1995 Project Abstract
For the Period Ending June 30, 1997
This project was supported by the Environment and Natural Resources Trust Fund

TITLE: ASSESSING WETLAND QUALITY WITH ECOLOGICAL INDICATORS
PROJECT MANAGER: Susan Galatowitsch
ORGANIZATION: University of Minnesota
ADDRESS: Department of Horticultural Science, 305 Alderman, St. Paul, MN 55018
LEGAL CITATION: Legal Citation: ML 95, Chp. 220, Sec. 19, Subd. 7(b).
APPROPRIATION AMOUNT: $275,000

Statement of Objectives

A. Establish a system of reference natural wetlands for comparative monitoring;
B. Identify plant and animal species that are indicators of wetland quality;
C. Develop guidelines for wetland assessment and monitoring.

Overall Project Results

Eight series of fifteen wetlands (120 sites) were used to develop wetland Indices of Biotic Integrity (IBIs). Each series covers a major wetland type in the state and is comprised of unaltered wetlands, sites surrounded by land use typical of the region and sites which are highly altered. The eight series include the following kinds of wetlands: large river floodplain wetlands, floodplain wetlands of Mississippi River tributaries, small stream wetlands of central Minnesota, littoral wetlands of non-calcareous lakes, littoral wetlands of calcareous lakes, wet prairies of the Red River Valley, prairie glacial marshes, forest glacial marshes. For each of the wetlands, the environmental features (soils, etc..) were characterized, a land use assessment was completed (GIS-based, multiple scale assessment), and biological surveys of amphibians, birds, fish, invertebrates, and plants were completed. Based on biological community patterns, between 28 and 63 plant and animal indicators (ave. of 43) were identified for each series. An analysis of the relationship between potential indicators and land use data revealed that approximately 70% of the indicators may have assessment value. Non-calcareous littoral wetlands are an exception, however, with approximately 30% of the indicators having possible assessment value. The most useful scale for wetland assessment varies among wetlands and among organismal groups, with plants tending to respond to land use degradation locally (within 500 m of sites) and vertebrates often responding at larger scales (e.g., 2500 m of sites). Birds and plants are more generally useful as biotic indicators for Minnesota wetlands than amphibians, fish and invertebrates. These aquatic animals cannot be sampled reliably or consistently in wetlands that are not persistently flooded. Before the indicators developed in this study can be used for assessment, additional statistical tests and land use relationships need to be conducted. A grant was obtained (using LCMR project funding as match) to complete this additional analysis.

Project Results Use and Dissemination

Information on each wetland (location, description, photographs, land use maps), summary tables for biological surveys, land use assessments and environmental characterizations, and the methods and results of indicator development have been made into an electronic publication, viewable with commonly available internet browsers. Because of the volume of the information (50 MB), this data is provided on a CD. After further refinement and analysis (by fall, 1997), the electronic publication will be accessible on the Web from a University of Minnesota server.

Date of Report: July 1, 1997

LCMR Work Program 1997

I. ASSESSING WETLAND QUALITY WITH ECOLOGICAL INDICATORS - I-1

Program Manager: Susan Galatowitsch
University of Minnesota
Department of Horticultural Science
305 Alderman Hall, 1970 Folwell Avenue
St. Paul, Minnesota 55108
(612) 624-3242

A. Legal Citation: ML 95, Chp. 220, Sec. 19, Subd. 7(b).
Total Biennial Budget: $275,000
Balance: $0

Appropriation Language: This appropriation is from the trust fund to the Board of Water and soil Resources for an agreement with the University of Minnesota to develop plant and animal indicators of wetland quality, establish a system of reference wetlands for comparative monitoring, and develop guidelines for wetland assessment and monitoring to guide replacement wetland monitoring. Data compatibility requirements in subdivision 15 apply to this appropriation.

Project Summary:

The Wetland Conservation Act of 1991 requires that wetland replacement plans must exist for most wetlands destroyed within the state. The specific conditions of each plan, including avoiding or minimizing impacts and creating a replacement wetland rely on the ability of the Local Government Unit to assess wetland quality. Unfortunately, very little ecological information is readily available, specific to each kind of wetland in each region, to guide permit and restoration decisions. This project focussed on developing easy-to-use but specific biodiversity criteria for assessing quality of each wetland type. Particular attention was given to wetlands in urban and agricultural areas of the state having the highest activity of wetland conversion and replacement.

