# SCOPE OF SERVICES
# LAKE DIAGNOSTIC STUDY

**LAKE AND RIVER ENHANCEMENT (LARE) PROGRAM**
**INDIANA DEPARTMENT OF NATURAL RESOURCES**
**DIVISION OF FISH AND WILDLIFE**

## I. Project Purposes:

The purposes of the Lake Diagnostic Study are to:

1. Describe condition and trends in the lake(s) and its (their) subwatersheds.
2. Identify potential nonpoint source water quality problems.
3. Prioritize potential watershed improvement projects
4. Propose specific direction for future work.
5. Predict and assess factors for success of future work.

## II. Project Tasks:

The scope of services outlined below should be considered a draft that is subject to revision prior to the final contract, based on discussion with the LARE staff, sponsoring local organization and local county Soil and Water Conservation Districts (SWCDs) regarding cost-effectiveness of proposed services.

1. Summarize historical information on trends in land use and water quality

Record the 12 digit HUC (Hydrologic Unit Code) for the study area, as well as the location using Latitude and Longitude Coordinates expressed in decimal degrees, using NAD 1983 Datum. If the project is for a lake as a whole, note the location of the outlet or lowest elevation in the lake watershed within the project's proposed bounds. Compile an annotated bibliography of all previous studies pertinent to land use and water quality changes in the lake(s) and subwatersheds, including data from volunteer monitoring. The Indiana Water Monitoring Council (www.inwmc.org/Default.aspx?pageId=319840) maintains an inventory of water monitoring locations in Indiana that may be useful. Briefly summarize pertinent information on climate, geologic history, topography, trends in land development, unique recreational resources related to the waterway or riparian areas, and water quality. Note whether any waterbodies in the watershed are listed as impaired on the 303(d) list. Include historical aerial photos of the watershed if available.

2. Map and describe current watershed conditions

Present maps and describe current conditions in subwatersheds to the lake(s). Maps and descriptions should include the following:

a. General location maps including watershed boundaries and the associated HUC codes;
b. Map showing subwatershed boundaries, table of lake and subwatershed acreages;

c. Soil type descriptions and maps of Highly Erodible Land (HEL) and hydric soils;
d. Current and historic extent of wetlands (from National Wetland Inventory) and potential wetland restoration sites;
e. Floodplain management areas (identified on FEMA floodplain map) and condition of riparian zones indicating any significant locations possessing or requiring unusual bank protection;
f. Significant natural areas;
g. General locations of known state and federally listed species;
h. Priority areas for conservation, restoration, and acquisition, based on results of the Indiana Biodiversity Initiative's Conservation Tool, land use development models that may be available for that area (e.g., LUCI), and any other tools, as appropriate;
i. State-owned land and easements that may be available for resource conservation and public access purposes; and
j. Land use information such as:
    1) Land use categories by acreage and percent of watershed area
    2) Map of broad land use categories
    3) Development trends (changes in land use over time)
    4) Number of lakeside homes and area's development history
    5) History of pursuit of public access sites
    6) Boat count on one weekend and one week day
    7) location of point source dischargers, including permit compliance information (LUST, NPDES discharge data available from IDEM)
    8) Location of any hazardous waste or Superfund sites
    9) Location of large septic fields or industry
    10) "Hot spots" of damaging land use practices
    11) Number and type of animals in confined animal feeding operations (CFO's, CAFO's)
    12) Tillage transect data/trends in the county(ies)
k. Visual assessment of the watershed based on a windshield survey.

Note that land use information should be reported at a relatively large resolution, not on a "field-by-field" basis. The report should not include information that specifically identifies individual landowners in the text or photographs. All land-use information should be collected and discussed with the sponsoring organization and the local county SWCD, the local staff of the USDA Natural Resources Conservation Service (NRCS) and ISDA Division of Soil Conservation in the watershed prior to inclusion in draft reports that are circulated for public review.

3. Collect and analyze information on water quality, biology, and habitat

Conduct water quality tests at pertinent sites in the lake and its tributaries, as well as one reference site in a high quality similar watershed (approximately 5-10 sites total). Sites should be selected with input from staff of the LARE program, the local sponsor, IDNR District Fisheries Biologists and staff from the county SWCD, the ISDA Division of Soil Conservation, and the USDA NRCS. At each site, collect and analyze data on water quality, biological communities, and habitat, as indicated below.

