more major ways, canals with differing end points, for example, will of course require separate regions of analysis. From the point of view of the utility of the impact statement, the important consideration is not that regions of analysis be consistent across all impact types but rather that the region examined for any specific impact be clearly specified.

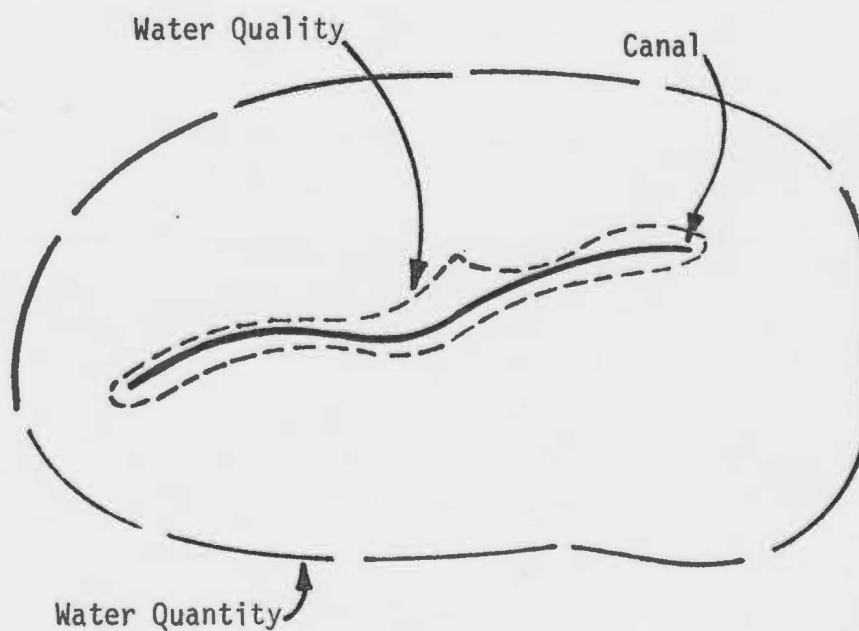
With the understanding that these suggestions are highly tentative and likely to be revised in the future, we suggest the following regional definitions as potentially appropriate to the Cross-Florida Barge Canal Impact Statement:

- (1) The on-site region will be defined by each discipline and will include all direct physical changes produced by the proposed action--for example, the on-site region for the aesthetic analysis may be line-of-sight or sound (noise) zone or a combination of these two (whichever is more extensive).





The on-site region for hydrology may be that area in which the quantity/quality of water is affected.



Five ecologically defined subregions can encompass virtually all of the existing alignment and design alternatives. These five are

- (a) The St. Johns River System
- (b) The Oklawaha System
- (c) The Highlands
- (d) The Withlacoochee River System
- (e) The Gulf Area.



Other on-site regions would, of course, be needed to handle other types of impact and as yet undefined different alignments or non-canal alternatives.

- (2) Project region - An appropriate project region can be only very vaguely defined until a preliminary look at secondary impacts has been made. These secondary impacts are associated with impacts on land use patterns, transportation patterns, behavior patterns, and economic activity patterns. For this reason, the project region can only be determined by reviewing the existing patterns and analyzing the with-project land use, transportation, behavior, and economic activity patterns along the canal route. This can be accomplished by analyzing transaction data, newspaper circulation, commuting patterns, shopping patterns, etc.
- (3) Out-region - No specific out-regions, other than the nation as a whole, have been identified to date. Additional ones could likely be identified through an analysis of interregional transfers of shipping activities, or of areas used by migratory wildlife.

TIME SEQUENCE FOR ANALYSIS

An adequate impact statement must explicitly treat the expected timing of impacts generated by the project. This point will be particularly important in relation to the Cross-Florida Barge Canal; where possible, long-term changes resulting from modification of hydrologic systems are of major concern. Since project-induced changes will continue to generate other changes beyond the limits of any predictive analysis, specific analysis cut-off dates are arbitrary--but none the less important. Tying an analysis of impacts to specific future dates is also important in that changes occurring in the project region but not triggered by the project must also be considered in the analysis. To adequately separate project from nonproject changes, it is necessary to state explicitly what assumptions regarding nonproject changes have been made and at what point in the future they are expected to occur.



In general, we recommend that impact statements deal with four specific points in time:

- (1) A date prior to the beginning of the project (if different from 2)
- (2) The present or baseline data for impact analysis
- (3) The date at which the construction will be completed and operation will begin
- (4) The date representing the useful life of the project (usually identified through the cost-benefit analysis).

For the Cross-Florida Barge Canal, we recommend the following dates be used:

- (1) Preproject date - 1964
- (2) Baseline date - 1974 - (consideration should also be given to a 1970 date due to the availability of 1970 census data)
- (3) Project completion date - 1985 (assumes a common completion date for all segments of the canal for simplicity)
- (4) End of useful life - 2035.

Though most impacts cannot be projected for a specific year, their approximate timing can and should be anticipated. For example, construction, early operation, late operation, and post operation phases can be identified and impacts grouped accordingly. It is important to recognize that the date--end of useful project life--does not imply that this is the absolute end point of canal use, rather that this date represents the estimated end of economic impacts created by the incentives and disincentives of the project.

SUGGESTED IMPACT PARAMETERS

The suggestion of a list of parameters for assessing the environmental impact of the Cross-Florida Barge Canal project was done with the knowledge that no single list of parameters for impact assessment is superior in all circumstances, and that there is no universally applicable set of parameters for assessing all environmental impacts without modification.



This list of parameters below is recommended to meet the requirements of the Corps for (1) comprehensiveness, (2) relatively quick and easy comprehension, (3) conciseness, and (readily measurable. The parameters are designed to evaluate and identify the environmental, social, and economic factors which should be considered under different management options--including construction, and operational and nonstructural mitigation measures. Recommended parameters are listed below and are defined or described in the Appendix. This list should be considered as an example only; as a practical matter, any technical specialist conducting an analysis is likely to define a slightly different parameter set with which he feels most comfortable.

This proposed framework is both flexible and adaptable to changing constraints and project considerations. It allows for an overview of project impacts (matrix) and will also permit a more detailed analysis of impacts (narrative).

Social Impact Parameters

Social Impacts

- Population
- Social Strata
- Social Organization
- Spatial-Physical Patterns
- Social-Psychological Patterns

Aesthetics

- Land-Water Interface
- Biota
- Water Clarity
- Compatibility of Scale
- Unique Composition
- Composite Effect
- Natural and Man-Made Sounds

Land Use Compatibility

- Land Use Plans
- Rate of Development
- Pattern of Development



- Type of Development
- Transportation Systems

Health and Safety

- Personal Effects
- Property Effects

Recreation

- Accessibility
- Variety
- Number of Users
- Distribution of Uses

Environmental Impact Parameters

Terrestrial Communities

- Natural Vegetation
- Agriculture and Forestry
- Large Animals
- Migratory Species
- Small Animals and Birds
- Threatened Species
- Pest Species
- Vulnerable and Unique Elements

Aquatic Communities

- Vegetation
- Zooplankton
- Benthos
- Fishes
- Pest Species
- Threatened Species
- Vulnerable and Unique Elements

Water Quantity

- Surface Flows
- Linkages/Surface Flow
- Water Uses
- Groundwater Level/Quantity



Water Quality

- Physical
- Nutrients
- Carbonaceous
- Thermal
- Trace Elements
- Biological
- Radiological
- Groundwater Quality

Solid Waste

- Solid Waste Generation and Disposal

Energy

- Net Energy Utilization

Meteorology/Air Quality

- Particulates
- Sulfur Dioxide
- Hydrocarbons
- Oxidants
- Oxides of Nitrogen
- Microclimate

Economic Impact Parameters

Economic

- Employment
- Property Values
- Fiscal Conditions
- Natural Resources
- Agricultural Productivity
- Public Infrastructure
- Regional Product
- Income
- Commerce

NOTE: See Appendix A for a definition of each of the above parameters.



TREATMENT OF IMPACT UNCERTAINTIES

Predicting future impacts of a project on the scale on the Cross-Florida Barge Canal is a perilous activity at best. Some impacts, mostly direct physical changes, are certain to occur if the project goes forward. Most impacts, however, are less certain and are predicted on the basis of professional judgment using data which are typically incomplete and often inconclusive. It is important that an adequate impact statement indicate the degree of confidence an analyst has in his impact projections. It is not the purpose of defining uncertainties to determine what is critical or what is statistically significant, rather it is a way for the researcher to express his confidence in his evaluation of a given impact. Very rarely can an explicit treatment of uncertainty be included by stating statistical confidence limits or probability limits, but cruder approaches are nonetheless useful. For impacts that are typically predicted in quantitative terms (parts per million, acres, numbers of people, etc), it is more appropriate to report a range rather than a single specific value. The range should be broad or narrow reflecting the confidence of the analyst in his predictions. Impacts that are generally not treated in a quantitative manner (social, aesthetic, some ecological, etc) can still reflect the level of confidence held by the analyst in a descriptive manner. In all cases the intent should not be statistical rigor, but rather to indicate to the public and to decision makers that all identified impacts are not equally certain. It is then the public and decision makers who must individually assess the significance and importance of a given finding or confidence level.