Studies of other wetlands and aquatic ecosystems have found that biodiversity in general, and the presence of specific plants or animals, can indicate site quality. Wetlands degraded by poor water quality or altered hydrology often lose sensitive species and become dominated by others that have a greater tolerance to environmental stress. Many high-quality examples of the common kinds of wetlands are included within the Minnesota Scientific and Natural Areas system. These sites form an important point of reference for identifying ecological indicators of wetland quality. Other natural wetlands, affected to varying degrees by environmental stress within urban and agricultural areas were used to gauge changes in plant animal composition with increasing degradation.

III. Program Summary:

Eight series of fifteen wetlands (120 sites) were used to develop wetland Indices of Biotic Integrity (IBIs). Each series covers a major wetland type in the state and is comprised of unaltered wetlands, sites surrounded by land use typical of the region and sites which are highly altered. The eight series include the following kinds of wetlands: large river floodplain wetlands, floodplain wetlands of Mississippi River tributaries, small stream wetlands of central Minnesota, littoral wetlands of non-calcareous lakes, littoral wetlands of calcareous lakes, wet prairies of the Red River Valley, prairie glacial marshes, forest glacial marshes. For each of the wetlands, the environmental features (soils, etc..) were characterized, a land use assessment was completed (GIS-based, multiple scale assessment), and biological surveys of amphibians, birds, fish, invertebrates, and plants were completed. Based on biological community patterns, between 28 and 63 plant and animal indicators (ave. of 43) were identified for each series. An analysis of the relationship between potential indicators and land use data revealed that approximately 70% of the indicators may have assessment value. Non-calcareous littoral wetlands are an exception, however, with approximately 30% of the indicators having possible assessment value. The most useful scale for wetland assessment varies among wetlands and among organismal groups, with plants tending to respond to land use degradation locally (within 500 m of sites) and vertebrates often responding at larger scales (e.g., 2500 m of sites). Birds and plants are more generally useful as biotic indicators for Minnesota wetlands than amphibians, fish and invertebrates. These aquatic animals cannot be sampled reliably or consistently in wetlands that are not persistently flooded. Before the indicators developed in this study can be used for assessment, additional statistical tests and land use relationships need to be conducted. A grant was obtained (using LCMR project funding as match) to complete this additional analysis.

IV. Statement of Objectives:

A. Establish a system of reference natural wetlands for comparative monitoring;
B. Identify plant and animal species that are indicators of wetland quality;
C. Develop guidelines for wetland assessment and monitoring.

Ecological indicators, based on plant and animal diversity, are being characterized for each kind of wetlands found in the urban, agricultural, and forested areas of Minnesota, by ecoregion. Biodiversity indictors may be used to establish guidelines for assessing wetland quality of existing wetlands during permit review and for establishing replacement monitoring programs.

Timeline for Completion of Objectives:

	7/95	1/96	6/96	1/97	6/97
A. Establish reference wetland system	>>>>>>>>>>>				
B. Identify plant & animal indicators	>>>>>>>>>>>>>>>>>>>>				
C. Develop assessment & monitoring guidelines				>>>>>>>>	

Establishing Reference Wetlands and Other Sites

We evaluated the level of land use impacts in the field for the 300 potential sites to identify the 120 wetlands to be used in this study. Land use effects at each wetland were assessed from the following: the presence of drainage tiles; the presence and size of storm water drains; the type and proximity of industrial use; the proximity of homes, roads and septic fields; the type and degree of recreational use; the type and degree of physical alterations to shorelines and banks; the type and degree of physical alterations to vegetation; and the proximity, type and degree of agricultural use. We collected and analyzed aerial photographs, National Wetland Inventory maps, soil surveys and topographic maps for each of these sites. In addition we interviewed Area Wildlife Managers, Soil and Water Conservation District Staff, local government representatives, private property owners and any other people that could provide information about the history of a site. Based on our assessments and permission we chose 120 sites in 50 counties during the first field season (1995). Forty-one of these sites are on private land, sixteen sites are on Nature Conservancy land, and the remainder are on state, county or city lands.

After additional evaluation of data from the first field season, twelve sites needed to be reselected because they did not meet criteria for their series. These sites were anomalous to others in the study in at least one of several ways: too large of a water body, different stream/river order, anticipated severe land alteration from development or management, and different water chemistry. Sites were reselected by contacting local natural resource agency staff, followed by a site visit. The final version of the catalog is included in the project CD. The electronic publication has been organized to maximize utility to field personnel seeking to use specific sites as wetland assessment models.