A. Water quality

1) Lake sampling

If an eutrophication index has been determined by the IDEM Clean Lakes Program (http://www.indiana.edu/~clp/ ) from a representative year within the past five years, the only further in-lake sampling would be a Secchi depth reading in mid-summer. Otherwise, one water sample should be taken at the surface and bottom over the deepest part of each lake in late summer (at peak stratification, typically in July or August) for purposes of calculating the IDEM Trophic State Index (ITSI) and Carlson's Trophic State Index (TSI).

Parameters include: Secchi depth, light penetration, conductivity, pH, temperature, dissolved oxygen, nitrate + nitrite, organic nitrogen (TKN), ammonia nitrogen, total and dissolved phosphorus, turbidity, plankton, and chlorophyll-a. A vertical profile of temperature and dissolved oxygen at one meter intervals should be taken at the same location.

2) Tributary sampling

Conduct tests at tributary sampling sites on physical and chemical water quality, including: pH, temperature, dissolved oxygen, nitrate + nitrite, organic nitrogen (TKN), ammonia nitrogen, total and dissolved phosphorus, turbidity, conductivity, and discharge. Fecal coliform as *E. coli* should be sampled at these sites, if appropriate. Stormflow and baseflow samples should be collected at each tributary site. Site locations should be well documented on maps, with photos and GPS coordinates.

3) Quality assurance

Water quality analyses must be conducted by a reputable laboratory and should follow analytical methods described in the most recent edition of one of the following publications:

(a) *Standard Methods for the Examination of Water and Wastewater*, jointly published by the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF) (http://www.standardmethods.org/)

(b) *Methods for the Chemical Analysis of Water and Wastes*, US EPA, Environmental Monitoring and Support Laboratory (EPA Publication #600479020, published March 1983). Available at http://nepis.epa.gov/EPA/html/Pubs/pubtitleORD.htm, search for #600479020.

Water quality analyses must be conducted using detection limits appropriate for the analysis of stream water samples. The following detection limits are suggested for LARE projects:

| Parameter | Limits (mg/l) |
|---|---|
| Total Phosphorus | 0.01 |

| | |
|---|---|
| Total Orthophosphorus | 0.01 |
| Ammonia Nitrogen | 0.03 |
| Nitrate Nitrogen | 0.10 |
| Total Kjeldahl Nitrogen | 0.10 |
| Total Suspended Solids | 4 |

Quality assurance/quality control procedures (QA/QC) must be a part of the sampling and water quality analysis. A copy of the QA/QC plan from the laboratory(s) conducting the water quality analysis must be provided to the LARE program office in Indianapolis.

B. Biological community and habitat quality

1) Conduct an assessment of the benthic macroinvertebrate community. Sampling should be conducted using the methods described in the *LARE Protocol for Macroinvertebrate Sample Collections and Index Calculations*, which follows the *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*, Second Edition (US EPA publication number EPA 841-B-99-002, www.epa.gov/owow/monitoring/rbp/). Sampling should use the single-habitat approach and consist of identification at the family level for a 100-organism subsample for the riffle/run sample. Calculate the standard metrics for LARE reports listed in the *LARE Protocol for Macroinvertebrate Sample Collections and Index Calculations*.

2) Each tributary sampling site should be biologically monitored once between July 15 and November 30. Site locations should be well documented on maps, with photos and GPS coordinates using Latitude and Longitude Coordinates expressed in decimal degrees, using NAD 1983 Datum.

3) Evaluate habitat quality at each site, using the Qualitative Habitat Evaluation Index (QHEI) as used by the Indiana Department of Environmental Management (available at http://monitoringprotocols.pbworks.com/f/IDEM+QHEI+SOP.pdf).