One workable method of dealing with the uncertainty issue involves the classification of predicted impacts into three major categories. A first category would contain those impacts that the analyst feels are virtually assured. The second category should include those predictions in which the analyst has less confidence. (For example, he may feel that a certain type of impact is very likely to occur but may be unable to predict the magnitude of that impact with any assurance.) The third category should identify high risk-low probability impacts. These impacts typically include accidents whose impact would be serious but whose probability is low.



ORGANIZING THE IMPACT STATEMENT
FOR EFFECTIVE COMMUNICATION

A fully responsive environmental impact statement for the Cross-Florida Barge Canal will necessarily be large and complex. To communicate effectively to decision makers and the general public, careful attention must be paid to the organization and format of the statement. Of course, NEPA and subsequent CEQ guidelines establish an overall organization to the report, but this organization is little more than the barest skeleton. One of the problems encountered in the usual practice of following the required content in a point-by-point manner ([a] project description, [b] environmental setting without the project, [c] the environmental impact of the proposed action, etc) is that information which must be directly compared to reach a decision on a project is strictly segregated and frequently buried within these major sections. Specifically, the setting without the project, the impacts of the proposed action, and the impacts of alternative actions are never directly contrasted on a point-by-point basis.

One way to make the impact statement more useful would be to prepare a second volume or an extended summary in addition to the typical massive data collection organized along the eight content points specified in the latest version of the CEQ guidelines. This summary would be streamlined, organized to effectively communicate the major conclusions of the analysis. This summary might present major conclusions in two formats. The first would be a parameter-by-parameter comparison of alternatives over time and over region of impact. This section would thus follow the following outline:

A. On-Site Impacts

1. Biochemical oxygen demand
2. Sport fish population

.
.
.



B. Project Region Impacts

1. Regional income
2. Regional population

.

.

.

C. Out-Region Impacts

1. Impacts on national forests and parks
2. Decreased shipping revenues in region X

.

.

.

Several possible methods for comparing alternatives within each parameter are described later.

The second major section of the summary might contain a series of future scenarios, one for each alternative. The emphasis in these scenarios would be on interpretation of impact significance, with conclusions expressed as verbal pictures of conditions expected to prevail in the area under each alternative. In developing these future scenarios, three additional factors should be considered in addition to the type and estimated magnitude of each impact identified in the analysis. These additional factors are

- Duration of impact
- Relation to cumulative trends
- Relative change and regional scarcities.

Duration of impact implies consideration of whether a particular impact is temporary, recurring, or permanent-long-lasting.

Cumulative impact considerations would include the following:

- (1) Number of similar projects within the immediate project region or within any relevant border region
- (2) Number of other types of activities causing impacts upon the same resources within the region



- (3) Significant trends in environmental indicators such as water quality, wildlife population, etc
- (4) Trends in social and economic conditions such as unemployment levels, welfare payments, population changes, and land use.

The consideration of relative changes involves analysis of the significance of a scarce resource use in comparison to the total regional or national supply. For example, loss of ten acres of grazing lands may be insignificant in a region dominated by similar lands, but could be far more important if this were the only grazing land within the region or if it were occupied by an endangered species. Similarly, if a land use produced by an alternative would preempt other land uses involving scarce resources (e.g., important mine sites), this fact should also be identified in the scenario discussion.

This summary is not intended to serve as the primary document for communicating with the general public, rather, it will present technical information in a streamlined form, without a great deal of supporting data. The Corps of Engineers will assume the responsibility of preparing a document for communicating the results of the impact assessment to the general public along with other information on the project.

Possible Frameworks for Comparing Alternatives

As mentioned above, there are several possible ways for comparing alternatives on a parameter-by-parameter basis. These include the following:

- (1) Description
- (2) Qualitative rating
- (3) Rating via standards
- (4) Percent change
- (5) Relative change.

Description involves nothing more than a verbal discussion of how a given parameter (e.g., biochemical oxygen demand) may vary between alternatives. This is obviously the simplest approach but would provide no consistency among the various impact parameters.



Qualitative rating implies the assignment of high-medium-low type evaluations to each alternative for any given impact parameter. Such an approach is simple and communicates well but is usually highly subjective, since criteria for each of the qualitative categories are seldom defined.

Ranking via standards involves the comparison of the impact expected under each alternative with some external reference point. This point may be a formal standard perhaps contained in water legislation for example, or it may be some more subjectively defined optimum level for the parameter in question. This approach provides a consistent, explicit basis for evaluation, but can pose difficulties when no commonly agreed-upon external standard exists for a particular impact parameter.

Percent change involves direct comparison of each alternative to the present or other baseline condition, regardless of whether that condition represents good or poor environmental quality for the parameter in question. This approach is easy to understand and objective, but like relative change, it may fail to identify the real significance of an impact.

Relative change involves the assignment of a rating to each alternative by comparing it to the alternative having the greatest impact on the parameter in question. Such ratings may be "normalized" by dividing the quantitative impact associated with any one alternative by the impact associated with the alternative producing the greatest change, or the alternatives may simply be ranked by their relative impacts. This approach is very effective in contrasting alternatives but does not, of itself, evaluate the significance of the impacts identified. For example, all alternatives may have an almost negligible effect on particulate matter in the atmosphere. But by this method some must necessarily be rated high and others low.

These alternative frameworks are intended as examples of ways to indicate and illustrate impacts associated with a specific parameter. Essentially there are two different measurement approaches--a qualitative approach (descriptive and qualitative rating) and a quantitative approach (ranking via standards, percent change, and relative change). However, all of these frameworks display similar information per parameter with the exception of the ranking via standards which involves the use of some external reference point. In this case the emphasis is not placed on the actual change as it is on how the new parameter rating compares to the external standard.



Selection among these and other methods of comparing alternatives is usually made on the basis of the quality of data available for analysis. The more complete and quantitative the data, the more appropriate are ratings via standards, relative change, or percent change.

Various types of graphic display devices are available for displaying the comparison of alternatives. These include matrices (Figure 1), factor profiles (Figure 2), bar charts (Figure 3), and time graphs (Figure 4).

SECONDARY IMPACTS ANALYSIS

In contrast to the analysis of primary project impacts, secondary and higher order impacts require a broader, more system-oriented examination of the affected region. The primary purpose of secondary-impact analysis should be to predict changes in the system's ability to perform its key functions.

The Cross-Florida Barge Canal project region can be visualized conceptually as a social system with the following key functions:

- Production - distribution - consumption
- Socialization
- Social control
- Social participation
- Mutual support.

The project region is also a natural system and may be analyzed in terms of the following:

- Energy circuits
- Food chains
- Diversity patterns in time and space
- Nutrient cycles
- Development and evolution
- Control (cybernetics).

The task of secondary impact analysis is to develop indicators and techniques that adequately identify changes in these basic functions. The following sections discuss what indicators of system functional performance



Input Parameters	Alternatives			
		Alt. A	Alt. B	Alt. C
Turbidity		*		
Sportfish				
Regional Income				
Population Size				
Etc.				

* High-medium-low, numerical ratings, etc.