B. Identify plant and animal indicators of wetland quality

B1. Activity: Review available data to identify ecological indicators for each kind of wetland in each ecoregion. Establish the sensitivity of these indicators from new field surveys of wetlands of varying condition.

B1a. Context: The criteria for determining whether a replacement site has, in fact, become a wetland, needs to be determined from parameters related to biodiversity. These criteria rely on the use of ecological indicators - plant and animal species or assemblages that are sensitive to ecological condition. Work accomplished for this objective determined the indicators (parameters) most likely to be useful for establishing wetland quality - those sensitive enough to vary among replacement wetlands as they develop and to vary among existing wetlands with different levels of stress, but not so variable as to be temporally sporadic. In addition, the field surveys of plant and animal communities needed to create the indices will serve as an important benchmark of biodiversity on the reference wetlands for long-term monitoriing.

B1b. Methods: Ecological indicators (primarily invertebrates) are widely used for streams and small rivers throughout the U.S. Recently, there has been interested in

expanding the use of indicators to wetlands. Paul Adamus recently completed a comprehensive review on the topic for the Environmental Protection Agency (*Bioindicators for Assessing Ecological Integrity of Prairie Wetlands, 1994).* This review compares field methods and suitability for algal and microbial communities, vascular plants, amphibians, invertebrates and birds as indicators. We have used this source as a primary reference for initial attempts at indicator selection and field method development. Information from this EPA review and from field observations in Minnesota wetlands suggest the best initial approach for indicator development is to characterize vascular plant, bird, amphibian, and aquatic insect communities. Releves, or plant community descriptions, were made in late summer 1995 and spring 1996 (2 visits to each site). Bird, amphibian, and aquatic insects were sampled on reference wetlands during the 1996 season.

Appropriate metrics for use in wetland assessments were determined from analyses comparing plant and animal communities from (1) sites known to be of differing quality (to determine sensitivity to ecological condition) and (2) within sites and within reference groups (to determine how much variability is actually noise). The project staff conducted a thorough search of data from Ecological Services, Scientific and Natural Areas Program, Pollution Control Agency and The Nature Conservancy, from the published literature to obtain additional perspective on indicator development as it pertains to assessing site quality. The theory and application of this approach as applied to stream ecosystems is described in: Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1(1): 66-84. Based on experience from stream ecosystems, these indices: 1) are most effective if developed for ecoregions, 2) have four components - community structure, species composition, condition (health of individuals), rates of biological processes, 3) are expressions of known influences of human activities on the characteristics of resident biota.

Information was recorded in the field on standardized forms to facilitate data entry into (1) statistical programs (such as SAS) and (2) state databases maintained by Ecological Services (DNR). Element Occurrence Records will be completed at the end of project, with all requested information, and submitted to the Department of Natural Resources. A major responsibility of the research fellow was to provide quality control for all data collected by field teams. The project manager arranged a short training session on EOR procedures for the graduate assistants and research fellow. Original copies of all field data will be maintained at the University of Minnesota. A paper file for each reference wetland will be maintained to include all raw data, maps, land use information, and special use permits. The project collaborators from BWSR and DNR will decide which portions of the files should also be maintained by their offices during and after the project. Plant and animal community data (other than EORs) has been entered into computer spreadsheets. Copies of this raw data are available on CD for other state-sponsored research projects and will be uploaded to the web after the information has been published and theses are complete.

B1c. Materials: Approximately $8,000 was spent on field supplies - including hip boots, invertebrate traps, oxygen and conductivity meters. No purchases over $1500 unit cost were incurred. Durable supplies will be retained by the investigators at the University of Minnesota to be used for long-term monitoring of reference wetlands.