4) A voucher collection will be submitted to the Department of Entomology, Purdue University prior to submission of the draft report, allowing two months for review. A voucher for each taxon identified at each site will be curated according to Purdue's protocols for specimen handling. Refer to the *LARE Protocol for Macroinvertebrate Sample Collections and Index Calculations* for details. The voucher submission should be coordinated through LARE staff, and sent to the following address:

**Purdue Entomological Research Collection**
**Purdue University**
**Dept. of Entomology**
**901 West State Street**
**West Lafayette, IN 47907-2089**

A Scientific Purposes License is not needed to sample aquatic insects. A fishing license or Scientific Purposes License is needed to collect crayfish, depending on the number and manner in which the crayfish will be taken. The only mussels that can be taken or possessed without a Scientific Purposes License are Asiatic clams, quagga mussels and zebra mussels. Individuals should not touch a mussel, or even just a dead shell, unless they know for sure that it is one of these three species listed above. Otherwise, a Scientific Purposes License is required to collect or possess a native mussel or dead shell.

For threatened and endangered species, adhere to the restrictions imposed by the Scientific Purposes License.

5) The study should include reports and brief analysis of surveys, trends, and management recommendations from other biological studies conducted in the lake and tributaries. Information on the lake's fish community may be obtained from IDNR Division of Fish and Wildlife's Fish Management Reports or other sources. Macroinvertebrate data for selected Indiana lakes is available from the Biological Studies Section of the Assessment Branch in IDEM's Office of Water Quality. This data and a discussion of its significance for resource management should be included in the report as an indication of water quality trends in the study area.

C. Aquatic plant community

1) The sponsoring organization should consult with the LARE staff to determine how expansive the aquatic plant portion of the diagnostic study should be. In some cases, it may be adequate to simply develop a distribution map indicating the approximate acreage of exotic species (e.g., Eurasian watermilfoil, curlyleaf pondweed) and conduct a single Tier II survey of the lake in late summer (i.e., July 15 – August 31) to obtain basic plant community information (see below). In other cases, it may be more appropriate to have a consultant perform the work necessary to develop a complete five-year Aquatic Vegetation Management Plan.

   In either case, at least some form of aquatic plant survey should be conducted in the lake. Aquatic plants should be identified to the species level, when possible, and mapped according to their distribution following the IDNR Tier II Sampling protocol Plants that may be of interest to the IDNR Division of Nature Preserves should be curated in accordance with the procedures outlined in their aquatic plant survey memorandum.

2) Because wetland conservation is a significant issue around most lakes and tributaries, the study should include a general description of the diversity and condition of wetland plants in the area. Recommendations should be made where the wetland plant community has not been adequately managed for protection of water quality.

3) Plankton samples need only be collected as part of the calculation of the eutrophication index. Methods specified in the IDEM Indiana Trophic State Index (ITSI) should be followed to ensure that the samples are collected and analyzed in a

manner that is consistent with state standards (www.in.gov/dnr/fishwild/files/fw-LARE_Indiana_TSI_Lake_Classification_Dec2010.pdf). A list of plankton species and abundance should be included, based on collections made for calculation of the ITSI. Attention should be paid to the identification and concentration of toxin-producing blue-green algae genera such as *Cylindrospermopsis*.

D. Nuisance species

If waterfowl, other nuisance wildlife or exotic invasive species (e.g., purple loosestrife) are of concern in the lake or watershed, a survey of the current count or distributions of the species may be conducted on a representative day.

E. Analyze trends relating physical, chemical, biological, and habitat factors

Analyze the relationship between water chemistry, habitat and biological community quality data and discuss any correlation. Indicate potential limiting factors. Describe trends in water clarity and quality and compare water quality with similar regional lakes.

4. Hydrology and Lake Habitat Quality

A. Water Budget

A water budget for the lake must be calculated if not done in a previous study. The hydraulic residence time of the lake(s) should be determined using data available from various sources. Describe how the hydraulic residence time may affect the predicted success of treatment efforts.

B. Lake Shoreline and Streambank Erosion

Map lake shoreline protection and erosion areas from existing engineering information, indicating the approximate extent and distribution of various seawall materials. Describe any water quality or habitat changes that have occurred along eroding areas. Conduct an aerial or ground survey of eroding streambanks along tributaries to the lake.

C. Sedimentation

If sediment removal from the lake or tributaries is under consideration, the Sediment Removal Plan requirements developed by LARE should be followed. Previous studies proposing sediment removal, including results of sediment sampling, should be referenced where available.