FIGURE 1. ALTERNATIVE COMPARISON VIA A MATRIX



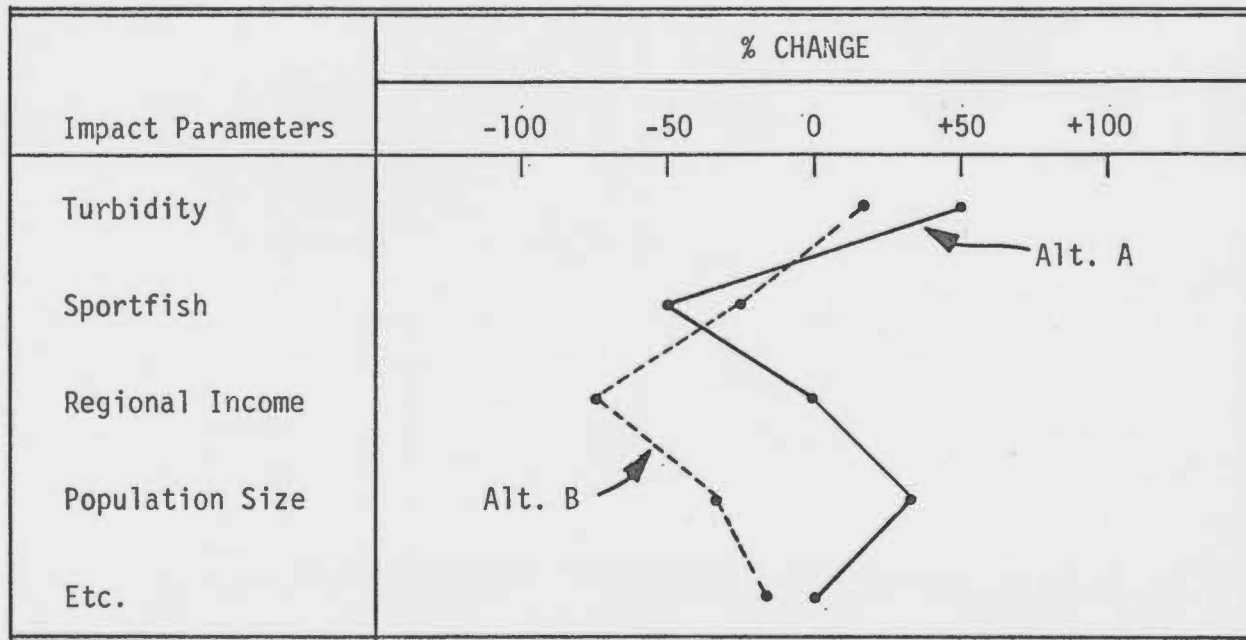


FIGURE 2. ALTERNATIVE COMPARISON VIA FACTOR PROFILE





FIGURE 3. ALTERNATIVE COMPARISON VIA BAR CHART



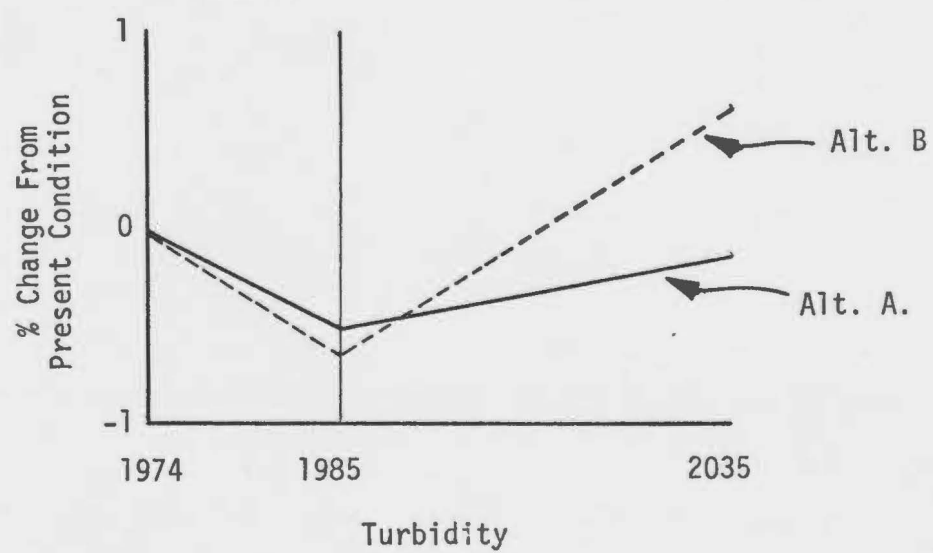


FIGURE 4. ALTERNATIVE COMPARISON VIA TIME GRAPH



should be examined, how the examination may be conducted, and possible forms for displaying the results of the analysis in an impact statement.

What To Look At

Many of the impact parameters listed above are suitable for secondary impact analysis if the analysis is conducted within a project region framework. In other cases, new, more aggregated parameters are required to deal with secondary impacts. An example of a listing of secondary impact considerations divided into environmental, economic, and social sub-categories is shown in Table 1.

Specific measurable indicators exist for all of the secondary impact considerations listed in Table 1.

TABLE 1. EXAMPLE SECONDARY IMPACTS CONSIDERATIONS

<u>Environmental</u>	<u>Economic</u>	<u>Social</u>
<u>Ecology</u>	<u>Revenue</u>	<u>Interest Group Influence</u>
Aquatic habitats	Ad valorem taxes	Number of persons
Terrestrial habitats	Personal income taxes	Percentage of persons
<u>Physical/Chemical</u>	Land value taxes	<u>Regional Social Services</u>
Water supply and demand	<u>Expenditures</u>	Health
Saltwater intrusion	Highway	Education
Water quality index	Police-fire	Recreation
Air quality index	Sewer	Safety
Complex source pollution	Education	<u>Local Social Services</u>
<u>Aesthetics</u>	<u>Employment</u>	Health
Unique areas	Direct (employment)	Education
Urban sprawl	Secondary (employment)	Recreation
Natural and man-made sounds	Reduction of unemployment	Safety
	<u>Income</u>	
	Direct salaries and wages	
	Indirect income	
	Income redistribution	
	<u>General Business</u>	
	Retail sales	
	Housing sales and starts	
	Service industries	
	Construction activities	



How to Conduct the Analysis

The projection of secondary impacts is a linking process; secondary impact parameters are linked to primary impacts and to each other. Basically, there are two major means of conducting the analysis--a separate parameters approach and a modeling approach.

The separate parameters approach, as the name indicates, deals with secondary impacts, one at a time. All that is involved is a logical analysis in which the cumulative effects of primary project impacts upon each secondary impact parameter are considered in turn. One useful way of evaluating secondary impacts identified in this manner is through an examination of infrastructural carrying capacities. A community's water supply, for example, has a "carrying capacity" in that the supply will be adequate only for a certain population size. Population increases beyond that capacity will necessitate the development of additional supplies, i.e., exceed the replacement capacity of that resource or necessitate decreased per capita consumption. Similarly, such carrying capacities can be defined for other infrastructural features, such as transportation facilities, sewer facilities, schools, recreation areas, etc. With the present state of the art, the analysis of impacts on infrastructural carrying capacities must be largely based on gross population changes, land use changes, and income.

In contrast to the separate parameter approach, a modeling approach views secondary impacts in a systems context. A number of modeling approaches at varying levels of complexity are now under development and might be applicable to assessing secondary impacts of the Cross-Florida Barge Canal project. The Land Use Trade-Off Model (LUTOM) developed by Battelle-Columbus, is an example of the sort of model that would be useful in this context. Basically, LUTOM is a four-phase process. During the first phase (Inventory), data concerning environmental, economic, and social characteristics of the region are collected and mapped. The second phase (Identification) involves the identification of the proposed primary development and a "development package". This package includes four main elements: the primary development (such as the Barge Canal), anticipated supporting industries, commercial and institutional development, and changes in population. During the third phase (Location), the various developments and land

use changes are located by a process that can evaluate suggested sites and identify feasible alternative sites. The final phase (Evaluation) evaluates the regional significance of the total development package. A diagram of the complete LUTOM model as used by Battelle in a recent study is contained in Figure 5.

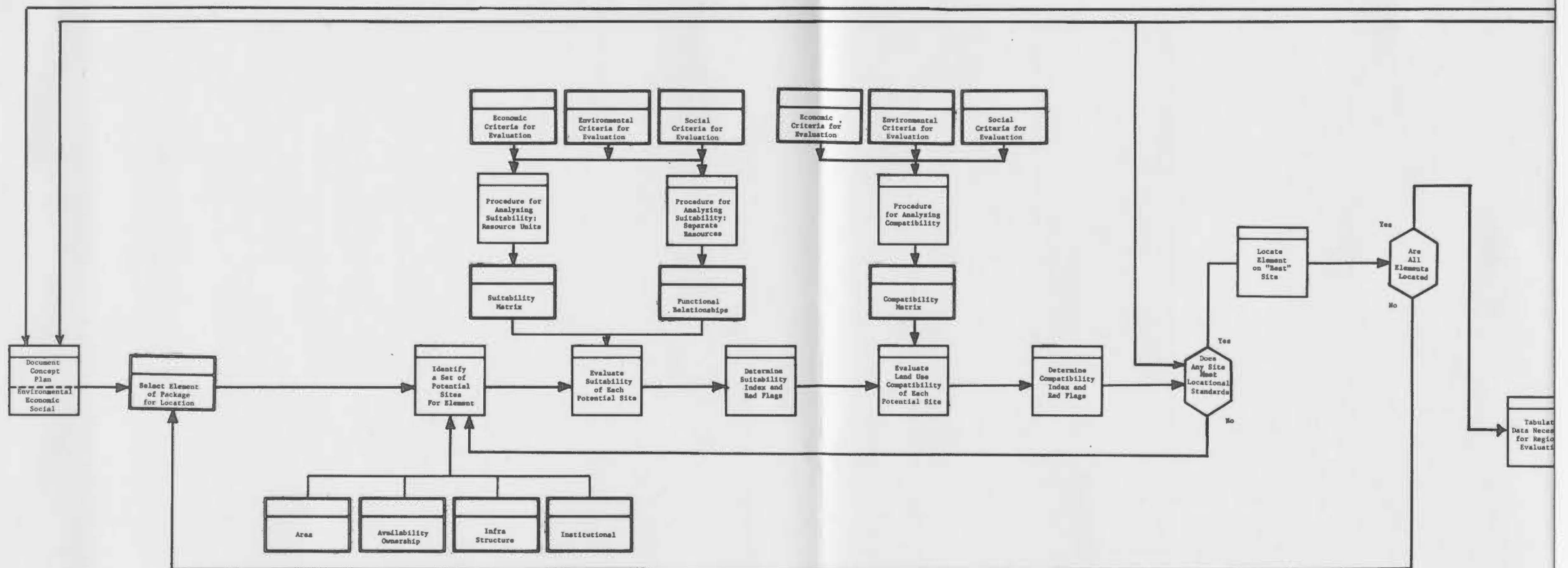
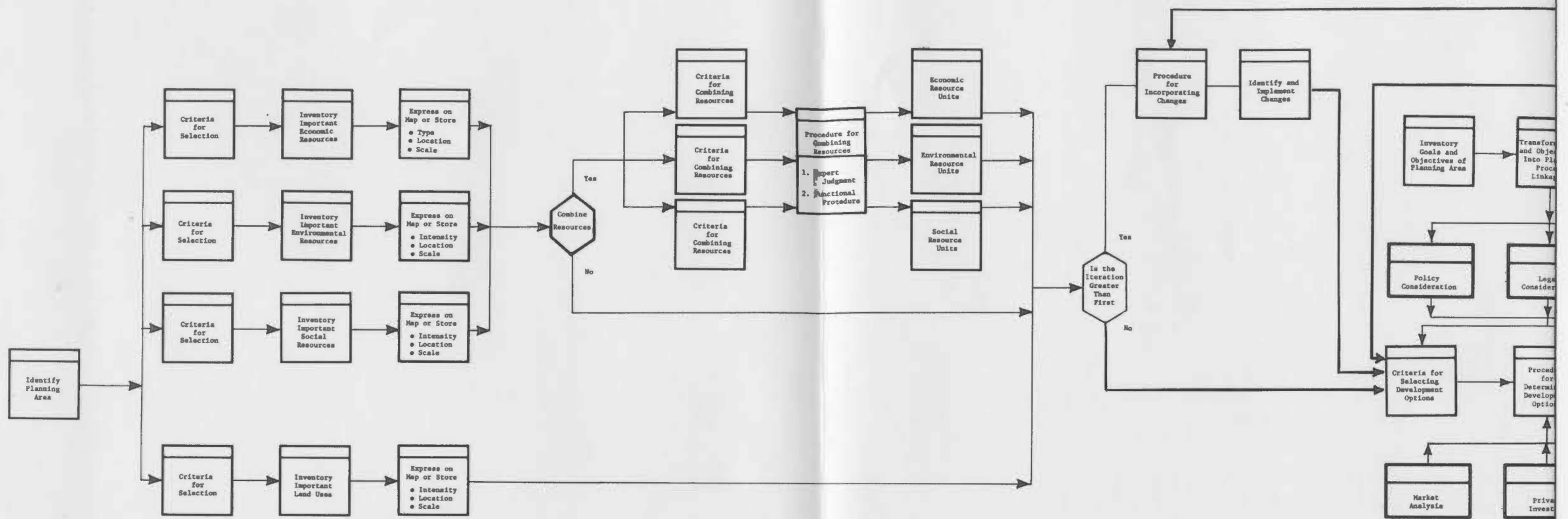
There may be many variations on this example, but the essential features of a model useful for the assessment of secondary project impacts are that (1) the model contain a mechanism for generating spin-off developments stimulated by the project and (2) the model assess the impacts on the total development package from a regional system perspective.