B1d. Budget: Total Biennial LCMR Budget: $ 139,000
LCMR Balance: : $ 0
UM-ORRTA will submit final detailed accounting

B1e. Timeline for Products/Tasks

	7/95	1/96	6/96	1/97	6/97
1. Review existing data and draft criteria	>>>>>>>>>>>				
2. Field surveys to verify criteria			>>>>>>>>>>>		
3. Final report including criteria					>

B1f. Work Program Update:

During the second half of the 1995 field season we characterized the plants of each wetland. One or two vegetation plots were sampled in each wetland. One plot (either 10 x 10 m or 20 x 20 m) was placed in each kind of wetland vegetation (forest, shrub, emergent herbaceous). The precise location of each releve was marked on a 7.5' USGS topographic map and as been provided to the appropriate land manager. Environmental conditions for each vegetation plot were also documented. Soils within the plot were described from a 1" soil probe to a depth of approximately one meter. Water depth within each plot was measured with a meter-stick (either on the surface or in the soil bore opening). Plant community data, including abundance of each species within a site, has been compiled and entered into a vegetation database which is summarized in the project CD.

During summer 1996 we censused or sampled bird, amphibian, fish, and invertebrate communities from 120 wetlands. We sampled amphibian larvae in six of the eight series: the three upland depressional series and the three floodplain series using aquatic funnel traps placed in wetland shallows. Data on species richness, species abundance, and the condition of individuals was collected. Birds were surveyed May-July 1996. We censused birds in our floodplain and upland depressional wetlands using 10-15 minute point counts. Invertebrates were sampled using three techniques designed to maximize the anticipated diversity in the wetlands: (1) vertical activity traps were used to sample most insects, (2) minnow traps were used for large predaceous insects, and (3) leech traps. Fish collected in all samples were identified and used for indicator development, as well.

The samples have been identified to appropriate taxa. We identified 170 species of birds, 10 species of amphibians, 40 species of fish, 61 families of insects, and 9 other orders of invertebrates from our 120 wetland sites. Dr. Jeff Lange (University of North Dakota) oriented graduate students to identification of amphibian larvae, and Dr. Jay Hatch (University of Minnesota) assisted with the identification of fish samples. Animal databases are included in the project CD.

C. Develop criteria for wetland assessment and monitoring

C1. Activity: Develop criteria based on all available information of ecological indicators and wetland quality in coordination with staff of Board of Water and Soil Resources.

C1a. Context: Interpretive criteria for assessing wetlands are being determined from the data on the indicators collected from all reference wetlands and representative restored wetlands. The primary focus of this objective is to determine the most effective criteria and to set threshold levels that are sensitive to human impacts - not set so high that sites with biodiversity typical of natural wetlands are considered in non-attainment - or so low that unacceptably impaired sites are scored as attaining. These criteria can be used to assess the quality of existing wetlands and their sensitivity to degradation during the permit process and the quality of restored wetlands during mitigation.

C1b. Methods: The data collected during the indicator survey (Objective B) and the characteristics of reference and representative wetlands (Objective A) are being explored graphically and statistically as described in the 1993 EPA report (listed in B1b). The approach for developing multimetric ecological criteria outlined by EPA (and other published papers) will be adapted for this project. Generally, 10-12 metrics will comprise an index for each kind of wetland within an ecoregion. For each metric, a score of 5 will be assigned if the study site deviates only slightly from the reference site, 3 if it deviates moderately, and 1 if it deviates strongly from the undisturbed condition. Reduced species richness, altered species composition, altered trophic and guild structure, and altered morphological condition of individuals relative to reference wetlands are deviations important for assessing wetland biodiversity. The sum of these metrics will yield an index score that provides an assessment of various aspects of biodiversity. Threshold score values relative to reference wetlands will also be established to assist in interpretation and decision-making. Index ranges for poor, fair, good, and exceptional are usually established. The graduate assistants will each conduct a portion of the analysis (e.g., plant community criteria) and propose thresholds. Final criteria will be established through close coordination between the project manager and the Board of Water and Soil Resources staff.

C1c. Materials: $2000 was been budgeted for printing the technical report to be dispersed to decision-makers throughout the state.

C1d. Budget: Total Biennial LCMR Budget: $ 59,000
LCMR Balance: $ 0

UM-ORRTA will submit final detailed accounting

C1e. Timeline for Products/Tasks

	7/95	1/96	6/96	1/97	6/97
1. Develop guidelines				>>>>>>>>	
2. Final report including guidelines					>

C1f. Work Program Update:

In-Depth Case Studies Criteria development has been enhanced by in-depth studies that are thesis topics for each of the four graduate students that work on the project. These students conducted additional research on topics in need of in-depth study beyond the primary objectives of the overall project. Two thesis projects investigate how vertebrate distribution is affected by land use. Vertebrates have often been problematic indicators because of relatively low diversity at a given site, seasonal variability in censussing, and unknown relationships to land use. Rick Lehtinen's project is entitled: *Factors affecting the distribution and abundance of amphibians in Minnesota wetlands.* Karen Schik's project is entitled, *The impact of agricultural land use on wetland avian communities.* The other two thesis projects relate to impact assessment. Jason Husveth's project, *Biodiversity of urban depressional wetlands: impacts of stormwater fluctuations and restoration designs,* focuses on the main land use stressor within urban landscapes in the state. Douglas Mensing characterized how land use has altered riparian wetlands in *Anthropogenic effects upon floodplain wetlands of northern Minnesota streams.*

Land Use Assessment Through additional funding from the U.S. Geological Survey - Water Resource Research Program, a second research fellow was hired in October, 1996 to focus on developing land use assessment protocols and developing the GIS land use databases. The initial phase of the land use assessment involved developing protocols for analysis, establishing data standards, and locating existing GIS land use databases.

During the fall of 1996, contacts were made with several agencies throughout the state to locate the extent of existing digital land use data. Land use data were collected at two different scales. At a small scale (1:250,000), a statewide land use/cover was obtained from the U.S. EPA and at a large scale (1:24,000) land use data was obtained from several state and county agencies. Digital data were acceptable for the large scale analysis if the data met these requirements: 1) land use data was interpreted post 1985, 2) minimum mapping unit (mmu)or resolution of 5 acres or less, and 3) a data dictionary existed for the data to tract original analog data. Digital data were obtained both in vector and raster format. Digital data were obtained from the following agencies: MNDNR, LMIC, NRRI, MDA, Metropolitan Council, Bemidji State, Clearwater SWCD, Hubbard SWCD, and the Wadena SWCD. All GIS coverages were projected to the UTM projection using datum NAD83. Because each data set was developed for specific purposes (i.e. mapping cropland, mapping forest vegetation, etc.), the attribute classifications varied among the data sources both in quality and quantity. One classification scheme was chosen and each GIS data set was updated to conform to this classification scheme. LMIC's 17 category land use classification scheme was selected as a suitable classification scheme. In addition to the land use data, a statewide CRP layer has been obtained from the MDA to identify CRP (Conservation Reserve Program) lands and their intended uses. National Wetland Inventories (NWIs) have also been obtained from the MNDNR to supplement the quality of the general wetland land use category. Statewide digital coverages for hydrography, roads, public land survey boundaries, and county boundaries were also obtained to provide contextual features for future analyses and hard copy outputs. Land use was evaluated at varying proximities surrounding each site. Percentages of land use classes were calculated for each site at radii of 500 m, 1000 m, 2500 m and 5000 m. Land use maps (at varying

scales) are presented in project CD. Land use data is summarized in tables in this report, as well.

Relationship of Land Use to Potential Indicators Potential indicators were identified for each wetland series based on exploratory multivariate analysis. An average of 43 biotic metrics were evaluated for each series. The relationship between each metric and each land use variable (land cover class at a particular scale) was tested with correlations. Between 896 and 1953 tests were made for each series as a first screening. While 70% of the indicators show at least one significant relationship at one scale, fewer show consistent, interpretable patterns that will make good assessment tools. In general, bird and vegetation metrics appear most promising. The next step of indicator development will be to screen each of the significant relationships listed above to ensure those used to develop criteria are not spurious. This additional screening will proceed with USGS funding and be completed by October 1, 1997. The criteria will be tested on restored wetlands as part of a 1997-99 LCMR project (to S. Galatowitsch). One important finding of this current study is that the optimal scale for wetland assessment may need to vary among different kinds of wetlands and for different biotic indicators to be effective. In some cases, a multiple scale assessment may be needed to adequately predict the effects of land use stressors on wetland quality. The project CD summarizes potential indicators by land use scale.

VI. Evaluation:

For the FY96-97 biennium, the program can be evaluated by its ability to: 1) discern indicators based on plant and animal composition that determine wetland quality; 2) locate and establish a system of reference wetlands that includes examples in both undisturbed landscapes and in typically used landscapes; 3) develop criteria for each wetland to assess impacts to existing wetlands and replacement wetlands; 4) provide local government units with a catalog of reference wetlands and criteria for assessing wetland quality with ecological indicators; (5) recommend selected wetlands to be dedicated as Scientific and Natural Areas.