5. Model nonpoint source pollution in lakes and subwatersheds

Use appropriate models to describe relative contributions to sediment and nutrient loads from identified or predicted sources of nonpoint pollution. A Vollenweider nutrient loading figure or similar illustration may be included with an interpretation. Calculate the load reductions needed to achieve water quality standards or targets for nutrients, sediment, and/or *E. coli*. Indicate the potential benefit derived from changes in land use practices.

Various computer modeling methods are available (e.g. STEPL, Region 5 Model) and may be useful in describing changes. Intensive modeling programs may represent a higher level of

resolution than is necessary for the purposes of this study. However, there may be smaller areas of particular interest where more intensive models would be appropriate.

6. Assess institutional resources

Describe the availability of watershed management and leadership resources, both human resources and existence of planning documents or land use management ordinances. Identify existing or recommend potential volunteer monitoring groups. Establish contacts with producer groups, environmental groups, developers, and land managers at public properties. Where possible, include brief summaries of pertinent reports on land use and water quality from these and other land management organizations in the watershed.

7. Prioritize management recommendations

Set reasonable goals for improvement of water quality factors. Prioritize subwatersheds and potential watershed improvement projects that would contribute to decreases in degradation from nonpoint source pollution. Discuss factors related to future success and limitations of recommended projects. Describe unusual physical or social characteristics of the subwatersheds or institutions that may support or challenge future lake or watershed projects. Include cost estimates and recommended timelines for implementation, as well as briefly list potential sources of funding for projects. To assist with implementation of future priority projects the Region 5 model should be utilized to list reductions in soil and nutrient loss for each specific project. Include a discussion of eligibility for IDEM 319 funds. Identify motivating factors that would encourage voluntary participation of land users in future programs. Include a detailed action plan for implementation.

8. Create a public information handout

Create and distribute an information handout that addresses factual issues concerning the state of the lake and costs or benefits predicted from the proposed project(s). The format of the handout should be tailored to the specific needs of the local sponsor, such as a 2-page flier, bi-fold brochure or magazine-style article. Recommend methods for keeping the public informed of future watershed management activities.

9. Facilitate meetings

Facilitate at least two public meetings for the purposes of: 1) identifying stakeholders, introducing the study and obtaining public input and concerns; and 2) presenting the final report. Document meeting dates, attendance, minutes, public comments, and an indication of the level of support for recommending particular implementation projects as an appendix to the report. As an option at the request of the sponsoring organization a steering committee can be established to help guide the planning process. An established number of steering committee meetings would be facilitated by the contractor to help create a consensus driven plan and provide input throughout the process.

10. Report project progress

Issue monthly progress reports during the duration of the project. Copies of progress reports must be submitted to the project sponsor and LARE program staff prior to payment of invoices for the work described in the monthly reports. A listing of completed tasks and percentages in the invoice is not adequate as a monthly report. Progress reports should describe completed tasks, any unusual issues, and whether the anticipated timeline needs any modification along with any other information pertinent for LARE staff review.

11. Complete lake diagnostic study report

Complete a Lake Diagnostic Study report including the following items at a minimum:

a. Executive Summary
b. Statement of project purpose
c. General overall project description
d. Heading, summary, discussion and recommendations for each project task
e. Project conclusion
f. Appendices should include (if applicable) but are not limited to:

1) All pertinent data, including field sheets
2) Water quality and index calculations
3) Computer model input and output
4) Necessary maps, charts, graphs, computations and computational breakdowns
5) Pertinent meeting minutes, attendance lists and public comments

## III. Data Presentation:

1. Where practical, the data should be presented clearly and concisely in the form of graphs and tables.

2. Figures should be incorporated into the main body of the report and not presented as attachments at the end of the report. Whenever possible, figures should be limited to 8 1/2" x 11" in size. In most cases, large-scale maps and photos are not necessary.

3. Present data in English units with metric units in parentheses. Example: 5 ft (1.5m). Similarly, use common names for species with scientific names in parentheses or include a table with all common and scientific names used in the document.

4. Raw data sheets need not be bound into each copy of the report. However, at a minimum, one set of all laboratory and field data sheets must be forwarded to the LARE program office to aid in the review of the draft report.