A third approach would be an energy systems analysis (several references on this subject are included in an attached bibliography). This approach equates parameters to energy units. It is a relatively new concept, in terms of its applicability to environmental impact statements, and is, consequently, not well understood or a well-tested approach.

Displaying Secondary Impacts Information

In addition to the opportunities described in the section of this report, "Organizing the Impact Statement for Effective Communication", additional devices may be particularly useful for secondary impacts. A useful tool for displaying the results of a separate parameter analysis might be a chart similar to that shown in Figure 6. In that chart, the various infrastructure carrying capacities are plotted in terms of maximum sustainable population, and the impacts of a project are shown. In the example shown in Figure 6, the project has resulted in an increase in the available water supply. The chart indicates that if the water supply capacity does increase to population level A, the most constraining factor on regional growth will become road capacity. If the project were to increase the water supply capacity to population level B, either an excess capacity will exist or, if the population actually increased to level B in response to the new water supply, other elements of the community infrastructure will be over-taxed. To our knowledge, no analysis of this type has been included in any impact statement to date; however, we believe such an analysis would be both useful and possible within the current state of the art.





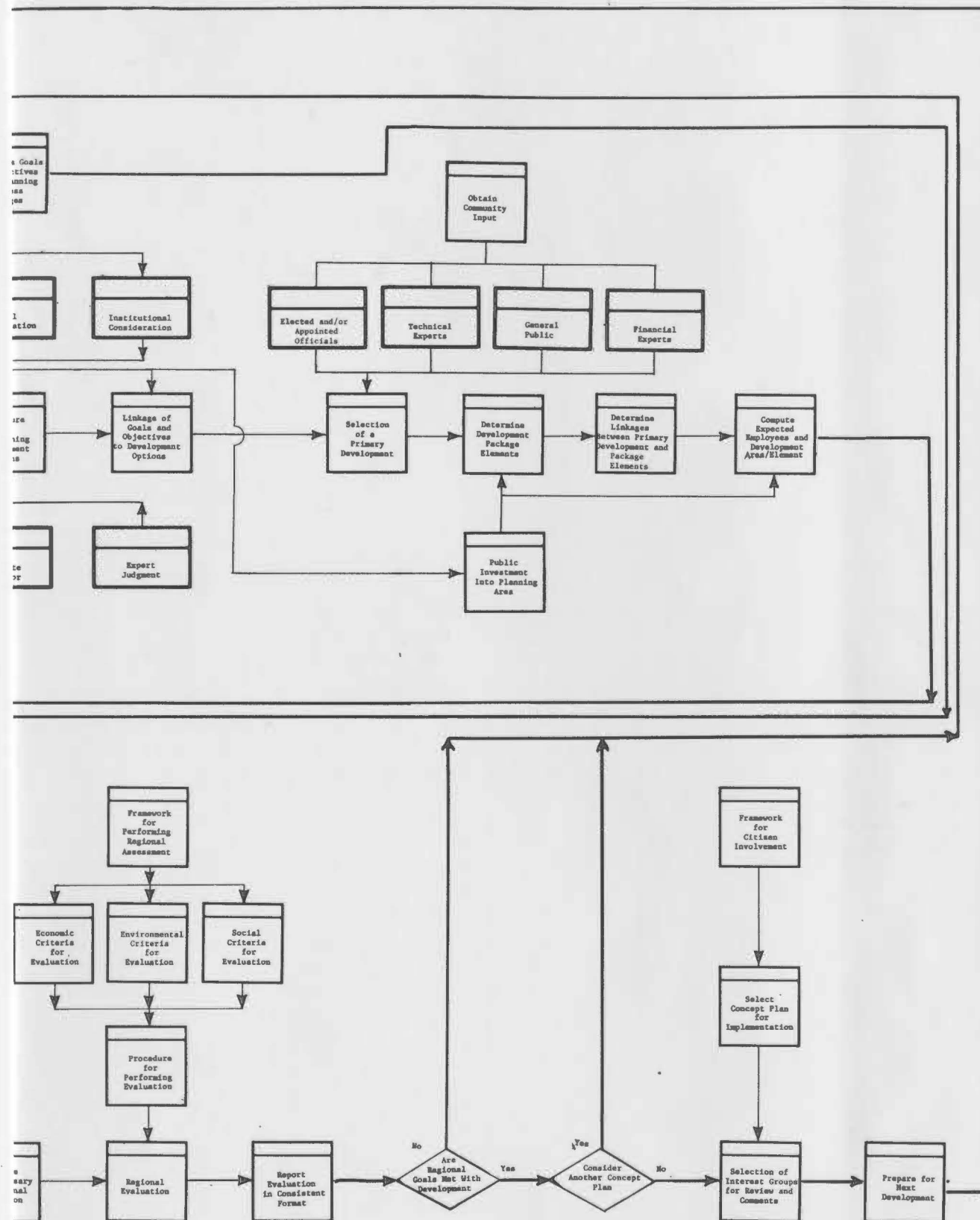


FIGURE 5. LUTOM PLANNING MODEL

Modeling approaches to secondary impacts will generally produce direct useful graphical output. For example, Battelle's Land Use Trade-Off Model will produce five types of display materials:

- (1) Overlays showing how uses of the land will change in the region because of the proposed project and its resultant developments
- (2) Map overlays showing the physical, economic, and social features of the land that will affect or be affected by change
- (3) Tables showing aggregate scores that diagnose the effects on physical, economic, and social features of the land and predict the "suitability" of a land for supporting development
- (4) Tables of "compatibility" scores that provide ratings on how compatible one land use is with another
- (5) Assessment indicators to show the regional impacts of all the land use changes predicted from the project and its related developments.