In the long-term, the project should be considered successful if: 1) the reference wetlands and associated criteria result in sound assessments of replacement wetlands by decision-makers in the state and 2) if the indicators and criteria are found to be acceptable to the scientific community as evidenced by the publication of project results in peer-reviewed journals. In addition, several Master of Science theses should result from this work.

VII. Context within the field:

Although considerable effort has been made nationwide to develop methodology for delineating wetlands and assessing their probable functions, little attempt has been made to assess wetland quality. Existing assessment techniques for wetlands are very general and do not adequately measure biological diversity. Since the overall goal of the Wetland Conservation Act is to achieve a no-net loss of the quantity, quality and biological diversity of Minnesota's wetlands, this project developed assessment criteria based on plant and animal indicators.

Using ecological indicators to assess the integrity of streams and small rivers has been accomplished. Various parameters related to the distribution, abundance, and co-occurrence of fishes and invertebrates have proven to be valuable indicators of anthropogenic stress on streams and rivers. Developing similar criteria for wetlands has been considered to be more problematic because of the spatial and structural complexity of many wetlands. The Pollution Control Agency (Judy Helgen) has been conducting surveys of reference wetlands in the central hardwoods ecoregion in Minnesota and has begun to develop invertebrate criteria. The project manager has done some preliminary work using plant guilds for assessments on the Upper Mississippi River. Implementing this LCMR project permitted these initial efforts to develop indicators to be accelerated and expanded to a broader group of organisms and over the entire state.

The use of reference wetlands for criteria development also follows the approach established for streams and small rivers. In addition, reference wetlands have been widely used in ecological studies to monitor long-term changes in ecosystems. For example, the U.S. Forest Service has established reference sites in undisturbed forests across the U.S. to assess background changes in ecological condition over time. Work has begun to characterize forested wetland sites in the Chippewa Forest (northern Minnesota). Similarly, the University of Minnesota (Eville Gorham and Jan Janssens - Ecology and Evolutionary Biology) established approximately 100 long-term monitoring sites in Minnesota wetlands (primarily in northern peatlands). These were contacted to determine if these existing reference wetlands can be included in the LCMR project and/or if field surveys can be conducted with comparable methods.

VIII. Budget context:

The USGS provided $50,000 to support GIS analysis that was not in the original LCMR proposal. MNDOT has provided $65,000 to use the criteria developed on some of their mitigation projects beginning June 1997.

IX. Dissemination:

Information on each wetland (location, description, photographs, land use maps), summary tables for biological surveys, land use assessments and environmental characterizations, and the methods and results of indicator development have been made into an electronic publication, viewable with commonly available internet browsers. Because of the volume of the information (50 MB), this data is provided on a CD. After further refinement and analysis (by fall, 1997), the electronic publication will be accessible on the Web from a University of Minnesota server. In addition, scientific journal articles are in preparation.

X. Time:

The project will be conducted within the two-year funded period.

XI. Cooperation:
Project Manager: Susan Galatowitsch

Objective A: 15%
Objective B: 10%
Objective C: 10%

Cooperators:

1. Greg Larson, Minnesota Board of Water and Soil Resources
   Role: Provide information on wetland permit activity, review suitability of indicators developed and reference sites selected; assist in development of criteria; disseminate technical report to decision-makers; assist in project administration; assist in assembling advisory group.
   Time: Objective A: 2%
   Objective B: 5
   Objective C: 10%

2. John Tester, University of Minnesota-Ecology and Evolutionary Biology
   Role: Assist in development of methodology for indicators and criteria; advise graduate students involved in field work; review suitability of reference wetlands; assist in assembling advisory group.
   Time: Objective A: 10%
   Objective B: 5%
   Objective C: 5%

3. Bob Djupstrom, Minnesota Scientific and Natural Areas Program
   Role: Coordinate the acquisition of existing data on plant and animal species and potential reference wetland locations within the Department of Natural Resources; assist in assembling advisory group.
   Time: Objective A: 1%
   Objective B: 2%
   Objective C: 1%

XII. Reporting Requirements:

Semiannual six-month work program update reports will be submitted not later than January 1, 1996, July 1, 1996, January 1, 1997 and a final six-month work program update and final report by June 30, 1997.

XIII. Required Attachments:

1. Qualifications: Attached vitae for Galatowitsch, Larson, Djupstrom, Tester.
2. Detailed Budget (Including Deliverables) and Staff Summary
3. Detailed Work Schedule