## IV. Review Process:

1. Five (5) printed copies and three (3) digital copies of the draft report must be provided to the LARE program office for review by the LARE staff and pertinent agencies and organizations at least two weeks prior to the final public meeting. The LARE staff will forward copies for review by other persons and agencies. *Note that the draft document will be posted on the LARE website for public comment.*

2. Both the draft and final reports should be reproduced with double-sided pages.

3. The title of the draft report should refer to the report as a "draft" version. Additionally, each page of the draft report should be labeled "Draft - Subject to Revision."

4. To facilitate review of the draft report, a meeting between a representative of the local sponsor organization, consultant, LARE staff, and other agency staff as needed may be held to discuss the review comments in conjunction with the final public meeting. The entire review process will be coordinated by LARE staff and normally takes at least eight weeks.

5. Upon addressing the review comments, five bound printed copies of the complete final report and plan sheets should be provided to the LARE office for distribution to the participants involved in the lake and watershed initiative. In addition, one unbound printed copy shall be provided to the LARE office, along with three copies of a single electronic file that contains the complete digital copy of the full report including appendices, figures, maps and photos in either Microsoft Word© or Adobe PDF© format. Do not submit multiple files that need to be merged into one file for web posting.

6. Both draft and final reports must be reproduced with two-sided pages for hard copies and as a single electronic file in Microsoft Word or Adobe .pdf format, suitable for posting to the LARE website.

Follow these guidelines for electronic copies:

a) Electronic file names must follow this protocol: Draft_Name_Lake_Name_County_Lake_Diagnostic_Study_Month_Year.pdf
b) All electronic copies must contain the complete digital copy of the full report including appendices, figures, maps and photos in either Microsoft Word© or Adobe PDF© format as a single electronic file. Do not prepare multiple files that need to be merged into one file for web posting.
c) Keep file sizes as small as possible to facilitate email exchange and downloading by adjusting pixel size on graphics, compressing photos, or exporting GIS files to pdf or jpeg formats.

**IDNR Checklist for Review of LARE Lake Diagnostic Studies**

Lake Name(s): (HUC ___)
Sponsor:
County:
Contractor:
DNR Reviewers:
Review Date:
Other Reviewers:

The following is a checklist of the minimum elements required to establish eligibility for LARE implementation funding. Comments on specific elements have been added in *italics*.

1. **Title Page**

☐ Title includes name of lake and county
☐ Title page provides name of company, name and contact information for local sponsor (e.g., watershed group), and date submitted

2. **Executive Summary**

☐ Provides clear and concise overview as a stand-alone summary

3. **Acknowledgements**

☐ As needed to reflect contributions

4. **Table of Contents**

☐ Complete and accurate

5. **Introduction**

☐ Statement of project purpose
☐ General overall project description
☐ Description of the steering committee and list of stakeholder concerns if applicable

6. **Summarize historical information on trends in land use and water quality**

☐ Annotated bibliography of all previous studies
☐ Briefly summarize pertinent information on climate, geologic history, development, etc.

7. **Map and describe current watershed conditions**

☐ Watershed boundaries and the associated 12-digit HUC codes. Latitude and Longitude Coordinates expressed in decimal degrees, using NAD 1983 Datum.
☐ Table of lake and subwatershed acreages
☐ Soil type descriptions and maps of Highly Erodible Land (HEL) and hydric soils.
☐ Current extent of wetlands and potential wetland restoration sites.
☐ Floodplain management areas and condition of riparian zones.
☐ Significant natural areas.
☐ General locations of known state and federally listed species.
☐ Priority areas for conservation, restoration, and acquisition.
☐ State-owned land and easements.
☐ Land use information, including development trends, “hot spots”, CFOs, etc. Location of point sources (NPDES, LUST), including permit compliance information.
☐ Land use information reported at a relatively large resolution and discussed with local sponsor, SWCD and NRCS.
☐ Windshield survey of watershed completed.

8. **Collect and analyze information on water quality**

☐ Calculate IDEM Trophic State Index (ITSI) and Carlson’s Trophic State Index (TSI).

- ☐ Graph vertical profile of temperature and dissolved oxygen in lake.
- ☐ Tests at tributary sampling sites on physical and chemical water quality (stormflow and baseflow).
- ☐ Water quality analyses conducted by a reputable laboratory.