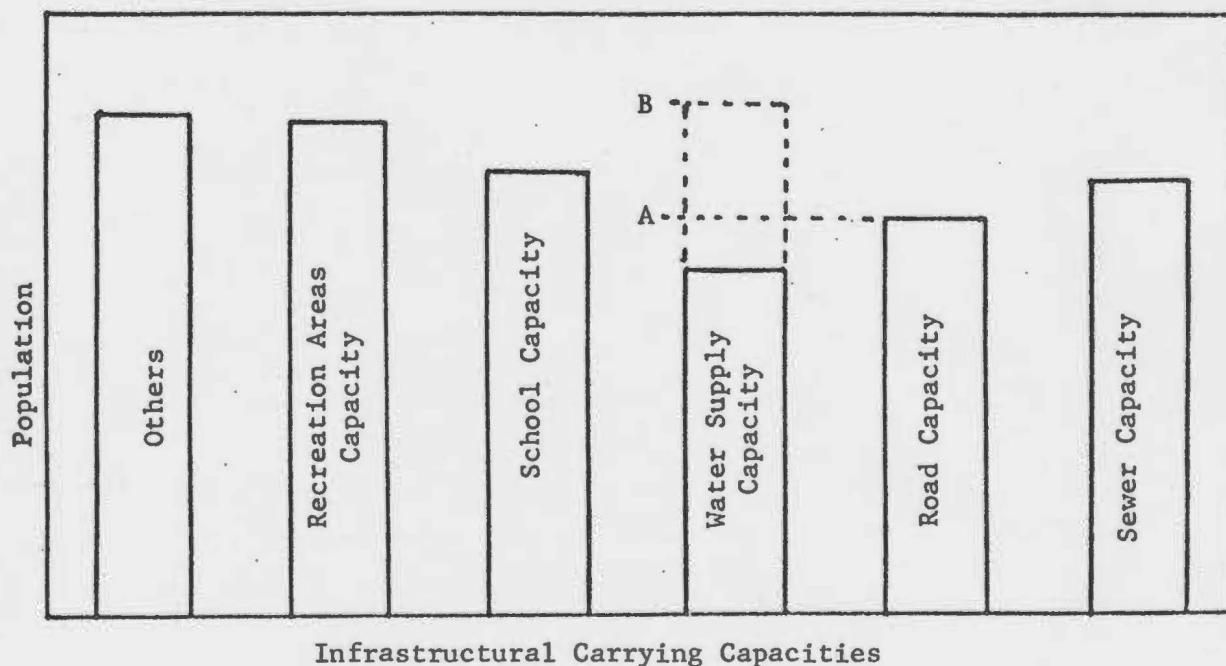


FIGURE 6. EXAMPLE DISPLAY OF INFRASTRUCTURAL CARRYING CAPACITIES ANALYSIS



In summary, considerable emphasis should be given to developing displays for communicating study findings to both decision makers and the general public.

Models and Methods Appropriate
for Assessing Impacts

There are no two models that are exactly alike in terms of their capability to identify and assess the environmental, social, and economic impacts (both primary and secondary impacts) of a given action or project. However, there are a number of models that are capable of such assessments-- Battelle's LUTOM is one of these. A detailed explanation of this model is contained in Appendix B.

Other models that perform similar functions or at least some aspects of environmental, social, and economic impact assessment are listed below. Readers are referred to a recent publication of the U.S. Army Corps of Engineers entitled Models and Methods Applicable to Corps of Engineers Urban Studies, Miscellaneous paper H-74-8, August, 1974, by J. W. Brown, et.al. for a comprehensive comparison of environmental, social, and economic models, including LUTOM.

- Model Title: A Multiregional Input-Output Model for the United States
 Organization: Harvard Economic Research Project (HERP)
 Cambridge, Massachusetts
 Subject: A model that can be used to analyze the economic interdependence among industries and regions (urban areas).
- Model Title: Environmental and Economic Trade Off Model
 Writer: C. W. Minshall, F. K. Goodman
 Organization: Battelle's Columbus Laboratories
 Columbus, Ohio
 State of Arizona
 Subject: Evaluates the Regional Economic and Environmental Effects of Urban Growth.



- Program Title: Land Use Model for the St. Louis SMSA
 Writer: A. B. Corbeau, C. F. Meyer
 Organization: University of Missouri--St. Louis
 St. Louis, Missouri
 St. Louis District, Corps of Engineers
 St. Louis, Missouri
 Subject: Forecasts alternative land-use patterns in
 ten year increments through the year 2030.
- Program Title: The Socioeconomic/Land Use Model (SELUM)
 Organization: Argonne National Laboratory
 9700 South Cass Avenue
 Argonne, Illinois 60439
 Subject: The model projects and allocates future
 levels of various growth activity such as
 population, employment, land use, and live
 stock.
- Program Title: Land Use - Benefit
 Writer: James E. Warren
 Organization: Project Evaluation
 USAED Galveston
 P.O. Box 1229
 Galveston, Texas 77550
 Subject: Urban land use demand is developed by
 residential activity; then in conjunction
 with industrial and agriculture, demand is
 allocated over available space.
- Program Title: The Planning and Land Use System (PLUS)
 Organization: Skidmore, Owings, Merrill, Inc.
 30 West Monroe
 Chicago, Illinois 60603
 Subject: Computer model to analyze urban development
 alternatives and to assist in the process
 of physical planning and development.
- Program Title: Land Use Allocation Model
 Writer: Computer Sciences Corporation
 Organization: Computer Sciences Corporation
 Silver Spring, Maryland
 under contract led by
 Bureau of Public Roads
 Ohio Department of Highways
 and
 The Housing and Urban Development Agency



Subject: LUAM is a computerized urban planning tool for evaluating zoning policy and growth trend effects on land use.

- Program Title: Dynamic Land Use Allocation Model III

Writers: DYLAM by Brian F. Walsh and Sigurd Grava,
Columbia University, 1969
DYLAM II by David Seader and H. K. Wang,
PBQ&D, 1971
DYLAM III by David Seader and Peter Messeri,
PBQ&D, 1973

Organization: Parsons, Brinckerhoff, Quade & Douglas, Inc.
One Penn Plaza
New York, New York 10001

Subject: DYLAM III simulates location decisions of land users, allowing for the projection and analysis of probable study area land use development.

Two final references pertain to conceptual models incorporating energetic considerations--Carrying Capacity Project for Florida and Its Major Regions Involving Natural Systems Inventory and Comprehensive Planning, prepared by State Carrying Capacity Committee, University of Florida, Gainesville, Florida, April, 1974; and the Coastal Plain of San Diego County, Interrated Regional Environmental Management Program, Laboratory for Experimental Design, California State Polytechnical University, Pomona, California, September, 1972.

It is important to emphasize that a large modeling effort, utilizing models such as the above, require substantial time periods for data collection, coding, etc. before any analysis can be made. For example, the application of LUTOM for assessing the environmental, social, and economic impacts of the Cross-Florida Barge Canal project would require a 7 to 9 month time period.



APPENDIX A

PARAMETER DEFINITIONS AND POTENTIAL
MEASUREMENT APPROACHES



APPENDIX A

PARAMETER DEFINITIONS AND POTENTIAL MEASUREMENT APPROACHES*

Social Impacts

Population

Population numbers, distribution, and composition are important variables to consider. Two sets of data would be required; baseline data before the project and data with completion of the project or the project alternatives.

Measurement Approach. Projections would be generated reflecting the impacts upon the region with and without completion of the Canal Project: ideally the projections would express actual numerical changes in population numbers, distribution, and composition.

Social Strata

The social strata parameter includes the life styles of the inhabitants of the impacted area (i.e., housing characteristics, educational characteristics, employment and occupational characteristics, cultural and associational involvement) and the operable stratification systems based on demographic differentiation, economic differentiation, religious differentiation, educational differentiation, occupational differential, and associational differentiation.

Social Organization

The parameter of social organization will provide an infrastructure framework for impact analysis including the variables of public services

* Possible measurement approaches are included for those parameters that are less well defined or that do not have common (well known) measurements.



(i.e., educational, health and safety, welfare and government), political structure (i.e., tax base, form, participation, activity), mobility (i.e., occupational and geographic), religious (i.e., faiths, denominations, ethnic identification, and the like), educational (i.e., public and private schools and colleges, vocational schools, training programs, facilities, expenditures, enrollments), associational (i.e., fraternal, civic, other), delivery systems (i.e., transportation by type, utilities, communications, technological, corridors/barriers), and land use (i.e., housing/residential, commercial, recreational, and the like).

Spatial-Physical Patterns

The spatial-physical patterns parameter will provide impact information on settlement patterns in relation to air quality (i.e., noise and air pollution), water quantity and quality, land use patterns, allocation of local resources, and conurbation continuum.

Social-Psychological Patterns

The social-psychological parameter will provide information about community cohesion, anxiety, values, attitudes, and dependency structures.

Aesthetics

The aesthetic component is designed to identify impacts of reservoir construction and operation on the beauty of the project area. Six parameters were selected to measure the aesthetic impact.

Because each project requires a slightly different approach to aesthetic assessment due to time, cost, available data, etc, it is necessary to have available a range of measurement approaches. Aesthetic measurement requires subjective values and judgments. The ranking or rating of these judgments should be used only to perform relative comparisons of management options, not to make absolute statements about aesthetic values. Evaluation techniques may be highly technical and detailed or very gross and general,



depending on the availability of data, time, and financial constraints.

Approaches include

- A descriptive ranking of each parameter under each management option. Example -

major positive aesthetic effect

minor positive aesthetic effect

neutral aesthetic effect

minor adverse aesthetic effect

major adverse aesthetic effect.

- A numerical ranking of each parameter under each management option. Example -

positive aesthetic effect 1 +2

2 +1

or

3 -1

adverse aesthetic effect 4 -2.

- A relative ranking of each parameter under each management option--either descriptively, e.g., "Parameter 10 under Option 3 has a more desirable aesthetic effect than Parameter 10 under Option 4

or

numerically, e.g., Parameter 10 under Option 2 1

1

2

2

4

1

1

1

1

1

20

Parameter 10 under Option 6 25.

- A fourth approach would be that of Battelle-Columbus' "Environmental Evaluation System" (EES). This approach disaggregates aesthetics into parameters, then assigns values and weights to each parameter.

- A fifth approach is the use of zeros, pluses, and minuses (0, +, -) to indicate a no change, positive, or negative aesthetic effect, respectively.
- Lastly, an approach currently being developed at Battelle incorporates the use of bar graphs, and color coding also has applicability to aesthetic measurement approaches.

Land-Water Interface

This parameter is designed to identify the aesthetic quality of the vegetation and surface material along the interface between the water and the land. It is measured by considering types and amounts of vegetation, litter and debris, erosion, as well as alignment of shore line, siltation, dead trees and shrubs, "bath tub rings", and the texture, color, and type of surface material. The degree to which each of the elements is important in evaluating the land-water interface is dependent on the management option.

Measurement Approach. Besides the measurement approaches noted in the introduction to aesthetic section, this parameter can be measured in terms of the number of acres affected.

Biota

This parameter is designed to identify the visual impact and attractiveness of wildlife and vegetation. Measures include amount, type, diversity-balance of wildlife and vegetation, as well as the degree of harmony in the biota.

Measurement Approach. Of those mentioned at the beginning of this section, it seems likely that an approach that compares each option to all other options (a relative ranking) is both feasible and appropriate.

Water Clarity

This parameter is designed to identify the clarity and color of water. Aesthetic impacts on clarity are measured in relation to the



deviation of water from a clear, blue transparent state. This parameter measures the visual quality of the water based on the degree of silt and sediment, algae, visible dissolved minerals, and pollution in the water.

Measurement Approach. Besides those listed in the introduction, this parameter can be measured by the extent (feet) of light penetration.

Compatibility of Scale

This parameter is designed to identify the degree to which man-made structures "fit in", blend, or are compatible with the local natural environment and with other structures. Structures should be in harmony with or subordinate to nature. This is determined by location and visibility, design, size, color, and texture. The more obtrusive a structure is, the lower will be the aesthetic quality of the feature.

Measurement Approach. Of the approaches mentioned in the introduction to the aesthetic section, a relative rating of this parameter under each project option can be considered appropriate.

Unique Composition

This parameter is designed to recognize and focus attention on rare or unique physical and biological elements in aesthetic composition of any site. The criterion used to evaluate unusual composition is the extent that the project options involve an unusual, rare, or unique site. If an unusual site is affected, the aesthetic value of that site would be reduced. The degree to which an unusual site is affected and the magnitude of uniqueness determine the aesthetic value.

Measurement Approach. Besides the approaches mentioned in the introduction to the aesthetic section, another measure would be to simply note the number of unique acres or sites affected by the various management options.



Composite Effect

This parameter is designed to identify the "total" effect upon the senses and emotions of the interplay of land, air, water, biota, and man-made structures. The aesthetic impact of this parameter is measured by only one criterion, "do you like, dislike, or are you neutral to what you see on and around the project area?". It is based on the philosophy that the total sum of the whole may be greater than the aggregate of the parts. The interplay of land, air, water, biota, and man-made objects can range from visually displeasing to spectacular.

Measurement Approach. Because the overall composite effect may vary considerably under different management options, a ranking scale may be the most appropriate measurement for this parameter--the greater the range in composite effect, the greater the range in the ranking scale.

Natural and Man-Made Sounds

This parameter identifies the various levels and types of noise stimuli from pleasant to unpleasant as related to human perception.

Land Use Compatibility

Land Use Plans

This parameter is designed to identify if management options are inconsistent, conflicting, or compatible with adopted Federal, state, or local land use plans (master plans, regulations on development of regional impact policies, controls, or comprehensive plans) covering or adjacent to the project affected area. Conformity of the management option to existing land use plans is determined by whether or not a plan exists for the area in question and, if so, whether proposed use conforms with the ones permitted in the plan.

Measurement Approach. Determining (measuring) conformity with a land-use plan is a straightforward proposition. A plan with which the proposed use can be compared either exists or it doesn't. If a plan exists,



the proposed use either conforms or conflicts with its provisions. The degree or significance of any nonconformity should then be evaluated.

Rate of Development

This parameter is designed to identify if the rate of development of the land surrounding the project area will change under the various management options. Rapid changes can be considered an adverse effect because of the drain such changes would place on local facilities, e.g., roads, schools, sewers, and water. Changes in residential and second home development, commercial development, and public facilities should be determined.

Measurement Approach. Information on the current rate of development can be acquired from the regional planning commission and/or county government. Capacity of local roads, sewage treatment plants, and water supply can be determined by local officials. By comparing the capacity of local facilities against projected growth rates under different management options, a determination of the feasibility of each option is possible.

Pattern of Development

This parameter is designed to identify the extent to which any changes in land use patterns resulting from the project under the various management options are compatible with or will disrupt existing development patterns. The pattern of development is closely related to rate of development and can have the same effects--overload existing facilities, disrupt traffic patterns, and change planned development.

Measurement Approach. (Similar to rate of development approaches.) Certain project options may encourage development in undesirable locations. The placement of recreation areas within the project or the location of access roads to project areas will become traffic generators and will consequently encourage certain patterns of development. Determining the acceptability of a management option depends on changes in the pattern of land use. Measurement should consider the degree of change in the pattern of land use, e.g., high, low, or moderate impact, or no change.



Type of Development

This parameter is designed to identify the compatibility between one type of development and another. Variables include type and intensity of use (residential, commercial, industrial, transportation, agricultural, mineral extraction, recreation, etc.). Different types of land uses encourage different population densities, noise, transportation patterns, and aesthetic effects. Project options will influence where specific kinds of land uses will develop.

Measurement Approach. The land-use types which are likely to occur under various project options should be compared with existing land-use conditions and plans. In the event that adopted plans do not exist, changes in the type of land use will be considered to have a significant impact. For example, industrial changing to recreation will be a high impact, or, vice versa.

Transportation Systems

This parameter is designed to identify any existing or planned transportation systems that will be affected by the project. Systems include road networks, railroad lines, mass transit, or airport facilities.

Measurement Approach. Information on existing transportation systems is readily available; information on proposed transportation systems will require contacting the planning sections of the appropriate agencies, e.g., state department of transportation, county highway commission, and the management of any local transit system. Although the project will either affect or not affect the various transportation systems, the magnitude of any effect depends on the importance of that particular system aspect, e.g., an interstate highway versus a local county road (number of people served), and what other alternatives are available to that system. Impact can be high, moderate, low, or no change.



Health and SafetyPersonal Effects

This parameter is designed to identify the health and safety factors that will be influenced by the development or nondevelopment of the project. Measures include number of individuals potentially affected, real and perceived, intensity, and probability of both physical and psychological effect.

Measurement Approach. The real potential health and safety effect on the down-river population can be assessed by delineating the flood swath of the 100-year flood. In addition to the number of residents in this flood area, a special consideration should be given to adverse secondary effects of any operation. This would include an investigation in the identified flood swath such as nuclear power plants or other hazardous or toxic materials production facility that could produce secondary health and safety effects.

The real up-river health and safety effects could be determined by identifying potential development or increase in disease vectors, insect and other pest species, and effects on local water supplies (i.e., quality and availability). Also included are effects of exposed mud flats, etc, upon local residents and recreationists. The size of the affected population is dependent upon the nature and extent of local system integration.

The perceived effect of the reservoir development on both up-river and down-river areas is measurable through perception and opinion surveys of affected populations. The size of the affected population is dependent upon specific management options, and upon geographic and user-population variables. Particularly in the areas of perceived recreation option-demand loss and down-river flood protection the affected population may be very large.

Property Effects

This parameter is designed to identify the health and safety effects of the project management options upon property. Measures include the number, extent, and susceptibility to effects of existing and planned property



developments in the project area. The degree of effect upon each of the elements is dependent upon the specific management options.

Measurement Approach. The effect upon the health and safety of both up-river and down-river property can be assessed by delineating the primary and secondary areas affected. (See Personal Effects - Measurement Approach.)

Recreation

Accessibility

This parameter is designed to identify the impact of the management options or user accessibility to recreation areas. Measures include the real and perceived constraints on recreation involvement by user population and recreation experience.

Measurement Approach. The accessibility to both the potentially lost and gained recreation resources and experiences can be determined. This parameter can best be measured by comparing the number of travel times which are likely to occur with and without the project. This comparison of travel times should be done for each major recreational group now using or projected to use the area (hikers, boaters, stream fishing, lake fishing, etc.). Losses and gains in user days for each of these groups should be noted.

Variety

This parameter is designed to identify the range of recreation experiences, and the physical base and facility requirements necessary to secure these experiences. Considerations include the range of existing or potential recreation facilities.

Measurement Approach. The diversity of the recreation resources potentially available to the base user population can be determined by considering to what extent the Saylorville Lake management options encourage the diversity of facilities. This can be determined by identifying the facilities and areas that will be positively or negatively affected as a result of the primary or secondary developments associated with the various



management options of the project, and comparing these opportunities to the existing range of recreational opportunities.