**9. Biological Community Quality**

- ☐ Conduct a Bioassessment Protocol for benthic macroinvertebrates
- ☐ Conduct a habitat evaluation using the QHEI.
- ☐ Surveys are conducted within appropriate sampling windows.
- ☐ Macroinvertebrate voucher collection submitted to IDNR or Purdue.
- ☐ Fisheries and macroinvertebrate results from other studies are analyzed for trends.
- ☐ Aquatic plant distribution map or Tier II survey, as needed.
- ☐ Plankton and other samples compiled for IDEM Indiana Trophic State Index (ITSI).
- ☐ A list of plankton species and abundance included.
- ☐ Information on waterfowl, other nuisance wildlife or exotic invasive species.

**10. Analyze trends relating physical, chemical, biological, and habitat factors**

- ☐ Analyze relationship between water chemistry, habitat and biological community quality data and discuss correlations.
- ☐ Indicate potential limiting factors.
- ☐ Describe trends, compare with similar regional lakes.

**11. Hydrology and Lake Habitat Quality**

- ☐ Calculate a water budget including hydraulic residence time and discuss effect on treatment.
- ☐ Map lake shoreline protection and erosion areas.
- ☐ Conduct an aerial or ground survey of eroding tributary stream banks.
- ☐ Address sediment removal plans, including sediment sampling as needed.

**12. Model nonpoint source pollution in lakes and subwatersheds**

- ☐ Use appropriate models to describe relative contributions to sediment and nutrient loads
- ☐ Calculate the load reductions needed to achieve water quality standards or targets for nutrients, sediment, and/or *E. coli*.
- ☐ Indicate the potential benefit derived from changes in land use practices (load reduction)
- ☐ Uses more intensive models in smaller areas of particular interest, as needed

**13. Assess institutional resources**

- ☐ Describe the availability of watershed management and leadership resources
- ☐ Identify existing or recommend potential volunteer monitoring groups

**14. Prioritize management recommendations**

- ☐ Set reasonable goals for water quality improvement
- ☐ List and prioritize potential watershed improvement projects
- ☐ Describe unusual physical or social characteristics of the subwatersheds or institutions
- ☐ Predict the success of the recommended treatments
- ☐ Include cost estimates and recommended timelines for implementation
- ☐ Briefly list potential sources of funding for projects
- ☐ Identify motivating factors that would encourage voluntary land user participation
- ☐ Include detailed action plan for implementation

**15. Project Conclusion**

- ☐ Summarizes results of study and recommendations

**16. Create a public information handout**

- ☐ Addresses factual issues concerning the state of the lake and costs or benefits of proposed projects
- ☐ Format tailored to the specific needs of the local sponsor

**17. Facilitate meetings**

- ☐ Hold a minimum of two public meetings, evenly distributed throughout the watershed
- ☐ Hold contractual number of steering committee or other stakeholder meetings if applicable
- ☐ Identify and invite interested parties (lake user groups, local government, state and federal agencies)
- ☐ Document and summarize public meetings in report (date, attendance, comments, etc)
- ☐ Document public concerns gathered at meetings or through personal communication in report
- ☐ Recommend methods to keep the public informed

**18. Include Appendices, as needed:**

- ☐ All pertinent data, including field and laboratory data sheets
- ☐ Water quality and index calculations
- ☐ Computer model input and output
- ☐ Necessary maps, charts, graphs, computations and computational breakdowns
- ☐ Pertinent meeting minutes, attendance lists, public comments

**19. Data presentation**

- ☐ Data presented clearly and concisely in the form of graphs and tables
- ☐ All tables and figures cited in the text
- ☐ All citations provided in standard bibliographic format
- ☐ Figures incorporated into the main body of the report, not as attachments
- ☐ Figures limited to 8 1/2" x 11" in size (higher resolution may be provided electronically)
- ☐ Data presented in English units with metric units in parentheses
- ☐ Used common name with scientific names in parentheses or listed in a table

**20. Format**

- ☐ Draft document: Five hard copies and one electronic copy
- ☐ Draft submitted at least two weeks prior to the final public meeting
- ☐ Double-sided pages with color figures as appropriate
- ☐ Title and each page labeled "Draft - Subject to Revision"

***Comments:***