The range of recreation needs has been fairly well developed in the recreation literature. An assessment of existing, planned, and potential local recreation facilities can also be identified by consulting area recreation plans and reports.

Number of Users

This parameter is used to indicate the total number of recreationists who constitute the base user population. It is measured by considering both the actual and projected use of existing facilities, as well as the impact on potential use by the various management options.

Measurement Approach. Both the present recreation use, as measured by records of seasonal visitor days, and projected figures for option demands for specific facilities can be identified. These data can be obtained considering a standardized base population defined by distance, time, or other parameter determinants. A comparison of these figures will determine the various merits or shortcomings of each option in terms of the number of recreational users.

Distribution of Uses

This parameter, in conjunction with the other recreation parameters, provides the essential data elements necessary to analyze recreation impacts. It identifies which user groups will gain or lose with recreation developments possible under the various management options.

Measurement Approach. The present pattern or distribution of recreation use should be compared to the projected changes in the pattern or distribution of recreation uses. A careful examination should also be made of the specific recreation needs associated with each identifiable user subgroup within the population. Specifically, characteristics of age,



where

N = Total number of individuals in habitat

$n_{1,2,...P}$ = Number of individuals in each species

P = Number of species in each habitat

K = Total number of habitats

ADI = Average Species Diversity Index

DI = Species Diversity Index.

Terrestrial Communities

Natural Vegetation

Natural vegetation is an important element of terrestrial ecosystems. Forests of all types and such areas as natural grasslands and old fields in all stages of succession are included within this indicator group. Areas within the project region which are covered with natural vegetation provide most of the food for wild animals and some food for domestic grazers living in the area. Changes in natural vegetation that reduce the food supply available for wild and domestic animals may disturb the stability of an ecosystem. Such disturbance may hasten erosion or permit reduction of the fertility and production of the land, and/or accelerate the invasion of noxious weeds or other pest plants.

Measurement Approach. A single measure of vegetation is not sufficient for an adequate description. A dual measurement approach should be used incorporating both the quantity and quality of vegetation within the project boundaries. The quantity is measured in terms of area, in acres, of vegetation within the project boundaries. An estimate of annual production for each species group (tree species, legumes and grasses, mosses and lichens, etc) is used as a measure of quality.

Agriculture and Forestry

An important land use type along the proposed route of the canal is agricultural. As both human centered (crops supply food for man directly or for his domestic animals) and natural food chains and nutrient cycles are



influenced by the kinds and extent of the various crops grown in the area, changes in the quantity and quality of agricultural crops result in a modification of the existing environment. Row crops, pasture, tree farms, and orchards will be included in the discussion.

Large Animals

The importance of this parameter lies in the fact that the large browsers and grazers which include cattle, horses, sheep, other livestock, and the wild herbivores, such as deer, are the dominant animals of many ecosystems in North America. Consequently, any change in their numbers or in the ability of the land to support the population may result in a significant impact upon the health and stability of the environment. Also, as those dominant species are either domestic animals supplying food and other products of value to man, or are desirable game animals offering recreation and food, the importance of predicting their change is increased.

Migratory Species

The migratory species of interest consist wholly of the migratory waterfowl and song-birds that seasonally inhabit the area along the route of the canal. The significance of this group lies in the potential of any changes in these species or their numbers to affect areas far removed from the canal route.

Small Animals and Birds

Included in this parameter are the small animals and birds. The importance of this group stems from the fact that it generally occupies an intermediate position in the food web, and any significant changes in absolute or relative numbers resulting from the canal project would signal a shift in the stability of the natural ecosystem, affecting components at both lower and higher levels of the food web.



Threatened Species

Species which are uncommon, rare, or endangered are particularly sensitive to change in the quality of the environment. Included within this parameter are those species officially listed as rare or endangered in the United States, as well as those species which are endemic to Florida or endemic to the United States. State endemic species are those found only in a single area within the state, even though they may be found in other states. They may be common when they are found.

The value of interpreting the status of rare or endangered species within the project area lies in the potential for the waterway to directly (by actually destroying an organism) or indirectly (by habitat destruction or alteration) cause a decline to one or more of any rare or endangered populations. The presence of rare and endangered species within the project area or a decrease in the number of existing individuals with a known rare or endangered population would constitute a project related decrease in environmental quality.

Measurement Approach. The rare and endangered species are measured in terms of the number of surviving or living members of a given species. The rare and endangered species numbers are counted in a given project area by a well-trained ecologist. In addition, the local bird watchers can be a useful source of information for this purpose.

Pest Species

Pest species includes species that are annoying or harmful to man, livestock, other animals, or vegetation.

Measurement Approach. The pest species parameter is measured in terms of the intensity of presence of identified pests in a given project area. Generally, the intensity of presence of a pest is measured qualitatively by an expert ecologist in terms of widespread, intermediate, restricted, or absent. Better methods of measuring this parameter will require further research and investigation.



Vulnerable and Unique Elements

This parameter keys out unique populations and natural or managed systems. As such, this parameter includes vulnerable or sensitive land habitats, environments that have been identified as being politically, economically, and/or aesthetically valuable for the maintenance or expansion of species populations important to man.

Aquatic Communities

Vegetation

Vegetation consists of those organisms that perform roles as primary producers. These can be further categorized as phytoplankton, certain periphyton members, and vascular aquatic plants.

Measurement Approach. A quantity-quality measurement approach is used for aquatic vegetation. The quantity is measured by the water surface area for each habitat type (river, lake, marine, etc). The estimated quantity is modified by a quality factor relating to existing or potential vegetation in the aquatic habitat. The quality is measured by the productivity, pollution tolerance, and species diversity of the vegetation. The quality modified area of the aquatic habitat measures the significance of vegetation in the aquatic ecology. Value judgments will consider the species composition, bloom potential, and potential for growth in the project area.

Zooplankton

This group consists of the animals of the plankton. These are unattached organisms having minimal capability for locomotion. They are important constituents of standing-water aquatic ecosystems. The typically herbivorous food habits of zooplankton provide an essential link between primary producers and higher carnivores such as game fishes.



Benthos

This indicator includes those organisms that exist for a substantial portion of their life cycle attached to or living within bottom sediments, e.g., mollusks, insect larva, and oligochaete worms. These forms are important in food webs and are generally the most sensitive indicators of stress in response to point source effluent discharges.

Fishes

This indicator includes both rough and game fishes, large and small. Fishes are important ecologically in that nearly all forms occupy significant positions insofar as food relationships within a food web are concerned.

Pest Species

Pest species include those organisms whose presence in an ecosystem pose a direct or indirect adverse effect upon baseline ("normal") ecosystem processes. Due to unusual increases in number or elaboration of biomass, some organisms naturally occurring in aquatic ecosystems become pest species. Others represent misplacement of exotic species, often due to human activities, e.g., the gypsy moth in New England and the lamprey in the Great Lakes.

Threatened Species

Concerns are identical to those listed in the Terrestrial Communities section, though species differ.



Vulnerable and Unique Elements

This parameter keys out unique populations and natural or managed systems. As such, this parameter includes vulnerable or sensitive water habitats, environments that have been identified as being politically, economically, and/or aesthetically valuable for the maintenance or expansion of species populations important to man.

Measurement Approach. This parameter can be measured by the number of such elements and the acreage that each covers within the project area and adjacent to it.

Water QuantitySurface Flows

Surface water quantity is evaluated by considering its spatial and temporal distributions. Separate components to be considered will include precipitation, evaporation, transpiration, percolation, runoff, and storage.

Linkages/Surface Flow

This parameter concerns the interactions between surface and groundwater.

Water Uses

Man's intrusion into the hydrologic regime can be measured, in part, by describing/evaluating water supply, irrigation, waste assimilation, flood control recreation, navigation, stream and power generation, and fish and wildlife enhancement.

Groundwater Level/Quantity

This parameter is included to assess changes that may occur in the groundwater level/quantity as a result of the construction and operation of the canal.



Measurement Approach. A quantity-quality measurement approach is used for the waterfowl parameter. The quantity is measured in terms of acres of wetland. The quantity is then modified by a quality measure. The quality of a waterfowl habitat is expressed in terms of year-round activity, good waterfowl protection, and control of hunting. The waterfowl impact is measured quantitatively by the modified wetland acreage. The modifying factor is based on qualitative rating of the habitat quality.

Water Quality

Physical

Included within this broad parameter are considerations of the physical aspects of water quality, including solids, temperature, taste, odor, and sediments.

Inorganic Chemical

Included within this broad parameter are considerations of pH, acidity, alkalinity, dissolved oxygen, minerals, salinity, and sulfate concentration.

Nutrients

This parameter considers levels of phosphorus compounds and nitrogen compounds.

Measurement Approach. Inorganic phosphate and nitrogen are measured in milligrams (of phosphorus or nitrogen) per liter (of water). This is numerically equal to "parts per million" which is another common means of reporting phosphate and inorganic nitrogen data. There are many different methods of measuring phosphates and inorganic nitrogen content in water. These methods are described in the Standard Methods for the Examination of Water and Wastewater.



Carbonaceous

This parameter considers levels of BOD, COD, TOD, and other organic compounds.

Thermal

This parameter considers possible changes in water temperature.

Trace Elements

Included within this parameter are considerations for concentration of metals, pesticides, herbicides, and other trace organics.

Biological

This category refers to those biological measures of public health significance (to be distinguished from biological measures with "ecological" implications), including coliforms, bacteria, viruses, and others.

Radiological

The presence of radioactive constituents should be measured and described in terms of their spatial and temporal distribution.

Groundwater Quality

This parameter is designed to identify changes that may occur in the quality of the groundwater as a result of the construction and operation of the canal, as well as any potential secondary impacts caused by development related to the canal, e.g., residential development.



Solid Waste

Solid Waste Generation and Disposal

This parameter is included to identify the location and assess the impacts of dredge material and other solid waste disposal associated with the project.

Energy

Net Energy Utilization

This parameter assesses the work (energy flow) done by natural and man-made elements of the system. Net work is defined as useful work within the system, plus exports, minus imports. For all systems, maximum net energy utilization is achieved at some level of partial development; levels below this maximum result if a greater or lesser percent of the land is converted from natural to man-made uses.

Measurement Approach. This parameter can be measured in calories.

Meteorology/Air Quality

Particulates

This parameter includes all solid particulates, such as dust, suspended in the atmosphere.

Sulfur Dioxide

This parameter includes gaseous emissions that contribute to respiratory problems in humans.

Hydrocarbons

This parameter includes organic compounds in the atmosphere that can react photochemically to produce smog.



Oxidants

This parameter is a by-product of photochemical reactions. Oxidants cause rapid deterioration of rubber products and also cause respiratory problems in humans.

Oxides of Nitrogen

Oxides of nitrogen are products of high temperature combustion that can react photochemically to produce smog.

Microclimate

This parameter keys out the possibility that secondary development associated with the project could alter thermal and local smog or fog conditions in the area.

Measurement Approach. This parameter is a combination of temperature and hours of sunlight.

Economic Impacts

Employment

Typical measures of employment are labor force participation rates or unemployment rates. However, the important element in employment measurements, for projects that are not likely to significantly alter the overall employment rate, is the distribution of employment among various categories such as mining, agricultures, manufacturing, services, government, etc. The distribution of employment also provides a surrogate for impacts on productivity (assuming employment is linearly related to output). Therefore, changes in productivity by sector should be estimated, and changes in the mix of economic activities identified.

Measurement Approach. Measuring changes in employment and economic activity will require projections to reflect economic conditions and activity in the canal region with or without the completion of the project.



Projections would be generated for each major sector, and each industry, to detail the change.

Property Values

The property value parameter reflects changes in the desirability of land and structures that result from the construction and operation of the project. These property values may be divided into residential, commercial, manufacturing, and service-related properties (agriculture is treated separately). Changes in values reflect the impact, in dollar terms, of the effects of the project on the subject area.

Measurement Approach. These value changes can be projected by comparison of previous land uses with the expected future land uses with or without completion of the Canal. These value changes can be expressed in real dollars or regional value judgments (higher versus lower uses).

Fiscal Conditions

This parameter measures the amount of government revenue and expenditures within an area. Some reasonable balance between the two is desired.

Measurement Approach. Projections would be required to determine future needs in the canal area for public utilities, highways, mass transit, etc. These projections would be based on expected regional conditions with or without completion of the canal. Also the future amount of tax revenues to be expected would be projected with or without completion of the canal.

Natural Resources

Natural resources are defined as all resources that are not replaceable in the short run by man's economic activity. This would include minerals, fossil fuels, soils, and timber. Soils may be improved by fertilization and timber may be replaced by reforestation, but significant time periods are involved for timber, and because of the natural fertility of the soils, increases or decreases of farm land constitute a net loss or gain to the natural resource base of the subject area. This parameter would



yield information on the irretrievable and irreversible commitment of resources required by the CEQ guidelines.

Agricultural Productivity

Although agricultural productivity would be analyzed in the employment and property value parameters, it is considered important enough as it relates to the subject area economic base that it is treated separately. Agricultural productivity refers to the gain and loss of land available for agricultural purposes in the project area.

Public Infrastructure

Public infrastructure refers to the costs of providing available publicly provided services such as water and sewer systems, hospitals, schools, and police and fire protection. The loss of any of these facilities or changes in the cost or ability to adequately provide these facilities due to the project should be identified.

Regional Product

This parameter measures the total productive capacity of an economic region. Changes in this parameter occur due to changes in the productivity of land, labor, and capital.

Income

This parameter measures the economic well-being of the resident population. Income can be examined in the form of total income, per capita, or family.

Commerce

This parameter measures the amount of goods and services produced and distributed within a region. Both business and personal services are included.



APPENDIX B

APPLICABILITY OF LUTOM IN ENVIRONMENTAL
IMPACT ASSESSMENT RESEARCH



APPENDIX B

APPLICABILITY OF LUTOM IN ENVIRONMENTAL IMPACT ASSESSMENT RESEARCH

One of the strengths of NEPA is that the analysis must be based on site-specific proposals. This allows the researcher to be precise in his study of specific environmental, economic, and social features of the proposal. A major weakness of this approach is that large developments cause many secondary impacts which are not part of the development proposal. The developer is not required to determine the location and nature of new housing, supporting industry, commercial developments, and the like. Yet, under the new NEPA guidelines, secondary impacts must be considered.

It is obvious that every possible site and every possible secondary use of the sites cannot be analyzed in the same depth as a site and design-specific development proposal. The cost of doing so would far outweigh any community benefits from the additional environmental information. Instead, we need an approach which provides guidelines to community decision makers first, on what secondary developments are likely to occur; second, where they may occur; and third, the relative impacts of these developments at each of the possible sites.

To establish these guidelines Battelle has developed the Land Use Trade Off Model (LUTOM). The model accomplishes the following:

- Determines the number of and land requirements for secondary developments. This includes supporting industry, commercial development, institutional support, and housing.
- Evaluates the suitability of all possible sites for development. Environmental, economic, and social factors are considered just as in an impact statement.
- Evaluates the compatibility of the proposed developments with the existing nearby developments.
- Conducts an assessment of any particular overall plan. A large number of alternative plans can be assessed at relatively low cost. These plans can be suggested by the community, by developers, or by the research team.



This approach is particularly useful because it is based on maps and overlays to show location-specific conditions. In conducting environmental impact assessments we have found that most of the controversy is caused by people upset about secondary impacts. Often this is not obvious. For example, people may join an environmental organization to oppose a project because of effluents when really they are afraid they will be forced out of business. The map and overlay approach lends itself to community involvement and input into the planning process. It allows them to see visually how their neighborhood and business center may be affected. Also, the community can see what kinds of land use regulations are needed to control unwanted developments. These regulations typically are in the form of zoning regulations and can be based on the land use suitability and compatibility analyses in LUTOM.

In summary, LUTOM is a practical way to analyze environmental impacts when sites and developments are not well specified. This is typically the case with secondary developments. Second, LUTOM provides an overall environmental assessment of particular development plans. Several plans can be considered to focus attention on the range of impacts that might occur. Third, LUTOM uses maps and overlays. These materials are particularly understandable to persons of different disciplinary backgrounds. They lend themselves to being uses in public participation efforts.



APPENDIX C

MODIFICATIONS REQUIRED TO PRODUCE AN
EIS BY MAY 1, 1975



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MODIFICATIONS REQUIRED TO PRODUCE AN EIS BY MAY 1, 1975

The body of this report sets forth the full range of considerations felt necessary for a fully responsive environmental impact statement, without regard for any time or money constraints. Listed below are key modifications from the comprehensive approach that would likely be required to meet a May 1, 1975, deadline for draft EIS submission:

- Only the proposed route and no project alternatives could be examined in detail. The other alternatives identified could only be addressed in a more superficial, qualitative manner--if at all. This modification is made necessary by the lack of available data on other alternatives and inadequate time to collect and analyze new data.
- Regions for analysis would necessarily be confined to those pertinent to the proposed route only.
- Secondary impacts would be treated descriptively only. Both the modeling and system constraints approaches discussed in the report body require more time and/or data than available with a May 1 deadline. Secondary impact analysis would therefore consist entirely of professional judgments, based primarily on land use and population shift estimates.
- Conclusions would be based on incomplete data. A May 1 deadline would not allow time to collect seasonal ecological and other primary data. As a result conclusions would necessarily be based largely on existing data. Therefore, less confidence can be placed in some conclusions and no conclusion may be reachable on the severity or significance of other issues.
- Findings of the Economic Transportation Study, in progress, would very likely be incompletely incorporated into the impact statement.



- Only high priority impact issues could be treated fully.
Since there would be inadequate time and data for a full treatment of all issues, it would be necessary to focus the bulk of one's efforts on the most obviously important issues--perhaps hydrologic, ecologic, and economic impacts.

In summary, a May 1 deadline would require preparation of an environmental impact statement that would be less complete and less definitive in its conclusions. As a result, the document's usefulness in informing the public and assisting decision makers would be impaired. It follows that the impact statement would also be a more likely target for challenges in the courts.



